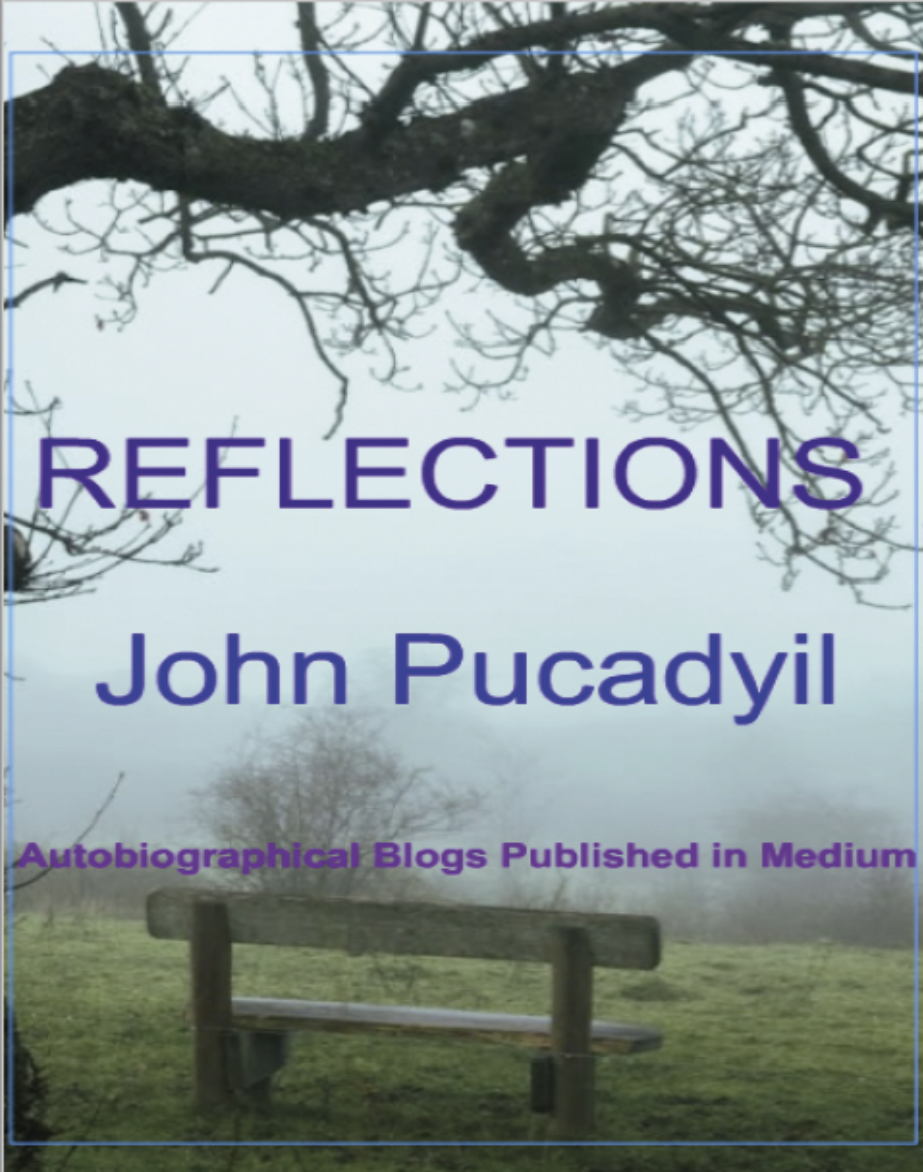




# REFLECTIONS

John Pucadyil

Autobiographical Blogs Published in Medium

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AUTOBIOGRAPHICAL BLOGS  
PUBLISHED IN MEDIUM

John Pucadyil

Kottayam, January 2025

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## **Preface**

The enforced seclusion caused by COVID-19 nudged me to start experimenting with blogging. I had kept notes on my work, personal life, and professional experiences on my laptop, which turned out to be handy raw materials for my blogs. Some blogs were on plasma physics experiments, plasma processing, thermonuclear fusion and other facets of plasma physics. I started writing on the Medium blogging site last year. These blogs attracted good responses.

Medium has many metrics for evaluating your post, including the number of viewers, readers and the time spent. Fans represent the users who clapped for any given story. You can get an idea of the reaction or overall sentiment of an article's performance from this data, an insight you may not get on other platforms. I have close to 4000 followers on Medium now.

I thought that compiling the blogs of an autobiographical flavour would be interesting to people who know me personally. So, here it is.

John Pucadyil

# 1 The House by the River



The river, a canal dug up to connect the Meenachil River to the boat jetty at Kacherikadavu, flows near my ancestral

house in Karapuzha, where Jacob, my youngest brother, lives. We got together recently before its demolition to be replaced by a brand-new two-story house when we reminisced about the place and its past.

My brother Jacob remembers the house being mentioned in an old historical document. Kottayam was part of the Thekumkoor kingdom, which was conquered by the Travancore (Thiruvithankoor) forces in AD 1749. They captured the Edathil palace situated in Karapuzha in the Pucadyil Kottarathil part of the land adjacent to the land on which our house is located. Edathil Royal family while fleeing the Thiruvithankoor army, left their valuables (Nidhi) in a vessel covered by another vessel and chained, digging a large hole at the premises to recover it later. It was widely believed that the “Nidhi”

was beneath the underground cellar (Nilavara) of Pucadyil Tharawad.

The piece of land, 2 acres, lay in two levels, with the house on the Southeastern side occupying the higher level. The river flowed by the western side. Kottarathil parambu (palace land) belonged to my father's elder brother, who built his house there in the 1950s. A fishpond, with a trap door to the river, assured a harvest of fish every time the trap closed. After my father passed away, my two brothers and I inherited the land on the Southwestern side, by the river. Never anticipating that I would return to Kottayam after settling down in Ahmedabad in the 1970s, I sold my piece of land in 1984. So did my two brothers, who had also moved away from Kottayam.

Our great-grandfather on my grandmother's side had built the house in its original form in 1886. The core structure consisted of A Thalam (sit-out), Arappura (store), Nilavara (cellar) and Thattumpuram (loft). The solid wood walls had a dark sheen from polishing. However, succeeding generations left their mark by adding to the original structure, and the house became a sprawling proliferation of rooms, passages and extensions. There was a Sarpakavu (serpent grove) in the compound, turning

derelict with time. Initially, the entrance was located to the east. A Padipura, a gatehouse with a roof, faced the narrow lane from the Union Club to the Karapuzha bridge. When my grandfather added a living room on the South side, the entrance was shifted to the South, facing the road from Thirunakkara to the West. My father expanded the living room, added a couple of rooms in the front and converted the passage connecting the thalam and the kitchen into a long dining room. More recently, Jacob, in another modification, changed the entrance back to the East with a porch and car sheds. He also partitioned the back side into an independent house. The whole complex now has three entrances and twelve rooms.

I have many memories of this house from my childhood. On the Western side, memories of our civil engineering efforts persist with graphic details. Small springs would start draining water from the higher level into the fishpond during the rainy season. We would build elaborate waterways with waterfalls guiding the water flow and erect paper fans attached to sticks along the canal. In the wind from the paddy fields from the West, these fans would be spinning furiously.

In the 1950s, before the Thanneermukkam bund in the Vembanad backwaters was built, the river would get very salty during the summers. The people who lived by the 'Kayal' (backwaters) would face a shortage of drinking water. Their solution was to fill their canoes with pots and reach the landing in our compound, which had a well, a perennial source of sweet water. For us, the people drawing up water and loading the canoes with the pots and their skillful manoeuvring of the canoes gave great excitement. Our hero was one of the water seekers who would land with a canoe and fill it with water up to the rim, mount the canoe and row away crouching precariously on the board.

The annual boat race in the Meenachil River was a time for celebration. My father would be persuaded to sponsor a boat to race in the festival. There would be daily practices, refreshments for the rowing team, and expenses for participating in the tournament. Children would sometimes be allowed on the boat in the practice runs. These rides occasionally ended in the scuttling of the rowboat, which deposited all of us in the river.

In the 1950s, local politics conspired to divide our land by a road through the compound. The

fighter he was, my father opposed it tooth and nail by appealing to various authorities. He suggested widening the existing lane on the eastern side into the proposed road. Finally, the district collector came to establish the facts on the ground. She could not speak Malayalam fluently. With his fluent English, my father was able to win over the collector. The road's local supporters were quite handicapped in this. The final decision favoured my father.

I left Kottayam practically for good in 1964, when I joined the Aligarh Muslim University for research, which yielded a Ph.D. and a faculty position in 1969. After taking my wife to Aligarh later that year and shifting to Ahmedabad in 1972, there would be annual and later less frequent trips to Kottayam. On these occasional visits to Kottayam with my family, I would be surprised by the changes in Karapuzha.

In a recent visit with my elder son Joseph and his family, I took my grandson to see the river. Draped in dirty green moss, it flowed under the old bridge on the narrow road going to Velloor. A mile down is the jetty where it submerges in the salty backwaters.

Standing by the bank, holding my grandson's hand, I remembered when I was his age and used to

stand here and stare at the dark green depth right under the bridge with dread. The paddy fields on the West are gone, though, on the bank, there were hutments, one nudging the next. Smoke from the cooking fires seeps through the roof like grey snakes dancing in the afternoon breeze. A few boats tied, rise and fall with the waves. I imagined them nodding as the river told them stories of its rebellious youth, swollen with the torrent of the monsoon rains razing the side banks and drowning the paddies. Instead, I noted with grief that the river had become a stagnant pool of detritus, decay, waiting for death and turned away, adding another loss to my remembered past.



## 2 A Lifetime of Reading



As the eldest child, I had the run of the house. One great pleasure was rummaging through the collection of old

books and magazines. Some of them belonged to my grandfather, a lawyer and a great lover of reading. My mother told me once that he would collect pieces of old newspapers from shopping packages, smooth them and read them. Some books even went back to my great-grandfather. Textbooks on astronomy and mathematics were from my father's college days in Calcutta. There were books in Latin and English. I remember trying to read Latin. It sounded very grand, though I did not understand the meaning. Though I could read only haltingly, Sir Walter Scott's *Ivanhoe* and the *Black Company* were favourites from the English collection.

I started serious reading when I joined the nearby Bharathivilasam library, which had only Malayalam books, and I quickly ran through the perennial favourites like Vaikom Mohammed Bashir,

Muttathu Varkey, Thakazhi and others. Within a short time, I read most of the fiction in this library. I also nagged my father into subscribing to Mathrubhoomi, the Malayalam weekly, which opened to me a world of modern writing in Malayalam. One of the stories I still remember is M. T. Vasudevan Nair's prize-winning story, Valarthumrigangal, about life in a travelling circus.

My friend John Isaac, whose father edited the Deepika newspaper, had a collection of translations from Homer. Borrowing one book each time, within a short while, I finished all the books. I also read a Malayalam translation of Edgar Burroughs 'Tarzan' from their collection.

When I went to Trivandrum to study at the University Intermediate College for the Pre-University course, I became a member of the University Hostel. Stay here was fortuitous since the famous

The University Library was next to the hostel. Through the good offices of my cousin Lilly, I became a member, which opened the grand world of English books. The library also had a vast collection of magazines and journals, and the luxury of spreading oneself on a plush sofa and reading Punch was unsurpassable. The librarian had a soft corner for

me, perhaps because I was one of the youngest members. Another hostel mate, Pyarelal, an Indian student from East Africa, was also a book lover. Hearing that I had a membership in the Public Library, he would ask me to lend him books. Our common interest was the adventures of Scarlet Pimpernel, Baroness Orczy's stories about the French Revolution.

I joined St. Berchman's College at Changanacherry for my B.Sc. degree. I was delighted that Prof. C. A. Shepard taught modern drama, Bernard Shaw's *Arms and the Man*. I decided to read all the Shavian literature, carried away by Shaw's critique of Bergson. By this time, I had become a member of the Kottayam Public Library. I was a day student at SB and travelled to and from Changanacherry by bus. On the way back, I used to stop at the library and pick up books. In a month, I read all the Shavian dramas.

I found that the SB college library had a collection of old Scientific American magazines stacked in an inaccessible part of the library. I persuaded the librarian to allow me to read them. This rich fare of articles further stirred my fascination for science. I was equally enamoured by the job

advertisements, which were a signpost to future possibilities in a career in science.

My two-year sojourn at the Union Christian College at Alwaye was not remarkable. The college library frowned upon anyone demanding books to take home. Except for an occasional visit to the Pai & Co bookshop in Ernakulam, coupled with a movie trip, I do not remember much reading done those days.

A high point of the Alwaye days was the start of publication of the magazine Imprint, which like the Readers Digest Condensed books, used to publish abridged versions of new books. I started buying it from the beginning.

By this time, my family had shifted to Trivandrum because of my father's work, and I joined the American Centre Library near the University where we stayed. On holidays from Kothamangalam, where I had become a lecturer in Physics in the Mar Athanasius College, I could renew my acquaintance with books, though now confined to American authors. I became acquainted with Steinbeck, Hemingway and John Dos Passos.

Then I went to Aligarh to do my PhD. The University had a vast library, a seven-floor giant, with

an extensive collection of English books. Many friends were fond of books, and I could read and discuss books. There was also a bookshop near the Sulaiman Hall, my hostel, where I could browse. Occasional Delhi visits took me to the Panchkuian road with its roadside bookshops.

I came to Ahmedabad in 1972, joining the Physical Research Laboratory. Bookshops were a rarity, though true to the Gujarati entrepreneurship tradition, lending libraries were popular. A flourishing one, GyanPrapa was near the Commerce College Junction in Navrangpura, close to Kuldip society where we stayed. Later, good bookshops opened in Ahmedabad, notably Cross Words and later Landmark conveniently close to my home in Bopal. The University area has roadside bookkeepers, and I go there regularly to browse the dust-covered old favourites.

I found that buying old books was enjoyable because one occasionally came across books read a long time back. The one-year interlude in Vienna in 2001, with the International Atomic Energy Agency was also a good period for reading. The UN Ladies' Association used to have weekly sales of secondhand

books in all languages, and I was an enthusiastic browser.

As a scientist, I travel abroad frequently and get a chance to investigate bookshops at airports and other strange places. A good part of my Dick Francis collection was acquired in London bookshops. While visiting the Max Planck Institute in Garching, near Munich, I found the Thurber carnival in an English book stall. In the narrow lanes of Aix-en-Provence, which I visit often in connection with the ITER work, my friend Abhijit Sen showed me Book-in-Bar selling English books and I became acquainted with the Provencal life depicted by Peter Mayle. This little book shop, situated in a lane connecting Cours Mirabeau, offers a large choice of books in very friendly surroundings. The ambience is enhanced by the coffee shop. I later collected all the books by Peter Mayle, including *A Good Year*, which was made into a movie starring Russell Crowe.

And finally, to Kottayam, after 40 years. Kottayam has become Aksharanagari, the city of alphabets, for achieving 100 % literacy. It is the home of the CMS press, the earliest printing press established by Benjamin Bailey, a Christian Missionary in 1821. A unique Travancore institution

that started in Kottayam in 1945 is the 'Sahithya Pravarthaka Sahakarana Sangham', Writer's Cooperative, which published books and gave financial security and social status to writers. There are many bookshops and, more importantly, second-hand booksellers in small cabins overflowing with books. Despite their scruffy looks, the shop owners know what the bestsellers are. Through long years of reading, especially fiction, I have realised how they change your perspective and outlook on life.

Fiction allows you to assume various identities, a great luxury denied to you in your paltry existence. Fiction is a great simplifier. It discards the non-essentials and highlights what matters.

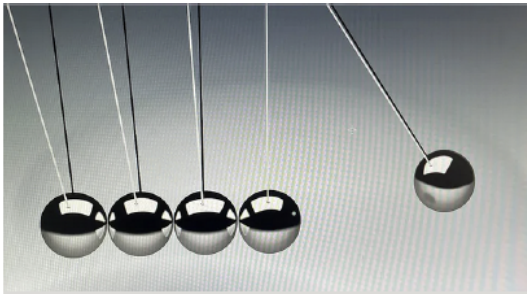
Events that take years are distilled into a few chapters. Changes that take place over the years: the evolution of a relationship, the emergence of a crisis, and the dissolution of a character, can be seen in a matter of hours.

Reading gives you a broad perspective and makes you understand the insanity of the world. Imagined lives are more colourful than real ones because imagination transcends knowledge and embraces the world. To quote Ernest Hemingway: "All good books have one thing in common — they are

truer than if they had happened, and after you've read one of them you will feel that all that happened, happened to you and then it belongs to you forever: the happiness and unhappiness, good and evil, ecstasy and sorrow, the food, wine, beds, people, and the weather



### 3 An Affinity for Science



Experiments with strips of film projected onto the wall using sunlight and a lens were the earliest memories of dabbling in science.

The hugely magnified faces had specks of dark spots all over them, and I wondered about their origin.

Chemistry taught in the school was fun, especially when accompanied by experiments conducted by T. M. Jacob sir. I remember my happiness when I understood the principle of displacement reaction, where one element exchanges place with another element in the compound. However, chemicals were relatively inaccessible compared to lenses, batteries and magnets. I remember producing hydrogen through electrolysis and filling balloons.

Two incidents strengthened my growing affinity for science. First, Dr Homi Bhabha established the Atomic Energy Establishment, Trombay, in January 1954 to intensify exploiting nuclear energy by

pursuing a multidisciplinary research programme. The advertisements about a training programme for recruits opened dramatic possibilities in the mind of an impressionable young boy.

The other incident was the USSR launching Sputnik 1, the first artificial Earth satellite. The newspapers were full of stories of the coming of the space age. Ayyappa Panicker's poem 'Hey Gagarin, Gaganacharin' celebrated man's arrival in space. For an imaginative young person, this was a demonstration of science's power to beckon us to brave new worlds.

When I went to the University Intermediate College in Trivandrum for my pre-degree course, I stayed in the University Hostel. I had many neighbours who were M. Sc students at the University. Their conversations were very colourful and included topics like the concept of entropy, the expanding Universe and the possibility of the heat death of the Universe. It is a fact that these conversations on cosmology and astrophysics went far above my head. But it created a heady excitement about the possibilities of science and strengthened my choice to pursue physics as a career. Quoting Russel (We are but a speck of Carbon crawling on the

cosmic dust) and seeing my father's shocked face was rewarding. He wanted me to join an engineering college. But I convinced him that a career in science is as good as engineering, and reluctantly, he agreed.

St Berchman's College, where I joined to study for a B. Sc degree in Physics, is an institution with solid foundational values and high discipline. Prof. S. L. Thomas, with his grand mannerisms, initiated us into the mysteries of electricity and magnetism. Of all his classes, I remember his last lecture: a general talk on what science means and how it impacts ordinary life. He talked about energy as the determining parameter controlling the quality of our lives. This talk was one of the reasons which firmed up my decision to pursue a research career.

Mechanics taught by Prof. K. K. John was also fascinating. To prove that anything thrown into space would travel along a parabolic path with predictable parameters gave me great satisfaction. I began to realize, though in a vague, unformed way, the universality of the laws of Physics.

I also learned that I had developed an ability for analytical thinking. The Malayalam drama we had to study was Antigone by Sophocles, taught by P. J. Thomas. On being asked to write an essay on

Antigone as a heroine, I decided to depict her with all mortal failings and argue that she transcended mortality through her steadfast loyalty to her father. The teacher was very impressed and made complimentary comments about this radical view.

The experiments were fun. I could do all those things with lenses, batteries, and magnets that I had always dreamed about for the first time. I remember enjoying doing electricity and magnetism experiments. The certainty of science was convincingly demonstrated when repeated measurements came up with the same answers.

An incident I remember from my B. Sc days were the visit of Dr John Mathai, the Vice-Chancellor of Kerala University, to the college. When he came to our class, he asked the students what they planned to do in life. The fear of answering in English made the students tongue-tied. Finally, I stood up and said that I wanted to pursue a career in research in a national laboratory. I became a 'minor celebrity' because of this answer.

By this time, I had become a science fiction addict. Stories by Asimov, Heinlein and Arthur Clarke excited me and made me wonder about the impact of technology on our future. Heinlein's Future History

is a series of stories describing the speculated future of humanity from the middle of the 20th century through the early 23rd century. Clarke's story, "Childhood's End", about the end of the earth as a home for humans, profoundly impacted me. His statement: "Any sufficiently advanced technology is indistinguishable from magic" made me wonder about the power of technology. Years later, I would have the opportunity to interact with him during his visit to PRL in Ahmedabad, where I would be a faculty member, building the first Plasma Physics Laboratory in India.

My father still cherished the dream that I would pursue a career in engineering. My cousin was studying in the Engineering College in Trivandrum which was reason enough to pursue the field. However, I was insistent on continuing with basic science. I finally convinced my father of my plan to do a master's and follow it with a research career. I enrolled at the Union Christian College in Alwaye for my M. Sc degree classes. I do not remember any inspiring teacher there who could create a spark in physics. Experiments were still fun, now more advanced with electronic circuits, electromagnetism

and spectroscopy. I passed out with a first-class M. Sc degree.

Research, to my unformed mind, was the ideal. Though I wanted to get into research intensely, I did not know precisely how to go about this. Meanwhile, I got an offer for a teaching position at the Mar Athanasius College in Kothamangalam, and I worked there for two years. I went to New Delhi during a bitter winter and got selected for a CSIR Scholarship in an interview but could not avail of it because I was not enrolled anywhere for research. Letters to heads of departments of various universities seeking a research position were not replied to. The best thing was a Bharat-darshan, a grand trip to the Universities of North India to talk to them directly. So, in the summer of 1964, I did just that.

The journey saw me going through Madras to Calcutta and towards Delhi. Allahabad and Patna did not impress me. I stopped at Aligarh when heading to Delhi because a friend had great stories about his alma mater. At Aligarh, I walked into the office of Prof. Rais Ahmed, who had recently returned from England and had taken over as the head of the physics department. He was surprised when I introduced myself and said I wanted to do research.

He asked me some general questions, which I answered well. I also told him I had saved some money from my teaching days and was willing to work without immediate financial support. He was indeed impressed by this offer. He managed to get me a Ministry of Education scholarship of Rs. 250/month, which, among all scholarships, was the most irregular. Months would pass before this money arrived.

I joined the department, and a few years of profound happiness followed because I was finally doing research and hopefully would create new knowledge. Ultimately, I emerged with a Ph. D degree in Physics and a job as a faculty member in the Physics Department.

## 4 Backwater Memories



Achan, my father's elder brother, lived in Cochin. He worked with Volkart Brothers, a Swiss Company and used to live on Lilly

Street in Fort Cochin in a house which my Great Grandfather had bought. This had a design developed by the Dutch, a two-story building with stores, a kitchen etc., on the lower part and living quarters with a wooden floor on the upper floor. The house had 4-foot-thick walls. We used to listen in horror to the stories told by the servants that the thick walls had 'kappiris', negroes buried in them. My brothers and I would be packed off for a short stay in Cochin during the summer vacation, accompanying Achan and his family on these trips. The boat trip through the backwaters was an experience out of this world!

Boat trips had a romance, which still has not faded. I have distinct memories of the mannerisms of the 'serang', the chug-chug of the boat, and the smell of kerosene mixed with the stench of the



backwaters. The trip takes the whole night, leaving the Kottayam boat jetty late evening and reaching Cochin early morning. The boat stops at places with evocative names like Pathiramanal, the midnight sands and Thanneermukkam, the place of water. Pathiramanal is reached at midnight and is a place for refreshments.

The Kayal stretches from Paravur in the north to Kainakary near Alleppy in the south. It connects to the Arabian Sea in Cochin. The Vembanad Lake, located in the low-lying area in the Central Travancore region, was originally a part of the shallow coastal area of the Arabian Sea. The geological uplift had formed a shallow bay in the area, and the rivers were draining into it. The bay ultimately transformed into a brackish water lagoon. National Geographic Magazine declared Vembanadu Lake “one of the fifty destinations to be visited in one’s lifetime”.

Vembanad is a victim of many human interventions. The earliest was the dredging of a natural harbor at Kochi and the creation of a new island for port facilities. Thanneermukkam barrier was constructed in 1976 across Vembanad Lake to prevent salinity intrusion during dry seasons.

Interventions in the river basins of the wetland system include three completed irrigation projects and nine hydel projects. All these have adversely affected the ecological health of the lake.

My earliest memory of the 'kayal' was a long trip in a 'Kettuvallam', a large boat made of planks tied together by ropes. The construction creates an ample belly for people to sit. The short platforms at both ends have men standing propelling the boat by pushing against the river's floor with long bamboo poles. My family was travelling to Kumarakom to participate in a wedding. The destination was a house in Kumarakom, not reachable easily by road.

Before the construction of the Thanneermukkam bund, the people who lived by the 'Kayal' would face the problem of how to find drinking water in the summer. Their solution was to fill their canoes with pots and reach the landing in our compound, where there was a well with perennial sweet water. For us, the process of the people drawing up water and loading the canoes with the pots and their skillful maneuvering of the canoes gave great excitement. Our hero was one of the water seekers who would land with a canoe and

fill it with water up to the rim. Then, he would row away, crouching on the board in the canoe.

Much later, there were many trips through the backwaters to Kumarakom, Alleppy and Cochin by boat. In the seventies, when I worked at the Physical Research Laboratory in Ahmedabad, I had to host Prof Charles Wharton from Cornell University. We were collaborators on a National Science Foundation-funded project in Plasma Physics. I thought the best way to introduce him to the cultural uniqueness of Kerala was to take him there physically. Among the things we enjoyed was an exploration of the Kumarakom backwaters by renting a boat and meandering around the area, occasionally stopping at small shops by the water selling toddy, coffee and snacks.

The lunch at the Taj Kumarakom was memorable. This place has a slice of history. The hotel used to be the home of an English missionary Henry Baker in the late 19th century. The hotel carries the traditional name of Baker's house. The resort with 28 luxurious cottages was originally a family estate spread over 15 lush acres.

## 6 Hostels and Homes



I saw hostels close by when I went to the C.M.S. High School and my father arranged for lunch in a mess. Many of my

classmates stayed in the hostel, and I thought they had an exciting life. But unfortunately, I had to trudge a weary road every day to come to the school.

My genuine hostel experience began when I went to Trivandrum to join the University Intermediate College for the Pre-University class. The University hostel where I got a room was a grand building, housing more than 300 students in single rooms of luxury. The University Library was next door, where I had managed to get a membership. So, I had a decent roof over my head and the luxury of all the books I wanted to read.

In contrast to this, the next hostel where I stayed, the St. Joseph's hostel at S.B. College was minimal in comfort. The warden, a Catholic priest, had strange concepts in sartorial propriety and objected to my wearing a lungi. Too many rules made

me a rebel, and I decided to leave the hostel. This coincided with the decision of the college to ask me to leave the hostel. My preferred destination was Keshavamangalam, a lodging facility where many friends stayed. The freedom from mindless rules and restrictions made lodge life very pleasant. Among the friends I remember were Mallappally and Gopi. When I went to the U.C. college for M.Sc. studies, I stayed at the Holland hostel, which was also quite liberal. Again, there were many friends from Kottayam.

After the M.Sc., I did a short stint of teaching at the Mar Athanasius College at Kothamangalam. I stayed in a small lodging facility near the college. The fellow residents were Jacob Elanjickal, who taught English, Daniel, who taught mathematics and David, who taught Physics in the Engineering college. The liberal atmosphere and the occasional 'spiritual' journey made the lodge a favoured destination for friends. There were delightful discussions with Prof. K. C. Peter and Prof. K. M. Tharakan, who would drop in occasionally. I idolized Prof Peter because he was already an established writer.

I spent close to five years as a PhD student at Aligarh, where I stayed at the Akbar Hall first and

later shifted to Suleiman Hall. Aligarh was a cultural shock. My inability to understand Urdu, the exalted forms of addressing, and the exaggerated 'Tehzeeb' were alien. The food, consisting of tandoori rotis and mutton curry, though delicious, was also unfamiliar. But the accommodation was quite luxurious. The new buildings of the Kuwait House and Kashmir House were well-designed with single-room accommodation.

After marriage, I moved into a house on Marris Road. This belonged to an old Bengali gentleman who ran a contract supplying locks to railways. His son, being my student, made the dealings with him easy. The strange condition was getting my electric connection from the power company. My neighbour was Prof. Ganguli, the head of the Physics Department in the Engineering College. He had worked at Harwell and was fond of telling stories of discoveries in nuclear science. Within a year, I got one of the houses built on the medical college campus, allotted to a Reader who had gone abroad. My wife, little Joseph and a maidservant had a great time there. My friends from the Kerala mess would drop in occasionally.

In 1972, I went to Ahmedabad to work at the Physical Research Laboratory. I started to think of a home of my own. At PRL, the staff members got together and started discussing the prospects of building a housing colony. The cooperative housing movement was strong in Gujarat, with accessible financing facilities. We gave a grandiose name, "The Space Colony," to the venture, evocative of the research interest of P.R.L. Unfortunately, this never took off because of the eruption of serious conflict between the staff union and the management. As a result, the Space Colony failed to launch.

Tired of living in rented houses, I decided to build a home of my own in 1987. Stirling City Development Co. had acquired a huge tract of land in Bopal, on the western edge of the city, with a plan to develop a housing complex. The remote sensing satellite data had found subterranean water in that area. The owner of the company was known to me, and I bought a small plot there in 1988.

I had fun designing the house. A young architect, Kandarp, and I managed to squeeze a studio into the design. Building the place was like chasing a dream. Raising the walls brick by brick, adding a lintel and roof, finally done, perfectly

meeting my modest expectations. It was far from the city and the crowds we detested. Those who saw the house said that we would be lost to the world in this barren patch, which we called home. Instead, the bare earth bloomed into a garden with time, and the speckled sunlight played on the verdant lawn. Flowers nodded to the passing wind, and the house slowly turned into a home. Sitting by the garden in the gloom of the dusk, I would reflect on the changes that Bopal has seen. No longer the distant nowhere, but bursting with life and nesting by the city, restless in its growth.

My wife wanted to convert the little piece of land into a lush green forest: perhaps to remind us of emerald-green Kerala. The division of labour was that I would take care of the lawn, and she would handle the garden part, trees and flowering plants. We planted Korean grass and made a contoured lawn sloping away from the house. With time, trees grew, the barren earth bloomed into a garden and the speckled sunlight played on the verdant lawn. Flowers nodded to the passing wind and the house slowly turned into a home.



## 7 Teachers and Mentors



Kalyani Behn, who taught me at the Gandhian school called Sadanam, where I spent my early years, persists in my memory. It was

my first school, very near our house. Kalyani Behn wore khadi and was very gentle. There were other behns in the school, all living in Gandhian simplicity. The school was perennially short of money, and I suspect that the inmates often went without food. On the annual day, I was given a prize, a book on Gandhi's speeches by none other than Sucheta Kripalani. Finally, the school moved away to some distant place - some said Kumarakom - and that was the end of my first school.

Summer vacations in those days were spent at Puthupally, in my mother's house. My grandmother thought that the children were going wild with nothing to do and made us attend a Kudipallikoodam, under the care of an Asan. The school was held in the open air, near our house.

Every morning, I would get ready to go to school, full of enthusiasm. My companion was Ammini, my cousin, who was a very reluctant student and Valiammachi, my grandmother, who had to motivate her strongly with a stick. The only memory I have of this school was of a paraplegic student being brought on someone's shoulders.

Karapauzha Government School was half a mile from our house, and I was admitted here for my pre-primary education. My father accompanied me for the admission, and being well known in those parts, the teachers were very deferential to him and even suggested that I could be admitted to a higher class, which my father immediately dismissed. He strongly believed that the roots were very important. The school has left no special impressions on me except for the music teacher who had a weakness for yellow saris, and the students promptly named her 'manja kili', the yellow bird.

After the third class, I was taken to the C. M. S. College High School, my father's alma mater. This was a school in the grand tradition of Christian missionary schools, situated on a hillock with big buildings, playgrounds and an impressive history. The primary section was in a separate building on

the northern side of the hillock. I have memories of the classes in English and geography. Geography was taught by Mathen sir, a pleasant old man. The description of distant places and the flora and fauna fascinated me. Even to this day, I enjoy reading travelogues.

In the six years I studied at CMS School, one of my distinct memories is that of all that walking to and from school. I was alone, trudging the long distance to the school, a winding road by the Union club, behind the Mahadeva temple, through the fields, up the narrow lane into the Chungom road and onto the school. In the rainy season, this was a tough trek. With time, my brothers Rajan and later Babu joined me.

But walking had its rewards. On the way to school, there was a house where two elderly friends would meet in the morning for a cup of coffee. One of them was known as Punchiry Aasan, as he was the owner of the Punchiry Boat service, though no longer active. The other person was called Swamy, a Tamil Brahmin who lived nearby. The morning coffee was invariably accompanied by very passionate and loud arguments about the state of the world, in King's English. For us, whose school English was confined to

renderings of Mary had a little lamb and Daffodils, the quality of English emanating from the Aasan-Swamy encounter was exceptionally high and we would linger on the road, drinking in the nectar.

After the sixth form, I sat for a state-run examination and passed, eligible for the Maharajah scholarship, a princely sum of 5 rupees every month. My father allowed me to spend it as I desired, and I promptly started buying books from the National Book Store near the Maidan. The scholarship also brought me to the teacher's attention. This had a bad side as well, as any lack of performance would bring forth reminders that I was a scholarship boy.

One teacher I was very fond of was Kanam E. J. Philip, our Malayalam teacher who was also a writer. Inspired by him, I started writing poetry, although he made it clear that poetry had no future and that I should write stories like him. I kept in contact with him in the later years, when he became an editor of the Malayala Manorama weekly. Kanam sir also initiated me into acting in the Annual Day Malayalam play. Invariably, young boys like us took on women's roles. My friend Chacko was a favourite in the female role, specializing as the shrew of the family and I as the demure, good wife.

The year I spent at the University Intermediate College was remarkably barren in the quality of teaching. However, I made many friends from the seniors at the University hostel. Thakazhy Ramachandran, who was doing M. Sc in physics, was a neighbor and influenced me quite a bit. Another mentor was N. N. Moosad who was a poet and was pursuing an M. A. in Malayalam.

Two excellent teachers I remember from the B. Sc days at the S.B. College, Changanacherry are K. K. John and Prof. S. L. Thomas. K. K. John taught us Mechanics in a very lively way and taught us all the tricks to solve problems from the book by Loney. Prof. S. L. Thomas had grand, professorial mannerisms while being an excellent teacher initiating us into the mysteries of electricity and magnetism.

After finishing my M. Sc at the Union Christian College, I was preparing to go north in search of a place to do my doctorate. I received an unexpected phone call from a friend working in the physics department of Athanasius College at Kothamangalam earnestly requesting me to the college as a lecturer and shelve my long-term plans for the time being. My parents thought that such an

offer for a first job should not be rejected outright. They perhaps thought that my proximity to the Valiapally at Kothamangalam might rein in the budding rationalism, which was beginning to annoy my father.

Meeting Prof. M. P. Varghese was another unexpected incident. He told us of his plans to organize a fund collection for building a separate facility for the Arts College, since the high-profile Engineering College was beginning to grow and wanted more and more of the old building. We talked about running a lottery to raise the funds. None of us had a clear idea as to how to organize a lottery. I found the whole situation quite challenging, and, on an impulse, I told Varghese sir that I would like to join the effort. O. M. Mathew was already an enthusiast, and we roped in a few other people.

It was clear to me that Varghese sir had a truly remarkable vision of the college. He could see the college growing, adding post-graduate and research projects and the faculty growing in stature. He was also impatient about small minds and petty politics coming in the way of realizing this vision. He had strong views about people, though discretely expressed. He was very critical of young people not

fully realizing their potential and would make cryptic comments about how they are wasting their time. He had a nobility of behaviour, which perhaps came into conflict with the politics he had to play in his dealings with the college administration and the management association.

## 8 Cheques and Balances



Stephen Leacock, a Canadian humorist, has satirised his traumatic encounter with banks in the short story 'My

Financial Career'. He says that he gets rattled when he goes to a bank. He wants to deposit \$56 and open an account. The behaviour of the accountant rattles him. He wants to withdraw \$6. Then he realised that he had written a cheque for \$54 instead of \$6. He makes a pathetic attempt to look like a man who had been slighted to justify why he is withdrawing the entire amount he had deposited a few minutes back. He collects the cash and rushes out of the bank to the accompaniment of a roar of laughter that goes up inside.

Banking runs in my family. My father started his career with the National Quilon Bank in its Calcutta branch after completing his B.A. At the Presidency College in Calcutta. The bank collapsed under the machinations of Sir C. P. Ramaswamy. On his return to Kottayam, he joined the Forward Bank as its Chief



Accountant. Prominent Syrian Christian Families promoted Forward Bank in Kottayam. The fact that the bank's secretary was C. M. Cherian, his college friend, perhaps helped.

After Forward Bank merged with the State Bank of Travancore, he was transferred to Trivandrum. There was a cold war between the SBT staff and the newly joined staff from the Forward Bank. He had hilarious stories of the SBT officials' ineptness and how he outplayed them on many occasions.

My two brothers, Joseph and Jacob, also had their careers in banks. So, in conversations around family dinners, I have been sufficiently educated about the intricacies of banking and have come to have high regard for the profession.

Forward Bank had its offices on the Southern side of the Thirunakkara Maidan, which in those days was the place where football tournaments and political meetings took place. I remember sitting by its windows and listening to Jawaharlal Nehru during one of his visits to Kottayam during the national elections.

At this bank, I got my first acquaintance with the Encyclopedia Britannica. The Bank had a complete collection. Once, when my father deposited

me in this room for me to watch a football match, I found Britannica more exciting than the game. The section I read was on internal combustion engines.

My acquaintance with banks has always been from the customer side of the counter. Though I started my career with a job at Athanasius College in Kothamangalam, I did not have a bank account there since the salary was quite modest, not worthy of a bank account to service that. The salary was handed over as cash, without even the courtesy of hiding it in an envelope.

I got into a transactional relationship with a bank only when I became a lecturer in Aligarh. The bank on the campus was the Allahabad Bank, to which the salary cheques were directly credited. This was the typical UP bank, with the senior clerks being called Babuji. They had strange procedures continuing from an outgone era. The clerks handling cash quaintly sat on a platform above the teller's counters. One could follow the cheque traversing various approval points until it finally appeared as cash from the teller. Since the bank was situated on the campus, we had friendly relationships with the bank staff.

When I joined PRL, I had to open an account with the State Bank of India in Navrangpura, which happened to be near Kuldip Society, my place of residence. This was a very friendly place, with total informality. The PRL clientele was treated with great respect. Our institution's association with Vikram Sarabhai (Vikram Bhai) and the knowledge that we go abroad frequently (Foren, in the Ahmedabad lingua) were probably the cause of the veneration. With foreign travel, Reserve Bank approvals for foreign currency became routine. Most of our travel allowance was handed over to us as traveller's cheques with a minuscule part as currency. After landing, everyone queues up at the airport bank counters to convert the cheques into cash. Those were the days when foreign currency was a great rarity, held in great reverence.

When we established the Institute for Plasma Research at the Bhat village, far from the city, SBI very considerately started a branch on the campus with their office in a couple of rooms in the main building. This was very convenient as secretaries could be entrusted with cashing a cheque. With seniority, the bank officials would come to my office

to have the papers associated with foreign exchange signed. But cash remained elusive.

My exposure to international banks started with my trips to the International Atomic Energy Agency in Vienna as a consultant. At every meeting, we would be ceremoniously escorted to the bank on the IAEA premises by a Secretary to encase the allowance paid by the agency. The bank at the Vienna International Centre was Bank Austria Creditanstalt. Later, when I joined for a long-term assignment, I opened an account for my salary.

Money is treated as a sacred commodity in Viennese banks. Transactions are done with great solemnity. The atmosphere is hushed. One feels that one's money is relatively safe in the bank. Ironically, the Creditanstalt crashed, and the name got erased in 2008.

When I moved to the Ahmedabad suburb of Bopal in 1989, I had two banks to choose from. Dena Bank reminded me of the Allahabad Bank. The new HDFC Bank, which had opened a branch there, was a bank with modern banking practices and impressive operational efficiency. Their staff was professional and had a friendly way of dealing with customers. They were one of the first banks to go digital, which

appealed to my conviction about the superiority of online processes. They also had their investment section, which allowed me to do all investment transactions online. Their relationship managers smooth out hiccups in dealing with the bank. My association with HDFC continues even after moving to Kottayam. The bank made my transactions in purchasing an apartment in Kottayam stress-free. I can sit in the comfort of my home and engage in all types of transactions online. They have opened a branch quite close to where I stay, literally bringing banking to my doorstep.

Banking is one of the oldest institutions serving humanity. It started with merchants making grain loans to farmers and traders while carrying goods between cities. Since then, the banking industry has evolved from a simplistic barter system and gift economies of earlier times to a modern, complex, globalised, technology-driven, and internet-based e-banking model. With the continuing improvement in the digital infrastructure in India, the banking experience should also see a concurrent improvement.

## 9 Baez and the Rest



We grew up to the beats of Binaca Geet mala blaring out of Radio Ceylon. The meaning eluded us, but the tunes were

captivating. Mohammad Rafi, Mukesh, Kishore Kumar, Manna Dey and Talat Mahmood were popular singers. Except for an occasional “O Basanti pavan pagal” or an “Aa jare, pardeshi”, I was not too fond of women singers. An exception was Geeta Dutt’s angst-laden liquid voice. Her ‘Na Jao Saiyan Chhuda Ke Baiyan’, singing for Meena Kumari’s inebriated character in ‘Sahib, Bibi, Ghulam’ blurred the line between fiction and reality.

With his velvet voice, Mohammad Rafi had a wide musical range, supreme artistic calibre and versatility. Talat Mahmood’s whisper-soft voice is gentle and soothing as in “itnana mujhse tu pyar Karo”. The tentative presence nudges at the self. Manna Day could whip up a semi-classical like “poochho na kaise maine rain bitai” with great ease.

With his lilting “chingari koi bhadke” Kishore Kumar has also given many haunting songs.

But the singer whose voice I fell in love with forever was Joan Baez. I heard her ‘Bangladesh’ inspired by the Dhaka killings of 1971 and started collecting her LPs in the late 1970s. In 2009, knowing my passion a la Baez, my son Thomas presented me with a DVD set of her complete collection.

Joan Baez and I share the same year of birth, 1941. She strummed her guitar and sang her songs for over 50 years and has established herself as a leading folk singer. She began her career performing in the East Coast, Boston and Cambridge area, the haunts of young people. Baez achieved great success with her music albums later. Soon, she became the partner of the legendary Bob Dylan. By the late ‘60s, she had become the voice of that generation. This was a period of protests, bohemian lifestyles, Eastern mysticism, marijuana and meditation. Materialism was vulgar.

Joan Baez has an incomparable voice and a unique, supple soprano that touches your heart. She released her first album in 1959 and has crafted more than 30 later. She has immersed herself in social and political causes, fought for civil and human

rights and helped set up the US chapter of Amnesty International. Not many performing artists have been as steadfastly loyal as Baez to one's creed and commitment. In an interview with The Washington Post, she says: "I have been true to the principles of non-violence, developing a strong aversion to the ideologies of both the far right and the far left and a deeper sense of rage and sorrow over the suffering they continue to produce all over the world."

Joan Baez is best known for interpreting traditional folk classics of the 1960s with her unique voice. However, her breathtaking breadth makes her an icon of modern music. With her musical versatility, she sang ballads and protest songs, for political movements and entire cultures and religions.

"She sang in Hanoi for all the Vietnamese and Americans who had died in the war and to those who had quit fighting when they had become disillusioned," says the Pantagraph from Bloomington, Illinois. "We Shall Overcome" is probably the most moving protest song ever sung. It is an anthem of politics and social change. In one of her interviews, she asks, "Where does a song like this come from? How does it emerge out of hundreds and hundreds of songs?" In an article in GQ, David



Levesley writes, "In the Woodstock performance of this song, we can hear three levels of Baez's voice: her robust speaking voice, as she informs the audience what line to repeat for the next verse; her forceful lower register, loaded with defiance; and those high notes, turning it into a spiritual song in praise of human tenacity".

She sang Bob Dylan's "Blowin' in the Wind", which evokes magic because of the recurring line, "The answer my friend is blowin' in the wind." Though Baez has recorded many songs written by Bob Dylan, her rendition of "Blowin' in the Wind" is the most resonant. Her powerful voice and his series of poetic and provocative questions in this protest song make the song particularly stirring.

John Lennon's "Imagine" is another haunting song. It was both an aspirational prayer and a challenge to authority that remains one of the most unashamedly plain-speaking songs to enter popular consciousness. In 1999, Broadcast Media Inc. named "Imagine" one of the Top 100 Songs of the Century.

'The Night They Drove Old Dixie Down' in the album "Blessed Are" is another great song; rebellious and almost up-tempo in a way her music rarely is.

Therein may lie the clue as to why it became such a commercial success.

“Dida” is from *Gracias A La Vida*, an album of Spanish and Catalan songs written and dedicated to the political prisoners of Pinochet. Baez had strong opinions on American policy in Latin America. The version of the song is slow and sad, but in its second iteration, it is light and breezy. Dida came out of a perfect fusion of two great musical voices: Baez and Joni Mitchell. Joan’s dulcet singing on the melody and Joni’s wails of repeating refrains is sheer heaven. “Children and All That Jazz” is playful and delightful.

Bob Dylan wrote “Farewell Angelina” during the mid-1960s. Baez included it in her 1965 album *Farewell Angelina*. Although only half of Dylan’s version, many critics think that the Joan Baez version is better than Dylan’s!

“Silver Dagger” describes the tale of a woman who rejects her potential suitor based on her mother’s warnings. Unfortunately, Baez’s version of the song includes only part of the full ballad. Released on her debut album in 1960, the song’s stretching intervals and sustained notes provide a fitting showcase of her evident soprano and agile vibrato.

A Yiddish language folk song, Dona Dona, was about a calf being led to be slaughtered - a strange theme for a song! This was translated in the mid-1950s and recorded by Joan Baez in 1960 as "Donna Donna." It's yet another Baez song that combines her beautiful yet haunting voice to deliver a dark story. Joan Baez's version of the Robbie Robertson song "The Night They Drove Old Dixie Down" was released in 1971. She gave it a sing-along sense, with her powerful voice accentuating the song's memorable melody.

"Amazing Grace" has been sung by almost every folk singer, but never with quite as much conviction as Baez. The song is subsumed with melancholy and nostalgia and daring and determination. It convincingly reveals the complexity of the struggle one faces when seeking grace.

Diamonds and Rust is Joan Baez's magnum opus. "As I remember your eyes/ Were bluer than robin's eggs/ My poetry was lousy, you said/ Where are you calling from?". The imagery was evocative and precise. The voice with crystal clear clarity had subdued into a warmer tone. A spectrum of genres - rock, jazz and soul - added new styles to her maturing sound. The song has an allusion to the

Baez-Dylan love affair of the 1960s. The song is about when Dylan called her from a phone booth and sang her his new lyrics. “Diamonds and Rust” is perhaps one of the great songs about love, disappointment and the spectrum of emotions surrounding such things. It is indeed one of the greatest break-up songs of all time.

Stevie Wonder’s ballad “I Never Dreamed You’d Leave in Summer” evokes great sadness. Most stunningly, Baez is reinvented with great empathy in “Billy Rose, the Prison Trilogy”. It is a protest to police brutality and the inhuman treatment of undocumented immigrants, climaxing in a call to action: “Help us raze the prisons to the ground.”

Once with the unlimited music offered by Amazon Music, I started collecting the songs of all those who sang like Joan Baez. This included Judy Collins, Sainte-Marie, Carolyn Hester, Tish Hinojosa, Alison Krauss, and Nanci Griffith. After listening to them for some time, I decided to be forever faithful to Baez and Baez alone

## 10 From Roja to Rahmania



On a rainy afternoon, my friend Sanjay Zaveri insisted that I with my wife Minnu, should accompany him to see a movie

called Roja. Having seen it already, he wanted to share its magic with me.

It was magic. The story wasn't much, but the songs were enchanting and different. The music was composed by A R Rahman, an unknown name. But the songs remained in my memory.

'Choti Si Asha', a young girl's aspirations; Minmini's voice floating over mountains and rivers like a bird. The deft movements and the quick turns, eventually Rahman's signatures, could be gently felt. Experts suggest that the song reflects a variant of the reggae form of music.

In 'Ye Haseen Wadiyan', the melodic whispering evoked the snows of Kashmir. Another Rehman signature was present in this song with sudden bursts in scale changes. 'Rukmani', according to the

Outlook magazine, was superb, raunchy urban folk. Rahman achieved the unique feat of receiving the National Award and Tamil Filmfare Award on his debut. Time magazine rated Roja as one of the ten all-time best soundtracks.

In 1995, Bombay arrived. Its album became the largest-selling Indian film album. If Roja was subdued and soft, Bombay soared in scale and tempo. In flute and violin, the Bombay theme was Rahman's tribute to his mentor, Ilayaraja. Remo's Hamma Hamma' was another irreverent number.

Rahman uses the flute in a sudden move to soften the interlude, a unique trait. The contrast is a respite from the heavy orchestration. 'Kehna Hi Kya' wraps a qawwali inside a song. The agile, animated chorus (always an integral part of Rahman's compositions) plays a companion to the music. More than a song, Tu hi Re is a prayer. Hariharan is down on his knees; his voice saturated with despair.

Rangeela has two songs with the Rahman touch. The earthy 'Mangta Hai Kya' by Sweta Shetty and Rahman, and the seductive 'Hai Rama' by Swarna Latha and Hariharan. Rahman's sensual songs are very understated.

In Dil Se, of 1988, Rahman exploits Lata's high range in 'Jiya Jale'. 'Chaiyya Chaiyya' has a robust rhythm and is exotic in the folksy voice of Sukhwinder Singh. In 1947: Earth, 'Ruth A Gayi Re' brings in the joy of the season, while 'Raat Ki Dal Dal', in the backdrop of the horror of Partition where the train carrying the dead stops at a station has great pathos.

In 1999, Rahman scored the hugely popular Taal. In Lagan (2001), for which Rahman won the National Award, the recurrent rendering of 'Ghanan Ghanan' evokes a sense of rain clouds and cloudbursts in you. In 2000, Rahman crafted another qawwali, 'Haji Ali'. In Tere Bina from 'Guru', the magic is the tarana, 'Dum dara, dum dara, mast mast'.

Rahman's music stood out because of his musical transposition of Western and classical elements. Despite being an amalgam, these elements are distinctly heard, making his sounds a multi-layered phenomenon. There is no better case in point than his rendition of Vande Mataram, which was a virile declaration of patriotism.

Rahman's music is a point in the trajectory of the evolution of Indian film music. By the mid-1940s, Hindi film songs had started infusing styles from

various genres, including jazz, waltz and other Western and Latin American genres, with established ragas from Hindustani and Carnatic classical music and regional folk genres. In general, non-Indian elements include Western orchestral accompaniment like that used by Shankar and Jaikishan in the 1970s and early 1980s.

The next phase of evolution in Bollywood music happened in the 1960s and 1970s when composers initiated a paradigm of music-making emphasising rhythm rather than traditional melodies. Music composers during this time incorporated traditional folk and classical songs with upbeat rhythms in tune with the changing trends in Indian society towards dance and other forms of expression. R. D. Burman was untrained in classical music and drew inspiration from world music exposure.

In the 1990s, Rahman composed songs inspired by Sufism. For example, he collaborated with Nusrat Fateh Ali Khan to create the piece “Gurus of Peace” (1997) labelled as “Indipop” in the Indian media. Rahman’s composition, “Khwaja Mere Khwaja,” is dedicated to the Sufi Saint Khwaja Moinuddin Chishti. Rahman’s Sufi music contains qawwali elements and is a unique blend of Bollywood and



global pop music that sonically signifies modernity among transnational consumers of Sufi music.

Rahman's adoption of technology was a strategic decision. With the ability to store and sample sounds using digital software systems, Rahman was able to control nearly all aspects of musical arrangements and sound production. In an interview with Apple Inc., Rahman shares how Logic, an Apple software, enables him to become a "programmer" who can manipulate sounds to produce a song. His on-the-spot compositional techniques promote creativity as musicians are encouraged to perform more freely during the recording process. Rahman prefers to record a single performer rather than an entire orchestral ensemble in a single go.

Due to a diverse musical background, Rahman appropriates numerous Western and Indian styles and genres into his musical compositions that, in turn, appeal to Indian cosmopolitans, urban youth populations throughout the world and a wider global audience.

The first opening moments of "Jai Ho" give listeners a sense that this song is not a typical Western pop song. "Jai Ho" incorporates a string

orchestra (comprised of an entire string section with basses, cellos, violas and violins) at sporadic moments in the song to emphasise certain melodic lines. Sometimes the strings can be hard to hear and are often mixed well within the overall texture of various instruments and drums.

Rahman's songs for the Slumdog Millionaire challenge current notions of genre in India. It has been suggested that Rahman's music has many similarities with Indipop, born in the 1980s. Indipop emerged to challenge the hegemony of popular film songs and has a "preference for guitars and drums. Experts point out that Rahman adds simulated Japanese taiko drums and the dholak to create an overall thunderous rhythmic quality in "Jai Ho".

Rahman, unlike older film music directors, chooses to use musical aesthetics found in non-film-based genres such as techno and rock to create a highly synthesised, electronically grounded style for his film music and to attract younger, urban middle-class Indian audiences who are much of the "remix" dance music genre (and Indipop) fans of India. Rahman mixes sound that includes Indipop, techno, and melodic tunes from regional Indian traditions

and a diverse array of traditional Western and Indian instrumentation to produce desired effects.

As transnational listeners become increasingly familiar with Rahman's music through *Slumdog Millionaire*, they join an expanding urban middle-class Rahman aficionado. Rahman was an unknown name in the American mainstream before the 2009 Academy Awards. British audiences were familiar with Andrew Lloyd Webber's *Bombay Dreams* of 2006. The Oscar success of *Slumdog Millionaire* made Rahman a star and gave him commercial traction in the US. iTunes and [Amazon.com](https://www.amazon.com) made Rahman's music more accessible to Western audiences. After the Oscar, Rahman's older compositions were immediately redistributed on separate compilation albums.

Rahman's expertise in digital technology and synthesising sounds in ways to produce music that appeals to a global pop music audience makes his music less recognisable as a distinct genre. One editorial review for MTV describes the music for *Slumdog Millionaire* as a "hip-hop fusion of a very up-to-date kind". Rahman's music is often described as a "fusion", a term used to connote Asian-ness within American culture.

At the beginning of Jai Ho, a movie about Rahman, he says: 'If music wakes you up, makes you think, heals you, I guess the music is working'. Listening to Rahman certainly makes you think that his music does more than work.

## 11 Where Music Has Gone



Recently, my Samsung music system broke down and I was left with a modest collection of music VCDs and DVDs

accumulated in the 80s. When the Samsung shop assured me that the system was beyond resuscitation since the parts had become obsolete, I went around the Kottayam shops to find a replacement at a moderate cost. I was told by everyone that music has gone digital, comes directly from the internet and that I should not invest in hardware, considering the cost and vulnerability to failure.

My own encounter with listening technology started when I acquired an HMV record player from the Rhythm House in Ahmedabad to play my growing collection of Joan Baez LP records. I soon grew tired of the finicky care required in launching an LP without damaging it and the constant maintenance required to keep the records free of dust, scratches

and warp. There was a brief interlude with cassette players, which were equally temperamental.

By the early 90s I had acquired an HP desktop computer and good connectivity with the Satyam dial-up wifi connection. The Windows Media Player introduced me to the pleasures of ‘ripping’ (suggestive of the violence in the process that violates the copyright associated with a DVD), DVDs to convert them into MP3 files. The MP3 file is an audio file that uses a compression algorithm to reduce the overall file size. This format was created by the Moving Pictures Experts Group and became the preferred format for digital sound in mid 1990s.

In 1998, Shawn Fanning, who went with the username “Napster” revealed to the internet community that he had developed a programme which would allow people to share their MP3 music files across the internet. Sean Parker, an aspiring entrepreneur, liked the idea and proposed collaboration. Napster, born of this alliance became active in May 1999. Shortly after this, its collection grew to 4 million songs. By March of the next year, Napster users exceeded 20 million.

I was introduced to Napster, befittingly, by my children who are music aficionados. I remember

sharing my modest collection of music with my peers. Despite the slow pace of file sharing due to poor wifi speeds, this made me realize the true meaning of the expression that the internet connects the world.

By the summer of 2000, Napster had explosive growth and close to 14,000 songs were being downloaded every minute. Fanning became a celebrity and was on the Time magazine cover in October 2000.

The Recording Industry Association of America and many music groups did not take the violation of digital rights lying down. They sued Napster for copyright violation and won. Napster was forced to shut down. By late 2002, the file-sharing service that had more than 80 million enthusiasts went out of business. Napster reopened in September of the same year, after paying the past and future royalties. It then tried to turn the service into a subscription mode. The unique contribution of Napster to the music world was to reveal without any doubt that the future of music was online, and not in racks of metal and plastic.

Steve Jobs, Apple's founder and chief executive, realized by late 2002 the true meaning of the Napster

revolution. The music fans clearly wanted to download songs they liked affordably and easily instead of purchasing it from a shop. But the record industry lacked an easy and legal option to enable this. Jobs began to contact major record labels with his plan. By this time, Apple had already hatched the iTunes Music Store and was ready with a piece of hardware that was hungry for content: the iPod.

At the 2001 Macworld Expo, Steve Jobs introduced iTunes, arguably the most important software Apple has ever released. iTunes led the way for its transition from a computer hardware and software company to the thought leader of the industry it has become today. The iTunes Music Store opened on April 28th, 2003, with a collection of 200,000 songs and selling a million in the first week. By mid-2004, it had sold a million iPods. The world was soon wearing the signature white earbuds and rocking to their own soundtracks.

In its first week, iTunes sold one million downloads and soon became the top music retailer. The business model shifted from high-cost CDs to inexpensive singles. This was how fans would buy music in the future, whether the record industry liked it or not.



iTunes is already an anachronism in the fast-changing digital world preferring live streaming. Thus, internet radio was pioneered by Pandora and followed by [Last.fm](http://Last.fm). These apps grew smart by adding algorithms which would figure out your music preferences from your choice of music and stream it automatically. Spotify entered the scene in 2006 and is the largest and most popular audio streaming subscription service in the world, with an estimated 286 million users.

The release of the iPhone was even more of a game-changer, with these formerly desktop-only apps offering a mobile option. Consumers were no longer beholden to Apple for music download or streaming options.

With the arrival of Apple Music in 2015, Spotify got competition. It secured exclusive deals with artists to stream their music first. The ubiquitous presence of YouTube and websites like Pandora, Rdio and Rhapsody makes it easy for fans to stream any song, anytime, for free. However, there is evidence that a good fraction of music fans believe in owning songs and albums.

Recent developments indicate that beyond Europe and US, new hubs of the music business are

emerging. Anghami, based in Abu Dhabi, has become a vital part of shaping the music business in the Middle East and North Africa. It has 70 million members and a huge library. It's also the first startup from the Middle East to go public on an American stock exchange. Anghami's trajectory indicates how the global music industry is finding new growth centres.

Liberating music from the physical constraints of vinyl and quartz allowed it to stream through the internet web and into your homes at the flick of a switch. This allowed us to experiment with music in a way never possible earlier. I have an app on my iPhone called Radio Garden. It is supported by the Netherlands Institute of Sound and Vision. The screen shows a three-dimensional picture of Earth. The picture is covered by thousands of little green dots, each representing a radio station. As you turn the earth, radio stations on the screen come alive. A circle on the screen locates one of those dots/stations and begins playing what the station is broadcasting at that moment. You can listen to the whole world.

## 12 Kothamangalam Days



I was a reluctant visitor to Kothamangalam. After finishing my M. Sc at the Union Christian College, I was preparing to go

north to search for a place to do my doctorate. However, I received an unexpected phone call from a friend working in the physics department of Athanasius College asking me quite earnestly whether I could join the college as a lecturer and shelve my long-term plans for the time being.

On an impulse, I went to Kothamangalam, joined the Physics Department and shelved the plans for departure. The college on the hill was imposing, the town had a rustic charm, and the students quite earnest, all of which I found appealing. I also found a delightful place to stay near the college, along with Jacob Elanjickal and K. K. Daniel.

Meeting Prof. M. P. Varghese was unexpected as he kept to himself due to College politics. One day O. M. Mathew took me along to meet him. Varghese

sir told us of his plans to raise funds for expanding the new building for the Arts College since the high-profile Engineering College was beginning to grow and wanted more and more of the old building. We talked about running a lottery to raise funds. None of us had a clear idea of how to organize a lottery. I found the whole situation quite challenging, and, on impulse, I told Varghese sir that I would like to join the effort. We roped in a few other people.

Running the lottery meant travelling to the nooks and corners of Kerala, meeting people and dumping ticket books on them. People were naturally quite reluctant to take on this burden. Considerable moral pressure had to be skillfully applied. I found Varghese sir in his element; he would curse and cajole and finally talk everyone we met into accepting more ticket books than they could realistically sell. He would paint a glorious picture of the great cause of education that the sale of the tickets would support. He knew many people, connected with the church and outside, rich and poor. He had an easy way of dealing with people.

These journeys, done in a group, typically lasted a week. Chatting in the evenings after a hectic day, I came to know Varghese sir quite well. He would talk

about his Oxford days. It was evident that he had deep-rooted respect for its excellence and its extraordinary impact on branding a person for life. The earlier formality was replaced by warmth, which comes from working together.

We had publicized that we would keep a record of the buyers of every ticket sold. Varghese sir was very particular about this, as he believed that this would add to the transparency and credibility of the lottery. The tedious task of keeping this record was mine, which meant that I had to collect all the counterfoils of sold ticket books, organize them in serial order, and keep the record in a register. That this worked well was proven when, immediately on the draw of the first prize, an Ambassador car, I was able to identify the ticket holder.

The lottery was quite successful in that it collected enough money to build a good part of the new building for the Arts College. Personally, this was a lesson in setting targets and achieving them, which proved very useful later in my career. It was also a remarkable period of education for me in taking a close look at Kerala.

The second year of my stay at Kothamangalam coincided with Varghese sir taking over as the college

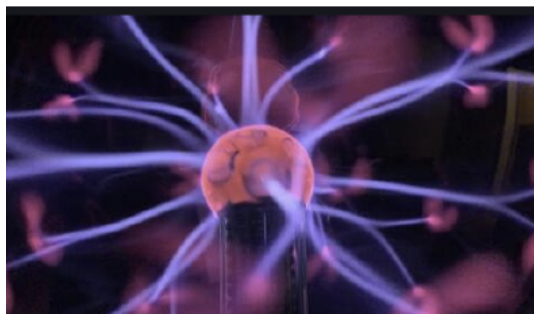
principal. He asked me to set up a film club, which was a huge success, showing English movies every weekend. We also added a music system with a collection of long-playing records of Western classical music. Varghese sir firmly believed that these would somehow touch the students' minds and leave an impact. I found to my delight that Varghese sir had an eclectic interest in many aspects of culture. However, I think he hid this aspect of Western sensibility, perhaps instilled during his stint at Oxford, with the rustic veneer of a son of the soil to put people off.

Varghese sir had a truly remarkable vision of the college. He could see it growing, adding postgraduate and research projects. He was also impatient about small minds and petty politics coming in the way of realizing this vision. He had strong views about people. He was very critical of young people not fully realizing their potential and would make cryptic comments about them wasting time. He had a nobility of behaviour, which perhaps conflicted with the politics he had to play in his dealings with the college administration and the management association.

I left the college at the end of the second year. Pressured with my battles of life and career, I lost touch with the college and Varghese sir for quite some time. I occasionally revived it and met Varghese Sir a few times on my infrequent visits to Kottayam. The last time I met him, in the summer of 2002, he told me about his fight against setting up the nuclear power plant nearby. He showed me the enormous amount of material he had collected on the environmental issues concerning atomic energy. He wanted the material to be compiled into a book. I found that the spirit of never saying die was still quite alive.

During the two years I was at Kothamangalam, I had never gone to the Old church there. On my last visit, in 2002, as I returned from Varghese sir's house to Kottayam and my car passed by the church, I asked the driver to stop. I went into the church and sat there in a corner. In the flickering shadows cast by the oil lamps, with the murmured prayers of the supplicants floating around me, I reflected on many things; life, work and people; in Kothamangalam and beyond. And about the remarkable person, I came to know and respect.

## 13 Becoming a Plasma Physicist



Chance made me a plasma physicist. Though I wanted intensely to get into research, I did not know precisely how to go about this. So, I

started writing to the heads of departments of various universities seeking a position in research, which did not elicit any reply. According to some of my friends, the next best thing was to go to these places and talk to them. So, I decided on a Bharat darshan. Going from University to University in search of an opportunity to work for a PhD, I ended up at the Aligarh Muslim University.

I walked into the office of Prof. Rais Ahmed, who had recently returned from England and had taken over as the head of the physics department. When I introduced myself and said that I wanted to do research, he asked me some general questions, which I answered well. I also told him that I had saved some money from my Kothamangalam days and was willing to work without immediate financial



support, which impressed him. He managed to get me a Ministry of Education scholarship, a sum of Rs. 250, which, among all scholarships, was the most irregular. Months would pass before this was paid.

Rais Sahib had worked on speech recognition in England and was trying to rebuild the research base of the department. He was aware of the work at Harwell on fusion and Oxford on ionised gases, and induced me to take a risk in starting experimental work in plasma physics. The department had no prior art or faculty members established in this area. Prof. D. C. Sarkar, who was suggested as my guide, had worked in the Varian Laboratories in the US in plasma physics. Without thinking of the consequences of my choice, I rashly agreed to his suggestion to set up an experiment.

There are two ways of learning new things. In one, you read up everything (prior art in the patent patois) on the field before doing anything. Then, in a second approach, you plunge into the new thing and learn as you struggle. This is the empirical, seat-of-the-pants approach to learning. Being somewhat impulsive, I have been a practitioner of the second school of learning. Looking back, I believe that while I had stepped into an extremely risky situation, I had

the ideal conditions to become an independent experimentalist since there was no one to tell me what to do.

The Physics department had lost its glory as a seat of physics research. The era of work in cosmic rays led by Prof. P. S. Gill and spectroscopy by Prof. Putcha Venkateswara had ended. Looking back, I think that I had the ideal conditions to become an independent experimentalist since there was no one to tell me what to do.

The topic of the thesis was an experiment to simulate the Luxembourg effect in which the powerful Radio Luxembourg modulated the ionospheric plasma such that weak European stations became gratuitous carriers of Radio Luxembourg. The Luxembourg Effect was first documented by Prof Bernard Tellegen. The story is that Tellegen was in the Netherlands, listening to a station transmitting from Beromunster, Switzerland, on 652 kHz. In the background of the Swiss signal, he could hear the audio of Radio Luxembourg, which usually broadcast on 252 kHz. He was so far away from each station that neither station's signal would have been strong enough to overload his receiver. The two signals seemed to be mixing somehow

through a phenomenon of cross- modulation between two radio waves, one of which is strong, passing through the same part of the ionosphere, a plasma region in the upper atmosphere.

In my M. Sc course, I had not heard of Plasma Physics. So, I set up a plan to read the essential books and papers in plasma physics. The department had journals like Physical Review Letters, Physica and Nuovo Cimento. The last two journals had articles from European Plasma Physics Laboratories. Though Nuovo Cimento was essentially dedicated to particle physics, the journal reported occasional experimental work in plasma physics. The textbooks were W. B. Thompson's "An Introduction to Plasma Physics" and Von Engle's "Ionised Gases", both excellent for a basic understanding. I learned from the research journals that the nonlinear interaction between electromagnetic waves was a topical and important subject.

Learning experimental techniques was the hard part. Review of Scientific Instruments became quite handy. So did the American Journal of Physics, primarily meant to support physics education. I had to learn vacuum techniques, how to build high-power RF circuits, how to modulate a carrier wave, how to

use Langmuir double probes to measure the plasma density, how Klystrons operate, how microwaves propagate through waveguides, how to make waveguide components like horns and couplers. The department had a 14.5 MeV neutron generator driven by a DC accelerator, which used an RF plasma source as the proton source. The source was my first introduction to laboratory plasma. Rajeshwari Prasad Mathur, working on the accelerator, would tell me about his problems with the plasma source.

My Radio Luxembourg was a high-power Radio-frequency source that would be used to form the plasma and, because of the amplitude modulation, would produce a periodic variation of the plasma parameters like density and electron temperature. Dr K. A. George from the Tata Institute for Fundamental Research advised me on how to build the RF equipment necessary for the work. An old Amateur radio handbook in the Department library was my guide. I designed and built a simple push-pull circuit using World War II vacuum tubes foraged from the Electrical Engineering department. The tubes had no data sheets, and I generated the current-voltage characteristics experimentally. Dr George also

supplied me with a glass discharge tube with a Langmuir double probe in his TIFR workshop.

The modulated RF discharge plasma was the medium through which an X-band microwave signal propagated and picked up the modulation. The microwave source, transmission lines and power supply were scraped together from Prof. Putcha Venkateswarlu's laboratory, who had left by this time to join the new IIT at Kanpur. My research scholar friends, Subhas Chandra, Yogendra Kumar and Rajeshwari Prasad Mathur, were very helpful in enabling me to chart the unfamiliar environment. Thesis work taught me everything from glassblowing to machining, and I got a degree in 1969.

I measured the modulation transferred to the microwaves while they went through the RF plasma. I realized that the experiment would benefit from a theoretical model for estimating the modulation transfer. Prof Sodha, the great plasma physicist from IIT Delhi, was visiting the department. He made me sit down and work out a rudimentary theory to estimate modulation transfer to the microwave signal. The comparison yielded a reasonable agreement, except for a bump in the measured

modulation at the low-frequency end. The results were published in Radio Science.

The viva voce happened at Prof. Nagchowdhury's office. The former Director of the Saha Institute of Nuclear Sciences was a member of the Planning Commission. Prof. Sodha was the other examiner.

I justified the excess modulation due to acoustic resonances in the low-pressure gas. Although this created some controversy in the thesis defense, I could defend it successfully. I had Uno Ingard's paper on the generation of sound waves because of neutral gas heating in an RF discharge as my supporting work. Later, I proved the validity of this interpretation by observing neutral acoustic waves in modulated RF discharges and publishing a paper on this in the Journal of the Phys. Soc. Japan. This was a lesson in the importance of the supremacy of observation in experimental work and standing by one's convictions. My thesis work taught me everything from glassblowing to machining, and I got a Ph D degree in 1969.

Looking back with the sophistication gained through five decades of making and manipulating plasmas, I find my first experiment crude and

unsophisticated. I did not extract as much information from the experiment as I could have. For example, had I measured the phase modulation of the microwaves, I could have extracted the density of the plasma and its modulation and cross-checked the density data from the Langmuir probe. The generation of acoustic waves and its resonance at low frequency should have been studied more extensively. On the other hand, now I realize the huge risk I had undertaken in volunteering to build the experiment with such limited resources. The sum of it all was that by setting up such an experiment, I learned Plasma Physics and gained a great boost of self-confidence. I was mentally ready to do greater things. My dream in those days was to build a Q-machine without really appreciating the complexity of such a device. This remained a dream until I collaborated in starting a project in the Institute for Plasma Research to create a thermally ionised plasma confined with surface magnetic fields, much later.

The year I got the degree, new posts were created in the Physics Department. Prof. Rais Ahmed called me and asked me to apply for this position. I became a lecturer. The teaching was engaging, and I

realized that I was good at it. However, it soon became clear that the department would not offer me many growth opportunities due to the factional politics in the department and the imminent departure of Prof. Rais Ahmed to join the UGC as its Vice-Chairman. The eternal lack of funds in the department was an added reason. Moreover, my attempts to get a post-doctoral fellowship in the US were turning out to be unsuccessful, perhaps due to the strained Indo-US relations after the Bangladesh war. Prof. Bimla Buti happened to visit the department at that time. She asked me whether I would like to join Physical Research Laboratory in Ahmedabad, which planned to start an experimental programme in plasma physics. Naturally, I jumped at the opportunity



## 14 Years at Aligarh



I spent close to eight years at Aligarh. First as a PhD student and later as a lecturer in the Physics Department. When I came here in 1964,

Aligarh gave me a culture shock. My inability to comprehend Urdu was a barrier to appreciating the culture. The exalted forms of addressing, and the exaggerated 'Tehzeeb', with adaabs strewn around, were alien. The food, consisting of tandoori rotis and mutton curry, though delicious, was also unfamiliar. But the accommodation I got in the Sulaiman Hall was quite adequate. South Indian students preferred this hall. The campus was a dream with beautiful buildings, stately halls, verdant lawns and lush gardens. Slowly, the strangeness diminished, and I was acculturated to a certain extent.

Aligarh is a residential university with an administrative structure patterned along Oxford. The Vice-Chancellor is the absolute ruler, and his personality gets stamped over the administration.

When I joined in 1964, the VC was Badruddin Tyabji, who hailed from a nationalist Muslim family. He treated the academics disdainfully, much to their resentment. Nevertheless, his stint in Aligarh could have contributed to the orderly functioning of the institution. The following VC, Ali Yawar Jung, a career diplomat, was from a noble Hyderabad family. In the Aligarh consciousness, his memory survives primarily because of the violent happenings of April 1965, triggered by his decision to reduce the share of 'internal candidates' for admissions to higher professional courses from seventy-five to fifty per cent. In the ensuing violence, the Vice-Chancellor and some faculty members were assaulted. The next VC was Dr Abdul Aleem, a leftist of long-standing. He was associated with the Communist group of Lucknow University and the progressive writers' movement. His proximity to Dr Zakir Husain brought him to Aligarh to infuse new academic blood into the institution.

Aligarh Muslim University (AMU) occupies a unique position within universities and institutions of higher learning in India. It evolved out of the Mohammedan Anglo-Oriental College in 1920 under the vision of Sir Syed Ahmad Khan. The Aligarh

Muslim University was the manifestation of a vision which was broad, far-reaching and nationalistic.

Spread over close to 500 hectares in the northern part of the city of Aligarh, the University now offers more than 300 courses in the traditional and modern branches of education. It draws students from all states in India and from different countries, especially Africa, West Asia and Southeast Asia. There are seats reserved for students from SAARC and Commonwealth Countries. There used to be a stream of students from Kerala to the university in the 1970s, which seems to have dried up, according to Prof Habib.

Aligarh was a mix of good and bad. Many Muslim academics came from affluent landowning families; their wealth was why they opted not to leave India. Many were educated in England and had left-wing leanings, which endowed them with a liberal worldview. However, the bulk of Aligarh Muslims were poor and came with a conviction that they were cheated out of their traditional position of power by the twists and turns of history. They looked at all changes as arising from a conspiracy to keep them backwards. I realised that though I also belonged to a minority, I never looked at myself as a

minority person; to me, being integrated with the idea and reality of India was second nature.

What drew Aligarh Intellectuals to Marxism? There is a thought-provoking essay by Professor Mushirul Hasan, historian of repute and my contemporary at Aligarh in India International Centre quarterly in 2003. The process that attempted to synthesise socialism with Islam began in the 1920s. In the 1930s, socialism was the new revelation that young idealists could invoke to exorcize communal rancour to unite everyone in a struggle against poverty. After the Aligarh architects of Muslim nationalism left for Pakistan, the socialists and the communists, encouraged by Zakir Husain, moved to Aligarh. The facilities at the university were excellent. The institution, however, did not produce scholars or scientists of excellence, with a few exceptions. Everyone's obsession was preserving the university's 'minority' character, and their conversations centred around the future of minorities.

Aligarh was rich in cultural activities. The hub was the Kennedy House, with its imposing mural by M.F. Husain. Notes from Beethoven and Mozart resonated in the music rooms devoted to western classical music. I remember a performance of

Bernard Shaw's Arms and the Man with Nazeeruddin Shah as Sergius. Mushairas were common, although it was all Greek to me. Among the budding Urdu poets, Bashir Badr and Javed Akhtar, who became legends in Bollywood, were prominent. So too were the painter Muzaffar Ali, the Hindi writer Asghar Wajahat. Madhosh Bilgrami and Humayun Zafar Zaidi were also a part of a lively literary group. The 140-year-old Aligarh Numaish, a cultural fair, is a part of life for Aligarhians.

Prof. Nurul Hasan, the leftist historian, was the leader among the academics. He moved to Delhi, first as a member of the Rajya Sabha and later as Minister of Education. Historians like Irfan Habib kept the Marxist flag flying. I remember attending talks by Mulk Raj Anand, the writer and Chanchal Sarkar, the editor of Statesman.

In the beginning, I took food from the common mess for a few years. Then I joined a cooperative mess run by students from Central Travancore. The cook was Thomas Chettan. A minority in this Muslim-majority place, we developed strong loyalties made possible by the shared culture of Syrian Christian upbringing in middle-class families from Central Travancore. The deputy Registrar, George sir became

our mentor and advisor. His house was like a second home to us, and we usually celebrated Christmas at that place. I have kept in contact with many friends from this time. The Geologist Mathen, Telecom Engineer Mathew Daniel, Surgeon Dr John Mathai, George Isaac from Chengannur, Businessman Georgy, Consultant Thomas Abraham, Surgeon Baby Mathew, Doctor Thomas Thomas, George Abraham in Singapore, Ivan John in Australia, to mention a few. Punathil Kunjabdullah, who became a famous novelist later, studied medicine and was already an established writer. Through the initiative of the mess, the Malayali group could set up a basketball club at the university, where the only recognised sport was hockey.

I had many Muslim friends on campus. Many came from middle-class professional families, and I could discuss politics, books and films with them with ease. Farhan Mujib, a close friend, later left the department to take art full-time. His art attempted a fusion of traditional miniature art and modern-day collage. Farhan Mujib is recognised as the physicist who brought precision to collages. He collaged pieces of paper from magazines and photographs to create intricate images. Another friend was Farrokh Nami,

an Iranian who was a chess wizard, and we spent many hours attempting regicide on each other.

I was appointed as a lecturer in the Physics Department in 1979. I got an accommodation in the warden's room in the Kuwait House, which I shared with another faculty member. The teaching was exciting, and I realised that I was good at it. However, it soon became clear that the department would not offer me many growth opportunities. The imminent departure of Prof. Rais Ahmed to join the UGC as its Vice-Chairman was a cause for concern. My attempts to get a post-doctoral fellowship in the US were turning out to be unsuccessful, perhaps due to the strained Indo-US relations after the Bangladesh war. Prof. Bimla Buti happened to visit the department at that time. She asked me whether I would like to join the Physical Research Laboratory, which planned to start a programme in experimental plasma physics. Naturally, I jumped at the opportunity.

I had no professional reasons to visit Aligarh after I left since the Plasma Physics activity I had started died away after my departure. I revisited Aligarh, along with my wife in 2022, after a period of 50 years after my departure when I received an invitation from the Physics department to celebrate

the 100th birth anniversary of Prof Rais Ahmed, the former head of the Physics Department and the person to whom I owe a great deal for starting me off on my career path in plasma physics research.

The travel by taxi from Delhi took about three and a half hours, and we reached Aligarh by noon. Once we reached the city outskirts, I realised that I was seeing much of the sprawling city for the first time, as I had never ventured out of the campus in my earlier stay here. The farthest I had strayed from the campus was to attend the famous “Aligarh Numaish” in the Numaish ground. I was told that the 135-year-old institution was still going strong.

The University now has 13 faculties comprising 117 teaching departments, and 21 centres and institutes. A special feature of the University is its residential character with most of the staff and students residing on the campus. There are 19 halls of residence for students, with 80 hostels.

While drawing around the campus, I noted that the campus has changed quantitatively with new buildings and facilities. Its basic form has not changed and even the new buildings are inspired by the old buildings. The Campus appeared to have developed as and when the need arose and sites



were designated often without foresight, or logic, resulting in giving a haphazard look to the campus. The new buildings lack a distinct architectural style. Over the years, the campus seems to have expanded haphazardly without much attention paid to spatial relationships inherent in the myriad variety of buildings and their land use pattern. This is despite starting out with a well-conceived layout with a remarkable architectural style that can still be observed in the original buildings that came up during the initial stages of the university's development. The Kennedy Centre, the Arts Faculty and the Library buildings remain unique and stylish. The physics department has added a new conference hall, which seems poorly designed.

After the meeting, I moved to the Lemon Tree Hotel on Marris Road to be closer to some friends who lived in that part of the town and to escape the drudgery of the guest house food. This is an excellent 4-star facility. We hired an E-Rickshaw to wander around the campus and nearby places, which used to be my haunts. The Shamshad market was closed due to it being a Friday. The New Kitab Ghar, which attracted me because of the English fiction books, has closed and now runs a medical shop. The

Paradise Hotel, where we had endless cups of tea, conversation and cigarettes, where there was a prominent display that “Patrons who insisted on using teacups as ashtrays would be served tea in the ashtrays” was closed. The shanty hotel, run by Thomas Chettan, our old cook in the South Indian Mess, who got the entrepreneurial urge, is no more. To me, it was a day of losses as the old familiars had disappeared into the mists of time.

## 15 Remembering Prof Rais Ahmed



We celebrated the 100th birth anniversary of Prof Rais Ahmed, the former head of the Physics Department,

Aligarh Muslim University and the person to whom I owe a great deal for starting me off on my career path in plasma physics research. A one-day memorial cum seminar on Future directions in Physics was held at the University on 5th October 2023 Venue. Prof. Irfan Habib, Prof. of History, AMU, Prof. Siraj Hasan (Former Director, Indian Institute of Astrophysics), Prof. Naresh Dadhich (Former Director, IUCAA), Prof. S. K. Singh (Former VC, HNBHU), Prof. Wasi Haider and Prof. Shyam Sunder Agrawal (Director General, KIIT Group of Institutions) spoke on the occasion. I spoke about my association with him and the future of Plasma Physics and Thermonuclear Fusion Research in India.

It was a forenoon in July 1964 when I first met Prof Rais Ahmed, who had become the Head of the Department that very year. I had travelled from

Kerala seeking an opportunity to do research. He asked me a few questions about physics, and I suppose I answered them reasonably well. But then he wanted to know why I wanted to pursue research.

I had rather romantic ideas like research leading to new knowledge, and our responsibility to seek pure knowledge, etc. It was clear that he did not take me seriously as he went on to say that science drives social transformation by changing our perception of our relationship with nature. Another observation was about science leading to technology, improving the quality of life.

Our conversation covered many things. I suppose he was gauging my mind and trying to find what kind of person I was. If it was a test, I passed it as he said that I could join for research. He made sure that I had no preference for Nuclear Physics or spectroscopy, the areas of ongoing work in the department. He talked to me about Plasma Physics as an emerging field and about the work which was going on in Harwell and Oxford on Thermonuclear Fusion Research.

I did not know about Plasma Physics even at an elementary level. However, I was willing to learn and was asked to talk to Prof. D C Sarkar about the thesis

work in more detail. I set up an experiment and after a struggle of five years, put together a thesis which got me a degree.

Almost immediately, he gave me a regular job as a lecturer in the department. As the Head of the Department, he did much to expand research and teaching in Physics in new areas. As Director of Academic Programmes, he organised the Semester System designed to update courses and provide more rigorous instruction to students. He made an alliance with Uppsala University in Sweden for faculty members to do research there. He arranged for PhD scholars to start teaching postgraduate students.

I recalled my interaction with university life during my eight years there. At first, Aligarh gave me a culture shock. My inability to comprehend Urdu was the first barrier to appreciating the culture. The exalted forms of addressing, and the too formal and exaggerated 'Tehzeeb', the gestural 'adaabs' strewn around were all alien. The food, though delicious, was completely unfamiliar. But the campus was a dream with beautiful buildings, stately halls, verdant lawns, and lush gardens. The library gave me all the books I wanted to read. The accommodation I got at the Sulaiman Hall was quite adequate. The students

from Central Travancore preferred this. There was a South Indian mess catering to our preferred food. Tea at the Paradise restaurant with friends was fun.

Rais Ahmed had interests ranging from his specialisation in Electronics to varied areas of science and education. He published over 100 papers on Electronic Circuit Analysis. Analogue Computers. Speech Recognition and Production, and Creative Teaching of Physics. The work he started in the 1970s on speech perception would eventually become an important branch of artificial intelligence and machine recognition of speech.

I recall a symposium he had organized on higher education, where we were asked to be volunteers to help the organization. The attendees were all academics from Universities and IITs and I was fortunate to listen to many of them. The remarkable skill with which Rais Sab generated consensus on many issues which were debated was an eye-opener for me.

In a department seminar, when his student Moonis Ali spoke on the design of an analogue computer system, some of us, ridiculed the idea by calling it a paper machine. Rais Sab defended the presentation vigorously, saying that new ideas were

what drove science forward and that they had as much importance in science as building new instruments.

His remarkable organisational skills were brought to bear at the prestigious Annual Meeting on High Energy and Nuclear Physics, sponsored by the Department of Atomic Energy. Prof Roy Daniel from TIFR was the coordinator of the meeting, and since he was from Kerala, we used to chat about the preparations for the meeting. The participants included bigwigs like Vikram Sarabhai, Prof M G K Menon and Dr Raja Ramanna. The meeting was hailed as very successful thanks to the planning and preparations led by Rais Saheb.

All of us in the department rejoiced when he was made a member of the Science Advisory Committee to the PM, then Mrs Gandhi. After each meeting, he would call all of us to the lawn near the workshop to convey to us the flavour of the meeting. We had the vicarious pleasure of being informed about the thinking in the places of power.

He would call me occasionally to his office to find out how I was doing. In one of these meetings, he advised me to read journals other than those

dedicated to pure physics. He cited the Bulletin of Atomic Scientists as an example.

Rais Sab had an abiding faith in Scientific Socialism and felt strongly about the increasing global dominance of the multinationals and about what he saw as a retreat by India from its independent position both in the Economic and Intellectual fields. He had a strong belief that human capital, in the form of expanding knowledge and scientific spirit, held the key to India's salvation. For this ideal, he worked tirelessly both as an individual and in administrative capacities.

In the 1950's he was an energetic organizer of the Association of Scientific Workers of India. Once when I asked him about the ethics of unionizing scientific workers, he defended it by saying that collective bargaining need not be about wages and working conditions only. Professional bodies of scientists had a role in influencing public policy.

After I left Aligarh in 1972 to join the Physical Research Laboratory in Ahmedabad, I had occasional interactions with him. He made me a member of the UGC Committee to visit Marathwada University to make an academic assessment. He funded my proposal to have an orientation programme for



university teachers in the emerging field of Plasma Physics.

I had an exciting and eventful life contributing to Plasma Physics in India, right from its inception at the Physical Research Laboratory, during the Plasma Physics Programme and its eventual transformation to the Institute for Plasma Research and when India became a proud partner in the ITER project of building the world's first Thermonuclear fusion reactor in France. I owe a debt of gratitude to Rais Saheb for initiating me into the research path, which made all this possible.

## 16 Manek Chowk and Malls



When we came to Ahmedabad in 1972, one of the monthly rituals was to go to Manek Chowk and buy groceries for the

month. Sometimes this extended to hoarding rice and oil for an entire year. We would engage an urchin to carry the basket around until we completed the shopping. Our journey back was in an autorickshaw, laden with the goodies. Over time, this monthly excursion began to fade in its novelty. The municipal market at Navrangpura with its Italian Bakery and Rasranjan sweetshop became more attractive.

Manek Chowk is the city centre where trading in precious metals and gems happened. Even today, one can find some old jewelry shops here. In the night, the area blooms by transforming itself into a vibrant street food market. The mouth-watering aroma of khandvi, dhokla and methi ka thepla permeate the air. I have had visitors from Kerala getting a shock of their life looking at all that glitter,

unimaginable back home, where everything shuts down at 8 pm. There are many stalls selling pav bhaji. South Indian food was trendy, and a few stalls specialized in only dosas.

Another shopping experience I enjoy sharing with visitors is the Law Garden Night Market with trinkets, jewelry, dresses, accessories and much more. Most of the wares come from the artisans of the Rann of Kutch. The bead and mirror work, all done by hand, are exquisite. Long, traditional skirts are awash in colour. The prices are shocking, and bargaining is the norm. The markets extend over the road and are always busy. Foreign tourists get a big kick shopping in the festive atmosphere.

There is a quaint Sunday market or Ravivari Baazar on the river- front between Ellis Bridge and Sardar Bridge. The market, which started in the 15th century, had moved many times, finally settling down on the riverfront in 1954. The market sells all sorts of things: household articles, kitchenware, agricultural tools, electronics, jewelry etc. Ravivari Bazaar is heaven for book lovers. Assorted collection of books, even rare books are available. I have gone to this market a few times, mainly to show the wares of

Ahmedabad to visiting friends. Unfortunately, I found the chaos a bit too much.

I saw qualitative changes in the shopping experience when the Big Bazaar opened in the western part of Ahmedabad. We had moved to this area in 1989. It was fun to watch the shoppers' response to the sheer volume of material available for buying. I realized that this was a world far away from the earlier times when almost everything was in short supply. Then, the sight of heaps of stuff, from toothpaste to kitchen machines, would make people start rummaging through them in a frenzy. This spoke volumes about the distance the Indian consumer had travelled.

The western side of Ahmedabad began explosive growth in the eighties. Shopping malls and multiplexes mushroomed up everywhere. I had built a house in Bopal, further to the west by this time. Close to this, many large shopping malls came into existence in the mid-80s. ISCON Mega Mall on the SG Highway covers half a million square feet. It has two substantial central atriums. The mall is famous today for its diverse collection of design ware. A convenient parking space is also available. Alpha One Mall is the largest mall with about a million square feet area.

The shop offers a vast array of global and Indian brands. Access from both the Ring road and SG road is possible. They have heightened the movie experience by combining 3D technology with motion simulators.

We live close to these malls, and the proximity has generated some unusual responses. For example, Thomas, my second son, when he returned on a short vacation from San Diego where he used to work, thought that the shops were too close. According to him, the farther you drive for shopping, the better the shopping experience is. I have found this logic beyond me.

A shopping experience (a cultural experience?) I cherish very much is IKEA, the Scandinavian supermarket. I was lucky to sample their ware in Zurich during our occasional visits to my son Joseph and his family, a longtime resident of Switzerland. IKEA's offerings are both practical and whimsical. The vastness of their shops, the predominantly white theme, the mirrors and the dressing up of the goods give one an immersive shopping experience. The cafeteria appears mid-way through the shop, and a hot dog stand is at their journey's end. IKEA is truly international, with stores in 294 stores in 40

countries. In India, they have opened in Hyderabad and are shortly opening in Mumbai.

I enjoy the pleasure of online shopping. Since my wife forbade buying more physical books, I have added to my Kindle collection. In the forced seclusion brought by the COVID contagion, I began to enjoy shopping at the Amazon site for everything from kindle books to candied gooseberry. I have come to love the web experience they provide, the packing and delivery and the ease of rejection of unwanted goods. For over two decades, Amazon has been the trailblazer in e-commerce.

I suppose it is my laziness that makes me admire Amazon. Both buying a product or returning it for some reason, the experience is effortless. Amazon has introduced several innovations for last-minute connectivity. Amazon Prime get free shipping on thousands of items. Products come ready with the paperwork for return. A straightforward way to access Amazon is through the Amazon app, especially Prime Day. Prime members can get notified when sale products become available.

Science says that our brains are chemically wired to resonate to acquisitions. Signs of clearance sale are akin to the triggers for other addictions:

alcohol, drugs, or even food. Stanford Researchers have found that when you see representations of things you want to purchase, an area of your brain with dopamine receptors responds. Dopamine is a neurotransmitter, which controls the pleasure centres of the brain. The dopamine receptors respond to new and exciting experience.

Contrary to what science says, years of middle-class conditioning has given me a psyche hardwired against splurging. There is a built-in sense of guilt when I overspend on non- essentials. For some strange reason, this does not appear to apply to a horde of useless things like bowls, vases and the like. In contrast to this, my wife and children have no guilt when they shop. Seeing my children and their wives shop without this baggage of regret is sheer pleasure.

## 17 Heroes and Heroines



Books take me to a world of my own. I have friends with whom I have forged close bonds while following their lives

and adventures.

Meet the twenty-year-old Miss Elizabeth Bennet, complex, honest, and outspoken. Elizabeth is the second eldest of the Bennet sisters. They belong to the estate of Longbourn, in the village of Meryton in Hertfordshire, England. An intelligent young woman, she had a lively, playful disposition, which delighted in anything ridiculous. She often exhibits a good-natured impertinence that does not offend. She is proud of her mental quickness and her insight into judging the behaviour and intentions of others. Elizabeth is her father's favourite, described by him as having "something more of quickness than her sisters"

A recent acquaintance is Precious Ramotswe, the first female private detective in Botswana. She is wise, intelligent and patient, as revealed in her



approach to the cases that she takes on as a private investigator in a small town in Botswana. The assignments include tracking down missing husbands and children to bring them back to their families. Precious Ramotswe is the daughter of the late Obed Ramotswe, a Motswana cattle farmer from Mochudi. After a disastrous marriage to Note Makuti, a jazz musician, and her father's death, she sold the cattle she inherited and founded The No. 1 Ladies Detective Agency in Gaborone, taking on Grace Makuti as her secretary. She does not limit herself to answering clients' questions but endeavours to do so with humanity and kindness. Sometimes this means responding to a client's unspoken need for affirmation or closure. In another investigation, she urges the clients to reconcile past bitterness. Often she does not reveal specific details of her discoveries to avoid distress to the clients.

Precious Ramotswe is a traditionalist in her adherence to the old Botswana moral values. She is also of 'traditional' build. She relies on social relationships to find information with the motherly touch of a woman of middle age. She highly respects the Queen, Nelson Mandela and Sir Seretse Khama, whom she often quotes. She loves the melons that

grow in her yard, the character of her countrymen, and the austere beauty of the Kalahari desert. She is fond of red bush tea, and she often promotes it as a therapeutic drink to her clients. In the evenings, she sits on the porch of her modest home on Zebra Drive with a cup of tea, grateful for the satisfactions of her life and the fond memory of her honorable, loving father.

I met Atticus on the pages of "To Kill a Mockingbird". He is one of the most upright characters portrayed in any novel. He wears spectacles because of his weakening eyesight. Tall, with a hint of grey in his hair, he is formally dressed most of the time. Atticus represents an ideal human being, both in his profession as a lawyer and in his personal life. He has the moral ideal of both a lawyer and a human being. He is honest to a fault, and a persistent crusader for what he believes are exceptional causes. He is honest and a tireless crusader for good causes (even hopeless ones). He practices pacifism and is free from the racial and class prejudices of his fellow citizens of Maycomb County.

As a father, he goes to great lengths to mentor his children on the importance of being open-

minded, reasonable and generous neighbours and citizens. He is eventually revealed to be an expert marksman. He chooses to keep this fact hidden from his children lest they think of him as a man of violence. Though once the best shot in Maycomb County, he quit shooting because he felt he had an unfair advantage. He takes great pains to teach his children about the imperative of keeping an open mind in all matters. He gave up hunting primarily because he believed the situation was heavily biased against the poor animals.

Jockey cum photographer Phillip Nore is a remarkably well-crafted character. He is multifaceted, intellectual and reflective to a much larger extent than is the norm. Nevertheless, Philip Nore drifts along in life, taking whatever comes his way without high expectations for life or high opinions of himself. He had a difficult childhood, his mother often dumping him with her friends while on a whimsical jaunt. This left him self-dependent and with low expectations from others. Though he is passionately devoted to his way of life, the winning and an occasional fall, he has become increasingly disillusioned with the cheating and corruption he perceives at all levels of the racing world. Nore is a

loner with a bruised sense of self-worth that the occasional triumphs cannot rescue on the racecourse. He appears to have no self-awareness.

He lived with a couple of male photographers for one happy childhood period and became a lifelong camera buff. At one point, he was also left with a racehorse trainer and learned the steeple-chasing dodge. "Things had happened to me all my life," he says about himself in 'Reflex'. "I'd never gone out looking. I had learned whatever had come my way, whatever was there."

Nore is now 30 and no longer quite the pliable good chap he grew up to be. The owner and trainer he works for have made him throw too many races, and he has reached the end of his rope. Either he rides to win, he insists, or he will not ride at all.

George Smiley is an antithesis of the other British spy, James Bond. He is quiet, self-deprecating, mild-mannered and middle-aged and lives by his wits. He is quite skilled in the practice of bureaucratic maneuvering and prefers it to using weapons, unlike Bond. He is not a habitual womanizer, again in contrast to Bond. Smiley was a silent sufferer of his wife Anne's dalliances. In "Tinker, Tailor, Soldier, Spy",

Le Carre describes Smiley as a “brilliant spy and inadequate man”.

Smiley is an exceptionally skilled spymaster gifted with a prodigious memory. A practitioner of espionage with a deep insight into human frailties and fallibilities. He is highly sagacious and perceptive with a strong moral conscience; he also understands his profession’s horrible and unethical aspects. Though he has retired many times, he maintains a substantial network of aides and assistants. This includes even “retired” police officers and former Service personnel. His loyalty to his followers and his upright character inspires tremendous respect. Le Carré’s description of his person is not complimentary; this includes comments about his couture.

George Smiley is an antithesis of the other British spy, James Bond. He is quiet, self-deprecating, mild-mannered and middle- aged and lives by his wits. Quite unlike Bond, he excels in the art of bureaucratic maneuvering rather than gunplay. Also, unlike Bond, he is not a bed-hopper; in fact, Smiley’s wife Ann is notorious for her affairs. In “Tinker, Tailor, Soldier, Spy”, Le Carre de- scribes Smiley as a “brilliant spy and inadequate man”. Le Carré

describes him as a somewhat short and fat man who always wears expensive but poorly fitting clothes (he “dressed like a bookie”).

One of the weirdest fictional heroes I have come across is Jack Reacher. Of the Jack Reacher books by Lee Child, 24 of which are essentially Westerns. Reacher is a loner, a wanderer. He grew up mainly in Europe, the child of a military family. His father travelled from one foreign base to another, seeding in his son a deep desire for exploration. One of his career options has been military, as he belongs to an army family. He joined the Army and progressed career-wise to the rank of a Major. When he saw downsizing on the horizon, he left the Army, walking away from a position of power, choosing the life of a vagrant, a life of great uncertainty.

He has a hatred for a conventional life. He is fond of travelling, preferably hitchhiking or taking a bus. Though he began this mode to explore the country, it has become a way of life by now. He has no wardrobe, buying new clothes whenever he needs them. His compulsive denial of possessions extends to ATM cards and mobile phones, though he decides to keep an ATM card in later books. He has no permanent address for getting in touch with him or

receiving mail. He has no driver's license despite being a skilled driver of sophisticated automobiles. He gets arrested regularly but gets released because of his military personnel record.

Though He doesn't actively look for trouble, trouble finds him. In each town, a problem comes to him, which he solves. The book permeates with violence in all forms. Reacher's violence has a very stylistic manner. The fight scenes are classic, reminding us of the Homeric tales. Lee Child uses a fantastic technique in the description of fights: he slows them down. In *Persuader*, four pages describe a fight that involves four blows.

Reacher likes and respects women and finds great pleasure in their company. Child's female characters are complete souls, neither needy nor tortured. This situation is rare in popular fiction written by men.

Reacher is Joseph Campbell's archetypal hero: the stranger who appears from nowhere and corrects the wrongs. Reacher stories fulfil the patterns which recur in myths and fairytales. He's the mystery man who shows up at a strange place where something has happened. He solves the problem and then walks away. That archetype has been a

fixture in fiction. He is the stranger who rides in American westerns. We find similar characters in Western legends. He is also cast in the mould of a mythical hero.

Katniss Everdeen, the narrator of Hunger Games and the sequels, is another strong character. According to Good Reads, "Katniss is slender with black hair, grey eyes and olive skin. She is sixteen years old and attends a secondary school somewhere in Appalachia, known in the book as District 12, the coal mining sector. She is quiet and is generally liked by District 12's residents, because of her ability to provide highly prized game for a community for which starvation is a constant threat".

I have many more fictional friends. Thomas Harris's cannibal hero, the sophisticated killing machine called Hannibal Lecter; Wodehouse's man of all seasons, Bertie, is given a life of utter enjoyment; Joseph Hellers Yossarian in Catch-22, the counterculture hero. Sometimes, I find the shadows of these characters in people I meet, but perhaps it is a product of my imagination.

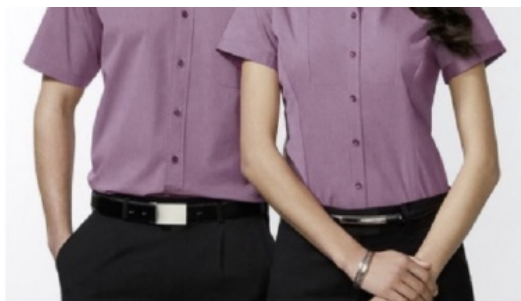
We meet the aristocrat-turned-detective Inspector Thomas Lynley for the first time in Elizabeth George's crime novel, A Great Deliverance.



Her novels are remarkable for their intricate plots, multi-dimensional characters and realistic but chilling explorations of the criminal mind. Lynley matches these characteristics of the story perfectly. He is complex and multi-dimensional. He is the aristocracy, the eighth Earl of Asherton. Oxford-educated and a privileged son of an elite family. Nevertheless, he throws everything into his cases and is a temperamental man given to deep passions and intense emotion. Lynley will do what he thinks is his job first and clear it with his superiors later. Steig Larsson's Lisbeth Salander is armed with unlimited skills in questionable pursuits like computer hacking and martial arts.

While writing this piece, I googled to find out why we relate to fictional characters. I got 45,60,00,000 results. I read some of the results. They discuss the deep psychological reasons for this type of transference. I believe that we love fictional characters because deep within our minds, we want to be like them, colourful, forceful, and adventurous. Because we know that we are nothing like that, struggling to live our drab, ordinary lives and failing in even that.

## 18 Shirts and Trousers



One of my childhood memories is of me and my two brothers walking to school dressed in the sartorial splendour of what was called a

bush shirt, all made of a material called linen, bottle green in colour. We never thought it was an incongruous choice of costume!

This came about since my father was a great believer in the economy of scale through wholesale purchase, and that summer, the local Seematti shop had a huge stock of green linen. I remember Chakrapani, the tailor, rambling deliriously with admiration for the material, to the great happiness of my father.

Green and pink linen bush shirts were exceptions rather than the rule since the school frowned upon any colour stronger than grey. Half trousers and later mundu with the half shirt were the standard attire. which also reined in possibilities. School and later college saw the continuation of

these subdued expressions of different shades of white and grey.

White remained the preference even when I got a teaching job at the Athanasius college in Kothamangalam, with the difference that I could afford better clothes without feeling guilty. The pants that many of my colleagues wore were an allurements, but I was too much of a native at heart to be lured by western garments.

My first encounter with a suit saw me a loser, as it would happen in most of my future sartorial adventures. While teaching at Kothamangalam, I was called for an interview in distant Delhi, a CSIR interview for a research scholarship. This was to be in December, and the Delhi winters were known to my father to be severe. Ever a practical man, he decided to have a woollen suit stitched for me, in deference to the weather and the occasion. Knowing that I would have objected because of the cost, he decided to get this done without consulting me. The tailor was shown a person of my approximate build and was told to dress him up. The shops in Trivandrum, not known for the winter collection, yielded coarse grey wool. When I landed in Trivandrum, ready for the journey north, I was handed down the apparel,

which, considering its provenance, fitted me reasonably well.

Later, when I reached Aligarh to start my Ph. D work, my friends sternly told me that the pants I got stitched in Trivandrum had a 1930s look. They insisted on a complete outfit change, despite the potential drain on the purse. Considering their appreciation of my selections, I decided not to tell them I was the proud possessor of a suit. This led to another splurge for the winter suit. The Trivandrum suit remained with me for a long time, never worn, until my wife decided to exchange it for an aluminium utensil, much to my grief.

Seeking freedom from whites and greys made me go through a phase of rash experimentation, which ended only with my marriage. The shocked expression on the face of my would-be wife when she met me for the first time at the airport when the flight from Delhi reached Cochin (I was wearing a creation in mustard yellow) made me realize that my experiments with primary colours were over. She continued to be in shock until we met again in the traditional custom of selecting the bridal sari at Seematti shop, with me in the traditional white of the Syrian Christian bridegroom. Much against the desire

expressed in various quarters that I should present myself in a suit at the wedding, I chose to wear the traditional white.

The liberalization of the late nineties brought new temptations to the market: ready-made shirts and trousers. Raymond was one of the pioneers in promoting apparel retail in India. After liberalization of the nineties, textile manufacturers began to set up retail chains before any other sector. Raymond, selling readymade over the counter really took off then. Raymond's stores led to its instant brand recall to this day. The relationship started in Ahmedabad and has followed me to Kottayam, which has an excellent Raymonds showroom.

With family and children, the focus shifted to children and how to dress them up in modern styles. Then, with my moving to Ahmedabad and a job with the Physical Research Laboratory, occasional trips abroad became an excellent opportunity to buy intelligent dresses for the children who admired their father's selections.

In my sixties, I realized the virtues of what is called the polo shirt. This is despite the taint the polo shirt has because of its association with delivery men or college boys. The Polo gets further damned as the

preferred raiment of the sartorially challenged — an event demands a shirt with a collar, but one can't be bothered to button up.

A Polo shirt has an identity crisis since it falls between a t-shirt and a dress shirt. However, it is an ideal wear for the many events in life that falls between formal and casual. I have found it exceptionally convenient to wear a polo shirt and jacket on my many ITER trips. Google tells us that Polo got its name from the designer Ralph Lauren, who called his line of casual wear Polo. At a time, outfitters Lacoste and Lauren battled it out for dominance.

Serious thinking on the wardrobe happened when I got the assignment at IAEA in 2001 as the head of the Physics Section. IAEA job is defined as International Civil Service, and there are guidelines on what to wear to work and for formal occasions. Fortunately, by this time, Ahmedabad had a collection of stylish out-fitters. So, I assembled my wardrobe, considering both the severe winter in Vienna and the sartorial demands of my job. We chose Jade Blue to execute the project.

Another occasion which demanded serious thinking on what to wear happened when I was

invited to attend the Padma Ceremony in Delhi. The protocol was prescribed, which covered what to wear. This time in Delhi, it was the blazing April, and in deference to that, I chose to wear a light suit stitched for the occasion.

As youngsters, we deferred to our parents' views regarding dressing up. We had no Facebook to set our fashion standards. The dress was not something to be fussed over. My grandchildren have strong opinions on what to wear, colour, and cut. I believe I saw its emergence in my children, but never with the vigour of the third generation

## 19 Movies and Memories



The Guardian, reviewing Quentin Tarantino's Cinema Speculation, says that "he likes looking under the bonnet and

pulling at the fabric, showing how a film was put together. As a critic, it transpires, Tarantino writes exactly as he speaks, in a torrent of information and opinions; fueled by breathless enthusiasm and unexplained grudges, rhetorical questions and full-throttle digressions. He's frequently at loggerheads with the films that he loves. Tarantino's celebration of Taxi Driver is very nearly a roast. Having convincingly established the film as essentially a "paraphrased remake" of John Ford's "The Searchers", he can't resist slamming what he regards as its compromised racial politics and accusing Martin Scorsese of hypocrisy for his pious stance on-screen violence.

My transition from a boy who lapped up movies indiscriminately to a discerning cineaste started when I was in high school, thanks to a very persistent motivator; Appu, our driver who was madly in love



with Hollywood. Every Sunday morning was a time for the morning show and the local Star theatre would have arranged for a western or a romance. Appu had no preference, as he would sit immersed in the happenings on the screen. He did not understand a single word of what was being spoken and once confessed to me that what he liked was the overall ambience and style and the goings about and that he was not concerned with the theme or the story. I am convinced that he would have done very well as a Bollywood movie producer.

Another providential happening that conspired to keep me glued to the silver screen was my being sent to Trivandrum to study for my pre-university degree. The theatre in Trivandrum specializing in English movies was Sreekumar in Thampanoor. The owner of Sreekumar theatre was an ardent devotee of M. S. Subbalakshmi, a fact that he advertised to the world by ensuring that the song in praise of Murugan, “njanapazhathe pizhunthu” was the only song played before the movies started and during the interval. Since this was the only song in the Sreekumar repertoire, it got played at least a hundred times. We joked the owner was a

perfectionist and was making MS sing the song until she got it right.

Sreekumar Theatre would faithfully bring a new movie every week. My earlier acquaintance with the Hollywood staples was vigorously renewed. The selection ranged from dishum-dishum westerns like *The Lone Ranger* to classics like *Gone with the Wind*. There were great movies like Gary Cooper's *High Noon* and the unforgettable *Casablanca*. I also remember admiring Disney's *Vanishing Prairie* and other nature movies.

My acquaintance with Hitchcock started during this period. *Rear Window*, *To Catch a Thief* and *Vertigo* were all appreciated. *Vertigo* stars Jimmy Stewart as a private detective with a fear of heights and involved in a spiraling, self-consuming web of obsession with a mysterious blonde (Kim Novak). It's now regarded as one of Hitchcock's great movies. Stewart abandoned his characteristic easy-going all-American persona to portray a man driven to the edge of insanity by his obsession with a woman he fears he can never have. Novak is the epitome of Hitchcock's icy blonde. *Vertigo* is thought to be Hitchcock's most personal film, with the story as a metaphor for his obsession with his leading ladies.

Vertigo is also noted for its innovative camera techniques to simulate the sensation of vertigo.

It's hard to imagine a more perfect romance than William Wyler's sad and sweet story of a night starring Audrey Hepburn playing a princess and Gregory Peck, a journalist she encounters during a night's adventure. Co-written by blacklisted screenwriter Donald Trumbo, Roman Holiday saw Hepburn winning the Oscar for Best Actress. It's perhaps the crown jewel of the star's storied Hollywood legacy. Occasionally Salim theatre in Pattom was also favoured for movies like Picnic, Joshua Logan's classic with William Holden, Rosalind Russel and Kim Novak, the smoldering Czech beauty.

Four years later, another phase of my movie-going started when I joined the Union Christian College at Alway for my postgraduate studies. The Sunday rendezvous was now with the Star Theatre in Cochin, a one-hour trip by bus. The theatre somehow got my name and address, and they would send a postcard on additional attractions, which made me feel somehow obliged to go. This was also the time of my transformation to a cineaste, genuinely admiring the art and craft of movies. I also got interested in the technology of moviemaking and started my

collection of books on movie craft. I learned about the difference between Cinemascope, Vistavision and Todd-AO and the magic of the green screen technique.

I read about the technical aspects of a movie presentation, how the credits appear, etc. The animated spirals of Saul Bass's title designs in Hitchcock's "Vertigo" nudge you to an effect of dizziness. Much later Dan Perri's design of the text "A long time ago in a galaxy far, far away...." crawling away at the beginning of Star Wars sets you up on a "Hero's Journey" as interpreted by Joseph Campbell. To meet some unexplained urge, I started making a database of movies, like the names of the director, screenplay writer etc. written and rewritten many times originally in a small notebook and later transferred to library indexing cards. This interest in databases spread later to other types of information, like books and DVD collections.

The next stop was Kothamangalam where I did a two-year stint as a lecturer. The second year of my stay at Kothamangalam also coincided with Prof. M. P. Varghese taking over as the principal of the college. He asked me to set up a film club. I went to the RCA offices in Trivandrum to negotiate for the

purchase of a 16-mm movie projector. We found a distributor in Cochin and the film club started to the great joy of students.

When I went to Ahmedabad in the early seventies, the first thing I checked out was the movie situation and was relieved to note that a few theatres like Natraj were regularly showing English movies. McKenna's Gold and the French Connection were movies I still remember. Ahmedabad had a great choice in movie houses, including India's first drive-in theatre.

In the eighties, the western side of Ahmedabad began an explosive growth, with shopping malls and multiplexes springing up everywhere. By this time, I had built a house in Bopal, further to the west. Proximity bred affection and our afternoons became a celebration of movie-going.

On trips abroad to attend scientific conferences, I have continued to feed my movie addiction. I remember that on my first trip to Los Angeles; I went to a theatre in Westwood, which was premiering George Redford's movie, The Sting, starring Paul Newman. What I found touching was the audience standing up at the end of the movie and clapping in appreciation. Another memory was

sitting in a theatre in Gothenburg, where we had gone to attend the International Conference in Plasma Physics and seeing 'Kelly's Heroes' with a Swedish soundtrack on a rainy afternoon. Another memory is that of standing outside a theatre

in Soho, waiting to buy a ticket to see 'Indiana Jones and the Temple of Doom' and being told by a stranger to watch for the scene where Amrish Puri, a thuggee leader, lounges at Harrison Ford, brandishing a sword, and Ford shoots him dead. Ever a Tarzan fan, I remember seeing Greystoke: The Legend of Tarzan, Lord of the Apes starring Christopher Lambert as Tarzan and the comely Andie MacDowell as Jane.

Another surge of movie-going happened when I spent close to a year in Vienna. Haydn Kino is a theatre on Mariahilferstrasse which brings a new English movie every week and is conveniently connected to where I live by the subway.

After returning to Kottayam, I discovered the delight of watching recent movies on Netflix and Amazon Prime in the pleasant confines of my study. I discovered sites like [www.xmovies8.com](http://www.xmovies8.com) and [www.gomovies.com](http://www.gomovies.com) where old Hollywood classics are available for free viewing.

Movies, like books, broaden one's mind, allow one to explore all possible and even impossible worlds and allow one to go on vicarious journeys of exploration, quest and conquest. Movies allow us to explore our minds to escape reality and to experience and feel things denied to us in the real world. It's not every day you're going to be caught up in a car chase down a military runway (Fast & Furious), getting hunted in the woods by a psychopath wielding a machete (Friday 13th), or be enlightened by romance (When Harry Met Sally)

## 20 The PRL Days



Prof. Bimla Buti of the Physical Research Laboratory, while visiting the Physics Department of the Aligarh Muslim

University, where I was working as a lecturer after receiving a PhD in Plasma Physics, asked me whether I would like to join PRL, which was planning to start an experimental programme in plasma physics. The institute, founded by Vikram Sarabhai in 1947, was the birthplace of India's space research. ISRO worked out of PRL in its initial years. Naturally, I jumped at the opportunity.

I joined PRL in 1972 and was assigned the responsibility of setting up the programme. PRL was very different from Aligarh: substantial funds, lots of discussion on planning the experiments, excellent library and workshop etc. The Plasma Theory group consisting of Bimla Buti, Predhiman Kaw, Ram Varma, R. V. Pratap, A. C. Das and Abhijit Sen was very active and helpful in consultations. Y. C. Saxena was an early collaborator.



The first experiment was designed to simulate ionospheric conditions in which these instabilities occur. The experimentally obtained dispersion relation differed significantly from linear theory predictions for strong electric fields. The first publication was on the nature of the spectrum of high-frequency instability. More publications followed on the nonlinear aspects of the cross-field instabilities.

In the summer of 1974, I got an opportunity to visit the Plasma Physics laboratory of the University of California Los Angeles campus, which was a major centre of plasma physics, working in frontier areas like parametric instabilities and building huge uniform plasma sources using the McKenzie technique of surface magnetic confinement. The giant devices referred to as machines were a revelation to me familiar with small experiments in the corner of a room. This was a great learning experience as it liberated me from being constrained to think small because of resource limitations to being comfortable with the idea of big devices. My colleague Prof Kaw also happened to be visiting UCLA at this time, and I had many opportunities for discussion with him about the physics of the ongoing

experiments. In addition, we discussed ideas of what we could do back in India to try to be at the forefront of experimental work.

With the success of the first experiment, a more sophisticated experiment on the confinement of single particles in a non-adiabatic magnetic mirror was attempted by Dhiraj Bora, Saxena and me. The motivation was theoretical work by Prof. Ram Varma, which attributed the non-adiabatic loss of particles from a mirror trap to tunnelling from the adiabatic potential well by particles of energy lower than the potential barrier. The experimental results conformed to theoretical predictions in some essential respects: The existence of more than one decay time, their dependence on the magnetic field gradient and particle energy.

An interest in ion-acoustic waves was triggered by a visit by Igor Alexeff from the University of Tennessee. In plasmas with electron temperature exceeding the ion temperature, a compressional pulse evolves into an ion-acoustic soliton, travelling with a speed greater than the ion-acoustic velocity and width inversely proportional to the square root of the amplitude. As the soliton properties result from a balance between nonlinearity and dispersion,

we examined its behaviour in inhomogeneous plasmas.

A talk by Prof Alexeff on the work in the Soviet Union by Leonid Rudakov and others on inertial fusion using intense electron beams triggered my interest in intense electron beams. Electron beams have interesting physical properties, even at moderate beam energies and currents, say a few hundred keV and tens of thousands of amperes. The associated space charge is intense, producing self-electric fields of the order of MV/cm. The self-magnetic fields are strong enough to turn the beam trajectories into complex shapes or even reflect the beam electrons. When injected into a plasma, the electric field gets cancelled by the expulsion of plasma electrons. The rising front of the self-magnetic field drives return currents. When such beams pass through plasmas, fascinating effects involving the interaction of beam fields with plasmas will happen.

The essential elements of sub-microsecond pulse power technology are high energy density capacitors, high-pressure spark gaps, Marx generators and transmission lines for pulse formation, etc. This field was born in the early 1960s

at Aldermaston, UK, and we had to catch up with more than a decade's accumulated knowledge. We experimented with every aspect, including making energy storage capacitors by rolling polyester sheets sandwiched with aluminum foils. A Marx generator erected on a wooden frame with exposed spark gaps was the learning tool.

Alexeff suggested writing a proposal for investigating the interaction between intense electron beams and plasmas for funding by the US National Science Foundation. I submitted this with Alexeff and Charles Wharton of Cornell University as collaborators. NSF sent an expert to look at our capabilities and, based on his report, reviewed the proposal. They said that while the proposal's objectives were sound, they doubted whether Indians would be able to master the Intense Pulsed Electron Beam technology.

I thought that the best way to respond to this rebuff was to demonstrate our capability independently. I managed to get funding to start this work from PRL. Denial regimes are the best triggers for indigenous capacity building. By this time, Kamallesh Jain had joined as a research student. My other collaborators were Dr Punitha Velu and Dr

Prabhakar Rao. Rao had a PhD from Oxford and had experience in high-voltage techniques.

Pulse power technology was a classified field. A very important lesson that we learned from these early forays was that although these are conceptually very simple systems, the complexity lies in the practice and prescriptions. For example, the water vacuum interface was a Perspex flange on which the cathode was attached. This is a classic triple junction where dielectric, metal and vacuum meet and is prone to electrical breakdown, dumping energy in a radial flashover. When I asked US expert Magne Christianson how to solve this problem, he admitted that he had the answer but could not help us since it was classified. So, we had to solve such problems from the first principles. We had to understand how to embed the radial electrical field in the dielectric, thereby stopping the avalanche build-up along the dielectric surface. Solving such problems involves building prototypes, testing them and thereby building up a knowledge base.

The experiments on the interaction of rotating electron beams with a plasma, formed Jain's thesis. He observed effects like an excitation of a cross-field return current layer after the beam exits the plasma,

the generation of magnetosonic waves by the return current layer, and heating by magnetosonic waves. Vijay Shankar studied of the dynamics leading to the conversion of the laminar beam into a rotating beam by the action in the cusp region and the effects of charge neutralisation and beam self-field on the conversion.

I gave an invited paper on our rotating electron beam experiments at the International Conference in Plasma Physics held in 1982 in Göteborg, Sweden. The chairman of the session was Prof. Ravi Sudan, who suggested that PRL should set up a collaborative programme with Cornell University.

Prof Charles Wharton visited us and sent a report to NSF highlighting on what we had done independently in pulse power development. This time NSF was convinced that we had the requisite expertise to deal with pulsed power systems and suggested putting in a new proposal. NSF funded our proposal for an experiment on understanding what happens when a high current beam is injected into a toroidal system, a hollow cylinder bent into a ring. Thus, the first toroidal device in IPR in which Chenna Reddy started experiments on injection and stacking of high current electron beams was built. We also

had enough money to build a new laboratory in PRL. The toroidal plasma device evolved into BETA, an acronym for Basic Experiments in Toroidal Assembly.

A fond memory of the PRL days is my interaction with Prof Devendra Lal, the Director of PRL and an internationally known Geocosmo Physicist. The interaction increased with PRL sliding into a period of turbulence. I became a member of an advisory committee to the Director and began to embrace a wider set of concerns generated out of the staff union's agitation against the management. During this period, I had the opportunity to see him closely and admire his human qualities. Despite the strained atmosphere, he kept his sense of humour and his smiling face. The prevalent mood did not deter him from pursuing his work passionately.

Prof. Lal was rather ambivalent about the Plasma Physics we were doing. As if to spur us on to more ambitious aims, he would constantly send me a stream of reprints from journals such as Science. One of these was a paper in Physical Review Letters on the collision between two plasmoids. Plasmoids are blobs of plasma with a self-contained magnetic flux. What excited Prof. Lal was that the dynamics resembled collisions between galaxies. When we

were building a plasma gun, which is an electro-magnetic accelerator of plasma streams, he was very excited and even wanted me to give a popular talk, waving the plasma gun in my hand. Wiser counsels prevailed and this idea was abandoned. When we started setting up an experiment to simulate the interaction between the solar wind and the cometary atmosphere, he sent me copies of papers on the cometary structure.

Prof. Lal had a deep insight into human nature. Many of his operations reflected this. He believed that a hobby, pursued with excellence and commitment went a long way in instilling a strong sense of self-confidence. He believed that people with hobbies were less insecure human beings. He once told me that I could achieve anything if I was willing to give credit to others. When he learned that I painted in oils, he told me of paintings he did while he was in TIFR. He painted with bare fingers, and he convinced me to try this to appreciate the sensuality and fluidity of the wet paint on canvas.

Despite his ambivalence about plasma physics and fusion, he played a decisive role in getting the Plasma Physics Programme approved by the Department of Science and Technology. PPP was the



precursor to the present-day IPR. This was truly Lal: generosity to people and their ideas, without being too judgmental.

Prof. Lal relinquished the position of Director in 1983 and pursued his research interests by dividing his time between PRL and the Scripps Institution of Oceanography, University of California, where he served as a full-time Professor since 1987. Whenever he visited India, he would enquire about what I was doing. When I showed him around FCIPT, the centre we had set up to link IPR with industries, he was very excited to see the process of technology development and commercialisation. When my book “Plasma Processing and the Creation of Wealth” was published, he made sure to order a copy for the Library at the University of California at San Diego.

## 21 Building IPR



TIFR had a toroidal pinch experiment running in the 60's. The TIFR programme was closed after the failure of the ZETA

pinch in Harwell. Vikram Sarabhai picked up the threads again when he established a Plasma physics Group in the late 1960s with Predhiman Kaw, a young scientist working at Princeton as its leader.

The experimental programme in plasma physics started at PRL in 1972. Though the stated orientation was towards the simulation of space plasma phenomena, there was an unstated purpose of eventually acquiring the skills necessary for building fusion experiments. Ultrahigh vacuum, pulsed power, magnet design and fabrication were some of the skills acquired.

In 1980, a group led by Prof Predhiman Kaw, proposed to DST to set up an Indian programme in Fusion research. Abhijit Sen was elected unanimously to engage with the DST bureaucracy. I was one of his partners in chasing officials in the corridors of power.

The Department's innate conservatism came in the way of declaring an outright commitment to fusion. So, what we got was a five-year activity called the Plasma Physics Programme, PPP for short. Not an independent institution, but an autonomous entity within the Physical Research Laboratory. PPP was started under the DST scheme of "Intensification of Research in High Priority Areas". Building the first Indian Tokamak ADITYA was camouflaged within this programme. PPP grew into the Institute for Plasma Research (IPR) in 1986. DST also provided funds for PPP to move into an independent campus outside PRL.

A specific requirement of the programme was the large quantum of electrical energy in repeated one-second pulses to be drawn from the Gujarat Electricity grid. This necessitated the campus to be situated at the northern end of Ahmedabad City for proximity to the large substation at Rana San. We were to get power through a dedicated 132 kV power line from Rana San.

Prof Lal, the then director of PRL and Prof S.P. Pandya, the deputy director, helped us deal with the Government of Gujarat to get land for the campus. Prof Pandya encouraged us to think big and ask for a

large tract of land to meet our future needs and wrote a letter to the Chief Minister of Gujarat requesting 50 acres of land for us. Thanks to these strong efforts, we finally got such a piece of land close to the western banks of the Sabarmati River near the village of Bhat.

Prof Abhijit Sen was the choice to lead the campus project. We selected a young architect, Karan Grover through an open competition. Grover had completed a Bachelor of Architecture in 1974 from Maharaja Sayajirao University of Baroda and a Graduate Diploma in 1975 from Architectural Association, London. We resonated with his idea not to create an immutable built space but an environment which is organically integrated with the surrounding nature.

When we started to plan the IPR buildings, we had endless discussions on how the buildings should reflect the spirit of openness that science inspires. We preferred a sprawling layout with lots of corridors, perhaps as a reaction to the high-rise architecture of PRL, where we had spent many years. The buildings were conceived to give one a sense of liberation. The wide corridors, openness to the sky

and the surroundings, and oneness with nature are all embodiments of this conviction.

Abhijit's strong aesthetic sensibility is reflected in both the microscopic and macroscopic aspects of the IPR buildings and their layout. His attention to detail was amazing. It was impressive to watch him compel the architect to go beyond large brush strokes to the less glamorous part of the nitty-gritty of detailing required for making a working building.

Adopting the typology of traditional dwellings of western India, the buildings are clustered around a series of interconnecting courtyards. This would affect the form of the building and the introverted nature of the complex. Cavity wall techniques and forms such as arches, conical shells, and barrel vaults, were used in construction. Stone cladding ensured a low maintenance façade.

The building encloses six major courts. The entry courtyard originally had a dramatic water body with many fountains. The fountains act as an alternative to the conventional cooling towers required for the air conditioning system. This water court is surrounded by public buildings: a library, administration, cafeteria and a small auditorium.

Large, wide corridors are more than mere connecting links; they are areas of interaction.

The more private areas of the building are four clusters of the scientists' office: eight offices form a cluster, each around a court. The four courtyards are also interconnected with walkways. The courts become an extension of the office, a place for interaction, where the building and its users can feel one with nature.

Situated around another large courtyard are the major laboratories and the workshop. These are high, vaulted buildings with facilities to accommodate overhead cranes. Behind the Tokamak building are the halls meant to locate the power supplies, which form the heart of the Aditya Pulsed Power System. Another large hall accommodated the basic experiments which supported the thesis work of students.

Finally, the greening of the campus, which was originally a grazing land covered with thorny bush. This was almost entirely driven by Abhijit together with the Nehru Foundation for Development, an environmental group in Ahmedabad. Within a few years, the whole of the 50 acres turned into deep woods.

The Bhat campus stands out in a city which is renowned for its architectural gems, and architectural magazines have written extensively about the buildings. Visitors to the campus make interesting comments about the layout. The necessity for the extra-wide corridors has been attributed to accommodating the oversized egos of the scientists working at the institute! The building has been called the Taj Mahal. But the most cryptic comment was made by Lech Walesa, the former President of Poland, who after being escorted around the building, said that the building was more convoluted than the science we were doing at the institute!

Additional floors and new buildings were added to the first phase building, essentially following the same design concept originated by Grover. These included another large hall for a second tokamak, office rooms and additional rooms for administration, including the Director's office, etc.

When the institute wanted to build a guest house and student housing over an area of 5,000 sq m, we turned to Bimal Patel of HCP Design. He was trained in city and regional planning at the University of California, Berkeley.

Four acres of contoured land on the northern side of the campus houses the hostel and Guest House facility. The HCP'S approach was aimed to make use of the natural landform to the fullest and integrate it in the overall composition of the development. The student housing is in three separate hostel blocks and accommodates 32 students each in single rooms with facilities for dining, library, and indoor games. The blocks for the students' hostels are modular two-story buildings of square geometry with a central courtyard. All hostel rooms sport a spartan interior theme. The guest house in a separate block includes 16 guest rooms and 4 suites with dining and conference facilities for visiting scientists.

The ITER Laboratory on the IPR campus is designed to serve a multinational project on building the International Thermonuclear Experimental Reactor in Cadarache, France by a consortium of seven countries, including India. The design intent for the ITER lab was to create a research facility that provides the physical flexibility to accommodate the complex building and laboratory services. The completed building provides ample space and is structurally designed for the large and complex



equipment required in the laboratory. The centrally air-conditioned laboratories are designed to be column-free spaces with heights ranging from 13 to 18 metres for maximum flexibility. Vertical shafts are provided around the perimeter of the building for easy movement of HVAC, electrical and other services as required for the laboratory experiments. Mezzanine floors for office/observation space and gantry girders for the movement of equipment have been provided. To optimize space, the terrace houses all the HVAC and plumbing services.

## 22 The ADITYA Adventure



Fusion reactions make the stars shine and give the hydrogen bomb its terrible destructive power. Fusion

research started in

the 1950s when scientists realised that controlled thermonuclear fusion reactions in the laboratory would open a path to unlimited and safe nuclear energy. Many countries began building fusion devices - magnetic bottles - to keep the hot plasma confined. A type of magnetic bottle, called the Tokamak, invented by the Russians, successfully reached the extreme temperature and other conditions necessary for fusion. In India, the early efforts in high-temperature plasma research at the TIFR were abandoned in the 1960s. However, Vikram Sarabhai picked up the threads again when he assembled a group in PRL in the early 1970s with Predhiman Kaw as its leader. I was the first experimentalist to join the group. The plan was to establish an experimental programme in plasma

physics, oriented towards the simulation of space plasma phenomena. However, there was an unstated purpose of eventually acquiring the skills necessary for fusion research.

In 1982, the Department of Science & Technology, realising the importance of starting an Indigenous fusion research programme, established a Plasma Physics Programme in PRL under its “Intensification of Research in High Priority Programmes”. PPP grew into the Institute for Plasma Research (IPR) in 1986. Within three decades, India acquired an international presence in Plasma Physics and its diverse applications. For example, it is a partner in the International Thermonuclear Experimental Reactor (ITER) project, a device to prove fusion’s viability as an energy source. Many students learn fundamental and applied plasma physics and theory and experiments. All this began with the Tokamak ADITYA, and I have been fortunate to have been on this journey.

The ADITYA concept developed under two conflicting demands. Being the first Tokamak to be built indigenously with no direct help from experts, it had to be reasonably straightforward in engineering terms. On the other hand, a contrary view was that

being a late entrant to the field of tokamaks, Aditya had to be complex enough to be capable of doing exciting experiments. This dichotomy led to various conflicts on the scale and complexity of the machine.

The project team for building the machine had the following constitution: Y. C. Saxena and Dhiraj Bora (magnets and structure), N. Venkata Ramani (Vacuum System), S. K. Mattoo (Diagnostics) and I in charge of Power Systems. Predhiman Kaw, an internationally known plasma physicist and the Director of IPR, led us through many tutorials to initiate us into the physics of tokamaks. I had seen Versator tokamak at MIT close hand thanks to an invitation of my colleague Prof. Abhijit Sen to visit him in Boston. Versator, with its picture frame coils and a capacitor bank, looked to be quite doable.

To acquire a first-hand assessment of the engineering support we could get in India, we visited BARC Central Workshop, BHEL at Hyderabad and Bhopal, L&T, IBP Vacuum Division, Kamani Cop- per in Baroda, and many other places. Discussions with L&T convinced us that a torus formed out of four welded quadrants was a feasible engineering concept. The Vacuum Group in BARC also thought that this concept made sense.

There was no history of large aperture high current wound magnets in India. So, we thought magnets formed out of brazed copper plates would be a sound concept in magnet design.

Predhiman used to say that the Princeton Plasma Physics Laboratory, where he had worked, could do great plasma experiments because it had the best power supply in the world. So, as project leader for Aditya Pulsed Power System (APPS), I ensured to meet Aditya's peak power demands of 500 MVA with an average demand of 50–60 MVA.

We could draw Pulsed power from capacitor banks, and we had some competence in this. However, the Capacitor Bank for Aditya's total capacity turned out too large to be viable. Procuring Energy Storage Capacitors also was problematic.

Princeton and most other Fusion Labs had Flywheel Generators where mechanical energy is stored in massive flywheels and extracted in high-power, short-duration pulses. We started to think in that direction. Unfortunately, importing such machines was not possible due to the 1974 US sanctions. Predhiman and I visited BHEL Bhopal to explore the feasibility of the indigenous development

of such devices. We were discouraged by the projected timescales.

What was left was the power grid. The idea of directly tapping the electricity grid to draw a large quantity of power transiently to energize the tokamak magnets and drive the plasma current was radical in 1982. The Joint European Torus (JET) in the UK was the only Tokamak currently using Grid Pulsing. Our power supplier was the Ahmedabad Electricity Company. Their total power capacity was inadequate to meet our demand.

We knew that the Gujarat Electricity Grid was powerful even in those days. So, we started talking to them. Pulsing the GEB grid to extract 50 MVA (enough to power a small town) for a few seconds was an idea that made GEB very uncomfortable.

Tata Consulting Engineers did extensive grid impact simulations to convince GEB of our sanity. What finally convinced them was the promise of massive tariffs from the 50MVA peak power demand! GEB agreed to lay a 132 kV line from Ranasan to the IPR site at Bhat, for which we had to pay.

The heart of the APPS was the Ohmic Transformer, an Inductive Energy Storage system that stores magnetic energy. The disruption of the

inductor current provides the high-voltage pulse necessary to create the toroidal voltage loop to produce the plasma and drive a high plasma current. We chose AEG, a German Company, to supply the APPS. Their design stood out for its overall simplicity. Charles L Neumeyer from Princeton helped us in the final decision-making.

We had a design review of Aditya at the Texas University in Austin organised by Swadesh Mahajan. Experts listened to our design presentations. The general comment was that the design was sound but that we were being very ambitious in our first machine.

The ADITYA subsystems were engineered by 1987, and we did the machine assembly the following year. The Assembly and Commissioning team used to work from early morning to mid-night with an erection team for almost a year before the machine got assembled.

ADITYA was a system with electrically active components like magnetic field coils distributed over large volumes. We decided to do an impulse test on the coil systems to assess their vulnerability to electrical failure. The first attempt produced a shower of sparks all over the machine. The faults

took almost a month to identify and seal electrically until the machine became breakdown-proof.

At last, by early 1989, the machine was ready for commissioning. Unfortunately, the primary 50 MVA transformer failed due to an accidental short circuit of the secondary distribution system. The transformer had to be sent back to Bangalore for repair. The repair was to take almost a year. We were heartbroken.

The delay was too long and unacceptable. So, we found a plan B. Sathyanarayana, Yogesh Saxena, Harshad Pujara, K. K. Jain and I decided to build a multistage capacitor bank to energize the ohmic transformer. A combination of capacitors charged to different voltages is switched sequentially with ignitrons to realize an initial high loop voltage surge followed by a lower sustaining loop voltage.

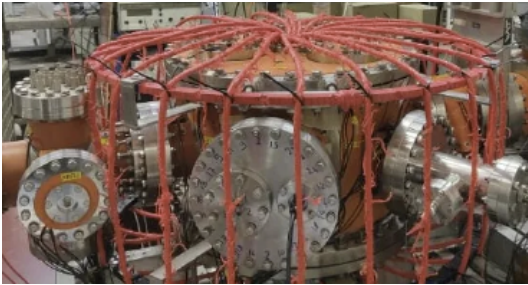
We had never built a capacitor bank of this complexity before. But the system worked beautifully. A capacitor bank thus generated the first plasma in Aditya, a concept we had abandoned favouring a more versatile Grid-driven power system. In the International Conference in Plasma Physics, held in Delhi in 1989, we could declare that ADITYA was operational after a seven-year effort.



Capacitor Bank discharges were a quick way to learn plasma control. We became experts at producing high-quality, repeatable discharges quickly. APPs came into full-fledged operation in a year, and we went on to regular Grid-driven power shots without much problem. Later, we strengthened the 50 MVA Transformer by adding an external inductance to make it sturdier by increasing the impedance.

I believe that designing, building, and operating ADITYA was a great challenge and an excellent opportunity for learning and developing teamwork. Among its many unique achievements, it has India's most advanced ultra-high vacuum system with a large deployment of turbo mechanical pumps. ADITYA has India's largest pulsed power system and the first inductive energy storage system. It is the only power consumer tapping two different power grids and the only power consumer that measures its power consumption.

## 23 Experiments with Electron Plasmas



In the late eighties, while struggling with erecting and commissioning ADITYA, India's first tokamak, I found

relaxation in thinking about the behaviour of dense clouds of electrons confined in electromagnetic traps. They exhibit collective effects like waves, instabilities and self-organisation and are plasma-like. John Malmberg and his co-workers at the University of California in San Diego pioneered studies on the fundamental properties of linear columns of electron plasmas, like equilibrium, instabilities, transport, vortex dynamics, relaxation to thermal equilibrium, cryogenic transition to Coulomb crystals, etc. I found their work fascinating, in the simplicity of the experimental device and the elegance of the experiments.

We found no reported work on the physics of non-neutral plasma rings trapped in toroidal devices. A torus is a cylinder bent into the shape of a hollow ring. We speculated that strong toroidal effects

should occur if the radius of the cylinder and the ring become comparable. This appeared to be a virgin territory, with the opportunity to do novel experiments. We built a device with a central conductor inserted into a cylinder along its axis. The current carried by the central conductor created a ring-like magnetic field. Electrons were injected into this by rapidly raising the toroidal magnetic field. The trapped electron cloud exhibited collective properties. Purvi Zaveri presented the first results on the formation and existence of equilibrium of a very low aspect ratio non-neutral plasma ring at the International Conference in Plasma Physics held in Delhi in 1989.

The first paper on the equilibrium features came out in the prestigious Physical Review Letters in 1992, the first paper in experimental plasma physics from India to appear in that journal. Interesting complementarity between charged non-neutral plasmas and current-carrying neutral plasmas, like the capacitive effects replacing inductive effects etc., are discussed in the paper.

I remember two incidents connected with talks I gave on non- neutral plasmas. The first one happened in Indore when I gave a talk at the Annual

Conference of the Plasma Science Society of India at the Centre for Advanced Technology in Indore in 1991. The Hindi newspapers from Indore promptly reported that “Scientists had discovered unnatural plasma”. The other incident relates to an invited talk I presented at the 1992 International Conference in Plasma Physics in Innsbruck. Among the audience was Prof. John Malmberg, the pioneer of non-neutral plasma research, who complimented me on the novelty of our approach.

In Sameer Khirwadkar’s work, we invented a method of plasma formation based on the modification of the vertical drifts into closed diocotron drift trajectories by combining the self-consistent space-charge electric field with an externally applied radial electric field. Unlike earlier experiments that used time-varying magnetic fields to transport particles and form toroidal clouds, we could access the inward-shifted toroidal equilibria in a steady state. Furthermore, the finite resistivity of the wall may also play a role in the formation of the cloud through this mechanism which

is essentially the capacitive analogue of the trapping of current-carrying electron beams in toroidal cavities due to magnetic energy loss. These

results also appeared in a paper in the Physical Review Letters in 1993.

The turbulent birth of toroidal non-neutral plasmas by cross-field transport in a rising magnetic field was a fundamental difference from the near-equilibrium placement in the Malmberg trap. This method also limited the number of electrons injected into the trap. Therefore, we speculated that the plasma formed by injection parallel to the magnetic field would be more quiescent. However, to do this in a torus, the filaments would have to be placed inside the drift space; the torus would no longer be closed. As a result, some theoreticians believed that there would be no equilibrium. We, the experimentalists, thought otherwise.

Sambaran Pahari built this device. A circular tungsten filament loop placed on a poloidal cross-section emits thermionic electrons when heated. A negatively biased grid placed in front of the filament is pulsed positively to extract electrons parallel to the minor axis. Another grid collector set behind the filament in the poloidal cross-section is biased negative. As the toroidal magnetic field, established by pulsing a current through a multi-turn coil, reaches its flat top, the injector grid is pulsed

positively to extract electrons along the field lines. After that, the grid reverts to negative bias, stopping further fueling. The injected electrons are now trapped toroidally between the negatively biased injector grid and collector grid.

Experiments in SMARTEX-C (Small Aspect Ratio Toroidal EXperiment-C shaped) have led to observing several novel features of toroidal electron plasmas. These plasmas have intrinsic confinement properties and unique mode structures in the limit of a small aspect ratio. The experiments and their interpretation by Sambaran and Hari Ramachandran demonstrate that rotational trans- form due to self-electric fields and a purely toroidal magnetic field can lead to significant confinement in toroidal geometries. To the best of our knowledge, the confinement time is the longest reported so far in the absence of an external electric field. In the limit of a small aspect ratio, due to strong toroidicity, the self-consistent electric field induced on the inner wall is sufficiently strong to make any external force field redundant.

SMARTEX-C has brought to the forefront several novel properties and, with it, the urgent need to further address these issues with new experiments

and theories. The compressibility of fluid in the presence of a strong inhomogeneous magnetic field brings an entirely new perspective. All of this may bring a paradigm shift in the investigations of toroidal electron plasmas. In particular, the amplitude saturation and frequency evolution warrant a further understanding of the evolution of the vortex. Efforts to confine toroidal electron plasmas have stood the test of time and made significant strides in the last decade. With the recent results on confinement, the traditional transport theories have been put to the test.

Interestingly, a series of large aspect ratio toroidal traps have also emerged in the last decade. A stellarator has succeeded in holding the plasma for 100 ms on nested flux surfaces, while one that employs dipole fields has achieved more than 100 sec. Much of the recent motivation and interest in toroidal traps seem to follow from the possibility of creating electron-positron pair plasmas due to the expected lack of instabilities in such plasmas and because of their relevance to astrophysical objects. Amidst all

this SMARTEX-C has a unique role to play as the assumed incompressible nature of the fluid is

expected to break down in the presence of strong toroidicity. With recent advancements and promising results, it remains to be seen if thermal equilibrium can also be achieved in toroidal traps as in cylindrical geometries.

Non-neutral plasma experiments were conceptually simple but required high technological skills and support to make them work. The persistent commitment over the years and exceptional skill shown by Purvi Zaveri, Sameer Khirwadkar, Sambaran Pahari, and Lavkesh Lachwani contributed much to the success of the experiments. In addition, the perceptive understanding of the electron cloud dynamics developed by Predhiman Kaw, Avinash Khare, Hari Ramachandran and Ganesh based on their deep knowledge of plasma physics played a crucial role in creating a coherent account of the physics of non-neutral electron clouds trapped in toroidal traps. Studies of toroidal non-neutral plasmas continue at IPR.



## 24 Commercializing Plasma Technology



In the early 1990s, during a lull following the commissioning of the Indian Tokamak “ADITYA” at the Institute for Plasma Research (IPR), the

idea of converting our rich experimental knowledge base created over two decades of producing and manipulating plasmas to industrial applications appeared attractive. Moreover, plasma science seemed to offer unique and novel opportunities in high-energy-density and high-value-added material processing.

Plasma processing exploits plasma as an industrial tool. Plasma can respond to external electromagnetic energy fields and transport energy. Setting up internal self-consistent electric and magnetic fields enhances fluid properties, resulting in collective effects like flows, waves, instabilities and self-organisation. Each species may have an independent energy distribution, not necessarily in equilibrium with other species. The internal energy is

composed of thermal, electric, magnetic and radiation fields, whose relative magnitudes allow the plasma state to exist in vast, multi-dimensional parameter space. Properties like high chemical reactivity, microscopic electric fields, sheaths, radiation and particle flux mediate plasma processing. Plasma-based manufacturing integrates the plasma-material interaction phenomena with the manufacturing process. The technology adds value to conventional materials and makes new materials and processing techniques possible by exploiting the characteristics of both the equilibrium and non-equilibrium plasmas.

The Plasma Processing Programme at IPR had some unique features not encountered in basic research. The necessity for it to be relevant to the industry, the fact that it can make or lose money in its commercial exploitation, the contractor-client relationship with industries etc., are some examples. It was the first time in India that a research institute ventured into a commercial application programme. So, the business plan evolved and matured along with our learning curve. The programme had to be industry-driven to make it agile and responsive to rapid changes and focused on a few thrust areas

where the immediate impact would be possible. Financial self-reliance was a goal from the beginning.

The first foray was into plasma nitriding because of the interest shown by several industries. Nitriding is a process in which Nitrogen is incorporated into the steel matrix to increase hardness. The prototype was a cold-wall furnace with only plasma heating. We added heat shields to minimise heat loss and increase thermal efficiency and uniformity. We obtained the auxiliary heated hot-wall reactor by actively heating the vacuum vessel with a heating element. We also added automation and computer control to build state-of-the-art systems during this time.

Plasma Nitriding became the first technology to be transferred to industry. In addition to this, we set up a job shop to do nitriding of high-value components like plastic dyes, etc., on a commercial basis. Work on many other applications like thermal plasma processing of zircon sands, anodic vacuum arcs, plasma ion implantation etc., followed this. The zircon dissociation was our first foray into thermal plasmas and plasma torches.

In 1997, we moved our activities to the industrial area in Gandhinagar. The primary reasons

for this were the relative inaccessibility of IPR being an institution under the Department of Atomic Energy and our concern that the grand settings would give an impression to the customers that the plasma technology would be equally exotic. As a result, the Facilitation Centre for Industrial Plasma Technologies (FCIPT) came up in a rented building in the industrial area of Gandhinagar to act as a bridge with industry.

We consolidated all technology development, demonstration, incubation, and commercialisation activities. FCIPT had a multi-disciplinary group of physicists, material scientists, chemists and engineers and infrastructure for process and instrumentation development for plasma technologies.

FCIPT is a pathbreaker in India in converting physics-based research into commercially and societally valuable devices and processes. We can:

- nitride industrial components like precision moulds and hydro turbine parts, reaching defined hardness and case depth values.
- synthesise large-area optical quality reflective and anti-reflective coatings using Plasma Enhanced Chemical Vapour Deposition.

- deposit super-hydrophobic fluorocarbon films on surfaces with expanding plasma jets, making them slide without friction.
- create high enthalpy flows to test material properties at high temperatures.
- densify, spheroidize or segregate ceramics in in-flight high-temperature plasma jet reactors and produce aerosols and nanoparticles.
- texture Angora wool in atmospheric pressure cold plasma to enhance the spinnability of the yarn.
- destroy medical waste with a 95% volume reduction and un- undetectable levels of dioxins.

We transferred technologies to industries by supplying complete process plants manufactured by FCIPT. We developed an atmospheric pressure dielectric barrier discharge system to produce large-area helium-free cold plasma. As a result, continuous streams of Angora wool fibre can be introduced and retrieved after treatment. A technology demonstration unit for Angora wool farmers has been functioning at Kulu in collaboration with the Wool Research Board and the Government of Himachal Pradesh.

Another development relevant to the brassware industry in India is a Technology Demonstration Plasma Polymerization reactor in which plasma dissociates a monomer containing silicon to form thin silicon dioxide coatings on finished brassware, providing a tarnish-proof lifetime protective coating. The brassware manufacturers in Moradabad are using the unit for the final finishing treatment of their products.

We developed a plasma treatment process for tyre valve stems made of brass to release Zinc, which interacts with Sulphur in vulcanised rubber to form brass-rubber solid bonds. This durable rubber-brass bond has a high resistance to dynamic and thermal ageing, typical in its use in automobile and truck tyres. We scaled up the process to treat more than 600 pieces per batch, necessary for industrial-scale exploitation by a manufacturer of these valves. In addition, this process is environmentally friendly compared to the conventional treatment, which uses chemicals and acids for the procedure.

In September 2000, I got an opportunity to participate in the third conference on “Physics and Industrial Development: Bridging the Gap” in Durban, South Africa. The meeting was the third of a series of

biennial conferences initiated by the Commission on Physics and Development (C13) of the International Union of Pure and Applied Physics (IUPAP) to empower physicists in developing countries to foster physics-technology bonds in developing countries. I described the IPR initiative in establishing links with the Indian industry for developing and commercializing advanced plasma-based industrial technologies. There were many participants from developing countries who found this initiative very inspiring.

Plasma processing has transcended conventional material processing applications into waste destruction, environmental remediation, water purification, flue gas treatment etc. It is emerging as an enabling tool with a broad spectrum of applications relevant to modern industrial society. Even after two decades, the spirit of innovation thrives in FCIPT. A cold plasma system to treat high-density polyethylene (HDPE) has been developed for the Central Institute of Plastic Engineering and Technology, Ahmedabad, for the inline processing of HDPE. An inline plasma treatment facility to treat synthetic textiles with plasma at the rate of 30 to 40 metres per minute has been supplied to the Man-

Made Textile Research Association (MANTRA) for innovation in the textile manufacturing process. We have developed an atmospheric pressure plasma system for food processing with continuous feeding of the food material. Nano-powder production technology has been transferred to the private industry. A plasma pyrolysis / Gasification system to dispose of the liquid solvent waste and generate useful fuel gas has been installed at CSIR-CSMCRI, Bhavnagar.

On 30th October 2021, FCIPT became one of the 'Atal Incubation Centres' as a part of the 'Startup-India' mission. As an AIC, it would support the nucleation and growth of startups based on plasma-based technologies in India and utilise the multi-disciplinary team of scientists, academics, students and industry representatives. Its location in the GIDC industrial zone is an added advantage.



## 25 The FCIPT Venture



I have an entrepreneurial streak: finding technical and knowledge resources to solve problems. I have accepted

challenges and risks as part of my professional life. While working at the Institute for Plasma Research (IPR) in Gandhinagar, I decided to start a programme to develop and market industrial applications based on plasma physics in a commercially viable manner. This activity was laden with many risks.

It was the first time in India that a basic research institute ventured into a commercial application development programme. So, there were no precedents or practices I could take guidance from. No pre-existing models of similar activity were available in basic research organizations in India. So, the business plan had to be developed ab initio, hoping that it would evolve and mature along with our learning curve.

The programme had to be industry-driven to make it agile and responsive to rapid changes. It focused on a few thrust areas where immediate impact would be possible. Financial self-reliance was a goal from the beginning.

The Plasma Processing Programme had some unique features not encountered in basic research. For it to be relevant to the industry, the acceptance criteria applied to the products ready for marketing were stringent, and the market was always brutal in making sure that the criteria were amply met. That it can make or lose money in its commercial exploitation, and the contractor-client relationship with industries, etc. are examples of the uniqueness of this type of activity.

The capital for this activity was the rich experimental knowledge base created over two decades of producing and manipulating plasmas to support research at the Physical Research Laboratory and the Institute for Plasma Research.

Plasma-assisted manufacturing exploits plasma as an industrial tool. Plasma can respond to external electromagnetic energy fields and transport energy. The fluid properties are enhanced by the particles setting up internal self-consistent electric and

magnetic fields, resulting in collective effects like flows, waves, instabilities, and self-organisation. Each species may have an independent energy distribution, not necessarily in equilibrium with other species. The internal energy is composed of thermal, electric, magnetic and radiation fields, whose relative magnitudes allow the plasma state to exist in an extended, multi-dimensional parameter space. The non-equilibrium state drives thermodynamically unfavoured chemical reactions.

Plasma processing was surging internationally with the realisation that the fourth state of matter offers unique opportunities for material processing. Properties like high chemical reactivity, microscopic electric fields, sheaths, radiation, and particle flux mediate plasma processing. The technology adds value to conventional materials and makes new materials and processing techniques possible. The characteristics of both the equilibrium and non-equilibrium plasmas can be exploited for commercial uses. Comparable stature of international and indigenous capability in this field was a rare opportunity for leadership in an emerging field.

The first lesson that I learned was the importance of scale and identity. We had started the

activities at IPR, which is an autonomous institute under the Department of Atomic Energy. It is a very affluent institute in a set-up which had great grandeur. The focus of the Institute was thermonuclear fusion research with the Tokamak Aditya. Seen against that, our activity was perceived by the visitors from industry as nothing more than a pastime to release the stress created by the actual work, which was fusion. I realised our activities had to be seen by the industry in a more authentic, industry-like set-up. We moved into a spacious and modern building vacated by a manufacturer of videotapes in the Gandhinagar Industrial Estate. We named the centre the Facilitation Centre for Industrial Plasma Technologies (FCIPT).

While developing technologies ab initio, it was necessary to go through the learning cycle. However, to have a product in a reasonable time, we had to speed up the learning process by compressing the development phases. For example, in developing a state-of-the-art Plasma Nitriding facility, we started with conventional DC glow discharges stabilized with external ballast resistors. Later, we incorporated pulsed DC.

The first prototype was a cold wall furnace with only plasma heating. Heat shields were added to minimize heat loss. By allowing a thermally insulated liner to reach elevated temperatures, we increased thermal efficiency and temperature uniformity. By actively heating the vacuum vessel or the liner with a heating element, we obtain the auxiliary heated hot wall reactor. Heating of the workpiece is obtained by the combination of plasma heating and radiation and convection heating by the wall. During this time, we also added automation and computer control to build state-of-the-art systems.

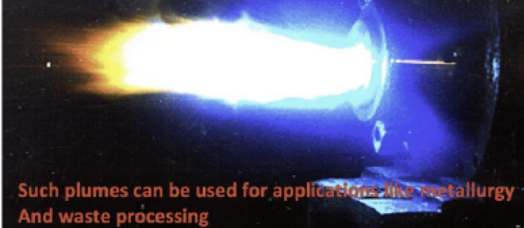
In process technologies it was essential to build up an extended database on the application process for different materials. The nitriding process cycle for all varieties of alloy steels had to be prepared through a very tedious learning programme. We also learned that technology lies in the unglamorous details. I had prepared a long list of questions for which we needed credible answers before we could claim mastery over nitriding technology. How do we distribute the workpieces so that the temperature is uniform or how we can control the microstructure are two of many such questions. To go through this learning process without spending a lot of our

money, we offered the nitriding technology on a job-shop basis to manufacturers of plastic dies and automobile products. This was the first revenue stream.

FCIPT has the unique distinction of being a path breaker in India in converting physics-based research into commercially and socially valuable devices and processes. The Centre, bridging the Institute with the industry, has developed and spun off many technologies. The Department of Atomic Energy sees some of these as societally relevant technologies of considerable developmental value. While India emerges as a knowledge economy, for FCIPT to realise its full potential, it is being converted into a knowledge-based company. This transition will be timely and rewarding in the context of the Indian economy pursuing the “Made in India” and “Atmanirbhar India” programmes in manufacturing and strategic spheres.

## 26 Healing the Hospitals

Plasma Torches can produce plasma plumes with Temperatures of the order of 10,000 degree K



Such plumes can be used for applications like metallurgy And waste processing

An international scandal involving a vast intra-European traffic in medical waste originating from France and

culminating in eventual redistribution in other European markets in the late 1980s led to the resignation of the French minister of health. The world was shocked to recognise the magnitude of the medical waste disposal problem.

India is no stranger to such horror stories. Recycled syringes and quilts packed with used surgical cotton have a thriving market. In 1991, Pioneer reported a well-knit racket operating from the backyards of the All-India Institute of Medical Sciences in Delhi transporting syringes to Meerut. Pathogens of deadly diseases like hepatitis B find a ready and fertile breeding ground in the piles of undisposed medical waste.

Public concern over the disposal and treatment of medical waste has resulted in increased regulations and court actions on a global scale. The

basic reason is the phenomenal growth in the quantity of medical waste generated in the hospitals, attributed to the growing use of disposable, as precautions against exposure to infectious diseases such as AIDS and in general to the growth of medical and public health facilities. The generators include hospitals, clinics, and medical research facilities. A rule of thumb for medical waste production in affluent countries seems to be 1 kg per bed per 8-hour shift.

Historically, landfilling was the most preferred means of disposal of medical waste. Public opposition and positive correlation with groundwater contamination have resulted in this option steadily going out of favour. Burning the waste material in the open air can never be complete, with small quantities of many organic and chlorinated organic compounds as well as pathogens surviving and leading to the dispersal of dangerous diseases that can spread through the air.

Incineration is the most popular method of medical waste disposal. About 85% of medical waste is incinerated, while only 6– 15% is waste that requires special handling and disposal. The essential problem of incineration is that the generation of heat



is determined by the chemistry of combustion. Efficient combustion demands airflow far above the stoichiometric requirement. The very high flow rate generates airborne pollutants and limits the attainable temperature. The effectiveness of incineration, measured in terms of the destruction and removal efficiency is low. The performance of the emissions control equipment to meet the stringent requirement of safe disposal is poor.

PVC (Polyvinyl Chloride) plastic, which contains chlorine, constitute many of the disposable products used in health care. When PVC products burn, they serve as a primary source of chlorine for dioxin formation. "Dioxin" refers to a family of compounds that can form when chlorine combines with organic material in a reactive environment. Dioxins and related chlorinated organic compounds are potentially toxic substances that produce a remarkable variety of adverse effects in humans and animals at low doses. These compounds are persistent in the environment and accumulate in magnified concentrations as they move up the food chain, concentrating on breast milk. Dioxin is known to be carcinogenic, interacting directly with DNA through a receptor-based mechanism.

In the late 1990s, the Technology Information Forecasting and Assessment Council (TIFAC) approached IPR to develop a Plasma Mediated process for medical waste destruction. With dramatic developments in high-temperature plasma sources, plasma technology can be applied to highly toxic waste and the final products can be harmless gases. The abundant flux of ultra-violet radiation in thermal plasma can dehydrogenate organic chlorine. The reactors can process gaseous, liquid, and solid materials.

Plasma-based medical waste treatment is an extremely complex technology since it must contend with extreme temperatures and a corrosion-prone environment. The process depends on complex pyrochemistry resulting in toxic and dangerous products. It deals with high volume, low packing density waste with a non-standard composition consisting of a variety of plastics, organic material, and liquids. Compliance with environmental emission standards is difficult. There are capital and operating cost constraints imposed by inferior competitor technologies.

Being an internationally competitive technology with very high commercial stakes, critical information

on many crucial aspects -both in basic science and technology -is not easily available. No peer group with expertise in this field exists within India for consultations on problem-solving. Under a development programme with intense time pressure, many problems will have to be solved concurrently with development.

The workhorse of plasma-based waste destruction technology is the plasma torch. Plasma torches are electrical discharge plasma sources with the plasma extracted as a jet through an opening in the electrode and out of the confines of the cathode-anode space. The inherent thermal and electromagnetic instabilities of the arc column are stabilised by forced gas flow along the current path. Interaction with a guiding wall or external magnetic fields also stabilises the plasma. DC arc, RF and microwave plasma sources can be converted into plasma torches. Plasma temperatures can easily reach tens of thousands of degrees and high-enthalpy gas flows get generated in large volumes.

The driver for the development of plasma torches was the space race in the 1960s. Missiles re-entering the atmosphere create shock-ionized air plasma. Laboratory simulation of these conditions

was necessary for the development of materials capable of withstanding the searing heat of re-entry. Arc systems can generate re-entry conditions using clean, high-enthalpy gases at high stagnation pressures. Many of the present-day plasma torches are derivatives of the plasma jet sources built for this application. The plasma torch is now meeting the need for intense heat sources for waste treatment.

Pyrolysis is the thermal disintegration of carbonaceous material into fragments of compounds in an oxygen-starved environment. The presence of charged and excited species renders the plasma environment highly reactive, which can catalyse homogeneous and heterogeneous chemical reactions. When the process is optimised, the most likely compounds to form are methane, carbon monoxide, hydrogen, carbon dioxide and water. The high temperature and high enthalpy inhibit the formation of hydrocarbons.

The product gas is high in hydrogen and carbon monoxide, with traces of methane, acetylene, and ethylene; therefore, it can be combusted very efficiently resulting in carbon dioxide, nitrogen and water vapour being the only gaseous exhaust to the atmosphere. The slag is a homogeneous, silico-

metallic monolith with leachate toxicity levels orders of magnitude lower than those of current landfill regulations. Emission and leachate results demonstrate convincingly that plasma gasification is a far more environmentally friendly method of disposing of waste than any competing technology. Plasma gasification provides more than a 95% volume reduction ratio of slag to input material. Other technologies typically offer an 80% reduction.

The prototype plant was built by Ganesh Prasad and Sudhir Nema using a conventional plasma torch and was installed at the Gujarat Cancer Research Hospital for field trials. For ruggedness and energy efficiency, we decided to use an in-house developed graphite electrode plasma torch. A commercial version of a Plasma Reactor came after a series of prototypes built to improve the reliability of the system. We installed this in the Goa Medical College in 2000. Manohar Parrikar, the then Chief Minister of Goa, came to see the facility and complimented our team for the good engineering of the plant.

Conventional plasma torches require large gas throughput to stabilise the arc, resulting in product gas dilution and a reduction in energy efficiency. We have innovated the graphite torch, exploiting the gas

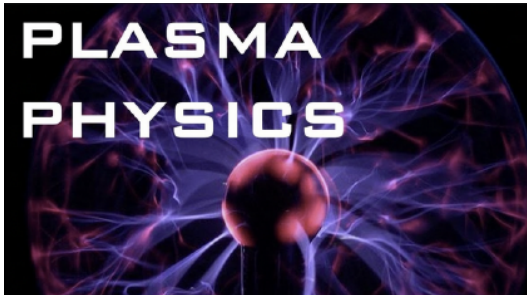
generation in the pyrolysis of organic matter. An inline suction pump sucks the product gas and sends it through a filter to remove soot particles. It is then fed to the plasma torch. We had a 35 % gain in energy efficiency with this torch. It also increases electrode life by reducing the electrode erosion rate. We received a Patent for the Endogenous Gas Feed concept in 2007.

After the successful trial of the system in the Goa Medical College, the Department of Science and Technology sponsored a programme of demonstration of this technology by installing several plasma systems all over the country, including one at the Shri Chitra Institute in Trivandrum. Many systems enabled extensive field trial of this technology. The technology was transferred to several manufacturers.

The final battle that Pyrolysis Technology had to fight was with the Regulatory Bureaucracy. The powerful incinerator lobby had put in many obstacles in the path of CPCB declaring Pyrolysis as an approved technology for medical waste destruction. This battle was finally won with the issue of a Gazette notification in 2016 approving Plasma Pyrolysis for medical waste destruction.

Plasma pyrolysis technology is one of the many societally beneficial applications developed by FCIPT. One important lesson that we learnt was that it was relatively easy to master the development of technology, but very difficult to fight the battle with entrenched forces which resist the introduction of advanced technologies, citing various reasons. Even government departments sometimes become part of these retrograde forces.

## 27 A Fascination With Plasmas



For a theoretical plasma physicist, plasma is an abstraction without a persona. However, for an

experimentalist, each plasma has an identity, blood and bone and character. An RF plasma is distinctly different from a DC plasma.

During a recent, long flight to Delhi en route to Aligarh Muslim University, where my encounters with plasmas began as a PhD student, I began to think of all plasma avatars that I have encountered.

Plasma is pervasive in the sense of an extremely extended parameter space in density, temperature or chemical reactivity. No other medium can provide temperatures or energy densities as high as plasmas. No other medium can excite atomic and molecular species to radiate as efficiently. No other medium can be arranged to provide comparable transient and non-equilibrium conditions.



My thesis work required a plasma with a time-varying density. To realise this, I excited the plasma with a high-power amplitude-modulated RF generator. I made a capacitive discharge with large copper plates bent to hug the glass discharge tube. I measured the plasma density and temperature with double probes inserted into the glass tube.

A critical requirement of a project to simulate the conditions of the Electrojet region of the ionosphere was to have a plasma with a variable density gradient. We used two coaxial annular plasma columns using RF discharge in an axial magnetic field. The relative densities in the axial columns could control the radial density gradient.

For experiments with ion acoustic waves, we built a large plasma device to study waves without the boundary effects. The plasma was produced by many filaments heated by a DC power source. The filaments, biased negative relative to the chamber, produced a low current arc supported by the thermionic emission from the filaments. The result was a well-behaved, uniform plasma filling the chamber by infusion of the plasma made at the radial boundary.

To produce fast-moving plasma streams for an experiment on plasma-neutral gas interaction, we built a coaxial plasma gun powered by an energy storage capacitor bank. The discharge of the capacitor banks with homemade spark gaps made the experiment rather noisy. The plasma stream impinged on a neutral gas cloud formed by the release of gas into a vacuum through a fast-opening gas valve.

For the experiments on injecting an intense 30 kA electron beam into a preformed plasma, we developed a gas-injected washer plasma gun. The washer stack made of brass formed a distributed cathode with a grounded anode at the exit. A seven-stage capacitor pulse-forming network with a pulse width of  $7.6\ \mu\text{s}$  excited the plasma stream.

The long-awaited tryst with fusion plasmas began with the commissioning of the ADITYA tokamak in 1989. The heart of the tokamak was the Ohmic Transformer, an Inductive Energy Storage system that stores magnetic energy. The disruption of the inductor current provides the high voltage pulse necessary to create the toroidal voltage loop to produce the plasma and drive plasma current. We built a multistage capacitor bank to energize the

Ohmic transformer. A combination of capacitors charged to different voltages is switched sequentially with ignitrons to realize an initial high loop voltage surge followed by a lower sustaining loop voltage. In the International Conference in Plasma Physics, held in Delhi in 1989, we could declare that ADITYA was operational after a seven-year effort.

An electrical corona is a low-density plasma which forms when electric fields intensify at a sharp point and cause the ionization of air. On nights, one can observe coronas on high-voltage electrical lines. The crown-like appearance gave it the name. This plasma source demanded a complex instrumentation in the shape of a repetitive nanosecond pulse generator for driving the corona discharge pulses. A practical way of getting high-voltage rectangular pulses of a width of less than one microsecond is with the help of a pulse-forming line. A PFL has the capability of providing a flat-top rectangular pulse with a fast rise time. We built a coaxial double-Blumlein high-voltage pulse generator with a sufficiently fast rise time and good voltage gain. The generator is of very low cost and is compact and easy to make. A fast-closing switch is necessary

for achieving fast rise time and rotating spark gap switches turned out to be the most appropriate.

My forays into plasma-based industrial applications allowed me to experiment with a variety of plasmas formed for the specific purpose of the application. These included abnormal glow discharges in Nitrogen-Hydrogen mixtures for plasma nitriding and very low-pressure plasma formed by an anode with an extremely constricted area.

A thermal plasma formed by driving a discharge in a flowing Argon gas between a hot tungsten cathode and three consuming graphite anodes formed very large plumes for applications like Zircon reforming and alumina spheroidization. This was our first experience with hot thermal plasmas. The consumable anodes requiring no water cooling made the torch very energy efficient. A similar configuration was used later for building a plasma pyro lysis system.

A microwave plasma torch had a quartz tube inserted into a waveguide through which high-power microwave radiation propagated. A spark would initiate a brilliant thermal plasma in the high-speed gas flow through the glass tube.

We jumped into ambient pressure non-equilibrium plasmas when work on surface texturing Angora rabbit wool fibres demanded cold plasma jets. These jets are driven by repetitive pulse trains exciting a gas flow through narrow glass tubes. Such jets were also used to create plasma-activated water by creating Reactive Oxygen and Nitrogen Species by immersing the jet in the water.

I believed that a student working for his Ph D degree should earn it in the hard way, right from building his experimental device, making it work, planning and doing experiments and writing papers using the results. This was the surest way for him to be an independent scientist and from what my former students have evolved into, this belief is quite vindicated. Another conviction was that the experiment should not be so heavily instrumented that the hands-on feeling essential for fundamental research should not be lost. Another pet conviction was that he should find unconventional problems to work on so that the results would have the chance of being novel. Finally, the experiment should be fun; playing with the plasma state as it were!

The transient sheath evolution resulting from an instantaneous pulse of the negative voltage

applied to the electrode was a topical problem. The basic assumption in all these models is that the conduction current alone is significant. However, in an expanding sheath, the displacement current due to changing electric field is significant. The general conclusion seems that in the rising part of the pulse the contribution from the displacement current is substantial.

Subroto Mukherjee, my student, took up an experimental study to ascertain the role of displacement current in the sheath expansion. In the experiment, a large negative bias is applied to a disc electrode immersed in a uniform plasma and the attention is focused on the flat-top phase of the pulse where the applied voltage is constant. The total current collected by the electrode is recorded as a function of time. The results are explained in terms of a model where the expanding sheath is regarded as a variable capacitor.

In an expanding sheath, the electric field changes with time even when the applied voltage is constant because the sheath plasma interface penetrates in the plasma starting from the ion matrix sheath thickness and the effect of the resultant displacement current must be considered. This can

be elegantly done by considering the sheath as a variable capacitor with varying thickness. We have experimentally measured the electrode current as a function of time during the flat top of the voltage pulse. During this phase, the contributions from the displacement current in the sheath are significant.

Electrical charging of objects is a ubiquitous phenomenon observed during exposure of a macroscopic body with a plasma. The charging takes place because of the energetic electrons impinging on the object. When the object is immersed in plasma the ions present around the object will tend to neutralize the electrostatic potential developed at the surface. As a result, the peak potential will be governed by the response time of the opposing charge species present inside the plasma.

Shantanu Karkari studied the charging mechanism of an isolated electrode immersed in a collision-less, non-equilibrium plasma, through irradiating its surface with a 100 ns pulsed electron beam. The pulse duration of the electron beam must be shorter than the ion response time, which is typically 200 times slower than that of background electrons. The electron beam generator has been optimised to operate in the pressure range, which is

two orders in magnitude lower than the conventional operational pressure range by providing a differential gas flow through the entire discharge tube. This has been achieved by an electromagnetically operated gas dosing valve which can deliver a pre-requisite amount of gas into the discharge while the background gas pressure inside the entire chamber did not get affected during the experiment.

These activities, where students could pursue small experiments and get trained in experimental work, performed an important function in both the Physical Research Laboratory and the Institute for Plasma Research. Many second-generation Plasma Physicists in India, trained through basic research programmes, formed the human resource base necessary for carrying out the present and future fusion research programmes.

Plasma is star stuff. When I explained this to a member of the Jaipur royal family, who came on a visit to the laboratory, he insisted that I make him a plasma globule which he could keep in his mini temple at home. He, being a Suryavanshi, thought it only appropriate that he had a sample of the Sun at home.



## 28 Travels for Science



Institutions like PRL and IPR have a liberal policy about allowing their faculty members to attend international

conferences for presenting papers on their research work. In the sixties, with the activities in space research flowering, “join PRL and see the world” became a reality. There were associated jokes about the excessive fondness of certain faculty members for foreign trips. We would ask them as to when they would be visiting India next.

However, these trips were for official work, albeit this meant sitting through talks and presentations, attending meetings, asking questions and chatting with colleagues about their work. In between this work, or in the evenings, one tries to grab sometime to see the sights and landmarks. Or, in my case, art museums.

My first trip abroad in 1974 was to present our research work on the simulation of electrojet instabilities. The place was Lubbock, a small town in

Texas, and the home of Texas Tech University, which organised the conference. I was the only person from India. The meeting was not remarkable except for the great interest shown by the faculty in setting up collaborative programmes with our institution.

From Lubbock, I travelled to Los Angeles to work for a month with plasma physics group led by Ken MacKenzie, famous for MacKenzie buckets which are plasma sources created by lining vacuum chamber walls with permanent magnets of alternating polarity to suppress plasma electron losses. Visiting the same group at that time was Noah Hershkowitz from University of Wisconsin who later founded The Journal of Plasma Sources and Technology. It was an intensive learning experience for me to interact with the active groups of UCLA involved with several basic experiments. Rainer Stenzel took me along to the Thompson Ramo Wooldridge factory to show me his contract research facility. This was my exposure to how big industries fund research in areas which they consider important for their future growth. I also had an opportunity to have a detailed talk with Frank Chen, the author of the bestseller "Introduction to Plasma Physics". I would use the weekends to visit Minnu's

sister, Lalu, settled in San Diego. The trip takes 4 hours by the Greyhound bus. Along with Lalu's family, we would go around the city. One such trip included visiting the Disney land, which was a great novelty.

Many more trips of this type happened, mainly to Europe and the US. A trip I remember fondly was attending the IEEE Plasma Science conference of May 1977 in the Rensselaer Polytechnic in Troy, NY. After the meeting, I was to go to the University of Tennessee to meet Prof. Igor Alexeff to finalize writing a research proposal for submission to the National Science Foundation, USA. Igor had a car, and we did that trip driving through the beautiful countryside of Maryland, Virginia and Tennessee, taking a halt in a motel and visiting the famous Luray caverns.

When the NSF sponsored collaboration happened with Prof Charles Wharton from the Cornell University as the as the partner, I visited the University for an extended stay. The campus at Ithaca is very beautiful, with small hillocks and streams. The town was quaint and was a short walk from where I stayed. I had many discussions with Ravi Sudan, the leader of the theoretical Plasma Physics group and Prof Fleischmann who was

involved in experiments on magnetic field reversal using intense electron beams.

1982 was the heady year for us because of the beginning of the Plasma Physics Programme. Attending the 1982 International Conference on Plasma Physics at Goteborg, Sweden to talk about our dreams was great fun. I reached Goteborg after a trip to Cornell University connected with the NSF supported collaboration with them. Heathrow airport had extremely high security because of the Falkland war. The meeting was organized by Chalmers University of Technology. We had great fun, discussing the concept of ADITYA tokamak with experts on small tokamaks. The presence of Swedish royalty in the Conference luncheon was a highlight. Another trip which is still vividly in memory is the one made in November 1994 to attend the International Conference on Plasma Physics held in Foz do Iguacu, Brazil. The sight of the 100 ft Iguazu water falls at the border of Brazil and Argentina was breathtaking. As scientists, we started to calculate the total energy stored in the fall. Witnessing the solar eclipse which happened during the period of the conference was another excitement.

In the late 70s, The International Centre for Theoretical Physics (ICTP) in Trieste, Italy used to hold summer schools in Plasma Physics. These were to help increase the interaction between scientists from developing and developed countries. I attended a few of these along with many Indian colleagues. In 1984, I attended a summer school and had the privilege of giving a talk on the Indian programme of building the ADITYA tokamak. I remember this specifically because Prof. Abdus Salam, the founder director of ICTP, called me to his office to convey his congratulations to India for taking up this challenge.

One trip stands out for its unpleasant memories. I was invited to be a part of a delegation led by Dr P K Iyengar of the Atomic Energy Commission to visit institutions in Moscow and Leningrad (St Petersburg). In the train to St Petersburg, I lost my traveler's cheques while sleeping in the train. I had to spend quite some time with the police in St Petersburg lodging complaints and so on.

In the 80s and 90s, before the coming of the internet, most Indian scientists were not networked well with their foreign counterparts. Conferences gave them an opportunity to talk about their work.

Meetings charge the intellectual battery, broaden one's horizons and help develop friendships and contacts.

Attending conferences is an important component of research work. They provide the opportunity to get feedback on a paper, to get informed about the work of others, and to talk to colleagues to exchange ideas. A relaxed atmosphere and being away from the office can promote creativity. You get to know about preliminary results on a work which has not yet been published. These ideas can be great inspiration for your own research.

Scientific conferences fit a pattern. New ideas and concepts are presented, criticized and accepted into the body scientific. The atmosphere is mostly pleasant, except when a radical idea is thrashed brutally. If the idea survives, it is accepted as the new paradigm. A miniature version of Thomas Kuhn's "Structure of Scientific Revolutions".

After all these travels I have come to realize that air travel leaves no impressions, being effectively cut off from the world for most part of the journey. Having become a utility, it has lost its romance. There is little interaction between passengers, each immersed with his own concerns. Airports have

become vast, shopping malls filled with chain outlets and ill-behaved travelers. The ever-present threat of terrorism has turned them into fortifications. Charles De Gaulle airport in Paris handles two lakh passengers per day. In that crowd you lose your identity as you drift with the flow of the vast, unwashed masses.

## 29 Travels with Children



My elder son Joseph, who worked with Roche Diagnostics, was transferred to Switzerland in 2009. He set up a house in Cham near Zurich in

2009. In one of my trips to Aix for the ITER meetings, I decided to take a bus to Nice and catch the Nice to Zurich flight to visit them. Nice is the primary gateway to the French Riviera. Tucked neatly in the southeastern corner of France, the French Riviera is laced with a scenic coastline punctuated by homes of Hollywood film actresses. The route along the Mediterranean can be described as one of the most scenic.

My younger son Thomas was selected for post-doctoral research at the Scripps Research Institute in San Diego. San Diego is a pleasant city with considerable Hispanic influence. I visited the town in 1974 during my one month stay at UCLA in Los Angeles. Minnu and I visited Thomas and Shanti for a month in late 2008.



Visiting Prof. Devendra Lal, my former boss at PRL, a Professor at the University of California at San Diego, was quite enjoyable. When I called him up, he insisted that my family and I should spend a day with him. He had the characteristic childlike excitement when he showed us his lab and explained what he was doing. First, he took us to the aquarium, a vertical jar containing a school of fish. The fish were constantly spiraling around. This led to a discussion about the direction of twirling, the quintessential Lal who saw science in everything around him.

Visiting the memorial of Juan Rodriguez Cabrillo at the lighthouse at Point Loma in San Diego gave birth to a poem 'Point Loma' inspired by a Chinese historian I met there who told me about the miserable lives of the transcribed Chinese labourers who built the railroad. Minnu was pleased to visit her sister Lalu after a long separation. Lalu is a U.S. citizen settled in San Marcos with her extended family.

La Jolla cove, home to harbor seals and California sea lions, is a great attraction. La Jolla Village is a beautiful, coastal neighbourhood of the City of San Diego in San Diego County, which has many beautiful homes on the dry side of the street.

La Jolla Village (commonly referred to by locals simply as 'The Village') is a small and tightly knit beach community home to historic buildings, grand hotels, fabulous restaurants, smaller quaint eateries, a variety of shops and art galleries.

The Maritime Museum of San Diego enjoys a worldwide reputation for excellence in restoring, maintaining and operating historic vessels. As a result, the museum has one of the world's finest collections of historic ships, including the world's oldest active ship, Star of India. The boat used in African Queen by Humphrey Bogart and Katherine Hepburn was one of the exhibits.

Three of my young IPR colleagues, Srinivasan, Raju Daniel and Hitesh Pandya, working with the DIII Tokamak at General Atomics on an assignment, visited me. We had a hearty chat far away from IPR. Their hair-raising adventures with a car assigned to them by G.A. made good listening.

Minnu and I visited Joseph's family in Switzerland in 2009. The trips included visits to Salzburg, the home of the great music festival. The Swarovski museum, with its brilliant collection of glass-ware, was a high point. Finally, we drove into Innsbruck in Austria to commemorate my earliest

visit to this town to attend the International Conference of Plasma Physics in 1992.

Later on another visit in 2014, we decided to take a train trip to Paris. 488 km apart, Paris Gare de Lyon is only 4 hours from Zurich thanks to TGV Lyria, which covers this distance at an incredible speed. It is a smooth journey with onboard food and all other comforts. The usual tourist attractions like the Louvre Eiffel Tower were covered.

Ever since I had read Dan Brown's Da Vinci Code, the legend of Mary Magdalene and her association with Camargues by the Mediterranean had fascinated me. During another visit to Cham in 2018, Joseph suggested a road trip to Camargues through Leon and Aix en Provence in France. This was 800-odd kilometers, taking about 12 hours.

We broke the journey at Aix, stayed overnight and drove the next day to Camargues. Aix is a place I regularly visit in connection with my responsibilities with ITER. The 19th-century post-impressionist painter Paul Cézanne lived and worked in Aix. Its boulevard Cours Mirabeau is one of the most beautiful boulevards. The street is lined by towering trees, creating a stunning tunnel effect, and along the road are countless cafes, restaurants, and shops. The

Atelier Cézanne, the studio in Aix where Cezanne created much of his works, is open for visitors. In addition, we passed by the site where the ITER tokamak was under construction.

The legend of the Maries of the Sea originated in Camargues. The village of Saintes Marie de la Mer, Maries of the sea, is the chief attraction. This is a place for pilgrimage for believers of the legend of the Maries: Mary, sister of the Virgin, and Mary, mother of St. James and St. John. Together with their black servant, Sara, they escaped persecution in Judaea about 40 C.E. and landed in the Camargues Coast in a frail craft. There are legends that a pregnant Mary Magdalen also travelled in this group, which formed the staple of the Da Vinci Code, a novel by Dan Brown. Today, the statue of St. Sara, a major figure of the Gypsy cultural tradition, is in the crypt, to the right of the altar. One can also see a pagan altar from the 4th century B.C. in the church. Once a year, in the second half of May, the Gypsies gather to venerate their Saint Sara-la-Kali - "Sara the Black" who guards the Romanies wherever they live. Thousands of gypsies reach the place, making the town appear to have gone back to the Middle Ages.

Seeing children grow up to assume significant life responsibilities gives great satisfaction to any parent. Seeing them set their own goals, motivate themselves, and work hard to reach these goals gave me great happiness. You also discover the pleasures of bonding with the grandkids. Travels with my children to these exotic places strengthened our familial bonds, shared values, and understanding of each other.

## 30 India Joins ITER



Thermonuclear fusion reactions power our Sun and the stars. The physics of nuclear fusion began to be understood in the 1920s when British

astro-physicist Arthur Eddington suggested that stars burn bright due to the energy released from the fusion of hydrogen to form helium.

By the 1950s, scientists started to replicate the process of nuclear fusion on Earth. The hydrogen bomb was the result. Soviet scientists Andrei Sakharov and Igor Tamm proposed a less destructive approach in 1950: a magnetic trap to confine the hot plasma for fusion. This concept was the Tokamak, which became the most successful. Academician Evgeny Velikhov sold the idea of international cooperation in building a Tokamak fusion reactor to General Secretary Gorbachev.

At the Geneva Superpower Summit in November 1985, Secretary Gorbachev proposed the idea of a collaborative international project to

develop fusion energy for peaceful purposes to U.S. President Ronald Reagan. Within a year, the European Union, Japan, the Soviet Union, and the USA agreed to jointly pursue the International Thermonuclear Experimental Reactor (ITER) design. Conceptual design work began in 1988, and the final design for ITER was approved in 2001. The People's Republic of China and the Republic of Korea joined the Project in 2003. E.U. began to encourage other countries to join.

In India, earlier efforts in high-temperature plasma research at the Tata Institute for Fundamental Research were given up in the 60s. However, Vikram Sarabhai picked up the threads again when he assembled a group in PRL in the early 1970s. In 1982, the Department of Science & Technology, realizing the importance of starting an indigenous fusion research programme, established a Plasma Physics Programme in PRL under its "Intensification of Research in High Priority Programmes". PPP grew into the Institute for Plasma Research (IPR) in 1986. Within three decades, India acquired an international presence in Plasma Physics and its diverse applications.

An opportunity for India to join the international efforts in building ITER came when Sir David King, the Science Adviser to the British government, visited India in March 2004. In mid-2004, India made a formal request to join ITER. Indian Collaboration in ITER was mooted at the Indo-E.U. Summit in November 2004.

Following this, an ITER mission visited the IPR and other centres in October 2004 to appraise India's competence in fusion research and industrial capabilities relevant to ITER. They visited Mumbai and Bangalore to appreciate India's industrial, engineering and software strengths. The report of the ITER exploratory mission on India was considered at the 2005 October ITER negotiations meeting in Chengdu, China, which identified a series of steps that needed to be taken by the parties to enable a decision on India. After the next ITER meeting in Vienna on November 7, India was directed to apply formally to the ITER parties for joining the consortium.

In the 2005–2008 period, numerous trips happened in connection with India's bid to join the ITER project. The process of being approved for the partnership happened in a series of negotiation



meetings held in Cadarache near Aix en Provence in France.

The Indian delegation was led by Dr Ravi Grover from the Department of Atomic Energy. Prof. P. K. Kaw, Director IPR was the scientific leader. Many colleagues from IPR and DAE were members of the Indian delegation. The meetings were extremely formal.

The Air France flight to Paris leaves Mumbai at midnight connecting the early morning flight from Paris to Marseilles in a small aircraft. Aix en Provence is 50 km from Marseilles in Southern France. Aix lies on the right bank of the Arc River, and the main routes to Italy and the Alps pass by it. It has a colourful history going back to Roman times when a military camp called Aquae Sextiae was built in 123 BCE. Aix flourished as a centre for learning under the rule of the dukes of Anjou. The University of Aix-Marseille was founded in 1409. In 1486 Provence came under the French crown.

Paris flights often had celebrities. ITER travels were done in the business class and hence proximity with them was usual. On one of the flights, Amitava Ghosh, Gyan Peeth awardee and the author of *Hungry Tides* and the *Ibis* trilogy sat beside me. I had

read all his books and hence it was not difficult to strike up a conversation with him.

The final meeting of negotiations took place in a bitterly cold December of 2005 in South Korea, on Jeju island, a traditional destination for honeymooners. This meeting was to finalize the major points of the agreement on the joint implementation of the ITER project. The Indian delegation included N. Parthasarathy, our Ambassador to S. Korea. Key issues such as intellectual property rights, cost-sharing and in-kind contributions were cleared. As a result, India was admitted as a full partner early in December at the ITER meeting at Jeju Island in Korea.

After India acceded to ITER, I became a member of the ITER Council and the Science and Technology Advisory Committee (STAC) representing India. I was also a member of a subcommittee on Resource Estimation for ITER of the Management Advisory Committee (MAC).

Fulfilling my mandate involved further trips. But now, the destination began to shift to other places. A meeting took place in June 2009 in Mito in Japan, a city one hour away from the Narita Airport by train. Mito has art shops resplendent with the prints of

Hokusai, the great Japanese master who created the 'The Great Wave', block-prints of Mount Fuji, with a palette of indigo and Prussian blue.

The following year, we had another Council meeting in Suzhou, China, known for its pristine UNESCO-designated gardens dating back to the 11th century and its ancient waterways. Unfortunately, being a two-day meeting, we were busy with work and had little time for sightseeing.

The assembly of the ITER machine has begun at the Cadarache site. Indian domestic agency ITER-India is committed to deliver 9 in-kind packages that includes Cryostat, Cryogenic System, In-wall Shielding, Cooling Water System, Electron Cyclotron R.F. Heating System, Ion-Cyclotron RF Heating System, Diagnostic Neutral Beam System, and Power Supplies. Most recently, the largest component of the ITER reactor, the giant vacuum Cryostat was dispatched. It was made in Gujarat by L&T and shipped to France; it weighs over 3,800 tonnes.

Attending the ITER meetings was a great learning experience. These were memorable trips, though burdened with the serious task of ensuring that India's interests were upheld. I saw how the national delegations, while fervently protecting their

interests, always made magnanimous concessions when the overarching interest was to create a unique international project that would usher in the energy for the future. I also saw our struggles to establish an indigenous fusion research programme being vindicated when the international community accepted our strengths and invited us to join a select club of fusion-faring nations.

From a modest start in the early 1970s, India has made great, largely self-reliant strides in experimental plasma physics. Competence in all fields relevant to magnetic confinement fusion devices has been demonstrated through the design, construction and operation of ADITYA and SST 1 Tokamaks. Joining the ITER programme is a demonstration of the international recognition of this competence.

## 31 Bridging the Gap



In India, research institutions are well funded. Money is generally not a problem in pursuing research; the lack of ideas and human

resources is. The situation in Indian universities is the converse. We have been very sensitive to this imbalance at the Institute for Plasma Research. My earlier association with Aligarh University strengthened this perspective, and I have taken many initiatives to correct this imbalance.

During the early days of the Plasma Physics Programme, it became apparent that capacity building in universities in plasma physics was essential to generate the human resource necessary for the development of future programmes. The first significant effort in initiating Universities into plasma physics research took place in 1984 when we organized a workshop on Plasma Physics Experiments in Universities under the sponsorship of the University Grants Commission. The basic idea

was to collect faculty members from universities with some or no prior background in plasma physics and motivate them to start working on basic plasma physics experiments. There were 45 participants from universities and other organizations and about 28 from PPP.

The workshop led to the Thrust Area Programme committee of the Department of Science & Technology initiating a programme to fund universities on nucleating plasma physics experiments. This became known as the Satellite Research project, satellite to the main task at PPP. The DST's Science and Engineering Research Committee (SERC) subsequently entrusted me with the organization of this programme. I conceived a pro-active programme of engaging academic faculty to prepare proposals for DST funding. Many different university groups, which are at present active in plasma physics, can trace their genealogy back to this initiation.

Later, with my growing interest in plasma processing, I conceptualized and managed the Cross-Disciplinary Plasma Sciences Programmes for DST, which helped nucleate research groups in universities and promote collaboration between

universities and research institutions. As Chairman of the SERC committee to implement this, I organized several inter-disciplinary workshops involving plasma, condensed matter and surface physicists, metallurgists, and chemists, coordinated the preparation of state-of-art reports, and developed procedures for evaluation of research proposals and funding them.

Research programmes linking plasma physics with other branches of physics, material science, chemistry, engineering and environmental sciences were identified and funded under this programme. The focus will be on basic scientific aspects, applications and technologies. Among the possible areas for CDPS activities, plasma-assisted processes in semiconductor manufacturing appear to be a promising and justified research activity. The first Target Group Meeting (TGM) on “PLASMAS IN SEMICONDUCTOR PROCESSING” was held at the Institute for Plasma Research on the 4th and 5th of January 1999. Twenty participants and experts from various universities/research institutes participated, and 18 proposals were discussed. The proposals covered diagnostics and modelling of plasma source phenomena, plasma surface interaction and

correlation of device characteristics with both source and surface interaction phenomena. Many of the recommendations had similar themes, and hence, possibilities of joint research were explored.

Development of cheap, indigenously built experimental systems was stressed and the development of computer modelling is indicated as an active area. The participants regarded the CDPS programme as a new, unique, focused and proactive way of spreading basic research in various branches of plasma science. The National Fusion Programme

With India's entry into the ITER project, a qualitative shift took place in our perception of fusion as a credible long-term option in the basket of futuristic nuclear technologies. While the specific details of the road map to energy from fusion will take time, preparations for acquiring the necessary competence in its scientific and technological skill and knowledge base must be initiated now, considering the long time scales demanded by such endeavours.

With participation in ITER, creating a human resource base for the future requirement of trained manpower in fusion science and technology became essential. Therefore, while IPR prepares to meet the



Indian commitment to ITER, it was thought imperative to conceptualize a long-term programme – a National Fusion Programme (NFP) - to acquire indigenous competence in all aspects of fusion science and technology. This will ensure that the country is ready to take up the construction of a demo reactor following the successful operation of ITER.

The programme is of a multidisciplinary, multi-institutional character, requiring expertise from various fields, ranging from the frontiers of fundamental science to advanced technologies. The research and development capability that will have to be nucleated in universities, academic institutions, national laboratories, and industries can be essential to realizing the NFP. Specifically, we must generate a community of fusion scientists and engineers, set up programmes for 'Balance of ITER' technologies, partner with industries as contributors to fusion technology and develop human resources.

The Board of Research in Fusion Science and Technology (BRFST) was conceived as the agency which will execute these functions and advise IPR on financial assistance to universities, academic institutions, national laboratories, and industries. The

charter of BRFST shall be to promote the nucleation and growth of research, development, and training of manpower in the field of fusion science and technology in universities and educational institutions through the award of research grants, support of training programmes, conferences and symposia and promotion of activities to increase collaboration between academia and the Institute for Plasma Research.

In association with Ravi Kumar, I developed the National Fusion Programme concept and established the administrative framework of BRFST for funding universities and educational institutions in basic research and human resource development in fusion science and technology.

India will learn 10% of ITER since we shall supply the hardware. The 'Balance of ITER' will have to be learnt through an indigenous programme covering core fusion technologies like fusion materials, fusion neutronics, RF and microwave power systems, power engineering, data acquisition and control systems, plasma diagnostics, robotics, superconducting magnets, and cryogenic technology etc. The National Fusion Programme (NFP) aims to acquire indigenous competence in all these fields.

The programme is multi-disciplinary, and multi-institutional. In broad terms, we must generate a community of fusion physicists, set up programmes for 'Balance of ITER' technologies, partner with industries and develop human resources. NFP programme is designed to extend and complement the IPR efforts in all fusion science and technology areas. Internal fine-tuning of the proposals and having IPR personnel act as coordinators ensure this.

To identify potential partners in NFP, we conducted roadshows at major universities, IITs and NITs across the country, highlighting the areas where IPR required collaborations in R&D. Once an interested collaborator picked up a project that was of interest to them, the collaborator from IPR would hold discussions with them and NFP to formulate the project proposal. This yielded good results, and faculty from over 40 institutions came forward and submitted research proposals in the same year, i.e., 2007.

A unique feature of NFP is its engagement with the industry to take up critical technology development efforts. The development of cryopanel using forming technology and the successful development of cryopumps and cryosorption

materials are good examples of such collaboration's benefits.

National Fusion Programme is aimed at broad basing the Indian efforts in developing Fusion Science and Technology by involving universities, other educational institutions, and industries to work with national institutions. The consequential creation of a community of specialists in plasma physics and associated material and engineering technologies would be an essential initial condition if India were to launch a credible fusion reactor development programme.

In a short period of 10 years, BRFST and later, Plasma & Fusion Research Committee (PFRC) funded over 200 projects with a total budget of ~ Rs. 55 Crores in a variety of areas of R&D that were of prime interest to IPR research goals. The beneficiaries of these funds ranged from Universities, Colleges, R&D institutions of CSIR, and Institutes like IITs and NITs across the country.

## 32 A Viennese Interlude



A train carrying Hindu karsevaks returning from Ayodhya was set on fire in Godhra in Gujarat on the 27th of February 2002. This

triggered terrible communal riots which lasted for three months. I was very depressed by the whole situation, including rumors about Government collusion and the callousness of people towards the events.

It was then that I received a call from the International Atomic Energy Agency (IAEA) in Vienna inviting me to take up a position as the Head of its Physics Department. The assignment was for eight months from September 2002. An American who was holding that position had decided to leave suddenly. I accepted the offer.

I assembled my wardrobe, considering both the severe winter in Vienna and the sartorial demands of my job (defined as an international civil servant), closed our house in Bopal and left for Delhi where

my son Joseph was stationed. I was to leave first and settle down and Minnu would join later.

IAEA, a UN Organization, is the world's foremost forum for scientific and technical cooperation in the peaceful use of nuclear technology. It contributes to the United Nations' Charter of Sustainable Development. It is the UN's watchdog to ensure that the member states honour their international legal obligations to use nuclear material and technology for peaceful purposes only. Teams from the IAEA had gone to Iraq to search for Saddam Hussein's "weapons of mass destruction".

IAEA came into being in 1957. In the 1970s, the Austrian Government provided a permanent residence called the Vienna International Centre (VIC) on the left bank of the river Danube. The iconic building of VIC on Wagrammerstrasse by the Danube was designed by the Austrian architect Johann Staber.

I was familiar with IAEA as I had many occasions earlier to visit and work there in week-long meetings. The Director of the division under which my section came was Dr. Sood, an expert on Radiation Chemistry, whom I had known from his BARC days. My job was to oversee the established

programmes and promote new programmes in Plasma Physics and Fusion Research. Co-ordination of the meetings sponsored by IAEA was part of the assignment. Liaison with agencies of similar interest, attending meetings and conferences and taking care of routine administrative matters were also in my charter.

Memorable meetings include the 19th Fusion Energy Conference held in October 2002 in Lyon, France, where I had to act as the Scientific Secretary. This is a biannual meeting of great heritage dating back to 1961 when the first meeting took place in Salzburg, Austria. The meeting with more than 500 participants reported significant developments in the performance of large fusion experiments, advances in critical technologies and new and innovative concepts.

Another event I enjoyed was the Workshop on Plasma Physics jointly hosted by IAEA and the International Centre for Theoretical Physics. This was a place I had visited in the 80s for the Plasma Physics Summer School held in November 2002. I also enjoyed a trip to Washington to represent the Agency at the Fifth Symposium on Current Trends in International Fusion Research. This allowed me to

visit my cousin, Dr. T. V. George (Thonipurackal, Puthupally), who worked with the US Department of Energy.

The major IAEA event is the General Conference where representatives of the IAEA Member States meet in a regular annual session. The purpose is to consider and approve the IAEA's budget and to decide on issues raised by the Board of Governors, the Director General and the Member States. With the General Conference, the IAEA regularly organizes a Scientific Forum on topics related to nuclear technology and science. The Indian staff in IAEA had an opportunity to meet with Dr. Anil Kakodkar, then Chairman of the Atomic Energy Commission.

The Agency played the role of godfather to the ITER Project through its early design phases. The ITER negotiations were carried out under the auspices of the IAEA. I used my stay at IAEA to gather information on ITER as there were informal discussions in our institute in those days on the pros and cons of being part of the international project to build a thermonuclear fusion reactor.

IAEA establishment offers shopping facilities to its staff and the staff of other international organizations based in Vienna. The Commissary



offers an international selection of foodstuffs and household items, thus catering to expatriate employees who may purchase familiar items that are not readily available in the host country Austria.

High-profile visitors to VIC were commonplace. I got an opportunity to hear Hans Blix, a former DG, on not finding the weapons of mass destruction allegedly possessed by Iraq. He was the head of the UN Monitoring, Verification and Inspection Commission from March 2000 to June 2003. In 2002, the commission began the search in Iraq for weapons of mass destruction but found none.

Responding to the IAEA Director General's request for ideas for new initiatives, I proposed the concept of 'Virtual IAEA: a digital history resource base'. I argued that the IAEA has no institutional memory as staff members come and go. I described how a retrievable collective institutional memory could be generated by compiling the memoirs of all the people who had an opportunity to work for the Agency. The idea was well-received.

After my wife Minnu joined me for a three-month stay, we decided that to sample the many wares of the city. Austria's capital offers a unique blend of imperial traditions and stunning modern

architecture. In addition, it is renowned for its cultural events, imperial sights, coffee houses, confectionaries, wine taverns, and exceptional Viennese charm. So, we used many random walks through the city using the Viennese facility of a single ticket valid for sub- ways, trams and buses.

Sacher-Torte, the classic chocolate confectionery, is a Viennese invention. So are croissants, associated with the period of failed attempts by the Ottoman Empire to capture the city of Vienna. During the Second Siege of Vienna in 1683, the Turks wanted to plant the Turkish crescent on Vienna's St. Stephen's Cathedral. A Viennese master baker named Peter Wendler created a crescent-shaped pastry to mock the Turkish crescent.

Belvedere Palace today houses the Österreichische Galerie, displaying the most extensive collection of works by Klimt (The Kiss) and Schiele. Vienna's prime landmarks are the gothic Stephansdom (St. Stephen's Cathedral), the Giant Ferris Wheel in the Prater, Vienna's old recreational park, and the Spanish Riding School with their world-famous Lipizzaner horses.

Vienna has many museums and galleries of international reputation: Kunsthistorisches Museum

with the world's most extensive collection of Bruegel paintings, MuseumsQuartier with the Leopold Museum, Museum Moderner Kunst (Museum of Modern Art), Architekturzentrum (Architectural Centre) and Kunsthalle rank among the city's most important cultural venues. In addition, the Albertina is home to the world's most extensive collection of graphic arts and prints (60,000 drawings, 1 million prints).

Inspired by all this art, I revived my passion for watercolor painting. Gordon Mackenzie's classic "Water Colorist's Essential Handbook", acquired in Vienna, revealed the mystery of "Wash", a technique of thoroughly wetting the paper so that paint would spread on its own, creating semi-abstract patterns. Armed with thick, absorbent Acquarello paper and watercolour tubes, I went on an orgy of wash painting. I gave away most of the pictures to colleagues in the Agency.

My interest in waste-to-energy technology made me take the time to visit the Spittelau incinerator. The plant processes around 250,000 tonnes of municipal waste every year. Around 50 % of the energy produced yearly from waste incineration stems from biogenic or renewable

sources. It produces an average of 60 GWh of electricity and 500 GWh of heating, supplying energy for 50,000 Viennese households (and heating and warm water for 60,000). It ranks as one of Vienna's most striking landmarks, with the huge golden ball on its chimney an integral part of the cityscape. The Municipal incinerator plants rarely become architectural highlights. Friedensreich Hundertwasser redesigned it in his unique style in the 80s after a fire destroyed the original structure built in 1960.

A poem I wrote recalls the daily train rides to office:

The train rumbles in; gleaming, sterilised; halts  
at Kaisermeuhlen, near where I work, I scramble in  
only to find crowded seats,

And hang on to the straps, a routine of many  
days. Comes Stephanplatz, where people get out

I too, must catch another train to reach home.  
The next one is empty, I can sit and relax

and look around with indifferent interest for  
that luxury in Viennese trains; smiles; rarely seen, let  
alone exchanged,

grim faces reflect on the cares of the world  
glazed eyes, in a trance, unseeing

stony faces seeking no response nor care,  
strangers we are and shall remain thus.

How deeply I miss the trains of my country  
dirty, dusty and eternally late

jostling crowds make way for you get in

and smilingly invite you to share their world

in the cacophony of a thousand conversations  
and the carefree laughter

booming at some joke and in sharing a handful  
of chana passed around

as you lose yourself as stations flash by.

Two Malayali names stand out in my memory  
of the Vienna days. James Pazhayadath, working in  
the administrative section, went to great lengths to  
make my stay in Vienna pleasant. We found that we  
share a common interest - books in Malayalam. I was  
impressed by his perseverance and motivation,  
which helped him to build a beautiful home in the  
suburbs and convert the compound into a mini-  
Kerala. Another friend was Dr Alexander Verghese,  
an economist with UNIDO. I recall many pleasant

weekends at his home, meeting many people, including the Indian Ambassador Sri Srinivasan.

My brief stay at the IAEA was great for educational and cultural reasons. I discovered closely how high-profile international organizations work. I learned how to resolve conflicts in meetings with participants from nations with conflicting ideological and political leanings. I knew at close hand how e-office functions. I made friends with people from all nationalities. It was a great learning experience.

### 33 My Life as a Manager



I have spent much of my scientific career at the Institute for Plasma Research in Gandhinagar, India. I started as a pure

academic who fulfilled Nicholas Butler's definition of a specialist: "An expert knows more and more about less and less until he knows everything about nothing."

As an academic, I guided students in research and help them become independent scientists. In that role, I had to build their confidence and make them believe they were leading the research.

In addition to the purely academic role, a good part of my work was involved with the execution of time and resource-bound projects, where one must take the role of a manager. As a project manager, I was associated with building complex engineering entities involving advanced technologies like pulsed electrical power, intense magnetic fields, ultrahigh vacuum systems etc. An example is India's first fusion device, ADITYA, commissioned in 1989, which

produced plasma at a temperature of 5 Million degrees. In fulfilling this task, I had to work together with hardware suppliers, erection contractors, staff engineers and peers to get the work done.

The second type of activity where execution was crucial involved developing plasma-based industrial technologies. I developed commercially and industrially valuable applications of Plasma Physics. This activity has led to setting up a Centre bridging the Institute with the industry in Gandhinagar, where many technologies have been developed and spun off. The Department of Atomic Energy, our administrative department, sees some of these as technologies of considerable developmental value.

The fourth activity covered work relevant to capacity building and skill development in Universities in Plasma Physics and Fusion Technology by motivating University faculty to prepare projects and help fund Universities to nucleate and grow research in these areas. This followed India's entry into the ITER project, and it was thought imperative to conceptualize a long-term programme, a National Fusion Programme (NFP), aimed at acquiring indigenous competence in all aspects of fusion



science and technology by supporting Universities to initiate research and development activity is plasma diagnostics and fusion technologies.

The fifth activity was related to India partnering with six nations to build ITER, the world's first thermonuclear fusion reactor. I was involved in negotiations prior to joining ITER and later had a role in fulfilling India's commitment of hardware delivery to ITER. As a member of the ITER advisory committees, I also dealt with several scientists from other countries while ensuring that Indian interests were protected.

We manage various resources. The physical resources are money, time, space and people. Skills like communication skills, technical skills, and intellectual skills are valuable resources. Foremost among these is the skill to execute projects on time. Management is all about execution. People can make or break your plans. Time is the most precious resource, and lost time is irretrievable.

Here are the ideas which I have gathered in this role:

1. Developing advanced technologies has many dimensions. It has more to do with men and society than with machines.

Organising men and systems and solving interface problems is the key to any high-technology development programme.

2. The most important resource is people, and a manager must know how to deal with them and build up cohesive work teams. The greatest motivator is success. If you want people to remain motivated, you must ensure that they achieve success in what they are doing. For this, you must remove all obstacles in their path. The barriers are usually administrative, constraining rules, lack of facilities, lack of human resources, workplace politics, delay in decision-making, etc.

3. Grand successes are great, but they take time, and people are generally impatient. Hence it is essential to set modest success targets, realizable in a few months. A skilled manager must know how to break down large tasks into achievable baby steps.

4. Progress must be advertised, and information disseminated widely. I have used Email, websites and newsletters for this. People like to be informed about what is happening. Another motivator is fame. If a person does

something well, make sure that he gets the ownership and that others know about this. Finally, the greatest de-motivator is credit due to a person being denied to him. Equivalent to this is the denial or delay of formal recognition through promotion etc.

5. When work is assigned, especially to new and inexperienced people, a process of mentoring is essential. Mentoring can be formal, through instructions on how the work is to be done, through self-study assignments or informal discussions and brainstorming.

6. Trust and transparency in your engagement with the people working with you are essential. If they think you have a personal agenda different from the common good, trust gets broken, and performance suffers.

7. Good people are not satisfied with what is assigned to them formally. They want to dabble in many things over and above the routine. Encourage this, subject to making them realize that the fulfilment of primary responsibilities has priority. A person constrained in a limited sphere is likely to

become frustrated or become an uninspired automaton.

8. Autonomy is essential for creative people. However, people who demand freedom are often reluctant to pass it on to those below them. So, a democratization of the autonomy principle is essential.

9. Do not expect people to come and report to you on their progress. A practice I followed involved a daily tour of the work centres and holding informal discussions on how the person is coping with the work.

10. Overall progress must be monitored through formal periodic reviews when work is assigned. A person left strictly alone either feels lonely or unwanted. Therefore, a measure of his progress, which he cannot gauge himself, must be provided through these interactions.

11. Work review should not be like a confessional, involving only the worker and the boss. Instead, it should be an open process involving all relevant people. In such circumstances, claims would be more realistic, and the person reviewed knows that what he has achieved and not achieved are in the public

domain. Further- more, during these reviews, everyone must be given a chance to talk about their work. There is nothing more frustrating than being denied a chance to talk about one's work.

12. Aggressive criticism while reviewing work can have adverse effects. Criticism must be balanced with proactive engagement and appreciation of the good points of the work under review.

A few words on schedule management. There are many professional techniques like the Gantt chart and mind mapping. I have learned that the best way to do this is to use an Excel sheet. I list all the tasks associated with a project in great detail in the vertical column. The horizontal rows record the progress of the job. If it is on my computer, I can often look at it and see where follow-up is required.

A final lesson learnt is this. Audits and reviews by external experts cannot fundamentally change the performance of organizations and groups of people. Such reviews can only bring the malaise to the surface. Fundamental change can come about only through self-critical internal analysis or change of critical personnel.

## 34 Remembering Predhiman Kaw



I met Predhiman Kaw for the first time in 1972 when I joined the Physical Research Laboratory. I had the task of setting up a plasma physics

laboratory from scratch. Over the years, this activity grew and developed into the Plasma Physics Programme in 1982, funded by the Department of Science and Technology to initiate fusion research in India by building the Aditya tokamak. In 1984, this became an autonomous Institute for Plasma Research which, in addition to the original fusion experiment, blossomed into many activities in plasma physics, fusion technologies and applications. The Steady-State tokamak programme started in the mid-1990s, was another quantum jump in scope and extent. In 2008, we saw India joining the ITER and the Institute setting up a Domestic Agency for overseeing the Indian contributions to ITER.

My association with Predhiman continued through all these transitions. I have seen him in

many roles; as a great plasma physicist, as a powerful motivator, as an interpreter with great clarity of thought, as a person with deep philosophical and spiritual moorings, as a clever and nuanced strategist, and above all as a person with a grand vision of India's role in fusion and plasma physics.

Predhiman was an outstanding scientist with a broad range of research interests and a prodigious research output spanning over 389 papers in international journals. His early work at Princeton during 1967–71 resulted in seminal contributions to nonlinear problems connected with laser-plasma interactions. From 1971–75, while he was at PRL, Predhiman extended the theory of parametric instabilities to magnetised plasmas.

Prof. Kaw received many honours and awards during his illustrious career, starting with the Indian National Science Academy's Young Scientists Award of 1974. In 1985, the Government of India honoured him with Padma Shri; in 1986, he received the SS Bhatnagar award. Recently, he was named the 2015 laureate of the Subrahmanyan Chandrasekhar Prize for "outstanding contributions" in the field of plasma

physics by the Association of Asia Pacific Plasma Physics Societies.

We collaborated on an experiment to study non-neutral plasma clouds. We analyzed the electron cloud using potential probes and found that we formed a toroidal cloud of electrons hugging the central conductor and proved that equilibrium does exist. The paper we wrote on this was published in the Physical Review Letters and was the first experimental plasma physics paper to appear in that journal from India. Predhiman's perceptive understanding of the electron cloud dynamics played a crucial role in developing a coherent knowledge of the strong toroidal effects in the behaviour of electrons in such a system. Furthermore, we brought out the strong complementary aspects between current-carrying neutral plasmas and charged non-neutral plasmas, and this was substantially due to Predhiman's deep knowledge of plasma physics.

Predhiman strongly believed that science should be pursued with complete freedom. When we started to plan the IPR buildings, we had endless discussions on how the buildings should reflect this. The buildings do give one a sense of liberation. The



wide corridors, openness to the sky and the surroundings, and oneness with nature are all embodiments of this conviction. It also turned out that we were rather free with the budget, which indeed raised many bureaucratic eyebrows.

Predhiman's unique capacity to absorb knowledge from all sources was evident when we built Aditya. Together we went on a grand tour of India to visit industries and assess how they could contribute to the engineering of the Aditya Tokamak, which was ambitious as a first fusion device. He had a childlike curiosity to understand how large mechanical components would be machined, how high current copper windings would be made for

a transformer, how precision welding was done etc. As a result, he acquired an engineering knowledge in a few months that every experimentalist learns over a lifetime. The fact that Aditya went into operation, despite many teething problems like the failure of the main power transformer etc., is a testimony to his skill in growing a team of experts and making them work together and systematically solving problems.

After Aditya got into routine operation, I became interested in exploring commercial

applications of plasmas. Although there were criticisms that this was a deviation from the original charter of the institute, Predhiman was wholeheartedly in support of pursuing this path. This completely complies with his belief that any interesting idea should be pursued with full vigour. We soon established a Plasma Processing Programme, which evolved into the Facilitation Centre for Industrial Plasma Technologies. The fact that it was the first time in India that a basic research institute ventured into a commercial application programme also meant that we could not learn the rules from experience. Predhiman again played a crucial role in ensuring that the learning process was sound, and the practices conformed to good management principles.

In India, research institutions are well funded. Money is generally not a problem in pursuing research; the lack of ideas and human resources are. The situation in Indian universities is the converse. Predhiman has been very sensitive to this imbalance and has taken many initiatives to correct this. He convinced the Department of Science and Technology to establish a programme called Satellite Research Projects for funding universities in plasma

sciences research. This and its later forms, such as the Cross-Disciplinary Projects in Plasma Sciences, have been instrumental in nucleating research in plasma physics and applications in many universities, some of which have grown to large centres. These are the forerunners to the later and ambitious National Fusion Programme, where universities and educational institutions are funded rather well to take up fusion-related research and development work.

We pursued many ideas; the Thursday Circle was one. The idea was to have meetings discussing issues relevant to society and life. This was put into practice at IPR for quite some time. While visiting BARC, we discussed converting physical movements like walking or random movements of our arms into electrical energy. We also set up small experiments to pursue this.

I would also like to say something about the critical role played by Predhiman in ensuring that India became a member of the ITER programme. This involved, in one part, a campaign within the Indian science establishment and concerned ministries to convince them of the importance of fusion technology from a long-term perspective of India's

energy security. There was an equally important aspect of convincing the existing ITER partners of India's potential to be an essential contributor to the ITER programme. Predhiman was the de facto leader of the Indian team, which participated in the presentation of the formal proposal for Indian membership in ITER and the negotiations in Jeju. His persuasive skills were very evident in these meetings.

Predhiman's critical role in giving direction to ITER in its early years is worth mentioning. He was the chairman of STAC, the ITER's Science and Technology Advisory Committee; the conscience keeper of ITER, making sure that there is no compromise in the final scientific and technical objectives of ITER. However, to ensure this in ITER, where the politics is even more convoluted than the technology, is a Herculean task. Nevertheless, there is a full realization within the ITER system that Predhiman did a fantastic job resolving many complex STAC issues and helping ITER formulate its technical specifications.

## 35 Remembering Mani Iyer



Mani Iyer walked into our life when we moved to Bopal, a suburb of Ahmedabad, where I had built my house. He was the CEO of a pharmaceutical company and was instrumental in setting up Amrutha Blood

Centre, the first commercial blood bank in Ahmedabad. Despite being a hardcore businessman, he had a wide spectrum of interests, and we found resonance in many; books, films, Kerala, people and their idiocies and idiosyncrasies and above all, food. He would occasionally drop in for a chat. The return visits invariably ended with a homage to Dionysus. Mani excelled in propitiating that god with many-splendored offerings.

Mani's wife Prema is also a person of many talents: a maker of exotic food, a collector of antiques and a person interested in books and art.

Our families have spent many hours in exotic eateries of Ahmedabad. I remember her joy when I presented her with prints of Gustav Klimt when I returned from a year-long stay in Vienna.

We spent many hours discussing our children. When my son, Thomas working at the Scripps Research Institute in San Diego sent me a copy of their paper describing their work on solving one of biology's neatest little tricks — how a cell's outer membrane pinches a little pouch from itself to bring molecules outside the cell inside without making holes that leak fluid from either side of the membrane. I showed it to Mani who got as much excited as I was. He immediately sent it to Dr Rustom Modi who headed their strategic research to look for an application. I watched their children's academic growth with a great deal of interest. When Ivan, their elder one joined a course in JNU on Art History, I was delighted.

When Mani floated his venture capital company, InCube Ventures, which was the first company to be recognized by SEBI as a social venture fund, he insisted on my becoming one of the directors. I was reluctant to do this because of my earlier unhappy experience with Indian Plasma

Systems, a company to which IPR had transferred know-how on Plasma Nitriding. The complexities of the financial structure of the venture capital business that he tried to make me understand also played some role in my reluctance to take up the task. Finally, we agreed on my being a Mentor to the company to advise them on the technological viability of some of their ventures. We also talked on many occasions about inducting FCIPT, the technology centre which I had set up in IPR, into the start-up incubation system. This never took off because I had already retired from IPR and had left for Kerala. One of our pet ideas was to set up a think-tank in Ahmedabad.

Incube Ventures set up an incubation centre in Ahmedabad where a dozen ideas led by young and committed entrepreneurs are nurtured, seed-funded and guided through their maturity.

They are provided with the right platform to explore new business ideas, validating and strengthening the ideas & resources thanks to legal/secretarial, financial (seed/angel funding) and marketing professionals available under one roof. An incubate could use extensive mentoring using the network resources. This would also serve as a space

to evolve new businesses, through concept testing, commercialization and performance testing leading to accelerated commercialization of new technologies.

After I returned to Kerala, I used to meet him off and on during my periodic visits to Ahmedabad in connection with my consultancy work with IPR. Finally, he insisted on sponsoring a trip for my wife and me for the celebration of the success of the startup village, sponsored by his company. I was to give a keynote talk and I talked about how technology evolves and what we can learn from that. He had arranged a luxurious stay at the Mani Mansions, an exotic heritage hotel in Paldi with old-world charms owned by our common friend Tushar Dalal. True to his nature, Mani found great happiness in giving.

Another project on which we invested considerable intellectual capital was C-NET, Centre for Nondestructive Evaluation Technologies. We thought that the time was appropriate considering the growth of Ahmedabad as an industrial centre, with companies like Tata Automobiles invested there. The framework is like FCIPT, IPR's industry outreach centre. It was to be a self-financing organization,



where it earns its income primarily through commercial exploitation of its NET hardware, expertise, and facilities to provide service to industries. The know-how and facilities coupled with formal courses are used to provide skill enhancement to deserving students in the field of NET services. The quality of training and service is enhanced by linking in-house research and development activity in emerging areas of NDT. R&D generates additional income and makes sure that the training faculty is innovation-driven and intellectually stimulating and competent. R&D skills are also used in the synthesis and development of special NET systems for commercial use. This internal linkage, which strengthens each limb, is the unique advantage of C-NET.

Our mutual friend Rajasekharan once told me that Mani was a pure soul untarnished by the cankers and corruptions of the real world. It is perhaps this otherworldliness that caused his unexpected and early departure from this world.

## 36 The Internet and I



In 1984, we moved to the IPR campus in Bhat, on the western side of Ahmedabad. One of the policy decisions was not to

have too many clerical and secretarial staff. Personal computers were beginning to be popular in India. We began to progressively make the documentation side of our work more PC-dependent.

The routine use of PCs for soft documentation had its plus side. I could write and edit confidential documents and scientific papers without being tied to the whims of a clerical person. In a short time, word processing transformed itself from the cumbersome Word Star to the MS Word application with the Windows suite. The agile transformation of MS Word into a word processor and editor/grammar/style checker is symbolic of the frenetic growth of digital technology. Unlike the expensive MS suite of Word, Excel etc., there are now free alternatives like LibreOffice with even better features. A similar transformation in the ease of use happened in the

case of email also. There was a time when the rituals associated with sending an email were so tedious and complex compared to the present when you could dictate your Gmail and send it off.

What made the digital transformation possible? It was a process of scaling down the size of electronic components like transistors. The size reduction follows a prediction made in April 1965 by Gordon Moore, the founder of INTEL. He said that every 18 months, the number of transistors squeezed onto a tiny computer chip double, thus doubling its processing power, increasing performance and reducing cost. Because of the exponential nature of Moore's law, each change arrives faster and faster. Today's smartphone is more powerful than NASA's mainframe computer to send astronauts to the moon. They are faster than the Cray-2 Supercomputer of mid-1980. The Apollo 11 computer had a processor that performed 430,000 operations per second. The latest iPhone's processor is estimated to run at about Two Billion times per second.

The rampant growth of smart-class technologies has converted the classroom into a 'connected' entity, thereby enriching the learning

experience for developing countries with relatively poor facilities like libraries or museums for cultural enhancement. In addition, the smart class and the internet have empowered students through videos on their favourite subjects and speakers and enabled them to take virtual tours of places of interest. When combined with the versatility of the digital experience, personalized teaching with its human contact element may create a powerful new model of education.

A couple of years ago, I decided to set up a website related to my professional life, books, poetry and paintings. Searching for a medium to host the website, I came across Wix. Its interface is intuitive, with great functionality among the ever-growing group of website-building services. A gallery of third-party site widgets and robust blogging features abound. There are hundreds of template choices with the usual options for text, media, social media widgets, buttons, shapes, and so on. You can set up a separate Google Analytics account for monitoring traffic. Web-Stats tells you where visits came from and what display, computer, and browsers visitors used, and keeps you informed about how people have responded to your site. In Wix, you can add

photos, galleries, videos, all formatted to taste. Adding a blog to your site is easy.

An application I have found extremely useful is Evernote. You can capture, organize and store almost any type of digital information with your phone, web browser or laptop. Evernote works with both Android and iOS for mobiles. There is a desktop app for Windows and Macs. You can also access it through a web browser. When you open a web page with interesting information, you can save the page to Evernote. For example, I subscribe to numerous blogs. When I get the free content, I store them in Evernote.

With TED, you can explore thousands of inspiring and motivating talks and ideas from extraordinary people, even if you have never heard of them. TED is illuminating, pushes your thought limits, and helps expand the boundaries of thought and imagination for every age. TED is beneficial for both students and teachers. TED provides some of the most empowering messages for students.

A writer using MS Word needs to make too many decisions before starting to write. Which font do you want to use? What is the best line spacing? These questions distract you from putting words

together. iA Writer eliminates nearly all the distractions in word processing apps and helps you focus on the text. For short-form writers searching for minimalism, iA Writer may be the best writing app available. One can format a draft text by exporting it to MS Word. iA Writer also has the advantage of the facility of dictation.

I use an app called Grammarly regularly to proofread my writing for my academic and blog writing. Even for those who have a good grasp of grammar and English rules, spelling and grammatical errors may creep into their writing. The free version covers the basics (grammar, punctuation, and spelling). The premium paid version offers stylistic and best-writing suggestions. It can be the difference between sloppy and unprofessional writing and clear and compelling writing. In addition, it gives you help with overall readability and other insights on improving your writing.

I bring out a monthly newsletter, Elders' Voice for the Senior Citizens' Forum, Kottayam, a fellowship of senior citizens from all walks of life. Rather than depend on professional layout technicians and printers, we decided to do it ourselves and take out a final Xerox copy. I found Affinity Publisher, which is a

desktop app. Affinity Publisher is the equivalent of Adobe InDesign. The best thing about Publisher is that you will be able to carry out anything you are used to doing in InDesign. It was the official Mac App of the Year for 2019. Affinity Publisher provides a wide range of tools such as graphics for working with multipage text.

Technology allows us to focus more on the end goal, less diverted by concerns about the path to reach there. A Pew survey reveals that close to 46 per cent of working adults feel their productivity has increased due to the internet.

## 37 Back to Kottayam



I had always thought that I would spend the evening of my life in Ahmedabad. This is a working city and has all facilities for a

comfortable life: good shops and malls, cinemas, and restaurants. Gujaratis appreciate business-like dealings. Institutes like P.R.L. and S.A.C. are closely connected with my work. Good roads, airport connectivity, Internet access: everything denoted good urban existence. Then, why leave Ahmedabad?

My concern was Minnu's growing sense of insecurity, lacking close family nearby. Our family was made up of my cousins in the Ahmedabad branch of the Pucadyil family, who were close to us and helpful. But she missed her close relatives and cousins, and I missed my brothers. So, while Minnu's reasons for moving to Kottayam got stronger, my justification to staying on in Ahmedabad weakened after my retirement.

The conferment of Padma Shri had revived many dormant contacts and connections from my



early days. Going back to Kottayam would allow me to refresh and re-cultivate these connections. Children took the idea of moving in their stride, insisting that we do what would work for us. Our being in Ahmedabad had seriously deprived them of family contacts. However, people we discussed the moving idea tried to dissuade us. They cited cultural conflicts coming in the way of happy resettlement. My answer to this was not to have great expectations.

On the day of Dussehra in 2011, I finally made up my mind to concede to my wife's desire to leave Ahmedabad. I never realised that I was stepping into two years of anxiety and uncertainty associated with my efforts in selling my property.

Someone advised that the best way to go about it is to find an agent. We found one in the Bopal area who assured that the deal would be done in no time. Then he began to bring all kinds of potential buyers to look at the house. All of them wanted a complete tour of the house. A few months of this and we could bear it no more. We told the agent that his services would no longer be required.

Helpful friends advised on a word-of-mouth campaign. So, I requested friends and acquaintances

to spread the word. Another stream of visitors responded to the availability of the property.

The crowd was now more bearable as many of them were known to us. However, I soon realized that my skills as a salesman were quite limited in extolling the virtues of the house. There was also no meeting of minds on the financial aspects of the sale.

Finally, after almost a year of despair produced by no forward movement in that no acceptable offers were coming, I was approached by a colleague in the Institute for Plasma research saying that he was quite keen in purchasing the house as he had seen it and was impressed by its aesthetics and architecture. We had no problem in coming to an agreement. He wanted copies of the property papers for him to approach a bank for financing the purchase.

This started another paper chase as some of the documents originally issued by the developers had problems and had to be rectified by filing affidavits and other legal documents. Despite everyone trying to be helpful, the pace was unbearably slow and full of procedural hurdles. After many months of these the papers were finally ready. The bank was satisfied by the papers, and we were able

to sign a purchase agreement pertaining to the property by August 2012.

The associated problem of finding an appropriate property in Kottayam for us to buy became imminent. Skyline Builders in Kottayam offered an apartment close to meeting our specifications. The only problem was that the owner was away in England, and he had to find a suitable time to come to India to execute the sale agreement. This also happened without too many hurdles.

Moving was the next major problem. In our 'grihasti' spread over almost 40 years, we had accumulated an enormous amount of junk, which we were carrying over from home to home. We had great difficulty in rejecting many of these mementos of our existence. We got a transporter to move the things to Kerala. He was so professional that he packed even an unfinished cup of tea with a cigarette stub. Everything went into the truck, which we followed by taking a flight. Everything arrived in Kottayam without damage.

We came back to Kottayam in November 2012. We arranged a customary housewarming by inviting friends and relatives to share our happiness of finally reaching Kottayam. My membership in the Senior

Citizens Forum has given us social interaction, fellowship and close friendships. I have been able to develop associations with MG University. Hour-long weekly ZOOM meetings keep contact with children strong and warm. Much of my time goes in watching movies, reading books, painting and writing blogs. My professional interaction with the Institute for Plasma Research continues long distance. So, moving back as a whole was a satisfactory experience.

A desire for a PhD took me to Aligarh in 1964. An offer of a faculty position at the University detained me in that small town until 1972. My actual research career started when I joined P.R.L. in Ahmedabad that year. Shorter durations of separation had happened earlier, when my father was transferred to Trivandrum and when I joined the Athanasius College at Kothamangalam in 1962. We came back to Kottayam by the end of 2012. I could find pleasant accommodation in the town.

## 38 A Small Town in Kerala



Kottayam's geography is strange. The town is stretched along two roads, the north-south Main Central Road (MC Road) and

the east-west Kottayam Kumali Road (KK Road)) which intersect on a hill. Being confined to both sides of these roads on a hill, the town has not expanded over the years. The town is situated by the Meenachil River, where it joins the Vembanad Lake in Kumarakom.

Kottayam's history dates to the 15th century, when the Thekkumkoor kings had their palaces and a fort near the Thaliyil temple in Thazhathangady. The name Kottayam is considered to have come from Kotta, meaning a fort and akam meaning inside. In the mid-18th century, Marthanda Varma of Travancore attacked Thekkumkur, destroying the Thaliyil fort and annexing the region into Travancore. In the early 19th century, the kingdom was made a princely state of the British Empire.

Kottayam has had a role in major political agitations at the time of the fight for independence. The 'Malayali Memorial' agitation of 1891 demanded better representation for educated persons from Travancore in the civil service. The Memorial, prepared at a meeting held in the Kottayam Public Library, was presented to the Maharaja Sri Moolam Thirunal. Kottayam also became the planning point for the Vaikom Satyagraha (1924-25), the historic struggle for eradication of untouchability.

The main temple of Kottayam is Thirunakkara Mahadeva Shiva temple at the centre of the town. The Devi temples at Pallipurathu and Kumaranalloor, Shiva temples at Nagampadom and Thaliyil are famous Hindu temples.

The Christian tradition is strong. Pazhaya (Old) seminary, the Orthodox Theological Seminary at Puthenangady has completed more than 200 years and have been witness to the struggles to preserve the Orthodox identity. St. Mary's Orthodox Syrian Church, built in 1579 and commonly known as Cheriapally ("small church") is one of the oldest churches in Kerala. It has a European architectural sensibility with galleries, pillars, cornices and pediments. Holy Trinity Cathedral of the CSI Church,

built in 1842 still preserves its architectural elegance. Thazhathangady Juma Masjid is a famous Muslim religious place of Kottayam.

Maharani Gouri Lakshmi Bai of the Travancore Royal family granted 16 acres of land for the construction of a college in Kottayam. The CMS College came up in 1817, many years before Mumbai's Wilson College came up in 1832. Rev. Benjamin Bailey of the Church Mission Society became the first Principal of The College. Rev. Bailey ensured that the academic programme at The College was no less rigorous than that at the University of Cambridge. Among its celebrated alumni are the former President of India, K.R. Narayanan, Chief Justice K.G. Balakrishnan, internationally renowned theoretical physicist E.C.G. Sudarshan, and Booker Prize winner Arundhati Roy, the author of *The God of Small Things*.

Realising that the students entering university lagged in English, Mathematics, and Physics, Rev. Joseph Fenn, who succeeded Rev. Bailey in 1818, started a Grammar School, which evolved into the CMS College High School.

The Saga of Baker Memorial Girls' Higher Secondary School goes back to 1816, when Amelia

Dorothea Baker, wife of Henry Baker Sr, realizing that a whole society can be developed if its women are educated, started it.

In 1821, Bailey established the CMS Press. He constructed a wooden printing press and cut the types with the help of local silversmiths from descriptions given in an encyclopedia. Bailey's round and sleek Malayalam type is characterized by legibility and economy.

In 1867 two papers were started from Kottayam. Santishtavadi in Malayalam and the Travancore Herald, in English. Both were printed at the C.M.S. Press. The first was outspoken in its criticism of the powers that be and soon fell afoul of the Travancore Government, which ordered its closure. The second-oldest newspaper in Malayalam, the Deepika, was launched from Kottayam in 1887 under the banner Nasrani Deepika. It emerged in 1938 as a full-fledged daily and became the present Deepika.

The Malayala Manorama started publication in 1890, initially as a weekly. The paper was floated by a joint stock company, perhaps for the first time in India. Started as a literary magazine, it evolved into newspaper and a daily in 1928.



The Powradhwani was yet another Kottayam-based paper. Started in 1939 by K.M. Chacko, this daily was always in the thick of the struggle for responsible government and commanded considerable readership. The Powradhwani stopped publication in 1955. The Keralabhushanam, launched in 1944 by K.K. Kuruvilla, closed in the late 60s.

Kottayam hosts several Malayalam book publishers like D. C. Books, Vidyarthi Mithram, and Current Books. Three-fourths of the books published in Kerala are from Kottayam. A unique Travancore institution that started in Kottayam in 1945 is the 'Sahithya Pravarthaka Sahakarana Sangham,' Writer's Cooperative, which published books and gave financial security and social status to writers.

Syrian Christian wealth made Kottayam a financial hub. Travancore Forward Bank was established in 1929. After losing viability, it was merged with the State Bank of Travancore in 1961. Other Kottayam-based banks like the Kottayam Orient Bank, and the Bank of New India were also merged with SBT at that time.

The major manufacturing facility in Kottayam is the Travancore cements, which was established in 1949. In 1959, TCL ventured into White Cement

manufacturing, using Lime shell, lying unexploited under the bottom of the Vembanad lake. The raw material for the company's white cement is "Lime Shell", which is the purest source of calcium carbonate available for cement manufacturers.

Kottayam is a centre of rubber products manufacturing, initiated by a Dutchman, Mr. Helen and Mr K. C. Chandy from Pala, who set up a rubber products factory in Kottayam. The Pallivathuckal family of Kanjirapally took the unit on lease in 1944 and ran it under the name of Aero Rubber Works. They started the National Tyre and Rubber Company, which, in 1951 tied up with the Goodyear of America to manufacture latex foam rubber under the brand name Pliofoam. This was the first rubber foam factory in India. Mr P.C. Sebastian of Pallivathuckal started Koolfoam Pvt. Ltd. and was the first to manufacture the popular Hawaii chappals in India in 1959.

MRF tyres set up a modern plant in 1969 at Vadavathoor near Kottayam to manufacture tyre-related products. The management also decided to start tyre production in Kottayam unit attracted by the various incentives on tax and power announced through a new industrial policy. The present turnover

of finished goods (automotive tyres, tubes, tread rubber etc.) is Rs. 350 crores per annum...

The annual boat race in the Meenachil River dates to 1887. This glorious water regatta sees the participation of majestic snake boats, churulans, oadis and irrutukuthies. In the 50s, through my father's generosity, our 'kara' would be the proud sponsor of a boat. Occasionally, the children would be allowed to climb onto the boats.

Mahatma Gandhi University, established in 1983, has many schools of advanced studies dedicated to special areas like Behavioural Sciences, Chemical Sciences, Computer Sciences, Environmental Sciences, Gandhian Thought and Development Studies, International Relations and Politics, School of Letters, Artificial Intelligence and Robotics etc. Rajiv Gandhi Institute of Technology, Kottayam is in Pampady, a Kottayam suburb. The Manorama School of Communication (MASCOM) has established itself as a premier journalism training centre in the country.

Kottayam is called the 'Land of Legends' due to its association with Kottarathil Sankunni (1855–1937), the author of Aithiyamala, a collection of legends about Kerala. He was one of the founders of the

Bhashaposhini Sabha, founded by Kandathil Varghese Mappillai and was also involved with Bharata Vilasam Sabha, another literary movement. He worked as the editor of the poetry section of Malayala Manorama

Kottayam has done exceptionally well in many metrics of human development. The Niti Aayog report on MPI shows the exemplary performance of the Kottayam town and the district: it is the only place in India with zero multidimensional poverty.

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The Kottayam Public Library began as a modest reading room with 35 members and 674 books and has grown remarkably over three centuries. It stands as the largest library in the state, with over 6000 members and 250,000 books on the ground floor of a three-story building. Recently, the library has added a reference and research area along with a special study room for students, research scholars and professionals. The original calligraphic version of the Indian Constitution in the library attracts visitors. A masterpiece by the eminent sculptor, Kanhai Kunjuraman, adorns the front.

Kottayam has been the centre of many political agitations, including the Malayalam Memorial movement, which began here, securing representation for educated people in banks and civil service. The memorandum was drafted during a public meeting at the Kottayam public library and presented to Maharaj Shree Mulam Thirunal in 1891, marking the start of the modern political movement in the state.

A unique place in Kottayam is the “Naalumanikkaattu”, meaning “the 4’O clock breeze”. It is a park by the state highway, where you can enjoy the caressing cool breeze and relax on the benches,

looking at the lush green paddy fields on either side. This was a waste dump once upon a time, recovered by the residents' association with technical support from the Tropical Institute of Ecological Sciences. Flowering plants smile in the speckled sunlight and children find a place to play on jhoolas and slides. For the visitors, the members of the 'Kudumbashree', a women's collective, prepare delicious snacks and serve them on plantain leaves. This allows the Kudumbashree members to earn an income. Despite the crowd of visitors every evening, the place is kept spick and span, thanks to the Kudumbashree members. There is a lending library from where you can pick up books to browse while relaxing.

## 39 On the Kerala Roads



After a long period of stay in Ahmedabad, I decided to return and settle down in Kerala after I retired from active service. We bought an apartment

in Kottayam which is a town in central Travancore, where I was born and had my early education.

Syrian Christians in Kerala are a close-knit community. It's true meaning is that the large number of relatives spread over the state are in close communication, especially in the WhatsApp age. Events like marriages, baptisms and death brings all the members together. A personal invitation or an invitation through a card specially printed for the occasion is a command to attend these events: not only is it bad style not to attend these events, but the grudge if you miss one is tended life-long.

The best way to travel to these events is to use your personal transport engaging a driver. This frees one of the stresses of actual driving, which can be substantial given the nature of the roads and the

traffic. The other consideration is that one can be relieved of the problem of finding a place to park while attending formal events like marriages. There are agencies who provide excellent drivers even on a short notice. Most of these drivers are persons who had some service in the gulf countries or have wives working there. This means that the drivers are financially well off and the driving is an activity which fetches an extra in- come.

Kerala has an extensive network of highways, major roads, and interior roads. Official statistics claim that the “Total Road length in Kerala is 2,38,773.02 km. Road density in Kerala is 548km per 100 sq. km, which is roughly thrice the national average. The length of road for a population of a lakh is 993.54km, and almost 90 per cent of the road network is single-lane. The National Highways, considered to be the primary network, carry 40 per cent of the total traffic, and the State Highways and Major District Roads (MDRs) - the secondary road network – carry another 40 per cent of the road traffic. Thus, around 12 per cent of the road network handles almost 80 per cent of the traffic in the State.

The crowds that we now see along these roads are also a reflection of the social transformation that



the state of Kerala has witnessed in the late nineteenth and early twentieth centuries. In Kerala, this period saw struggles by people across castes for access to public spaces: roads, markets, temples. The famous Vaikom Satyagraha led by Ayyankali for temple entry for Dalits was equally for their access to the roads to the temple, which were denied to them earlier.

Ayyankali, who came from a Dalit family in Kerala, was a social reformer. In Travancore/Kerala, members of lower caste communities were not allowed to enter public roads as these roads were controlled by the members of higher caste communities. So, 'Villuvandi Samaram' (Bullock cart strike) was the direct result of this social discrimination, and this movement was led by Ayyankali himself. In 1893, Ayyankali brought a Bullock cart from a neighbouring state and marched over the public roads of Venganoor.

The physical spaces have now extended to other manifestation of spaces like reading rooms, libraries, public education institutions, teashops—where the modernity was produced (and reproduced) daily through lived experiences.

Ubiquitous along the Kerala roads are churches ranging from Grand Cathedrals to wayside shrines. So are the teashops (Chayakadas) where people gather to have a cup of tea, read the newspaper, and enter friendly political debates.

Another sight is religious processions, usually accompanied by a drum beating group and occasionally by a caparisoned elephant. Women take part in these processions quite strongly. They end up in the local temple on auspicious days.

On the road you pass every few kilometers to a new village with a strange and sometimes evocative name. A friend of mine, Kottayam Baburaj, has travelled across Kerala on a scooter to write 'Sthala Vijnana Kosam' or an encyclopedia of various places in Kerala. He has some amazing fun facts to share about the nomenclature of Kerala. Kerala Sthala Vinjanakosam, prepared by Kottayam Baburaj, has info of more than 25,000 places, 532 route maps and a list of various shortcuts.

He found out that there are many other 'Keralams' within Kerala. Keralapara in the Kottayam district is near the Angel Valley in the Erumely panchayat. There are places named Keralapuram in three districts. You could visit Keralapuram at

Koduvayur in Palakkad, Kottangal panchayat in Pathanamthitta and in Kottamkara - Perinad panchayats in the Kollam district. Meanwhile, Kerlaparambu is in the Alathur panchayat in Palakkad. There are two places called Keralam in Malappuram district.

Since Kerala has predominantly been synonymous with lakes, ponds, rivers and backwaters, most cities and towns in the state have names suffixed with kulam and puzha, which translate to pond and rivulets in Malayalam, respectively. Although many places were addressed with anglicised monikers during the periods of colonialism, the last few decades have seen most of them reverting to colloquial titles. Kollam from Quilon, Kannur from Cannanore, Alappuzha from Alleppey, Kochi from Cochin and Thiruvananthapuram from Trivandrum, to name a few.

As an example of the etymology of places, we may consider Kottayam, my town. The name Kottayam is considered to have come from Kotta, meaning a fort and akam meaning inside. In the mid-18th century, Marthanda Varma of Travancore attacked Thekkumkur, destroying the Thaliyil fort and

annexing the region into Travancore. In the early 19th century, the kingdom was made a princely state of the British Empire.

Kerala has a vibrant and unique social life on its streets. The concept of “street life” can refer to the social activities and interactions that take place in public spaces. In this sense, street life can be seen as a reflection of the social fabric of a community

and can provide insight into the level of social harmony and cohesion in that community. The state is known for its diverse culture, art, and cuisine, which is reflected in the lively streets of its cities and towns. A notable aspect of the social life on the streets of Kerala is the abundance of street food. You can find a variety of delicious snacks and meals being prepared and sold by vendors on the streets. The most popular street foods in Kerala include appam, puttu, vada, samosa, and parotta.

In addition to food, the streets of Kerala are also filled with people engaging in various activities. You can find groups of people chatting, playing games like carrom or chess, or simply enjoying the company of their friends and family. In some areas, you may even see street performers entertaining passersby with their music, dance, or theater.

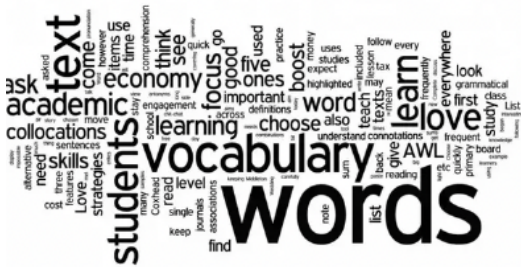
Another significant aspect of social life on the streets of Kerala is the abundance of markets and bazaars. These bustling areas offer a range of goods and products, from clothing and accessories to fresh produce and spices. The markets are not just a place to shop but also an opportunity for people to connect with one another and exchange stories and experiences.

Overall, the social life on the streets of Kerala is rich and diverse, reflecting the state's unique culture and traditions. Whether you're looking for delicious food, entertainment, or a chance to connect with locals, the streets of Kerala offer an experience unlike any other.

Kerala is known for its rich cultural heritage, and many of its traditional art forms and festivals involve public performances and processions that take place on the streets. Additionally, the state has a high level of social capital, which refers to the networks, norms, and trust that exist between individuals and groups in a society. This social capital can help to foster a sense of community and cooperation, which can be reflected in the way people interact in public spaces.

Overall, it can be argued that street life in Kerala is indicative of a relatively high level of social harmony and cohesion. However, it is important to note that there are also challenges and inequalities that exist within the state, and these can impact the experiences of different groups within society.

## 40 Words and Images



Words and the images  
they evoke have  
always had a  
fascination for me. I  
like poetry because of  
the images created by

clever and careful use of words. I attempt to write poetry for the same reason. The ultimate objective of poetry is to depict intensely felt emotions and abstract philosophical thoughts. To realize this, the poet must employ the vehicle of carefully chosen words which evoke visual and sensory images. These words are spontaneous with the power of vivid description.

A writer of the 1930s, James Thurber was a genius at creating spectacular verbal images. "On bedside tables across America, stacked next to Bibles, were copies of *The Thurber Carnival* and his fictionalised autobiography, *My Life and Hard Times*, for a few belly laughs during nights of the soul. My own well-thumbed copy of the *Thurber Carnival* was acquired from the English Book stall, near the Max Planck Institute in Garching, near Munich. His word

images and drawings have given me intense pleasure through recurrent reading.

Thurber's "secret, surrealist landscapes of his youth had many strange figures: the old lady who was always up in the air, the husband who did not seem to be able to put his foot down, the man who lost his head during a fire but was still able to run out of the house yelling, a skeleton unlocking a lock, the young lady who was ... a soiled dove. His literal images of a man tied up at the office or of a girl who was all ears are comic."

"The New Natural History" presents a whole new way of seeing, by the literal, pictorial representation of metaphorical or abstract words and phrases. Thurber draws pictures of "a semi-edible vegetable," the "Arpeggio;" "a bare-faced lie;" "a trochee encountering a spondee;" and "an upstart rising from a clump of Johnny- Come-Lately." The visual images for common words include a carrot-like vegetable called a "scabbard," an animal with a toothy-pointed back called a "metatarsal," and a snake-like creature which is a "serenade."

Thurber's fictional characters are as colourful as his words. In the hilarious sketch titled "The Black Magic of Barney Haller" in *The Thurber Carnival*, he



describes his hired man, whom he believes “traffics with the devil” and makes lightning and thunder follow him. Barney says cryptic things like “Bime by I go hunt grotches in de voods,” and “We go to the garrick now and become warbs.” Thurber is convinced that, despite his sturdy, Teutonic looks, Barney is a practitioner of black magic and can morph himself into strange beings. Thurber is afraid that Barney would render him into a warb or conjure up a grotch. It is only later that Thurber realizes that grotches are crotches where the branches will spread out from the main trunk of the peach tree or that warbs are wasps to be cleared in the garage. As the story ends, Thurber expresses regret for having let Barney go since his new man is not so good at removing the wasps from his garage.

In the story “What do you mean, it was brillig?” his maid Della takes unfettered freedom with English words. “They are here with the reeves,” means somebody was bringing Christmas wreaths. In describing her family to Thurber, she says that “she has three brothers and that one of them works into a garage and another works into an incinerator where they burn the refuse. The one that works into the incinerator has been working into it since the

Armitage", meaning armistice. About Thurber's illness, Della says that "His mind works so fast his body can't keep up with it,"

Mrs Ulgine Burrows of the "quacking voice and braying laughter" appears in the "Catbird Seat". She is disliked by her colleagues because she is given to strange expressions like "Are you lifting the oxcart out of the ditch? Are you tearing up the pea patch? Are you hollering down the rain barrel? Are you scraping around the bottom of the pickle barrel? Are you sitting in the catbird seat?", expressions borrowed from Rugby games commentator.

"The Secret Life of Walter Mitty" is Thurber's fictional story about a man is forever lost to reality. I can empathize with Walter Mitty who would go on a trip merely on hearing a suggestive word. He lives in an extended reverie consisting of situations in which he pictures himself as a heroic figure; a world-renowned surgeon conducting a risky surgery, a pilot raining bombs on the enemy, and a martyr facing death by shooting. These manifestations reflect escape from the colourless and humiliating ordinariness of his real life, where he is a hen-pecked husband.

Thurber's real-life characters are equally colourful, or he makes them colourful through his writing. I realized this when I read "The Years with Ross", Thurber's biographical sketches of Harold Ross, the legendary founder-editor of the New Yorker magazine. It chronicles the restless genius of Ross, who brought together in 1925, an extraordinary cavalcade of talent, including Thurber, to bring out a magazine which focused on New York city's vibrant social and cultural life. The New Yorker became known for stories, essays, and sharply drawn profiles. The drawings were in- deed funny. There were reviews of movies, books and theatre. The book is also full of wistful and often hilarious description of Ross's management style, which is unique and at the same time frustrating for those who were managed. Ross was well known for his aggressive editing style.

Ross was compulsive about fact-checking and employed a pool of fact-checkers with the ardent hope to bring out each issue without a single mistake. His "wistful hope of getting out a magazine each week without a single mistake," led one fact-checker to remark that "if you mention the Empire

State Building ... Ross isn't satisfied it's still there until we call up and verify it".

Cartoonist Aravindan had the same comical genius as Thurber had. Many of his drawings were inspired by the images that certain words or sentences evoked. A girl is sitting and planting her eyes in a field, (in Malayalam 'planting one's eyes' means looking). Another equally bizarre image would be when this girl throws her eyes at someone, which again only means that she was looking at someone.

One of Aravindan's cartoons showed a mad artist committing suicide by laying himself on a floor near the wall on which had drawn a picture of an approaching train. The following poem, "Train" was inspired by that cartoon.

The mad artist drew two vertical lines on the wall of the room, his prison

Lines receding into the distance, converging. He knew perspective!

To him, it looked like a rail track and inspired by that insight,

drew a train on the track with engine puffing smoke

he thought could hear the chug-chug of the  
fast-approaching train

and laid himself down on the ground with his  
head near the wall

waiting for the train and certain release.

## 41 Cathedrals and Basilicas



In the late 70s, the International Centre for Theoretical Physics (ICTP) in Trieste, Italy, used to hold summer schools in Plasma Physics. These were meant to help

increase the interaction between scientists from developing and developed countries. I attended a few of these along with many Indian colleagues. We would spend the weekends taking a 4-hour train ride to Venice, spending the day there and returning in the evening.

My first visit to the Basilica of San Marcos happened on one of these trips. St. Mark's Basilica is a prime example of Byzantine architecture. The signature of this style is the opulent marble floors and luminous gold mosaics. After the fall of Constantinople, Venetian crusaders brought back gold reliquaries, making St. Marks wealthy beyond imagination. The 4000-odd square meters of impressive mosaics highlight St. Mark's life and

religious scenes from the Old and New Testaments. Today, St. Mark's Basilica is Venice's most important monument, housing the apostle's remains, a great symbol of Christian faith.

Venice is built in the middle of a lagoon. After the fall of the Roman Empire in the fifth century, which led to general lawlessness, the farmers from the mainland fled to the marshes and sandy islands of the Venetian lagoon to escape rampaging barbarians. Battered by tides, they built houses on stilts. Their settlement grew into a city, which grew into the greatest naval power in the Mediterranean—with the whole thing built on stilts. But in the last century, the extraction of groundwater and natural gas caused the city to sink faster, while the Adriatic Sea level rose.

When Minnu was with me in Vienna during my assignment at the IAEA, we decided to visit Venice in December 2002. We travelled by train - an 8-hour journey through the scenic Alps. I could not help but compare the changes after twenty years. Floods, for example. San Marcos was flooded during our visit. The northern Adriatic region has strong tides, unlike most other Mediterranean regions.

The Campanile di San Marco was first built in the 12th century and rebuilt in its current form in the 16th century. It is an impressive 99-meter-high tower in the centre of St. Mark's Square. Originally, it used to be a lighthouse for ships and a watchtower during wartimes. Today visitors can climb the Campanile to its very top. While admiring the largest of the tower's five original bells, they can enjoy a breathtaking view of the city.

St. Mark's Basilica is an excellent representative of Byzantine architecture. The signature of this style is the opulent marble floors and luminous gold mosaics. After the sack of Constantinople by Crusaders, gold reliquaries brought back by them made St. Marks wealthy beyond imagination. The 4000-odd square meters of mosaics represent highlights from St. Mark's life and stories from the bible. St. Mark's Basilica is Venice's most important monument, housing the apostle's remains, a significant symbol of Christian faith.

In 2008, my son Joseph moved to Switzerland. While visiting them during the summer of 2009, we made a trip to the Einsiedeln Cathedral which contains the Chapel of Our Lady. The town of Einsiedeln stands on the bank of Alp Stream.



Einsiedeln grew around the 10th century Benedictine abbey, which became a principality of the Holy Roman Empire in 1274 and belonged to Schwyz after 1386. Its wooden statue, the “Black Virgin” became a sacred object of European pilgrims from the 14th century. This has been one of the most significant pilgrimage places in Europe.

The shrine dates from the 9th Century when Meinrad, a young nobleman who had been a monk, left the monastery of Reichenau to live a hermit's life in the deep woods of northeast Switzerland. He brought with him a wooden statue of the Madonna. Meinrad was known for giving hospitality to strangers, but unfortunately, that led to his death. A monastic community came up at the site of St. Meinrad's hermitage. Then, in 940, the Benedictine Monks turned this into a small chapel housing the statue. The magnificent Baroque abbey complex and church were consecrated in 1735.

Inside the church, the object of pilgrimage is a mid-15th century Black Madonna icon (the earlier icon got destroyed in a fire). This Black Madonna holds court in her black marble Chapel, enclosed within the basilica's nave. Small painted plaques adorn the dark walls of the chapel, offerings made by

devotees expressing their deep gratitude for her healing or intervention in their lives. Many of the devotees are Sreelankans.

The Einsiedeln Chapel has been one of the most significant pilgrimage places in Europe since the Middle Ages. In 1466, the monks brought the present statue of the Madonna to Einsiedeln, and the place became a noted Marian shrine in Switzerland. However, throughout Western Europe, there are over 200 examples of these black images, revered for their esoteric, magical, and wonder-working powers.

After visiting the shrine, I wrote the following poem:

Perched on a little hill, the church stands aloof.  
impervious to the crowds on the road below

the two towers rise together as if in prayer. the  
grey walls bloom in the soft sunlight

we walk up the hill, my children in tow.

the wooden door creaks as we push it open. in  
the flickering light of a hundred candles,

shadows move like souls seeking redemption.

People are scattered on the floor, lost in prayer  
and some light candles, adding to the glow.

some sit huddled sharing a private grief.  
occasionally glancing at the statue by the wall  
The Madonna with the child gazes at me  
asking me perhaps, where I have been.  
I have no answer except to mumble.

not to construe the omission as a denial. Where  
have I seen this face, I ponder,  
as I come out of the church and wander  
reflecting on faith, love, and redemption and  
how myths become real over time.

During another visit to Cham, Joseph suggested  
a road trip to Camargues through Leon and Aix en  
Provence. This was 800 odd kilometers taking about  
12 hours. We decided to break the journey at Aix,  
stay overnight and drive the next day to Camargues.  
Aix is my camp during visits to Cadarache to attend  
the ITER meetings. I wanted my family to pass the  
site where the ITER tokamak was being constructed.

The chief attraction of Camargues is the village  
of Saintes Marie de la Mer, Maries of the Sea. This is  
a place for pilgrimage for believers of the legend of  
the Maries: Mary Magdalene, Marie-Salome, Marie-  
Jacobe. Together with their black servant, Sara, they

escaped persecution in Judaea about the year 40 CE and landed on the Camargues Coast in a frail craft. There are legends that a pregnant Mary Magdalen also travelled in this group, which formed the staple of the Da Vinci Code, a novel by Dan Brown. Marie-Salome and Marie-Jacobe became, in time, objects of veneration to the local people. St. Sara, an important figure in the Gypsy cultural tradition, is represented in the crypt, on the right side of the altar. Once a year, on the second half of May, thousands of Gypsies gather to venerate their Saint Sara-la-Kali- “Sara the Black” who is the patron saint of the Gypsies.

Once a year on the second half of May, the Gypsies gather to venerate their Saint Sara-la-Kali — “Sara the Black” who is the patron saint of the Gypsies. Thousands of Gypsies reach the place, which makes the town look as if it has gone back in time to the Middle Ages.

During my year-long stay in Vienna, we made Stephanplatz by the St Stephen’s Cathedral, a regular haunt. Vienna’s most culturally significant landmark is also the centre of the Roman Catholic Archdiocese of Vienna. It is a lively space with a crowd of English speakers.

The cathedral is an icon of Vienna. Its stunning mosaic roof and the sheer height of its south tower makes it one of the most recognizable attractions in the city. The construction of the original church began in the 12th century, on a site believed to have been an Ancient Roman burial ground. The first building, completed in 1160, was destroyed by fire in 1258, leaving only the stone foundations. The church was rebuilt in 1263 and consecrated. Since then, St Stephen's Cathedral, or Stephansdom has continued to evolve and grow over time. Large sections damaged in World War II were rebuilt along with various towers, extensions and decorations.

The towers of St Stephen's Cathedral pierce the sky with their mottled, ornate spires. Inside St Stephen's Cathedral, Gothic columns supporting the roof tell stories of the Christian saints. Their solemn stone faces peer out from high up the walls. The cathedral boasts of 18 altars. The High Altar portrays the stoning of Saint Stephen. Elisabeth of Austria, Queen of France and a host of prominent people found their last abode here.

The Syrian Christian tradition is that the Apostle St Thomas established seven and a half churches. The church at Kottayam that I and my wife

occasionally visit is the St. Mary's Cathedral at Manarcad, a suburb of Kottayam. This is the Global Marian Pilgrim Centre, which celebrates the feast of the Nativity of the Virgin Mary on September 8. September 1 to 8 is the historic Eight-Day Lent at Manarcad for which all roads lead to this holy shrine, and hundreds of thousands of pilgrims throng here seeking favours and blessings from the Holy Mother.

The stone inscriptions in the 'nanam monam' script of Malayalam claim that the church was built around 910 AD, first with bamboo and later in the 16th century in stone in the Portuguese tradition. A dozen Nasrani Christian families who fled the Vadakumkoor king settled in Manarcad near Kottayam. They had an intense desire to have a church to conduct services and they prayed for eight days when they had a vision of a white cow with a calf. They found them in a nearby cane forest, where they built the church. The eight-day Lent, a glittering event inviting hundreds of thousands of believers, is a remembrance of this.

The heritage churches are the real showpieces of Kerala Christianity. Living far from the major centres of Christianity, the early Christians looked at temples for inspiration in building churches. The

cross seemed to be the only popular icon among St. Thomas Christians until the 15th century. The ancient churches and temples looked alike, except for a cross on top of the church.

Ancient churches used building materials which were not durable and hence have not survived the ravages of time. A few artefacts, such as St. Thomas' crosses and baptismal fonts, survive to this day. They were made by carving granite, which is very durable. There are also a few other architectural elements such as open-air granite crosses which trace their allegiance to the indigenous traditions of the land.

Though not a deep believer, I find contemplation sitting in a dark corner of a cathedral deeply peaceful. I have had a nodding acquaintance with many other cathedrals as well. They stand as monuments to human spirituality, architectural imagination and engineering ingenuity, creating sacred spaces that bring heaven down to earth.

## 42 Fellowship and Feasts



Loneliness is a curse faced by the senior citizens face, especially if they live alone. They have limited opportunities to socialize. Regular

social interaction is essential to happier and more fulfilled lives. This also provides improved long-term mental health for them.

While socialising contributes to a higher quality of life, it is also essential to health. Dementia and a range of physical problems, including high blood pressure, arthritis and cardiovascular diseases, are of concern. Social activities help them lead more meaningful and engaged lives. Social isolation, on the other hand, leads to the onset of depression and other mental and physical issues.

The Senior Citizens' Forum is the oldest association of Senior Citizens in Kottayam, established in 1987. SCF activities include periodic meetings, discussions, charitable activities, visits, picnics etc. They are primarily meant to engage the



Senior Citizens in intellectual and social activities and provide them with some form of fellowship. With over 800 meetings held with exceptional regularity, the Senior Citizen's Forum of Kottayam has established a remarkable longevity record. It brings out a monthly newsletter, "Elder's Voice" and maintains a website [www.scfktm.net](http://www.scfktm.net). It spearheaded the formation of the Federation of Senior Citizens' Associations Kerala at the state level and is affiliated with it.

I joined the Forum in 2013 after our return from Ahmedabad. We found the fortnightly meetings enjoyable, and the Forum provided fellowship with eminent senior citizens of Kottayam. I volunteered to host a website for the Forum, which we did by May 2018, using an agency to do the coding. I also created a new layout for the monthly newsletter, Elders' Voice and brought out copies by Xeroxing. The Forum very graciously recognised these contributions by presenting a merit award.

In 2019, I became the President of the Forum. The new team was sworn in during the Installation Ceremony held on 13th April 2019 at the Hotel Aida. Prof. Sabu Thomas, the Vice-Chancellor of the Mahatma Gandhi University and the Founder

Director of the International and Inter-University Centre for Nanotechnology, was the Chief Guest.

We continued the tradition of uninterrupted meetings, which presented talks and discussions on interesting subjects, community events and other activities. These largely contributed to fulfilling the objectives of the Forum, namely, to engage the Senior Citizens in intellectual and social activities and provide them with some form of fellowship.

The subjects of the talks were eclectic, ranging from environmental concerns, health, family life, cultural diversity, farming, humanity's future, and social service. Among the visitors we honoured, I especially remember Mr P. U. Thomas of the Navajeevan Trust, whom I believe is altruism incarnate. While confined to a hospital bed for many days, he had an epiphany about doing good to others a long time ago. This journey ultimately ended with establishing Navajeevan Trust, a home for the homeless, which has become an institution of note in Kottayam. The Senior Citizens Forum felicitated him and celebrated his 70th birthday.

I realized that many of the members did not exploit Internet Technology's full potential and benefits. Therefore, tutorials to update the computer

and Internet skills of the Forum members began on 18th July 2018 at my apartment. The whole course covered Hardware, Operating systems, Windows 7 basics, Computer networks and the Internet, Backing up data, Email, Cloud storage, Net shopping Net banking etc. This was a very satisfying experience as I found even our senior-most members past 90, diligently taking down notes during the course.

Eminent personalities invited to address the Forum included Lok Aayukta Justice Cyriac Joseph, and Shri Hormis Tharakan, formerly of the Research and Analysis Wing of the Cabinet Secretariat, Govt. of India, among others. They were impressed by the activities of the Forum and commented on the proactive inter- action of the members.

Among the events celebrated, I recall the Onam celebrations held at the Johnny Moose Backwater Farm at Aymanam. It was an excellent opportunity for our forum members to showcase their talents and entertain us in a very exotic setting. The Onam Sadya which followed was delectable.

We celebrated Christmas with great enthusiasm. Fr. Joshua gave the Christmas Message. While delivering his message, the father explained that 'Esu, means a savior and that the words of Christ

were relevant even today. Christ believed in happiness for all. He advised all members of the SCF to face 2020 with a new determination.

As President, I wanted to raise the intellectual level of discussions in the Forum. I chose to speak about topical issues of the times. These included the idea of the Universal Basic Income, startups and their evolution, the concept of a circular economy, existential threats to humanity, early Indians, Carbon recycling for mitigating global warming, mega-science projects and Black holes. I hope the members enjoyed these forays into esotery.

The Elder's Voice, the newsletter of the Forum, was published regularly, with a new computerised layout and exciting content. Unfortunately, the website hosted by WordPress ran into problems due to hacking. So, I redesigned the website with fresh content and hosted it under WIX patronage. The content includes the monthly newsletters, reflecting the multi-faceted activities of the Forum.

In early 2020, we elected a new team with Dr Joseph Cherian, an eminent member of the medical profession, as the President. Unfortunately, however, they could not take charge because of the COVID situation.

One of the consequences of the COVID outbreak was suspending our physical meetings. During the fortnightly get-togethers, we could see each other, share a joke, pass on gossip, laugh together, and partake in a feast. All these gave so much to us that was beyond measure. We started ZOOM meetings with all the members enthusiastically joining in. The sessions are engaging, sometimes gossip and chitchat, and occasionally a short talk. But we do miss both the fellowship and the fortnightly feasts.

A sense of what we were missing in the fellowship returned on my 80th birthday. A group of Forum members descended on our apartment with gifts and birthday greetings. We reminisced on the good old days we had in the Friday meetings at the SEERI auditorium and swore that we would get together as soon the pandemic receded.

## 43 Experiments with Blogging



In “Why I Blog”, Andrew Sullivan writes that ‘as blogging evolves as a literary form, it generates a new and

quintessentially post-modern idiom that’s enabling writers to express themselves in ways that have never been seen or understood before.’

The enforced seclusion caused by COVID-19 nudged me to start experimenting with this form. I have kept notes on my work, personal life and professional experiences on my laptop, which turned out to be handy raw materials for my blogs. The speeches I had given on various occasions also became good material to be converted into blogs. Some of these were technical talks on plasma processing, thermonuclear fusion and other applications of plasma physics, which, when converted into blogs, attracted good response. How my poems came to be composed became an interesting set of blogs.

I had a dormant [blogspot.com](https://www.blogspot.com) account, and I decided to start writing on that site. After continuing Blogspot for a couple of months, I shifted to a WordPress blog site. In a short time, I converted to a paid site, [www.pucadyil.blog](https://www.pucadyil.blog), which I still maintain.

Web statistics reveal that there will be over 600 million blogs and 1.9 billion websites worldwide in 2022. There are over 6 million blog posts published every day and more than 2.5 billion every year. It is the Internet's true gift of empowerment to writers, giving them to link with their peers and readers without third-party interventions.

I started writing on Medium last year. Medium is an internet platform for writers created in 2012 by Ev Williams, the co-founder of Twitter. The community of active users is said to exceed 60 million per month.

Medium takes care of the technical aspects of maintaining a website, allowing you the luxury of focusing on your writing. They also provide a community of writers who interacts with your piece, which is quite different from posting on an owned website, where you are the only writer.

Medium has many functionalities, which makes posting easy. You can import your published stories

from other sites, edit the content after import and effectively re-publish them to your platform. Your Medium account can be linked to social media pages, allowing other people to find you.

Medium has many metrics for evaluating your post, the number of viewers, readers and the time spent on the post. Fans represent the users who clapped for any given story. You can get an idea of the reaction or overall sentiment of an article's performance from this data, which is an insight that you may not be able to get on other platforms. The mobile app is a handy method to keep track of the reader-response metrics.

In principle, you can get paid on Medium if you are a member of the Medium Partner Program. However, I learned that the programme does not extend to writers from India and a few other countries. Medium may have reasons to follow this practice. But this is discriminatory, and I hope Medium will correct this asymmetry in the future.

Writing compels you to organize your thoughts. While writing on serious and technical subjects, the gaps in your knowledge will pop up, which you will have to examine and fill in. Writing is a great way to internalize ideas, knowledge and experience. In



addition, writing helps you gain complete mastery over the topic you're writing about.

There are many expositions on the motivations behind blogging in the blog literature. The blogs function to broadcast content and opinions and become a medium to interact with a community. Blogs are a tool for creativity. While writing, the bloggers may be sensitive to their potential readership. The blog may be meant as a tool for social interaction, although the blogger may downplay that. Response by readers in the blog metrics in a comment or critique may produce a sense of connection in the blogger. This response is essential for the blog as a tool for communication. Whether blogs are ephemeral or whether they have lasting value and credibility like printed material is an open question for research.

Julia Davies and Guy Merchant make some interesting observations on Blogs being a new kind of literary vehicle. Blogs provide novel capabilities like hyperlinks to information sources. Site meters monitor "visits" from others. RSS feeds alert subscribed readers to other newly updated sites. There is a facility to embed other texts within one's own and the possibility of including a range of

modalities, from audio podcasts to video streams. All these add dimensionality to the otherwise flat text. Imagine how much richer the great classics would have become had these new digital functionalities been available to those writers.

Blogging appears to be closely associated with self-presentation and forming an impression - a subtle way of digital preening. By publishing without any editorial evaluation, the blogger may become vulnerable and the victim of wrong interpretation. Yet, at the same time, the blogs give us visibility, thereby helping us gain digital identity, acclaim and respect.

The social software used by blog hosts promotes the development of online relationships. The regularity of blog updates may invite those in a social network to make regular visits. In this social world, the visitor or reader has considerable freedom to determine the reading path, and the level of attention paid to the text, depth of reading, and degree of interactivity. Bloggers, whether at any one time, they are producers or consumers, navigate their way around a thickly interwoven fabric of online and offline texts, which often blend severe and more frivolous discourses.

Blogging is the characteristic of a unique type of social networking. Experts have described this as localized and networked individualism. These particular social networks operate in both online and offline spaces. The blurring of those boundaries that define the public and private spheres of our lives in these times is a vital characteristic of blogs in general.

## 44 The Medium Experience



I had started writing on Medium in October 2021. As I complete a year of writing, I wanted to look back and assess

my experience and what I have learned as a writer. I have been guided by how other writers have approached this issue.

Some of the writers have approached this matter using earnings as the primary measure. Medium's discriminatory Partner Programme, where Indians were not allowed to be members, was corrected recently, and I became a member. Monetary gain was sparse, and I had to reserve the pieces for members only. Due to these reasons, I decided to terminate my membership in the partner programme.

I had interesting responses from readers. Francesco Beni wrote, "I've just started my own podcast about books and literature and related topics. This is why I write to you: could I use some of your articles published on the website? I would like to

translate them in Italian in order to tell those stories on my podcast, mentioning your name and inviting people to read the original article too."

Justin Boyette wrote: "One time when I visited a bookstore in Blue Ridge, Georgia, I found an early edition of Robin Hood with a short love letter inside. It was originally a Christmas gift to someone who existed an entire lifetime from when I found it. Incredible. Appreciate your insights here."

The raw material for my blogs has been notes on my work, personal life and professional experiences on my laptop. The speeches I had given on various occasions also became good material to be converted into blogs. Some of these were technical talks on plasma processing, thermonuclear fusion and other applications of plasma physics, which, when converted into blogs, attracted good response. How my poems came to be composed became an interesting set of blogs.

I have acquired about 700 followers in this period, and I am grateful to them for that honour. I have a rule of reciprocating courtesy. I try to read their pieces whenever possible. But being of an advanced age, time is indeed a precious commodity,

The pieces that got traction were those on science and technology. The Explosion of the Fusion Startups, describing the visionary inventors behind the private commercial efforts in Fusion technology startups and following a dream thought unachievable by many for a long time, attracted 747 views. This was an eye-opener because I had a mistaken impression that people do not prefer 'hard' subjects. I have decided to spend more time preparing articles on science topics, especially plasma physics, plasma processing and application, Thermonuclear Fusion, etc., where I have expertise.

Film and book reviews also got good response. Bollywood finds Bharat had more than 4000 responses. The article on "Covenant of Water" had a huge - 13,000- response.

Plasma Route for Cheap Hydrogen which describes the microwave-assisted plasma pyrolysis technology which converts Methane into plasma in which light hydrocarbons react to form allotropes of carbon, which have high commercial value with 184 views.

The Syrian Christians of Kerala described the ancient community of Nasrani Christians converted from Hindu faith into Christianity by St Thomas in the

first century AD. This attracted 138 viewers, proving that the exotic sells.

A Man Called Reacher was an appreciation of Lee Child's character who has been described as Joseph Campbell's archetypal hero: the stranger who appears from nowhere and corrects the wrongs. Reacher stories fulfil the patterns which recur in myths and fairytales. This collected had 202 views.

Reflections on Building India's First Tokamak described how a small team of scientists at the Physical Research Laboratory in India ventured into the hallowed area of Fusion Machines and successfully built a state-of-the-art machine in 1989. This attracted 125 views.

It is possible that my marketing is quite weak. Apart from putting links in Facebook and Linked In, and a Gmail announcement to a small group of friends, I do not spend many efforts there. I shall be grateful for advice on how to improve this shortcoming.

Except for A Thousand Lives and New Writers Welcome, I have not bothered to become member of writing groups. This was due to laziness and a reluctance to avoid bureaucratic formalities. Now

that I have spent a year, I shall take joining writers groups more seriously.

The pieces which did not do very well in terms of attracting a large viewership were those of a reflective, autobiographical nature. These included pieces on shopping in India, descriptions of efforts in becoming a writer of books, experience and evolution as a self-taught painter, thoughts on innovation, fascination with words and the images they evoke, childhood memories, etc. Perhaps the Indian ethos and perceptions colouring these pieces do not strike a universal chord.



## 45 On the Blogger's Craft



My way of painting is to spread paint over the entire canvas in patches reflecting the general layout I want to create and then apply the brushwork and more paint to

create the precise shapes I had originally in mind. In the process, the original idea itself may give way to the suggestions made by the canvas as painterly feedback. So, what I create often differs from what I originally had in mind.

My writing also reflects this general behaviour. I dump a lot of material onto the screen and chisel away until something close to my idea of perfection emerges. This may involve multiple rewrites during the process of chiselling away. I prefer this to the process of creating the perfect sentence by choosing the perfect set of words.

I am consoled by the fact that all great writings have been the result of rewriting the original draft many times. Listen to Anne Lamott in *Bird By Bird*:

Some Instructions on the Writing Life: “Almost all good writing begins with terrible first efforts. You need to start somewhere. Start by getting something – anything – down on paper. A friend of mine says that the first draft is the down draft – you just need to get it down. The second draft is the up draft – you fix it up. You try to say what you have to say more accurately. And the third draft is the dental draft, where you check every tooth, to see if it’s loose or cramped or decayed, or even, God help us, healthy.”

An equally convincing instruction is from Susan Sontag in *Directions*: “Write, Read, Rewrite. Repeat Steps 2 and 3 as Needed.” *New York Times*. “And though the rewriting — and the rereading — sound like effort, they are the most pleasurable parts of writing. Sometimes the only pleasurable parts. Setting out to write, if you have the idea of “literature” in your head, is formidable, and intimidating. A plunge in an icy lake. Then comes the warm part: when you already have something to work with, upgrade, edit...

Let’s say it’s a mess. But you have a chance to fix it. You try to be clearer. Or deeper. Or more eloquent. Or more eccentric. You try to be true to the world. You want the book to be more spacious, and

more authoritative. You want to winch yourself up yourself. You want to winch the book out of your balky mind. As the statue is entombed in the block of marble, the novel is inside your head. You try to liberate it. You try to get this wretched stuff on

the page closer to what you think your book should be — what you know, in your spasms of elation, it can be. You read the sentences over and over. Is this the book I'm writing? Is this all?"

I was steady in my blog writing in 2023, posting a story every weekend. One post which caught maximum attention and sustained readership is the review of "The Covenant of Water", a story by Abraham Verghese about a strange affliction of a family which renders the members vulnerable to death by drowning. It received more than 6000 views, which continues to attract readership as revealed by the weekly writer summary. Time magazine categorizes the book among the 100 Must-Read Books of 2023.

The story begins in 1900 with Mariamma, an impoverished 12- year-old girl in the Travancore princely state in southwest India, becoming a bride to a widower 30 years her senior and dedicating herself to her duties as the Mater Familia of the

Parambil family. Her husband shows her the Parambil family tree, a catalogue of the malady that has shattered the family. She calls the parchment the Water Tree, where each death is marked by a sign of a cross over water. Her granddaughter Mariamma becomes a doctor and, along with her neurologist colleague Dr Uma, begins investigating the condition. Mariamma's father, Philipose, also drowns on his way to meet her in Madras. On examination of his brain, Uma finds that he had a variant of neurofibromatosis called von Recklinghausen's disease. The signals to locate his orientation and position in space never reach the brain. In water, without firm contact with the ground, he would lose all sense of orientation, leading to drowning.

Covenant also charts the history of diseases and their treatment in India from the pre-independence days to the present. The book explains how medical science and people's attitudes about medical conditions evolved progressively.

MY Zoom Background, published on August 26, 2023, also attracted some attention. Wanting to create a natural-looking background as a backdrop for my ZOOM meetings and online talks, and after failing to be satisfied with the virtual backgrounds

that Zoom provides for its lack of authenticity, I decided to create a natural-looking background behind my chair by painting a mustard field on my wall. The choice of the mustard field was motivated by the predominantly Cadmium yellow background that it needs, which is a pleasant colour. The shimmering mustard fields are part of the Indian ethos. Though physically confined to the north of India, its pan-Indian acceptance has been promoted by Bollywood movies.

A description of the Institute for Plasma Research Campus at Bhat published on February 16, 2023, also elicited much response. In 1982, the Department of Science & Technology

(DST), realising the importance of starting a research programme in Plasma Physics and Thermonuclear Fusion, established the Plasma Physics Programme (PPP) in the Physical Research Laboratory under the Department of Space, where a programme on basic Plasma Physics had been nucleated in 1972. DST also provided funds for PPP to move into an independent campus outside PRL.

The blogger's craft is rather lonely. My fellow blogger Susanna Gebauer has commented on the long, lonely workdays that are ahead for a blogger

and confirms that one is sure to experience the loneliness of blogging sooner rather than later. He sends out the piece on which he would have spent considerable effort out into the world, hoping for some appreciation or a kind word from the stoic reader. Medium is kind enough to keep one informed about how the blogs have fared in the harsh world. There are also claps and comments from the readers to express how they have felt about the blog.

My fervent wish is to continue writing and accumulate more loyal and appreciative followers, who continue to sustain my confidence, for which I am deeply grateful to them. I hope that I find interesting events and ideas to write about, which, in my retirement, is one process giving substantial sustenance to the spirit. My appeal to my followers is to give me the support that lifts one's spirit and helps me continue in my task.

## 46 Paints and Palettes



My mother would collect the India ink sketches I made, copying pictures of film stars from the Screen Weekly published

from Madras. Meenakumari and Dilip Kumar were favourites. Those scraps of paper are lost forever.

A poor young man of Tamil Brahmin extraction who lived in a bye-lane of Kottayam, going down from the Temple Road to the Boat Jetty, was an early influence. Sometimes, while returning from the CMS High School, where I had my early education, I would spend hours lost in the mural masterpieces created on the wall of his Veranda. The characters were mainly Gods and Goddesses. Shiva was a recurring presence.

Another influence happened when I went to Aligarh to do my PhD. I met Johnson. As a student, Johnson had respectable seniority even by Aligarh standards. Students came to the University to escape the rigors of life in mofussil towns and villages and stayed on pursuing degree after degree. Rumor was

that Johnson's parents had disowned him because of his refusal to marry a girl of their choice. He made a living by selling paintings in the Delhi art market. He had a style of stark realism with poor women and children staring out of the canvas with eyes filled with despair.

Farhan Mujib, a close friend, was also a painter. We were lecturers in the Physics Department. He later left his job to take up art full-time. His art attempted a fusion of traditional miniatures and modern-day collage. Farhan Mujib brought precision to collages. He collated random pieces of paper from magazines and photographs to create intricate images. He had an exhibition at Triveni Kala Sangam in New Delhi in 2003. He has also held shows across India.

An intense desire to paint re-emerged, while I was recovering from a bout of chickenpox in early 1982. I got someone to buy me the basic painting kit of watercolour, brushes and paper from the Kikabhai Mulla Gulamally shop in Khanpur. Paper pasted onto particleboard cut to the required size, and I was in business. The first painting created had three tall rocks in the sea done with various shades of blue.



Even the rocks had a tinge of blue. I have had a recurring compulsion to represent rocks in the water.

After recovering from chickenpox, I had to go to Gothenburg in Sweden to attend the International Conference on Plasma Physics. Gothenburg shops had luxurious collections of oil painting materials, and I collected a set of oil paint tubes made by Winsor & Newton.

Soon painting became therapy. At this time, we were neck deep in the task of building India's first fusion machine, the "ADITYA Tokamak". Painting relieved the tensions of engineering and commissioning a device of great complexity.

In our house in the Chitranjan Society near the St. Xavier School in Navrangpura, a corner in the dining room was my studio. I recall many ongoing battles with canvas to create art, to capture the tree-ness of a tree and the jagged craggy-ness of a precipice. Realizing that the lack of formal training was cramping my craft, I learned the techniques by reading some basic books like "A Complete Guide to Painting and Drawing" by Colin Hayes. Later, while crawling on the internet, I found many websites, blogs and virtual galleries where artists write extensively on their craft.

I had an opportunity to visit Tate Gallery to see the Joseph Turner collection during my visit to London to attend the 1984 Fusion Energy Conference. Turner's vision of violent seas, shearing winds and misty lights are still alive in my memory. During a visit to Russia as a member of an Indian science delegation from the Department of Atomic Energy in 1989, I visited Armitage in Leningrad, with its Titian collection.

When I built a house in Bopal, a suburb of Ahmedabad, I created a small studio hoping to spend pleasurable hours fighting with brush and canvas. We moved into this place in 1989, at the peak of our work in commissioning the ADITYA tokamak at the Institute for Plasma Research. As Head of the group responsible for commissioning the machine, my days started at 9 am and ended at midnight. Later, I got busy setting up the Facilitation Centre for Industrial Plasma Technologies, a centre to promote applications of plasma physics, and I found no time to paint.

My serious visits to art galleries happened during my 8-month stay in Vienna when I joined the International Atomic Energy Agency in Vienna. My wife joined me in November 2002. The baroque

Belvedere Palace housed the Österreichische Galerie, displaying the largest collection of works by Klimt. The Kunsthistorisches Museum Vienna had the world's largest collection of Bruegel paintings. Museum Moderner Kunst (Museum of Modern Art) with many Picassos, Chagall, Klee, etc., was also a favourite. Albertina houses the world's most extensive collection of graphic arts and prints. A fantastic collection of 60,000 drawings, 1 million prints!

Gordon Mackenzie's classic "Water Colorist's Essential Hand- book", acquired in Vienna, revealed the mystery of "Wash". Wash is the technique of thoroughly wetting the paper so that paint would spread on its own, creating semi-abstract patterns. Armed with thick, absorbent Acquarello paper and watercolour tubes, I went on an orgy of wash painting. I gave away most of the pictures to colleagues in the Agency.

In March 2003, I visited Washington March 2003 as a part of my work at the International Atomic Energy Agency to attend the Fifth Symposium on Current Trends in International Fusion Research. In the Smithsonian Gallery in Washington D.C., I got to see Matisse's 'Dance'.

Among the Indian painters, I admire Jehangir Sabavala for his abstract expressionistic landscapes of tortured paths between soaring rocks and the pilgrims in their journey towards the promised land. Another painter was J. Swaminathan, who began combining elements from nature in his conceptual landscapes. His series of paintings during the 1970s, which he called Time and Space, appealed to me. The iconography of the archetypal bird, the mountain, the tree, the reflection and the shadow became his tenor of symbolism. In a quaint way, this embraced the symbolic quality of the surrealists.

Every artist asks himself: why do I paint? Why did we choose to paint over many other options available for self-expression? More than any other means of expression, painting has an emergent element. We do not always know where the picture is going. Conclusion: there is complex feedback from the image and our state of mind, which changes the outcome. The painter is sub-consciously led a certain way determined by the painting. The satisfaction a picture gives one is the pleasure of discovering its final form.

Ruins and quiet places attract me. So does the impressionistic representation of landscapes. My

self-taught journey in painting started in 1982 and is continuing. After coming to Kottayam, I tried painting with acrylic but soon returned to oil. I have gifted my paintings to friends, so I can claim that they are exhibited all over India and even abroad.

Have I experimented with radical techniques? Yes! Prof. Devendra Lal, my boss in the Physical Research Laboratory, once told me of paintings he did with his bare hands at the Tata Institute for Fundamental Research. He persuaded me to try this technique to appreciate the sensuality and fluidity of the wet paint on canvas. I found this very productive since one could directly communicate with the canvas, bypassing the intermediary of the brush. The 'Old Fort' was a painting I made in the early nineties. I realised at that time that each technique creates its own art.

## 47 Thoughts for the Road



While living in Bopal, a suburb of Ahmedabad, I had to take a long journey, almost an hour, from my home to

Gandhinagar, where I

had set up the Facilitation Centre for Industrial Plasma Technologies. The routine was that I would spend time until lunch here before going to the main campus of the Institute for Plasma Research at Bhat. The office provided a car so that I could relax on the back seat; in “solitary splendour”, as a friend remarked about another rider. The highway is part of the Ring Road, which goes around the city. There are no traffic snarls and crowds of bustling vendors. The drive would be utterly boring if it were not for the passing vehicles and my stream of thought.

The highway vehicles, in their variety, reflect the diversity of India. There are shining new ones and rickety old ones kept together by hammer and nails and the drivers will. Fast cars flash by while senile oldies chug along slower than a tractor. Camel carts

piled high with household goods of a family moving house lumber along, with the camel with its head held high with disdain at all the surrounding fuss.

Most trucks want to communicate something to the world. 'Horn OK please' is a common refrain. There are many suggestions about what to do with the dipper. "Use dipper at Nite" was very suggestive. If one did not know what a dipper was, it might sound plain naughty. There are stern warnings to keep your place; 'apne aukat mat bhoolo'. "Buri nazarwale, thera mooh kala!" was a warning to all those who looked at the truck with bad intentions.

Truck drivers are enthusiastic versifiers. I saw this delightful couplet on the back of a truck: "Yeh neem ke ped Chandan se kam nahin, Hamari Ludhiana London se kam nahin (This Neem plant is not less than Sandalwood, Our Ludhiana is no less than London.)", which made me think of the burly sardarji driving the truck, scratching his head, thinking up the rhyme.

A thoughtful comment by my daughter-in-law made me look at the truck drivers with new respect. She said that the truckers are generally considerate to the car behind honking to pass. It is the yuppies in

their BMWs who make a nuisance on the road with their self-importance.

The long ride gives me time to put on my thinking cap. I have spent my professional life searching for how we can find commercially and industrially useful applications derived from Plasma Physics. Through these efforts, a Centre came up in Gandhinagar and numerous technologies have been developed and spun off. One of these ideas was to do with the Plasma Torch used in the plasma pyrolysis process we were working on. The idea of using the gas generated during pyrolysis to be sent back through the plasma torch to replace external Nitrogen gas source was germinated during my morning trip. We got a patent for this invention because it dispensed with the expensive Nitrogen cylinder for the operation of the torch. The patent was for "Plasma Torch with an Endogenous Gas Source".

A truly innovative idea came up when we were planning to develop Teflon like coating on metals surfaces. The precursor for the plasma polymerization process was Carbon Tetrafluoride gas, which was difficult to come by in small quantities. We hit upon the idea of pyrolyzing waste



Teflon to generate the gas, with which we could synthesise the Teflon coating.

The seed of an idea, which was born while discussing with my friend Abhijit Sen on scaring away pigeons which used to foul the terrace of his palatial home, got muscles and body during a road trip. Spark gaps and capacitors gave a loud bang, enough to scare away the pigeons, but they were considered dangerous. A potentially successful idea was a dispenser which would drop clumps of quicklime or Calcium Oxide into water with random periodicity. The resulting slaking reactions would cause explosions, which we thought would scare the pigeons away. We never built this.

I have always had a fascination for words and the images they create. The long drive was an appropriate time to recall some enjoyable images. The great cartoonist Aravindan had a comics series called 'Cheria manushyanum valiya lokavum ', meaning small people and the big world in Mathrubhoomi weekly. He used images that certain words evoked to great effect. A girl was sitting and planting her eyes in a field, (in Malayalam, planting one's eyes means looking). Another equally bizarre image would be when this girl throws her eyes at

someone, which again only means that she was looking at someone. Thurber was a genius at creating spectacular verbal images. His colored helper Della (of the reeves), Barney Haller, who went to the garrick and became warbs, and Walter Mitty, who would go on a trip merely on hearing a suggestive word, are characters I can empathise with.

Steve Jobs believed that: "Creativity is just connecting things. The broader one's understanding of the human experience, the better design we will have." Tarun Gulati, Organisational Trainer, writes, "It is this mental, and most importantly, the physical act of Contemplation — stopping to do what you were doing, sitting on a chair or going for a walk, and only thinking and doing nothing else — that makes innovation possible. Contemplation is an in- novation incubator." My morning car rides have been ideal for contemplation and perhaps, modest achievements in innovation.

## 48 My Investment Journey



I came into a little money in 2001 after spending close to a year at the International Atomic Energy Agency in Vienna in a senior

position. Being a UN organisation, its civil servants are paid rather decently. After returning to India, wealthier than I was before, I decided to indulge in my long-desired dream of investment in mutual funds. I had read about this magical path to the world of riches and had dreamt of doing this for a long time. All I required was a little capital.

Living in a place like Ahmedabad, one cannot escape talks about shares and investment. Pieces of small talk with my cousin Jacob illustrated to me the extreme fluidity and turbulence of investing

in equity. By integrating over the risks associated with many equities, mutual funds appeared to have a less volatile temperament, which suited my risk-averseness. I decided to approach an investment company in Ahmedabad, where I worked,

to initiate me into this mysterious territory of mutual fund investment. They listened to my proposal very gravely and shared their illustrious history of guiding many novices like me into the dreamland of wealth. I was asked to sign some forms, which I did, and there I was, an investor!

I had only a vague idea about how financial markets worked, and the only way in those days to know how I was faring with my investment was to look at the NAV listings in the Economic Times. I did this for a few days and found it very tedious. Let the markets work their magic, I said to myself and got busy with more interesting things like my work.

After a few months, I got a frantic phone call from my investment advisor who asked me to hurry up and go to their office. It appeared that there was a market downturn, and all my investments were turning negative. They said it was better to put the funds into floating-rate funds and wait for the storm to pass. Again, I signed the papers put before me.

I realised within a short time that the investment agency managing my funds was rather conservative, seeking the safest funds to put the money in. By this time, the HDFC bank, where I had my accounts, had started an online mutual fund

investment service which I joined. My observation was that financial advisors from banks would proffer their advice to those who had the least clue about what was happening to their wealth. Perhaps because I was a beginner and not playing with large corpus, they did not proffer any investment advice, and I was left alone to chart my progress.

Over time, I came to realise that the best financial advice on investments is ideally generated by the investor himself. There are reports on how financial advisors, when asked for advice on and existing portfolios made of perfect low-cost, diversified packages, advised on substantial rebalancing of portfolios guided primarily for their own gains in the reinvestment process. Economic Times reports that on average, investors advised by brokers had returns that were lower by three per cent a year. In the US, the current argument is about the so-called 'fiduciary rule', a law that says that advisors are legally obliged to put clients' interests ahead of their own.

Dhirendra Kumar, CEO of Value Research, writing in Economic Times recommends acquiring personal knowledge for being guided in financial investments. "Financial services are a zero-sum

game: the input, product and output of the business is all money. Being in a business, they must make a profit, and the only way they can earn more is by ensuring you get less of it. For a given type of financial service, and a given competence with which it is run, the only way the provider can make more money is to give you less of it. This drives every interaction you have with your bank, insurer, stockbroker, mutual fund and those trying to sell you, their services. The only way to make the right choices when you save, invest, is to arm yourself with knowledge and make decisions yourselves without depending on a salesperson."

A rigorous assessment of the investment-worthiness of a mutual fund needs analysis of the following factors: past performance, consistency of returns, conformity with your long-term financial goals, risk associated with the fund, performance of the asset management company, cost or Total Expense Ratio associated with the fund and a host of others. Doing this type of due diligence is a full-time task and perhaps feasible only for financial experts, which I wasn't. Fortunately, there are agencies like Moneycontrol and Value Research who do all this analysis and create their own database and allow

customers to access the database on payment. Moneycontrol, born in late 1999, claimed to have a single-minded passion to become the country's greatest resource for financial information on the Internet. It also provided a portfolio service where I could list the funds and watch their daily status.

The other database is Valueresearchonline, started by Dharendra Kumar, which provides advice and insight to investors via his column First Page and the webinar Investors' Hangout. The site also brings out the Mutual Fund Insight from 2002. Mutual Fund Insight has helped investors invest in mutual funds with confidence since 2002. It contains information, analysis, opinion and advice on mutual funds and personal finance. Each issue contains a comprehensive scorecard of all Indian mutual funds. This magazine is not for those looking for hot investment ideas. The magazine is a steady and conservative guide meant for those who want to enhance the returns on their long-term investments and savings without taking more risks than they can handle. and Mutual Fund Insight periodicals. The Mutual Fund Yearbook also offers guidance to the newbie investor. There's a chapter on how to build a portfolio by choosing the appropriate funds. It also

tells investors how to use the free online mutual fund portfolio tracker offered by [valueresearchonline.com](http://valueresearchonline.com). At a cover price of ₹695, it is terrific value for money. What's more, you can buy the online version at a discounted price.

The site provides data on mutual funds, analyses the fund performance and provides a portfolio for tracking fund performance. Their magazines provide valuable information on the investment strategy.

The enforced confinement to home due to COVID was a good reason for me to give more time to tend to my investments. I realised that I had no systematic data on how my investments fared over the years. What I wanted to build was a year-wise growth of the investment, buying and redemption and the profits/losses account.

For the convenience of Mutual Fund investors, Registrar and Transfer Agents (RTA) CAMS and KFinTech have come together to provide a consolidated account statement. This statement provides a comprehensive view of the investor's holdings across Funds serviced by all the RTAs. RTA stands for Registrar and Transfer agents; these are firms registered with the Securities and Exchange



Board of India (SEBI). RTAs facilitate record maintenance in mutual fund companies. They act as a single-window reference for the investors. As a result, they can collect all mutual fund investment-related information from RTAs.

The extended investment history revealed to me that my investment performance has ranged from extreme imbecility to absolute brilliance. I hope that the analyses that gets revealed shall come in my way in the future for responsible investment decisions. But transcending all my mistakes and foolishness, I have enjoyed every minute of investing in mutual funds.

The period 2002 to 2023 has generally been a good period for Indian investors, with the Indian economy and stock market both showing growth and development over this time. The Indian SENSEX, one of the leading stock market indices in the country, has seen significant growth during this period, with occasional fluctuations and downturns.

## 49 Experiments with Innovation



Innovation is a basic human instinct. The requirement to adapt physically and functionally to the surrounding environment drove us

on the evolutionary path for millions of years in the past. Innovation is the remnant of that process where we modify our environments to suit us.

I was recently invited to give the Kuriakose Mar Gregorios Memorial Lecture at a college in Pampady, a small town near Kottayam. I discussed the role of ideas in innovation, the concept of the combinatorial evolution of innovations from earlier innovations, the environments where innovation happens, the concept of 'The adjacent possible' and the Indianized concept of Jugaad innovation. At the end of the talk, the students wanted to know some examples of innovation which I had initiated. That triggered a stream of thought related to a phase in my life where inventions and innovations were an integral part of my professional existence.

Scarcity is the mother of innovation. In the early days of our setting up the Plasma Physics programme at the Physical Research Laboratory in Ahmedabad, a persistent problem was the non-availability of critical laboratory parts required to do advanced plasma physics experiments because of strict import restrictions and lack of adequate financial resources. We had to find ways to improvise and invent out-of-the-box solutions.

For example, we devised vacuum RF couplers with Amphenol connectors embedded in an epoxy cast. High-voltage feed-throughs were made using outsized O-rings forming electrically floating vacuum flanges. Sinusoidal voltage bias on a Langmuir probe ramped it to create current-voltage characteristics. We learned to trigger vacuum spark gaps with Bostick plasma guns made from two wires embedded in a plastic stub. We learned that a piece of paper with pencil scratches would act as an overvolted surface discharge source to trigger a coaxial plasma gun. Finally, we even learned to create high-voltage pulse trains with nano-second rise time by using a double-Blumlein pulse-forming line with discarded Coaxial cables and rotating spark gaps.

Another innovation happened in connection with the development of plasma nitriding, a surface engineering process for hardening steel by incorporating Nitrogen into the steel lattice from  $\text{NH}$  radicals extracted from an abnormal glow discharge in a Nitrogen- hydrogen mixture. The workpiece to be hardened acts as the cathode of the abnormal glow discharge. This type of discharge operates near the glow-to-arc transition, with small arcs getting initiated at the work surface. The arcs can damage the surface of the workpiece and must be prevented.

The arc initiation happens after a time delay of a few tens of microseconds after the full voltage for the glow discharge is applied to the workpiece. So, the technique for preventing the arc transition is to operate with a train of voltage pulses instead of a steady DC discharge voltage. The power is turned on for a few tens of microseconds and then turned off, the sequence repeating for the full nitriding cycle, typically a few hours. The switching is done by power transistors.

Power supplies are the most expensive component of a plasma nitriding reactor. Pulsing at a 50 per cent duty cycle means that the expensive system is used for only half of the operating time. We

wondered whether we could switch the power supply to a second nitriding workload when the first load is off. Then the power supply would be used for its full duration, although each load is energized for only half of the time. Full-time utilization is the optimum exploitation of expensive capital equipment and impacts the economics of plasma nitriding. We implemented this idea in a prototype machine but did not develop it for Commercialisation.

Another creative idea sprang up during the development of a plasma pyrolysis system for medical waste. We use a device called a plasma torch to create very high-temperature plumes of plasma. Temperature is as high as ten thousand degrees, which promotes fast pyrolysis of organic waste. It is an electrical arc between two electrodes, extracted out of the electrode region using a high-speed flow of Nitrogen gas. When the plasma plume from the torch falls on organic waste, it gets sublimated and converted into gases such as Carbon Monoxide and Hydrogen. This is burned in a vertical furnace and the products are cleaned and released into the environment.

The CO + H<sub>2</sub> mixture, produced during the pyrolysis of any organic waste is the Syngas, which

contain chemical energy. If this is purified, compressed and collected, it can be commercially used as an energy gas which can either burn or power internal combustion engines. This is the basis of the waste-to-energy concept in plasma pyrolysis.

But if the Torch uses Nitrogen, the Syngas get mixed up with Nitrogen. Nitrogen must be removed because it cannot burn. The separation is a costly process. However, if the pyrolysis product gas is collected, cooled and recirculated in the torch, there will be no dilution of the product gas with Nitrogen.

This invention also made the pyrolysis process more efficient. It also dispensed with the expensive Nitrogen cylinder for the operation of the torch. We got a patent for this, "Plasma Torch with Endogenous Gas Source".

A very innovative application we developed was in response to an enquiry we received from the Department of Science and Technology on the possibility of using plasmas to clean the Carbon soot deposited on the walls from the oil lamps used in temples. We found a NASA invention of producing atomic oxygen in a high-voltage streamer discharge. The atomic Oxygen would react with Carbon in the soot and convert it into Carbon dioxide. We even

packaged the Atomic Oxygen generator inside a hairdryer to demonstrate to DST officials the ease of using it.

A truly innovative idea came up when we were in the process of developing a Teflon-like super-hydrophobic (water-repellant) coating on metal surfaces. The precursor for the plasma polymerisation process was Carbon Tetrafluoride gas, which was not available for purchase in small quantities. We hit upon the idea of pyrolysing waste Teflon to generate the gas, with which we could synthesise the Teflon coating.

The seed of an idea, which was born while discussing with my friend Abhijit Sen on scaring away pigeons which used to foul the terrace of his palatial home in Ahmedabad, grew muscles and body with further thinking during our travels to the office in shared transport. Energy storage capacitors discharged through atmospheric pressure overvolted spark gaps give a loud bang, enough to scare away the pigeons, but were considered dangerous for use in a domestic setting. A potentially successful idea was a dispenser which would drop clumps of quicklime or Calcium Oxide into water with random periodicity. The resulting slaking reactions would

cause explosions, which we thought would scare the pigeons away. We never built this.



## 50 The Path to Padma



On 14th January 2010, on the day of Makar Sankranti and kite flying, some officials from the Home Ministry and the Intelligence Bureau

came home and said that they wanted to felicitate me for the Padma Shri award. When I asked them whether this was confirmed, they hedged and said that it was 99% confirmed. This was the first inkling I had that something was happening.

On the morning of 25th January, on the way to the office, I had another call from a Joint Secretary of the Home Ministry congratulating me and asking whether I would accept the award. He said that the formal investiture would happen sometime in April and that the list would be uploaded to the President's website by the evening.

In the evening, while Minnu and I were out buying cakes and sweets from Melanie's place (who was thrilled on hearing the news and insisted on our accepting a cake from her), Indiavision TV called to

congratulate me. Almost immediately Deepika newspaper from Kottayam called and said they were at my ancestral house in Karapuzha, and they interviewed me. Manorama also did the same. They all wanted my photograph and a profile, and I started preparing this in between phone calls. By late night, I was able to send some material.

The deluge of calls from the press started the next day, and messages of congratulations started pouring in. The phone line collapsed amidst this. The editor of the newsletter of the Malankara church wanted a biographical sketch, highlighting the fact that I was the great-grandson of Pucadyil Ittoop Writer, who wrote the first history of the Syrian Christian Church. The photographer from the Times of India landed at our house and made us pose in many ways until he was satisfied.

The next day, I had to go to ITER India for the Republic Day flag hoisting and to give a little speech on how their plan to go into ISO 9001 was important. I added some stuff from Prof. Ram Charan's book on "Execution" to make the talk sound professional. I also mentioned Paul Romer's TED talk on how rules were important.

Back home, the representative of the Bopal chapter of the Kerala Samajam came to invite us for felicitation in the evening in the Tulip School. A small delegation of members of the church also came with a bouquet and compliments. While they were at home, the head of the Jacobite Church, His Holiness Baselios Thomas I called and said that I had brought great honour to the church. Other church dignitaries, notably His Grace Thomas Themotheos from Kottayam (whom I knew from the Vienna days), also called and said similar things. Professor K. K. John, my former teacher at the S. B. College, became very emotional when he talked. He also made sure that the present principal talked to me, who mentioned that he was on his way to the Alumni meeting and said that he would talk about me and the award.

The Manorama online article triggered calls from Vienna, from former IAEA friends. George Varghese called from Dallas and reminded me of the Always days when I used to create Malayalam songs on the tune of Hindi film songs. He sang some of them, and I was very touched.

Jumana Shah from DNA wanted an interview, and I invited her home on Wednesday evening. This resulted in a beautiful piece mentioning my interests

in poetry, painting and the social commitment of science, etc. The DNA piece created another flurry of messages. A very interesting result was that my neighbour, a young businessman, brought many of his business friends and family members for a 'darshan'. His wife Babita and sister-in-law Poonam also came for 'blessings'. The Sterling City managing committee also came home to congratulate us.

On 31st, the following Sunday, there was another felicitation in the church for both of us. I read my poem on Einsiedeln, which created some interest. Deepak, my former student wrote from Los Angeles congratulating me and mentioned that he got carried away and created a Wikipedia page about me.

A belated congratulatory telegram from P. Chidambaram, the home minister was another rite of passage. Another letter from Home Ministry wanted a citation to be drafted by me for inclusion in the commemoration volume. A major task was to spell my name in Hindi, which turned out as hard as getting the award. Many consultations with friends yielded many versions. Someone tried Google translator, which gave me yet another version.

Finally, the Hindi officer of the institute was brought in, and he solved the problem.

The DNA article created a further spin-off. Sabina Griffith, the editor of the ITER Newsline, wanted an interview and materials relevant to my interest in painting and poetry. This piece came out quite well.

And finally, on 5th April, we left for Delhi to take part in the ceremony. The home ministry had graciously provided accommodation at the Taj Palace. My son, Joseph had planned to accompany us to the ceremony but opted out because of a vacation trip to Prague.

There was a rehearsal on the 6th when we were made to go through the paces. On the 7th evening, we filed dutifully into the Ashoka Hall of the Rashtrapati Bhawan to wait for the President and other dignitaries. The Padma awards are given here in a glittering event of unparalleled grace. Under the painted vault as I waited my turn to be called before the President to receive my award, I felt a strange sense of satisfaction, of arriving at my destination after a long journey. When I started my journey all those years back, I had no inkling that I would be fortunate to reach where I am, a journey from

humble beginnings and of struggles and occasional triumphs.

Inspired by the events, I wrote the following poem:

“Under the painted ceiling, amidst my peers  
I sit, waiting to be called to the presence  
and for the scroll and the medal, a lifetime’s  
reward

for going my way and doing whatever I did.  
My wife sits among the guests, in signature  
blue

Her eyes, darting my way in constant concern  
when she was not watching the gathering  
crowd

of movers and shakers who make up Delhi.

They gesture and prance and surreptitiously  
look for

The wandering press, perchance a shot  
For the page three prominence, the holy grail  
and those who arrive late, with those who  
arrived, and the hall slowly fills up,

the last seats taken and a hush as trumpets  
rumble and bugles flare.

As we are called, we present ourselves  
in well-rehearsed order, with obsequious care,  
namastes strewn around, cameras flash  
and back in the seat, the trophy clasped in  
hand."

## 51 Portrait of my Family



Minnu came into my life in 1969. Shortly before that, I had acquired a Ph D degree in Physics from the Aligarh Muslim University and

a lecturer's job in the Physics Department.

My parents searched far and wide to find a suitable girl. One day, on his way back from the office, my father happened to meet an old college friend. It turned out the friend was looking for a groom for his daughter. The old friends shook hands on becoming relatives by marriage.

My first meeting with Minnu was a disaster. I arrived at Cochin from Delhi by flight after a previous night of revelry, celebrating my last day of freedom with my friends. My hangover had not subsided even when the flight landed in the Cochin airport, those days in Wellington Island. Still tipsy, I came down the aircraft to be met by my father, who, thoughtfully, had brought Minnu along. My wind-swept hair and



brown shirt did not impress her, and it took another meeting, later in more sober conditions, to woo her.

The wedding was a typical Syrian Christian one. After marriage, Minnu continued her studies and joined me a year later when we set up a home in Aligarh on Marris Road. Our friends were from the Malayali students and the family of P V George, the Registrar of the University. Joseph was born in April 1971. Shortly afterwards, I moved to Ahmedabad to join the Physical Research Laboratory, where we settled down in a house in the Kuldeep Society near the Commerce College junction. I discovered a relative, Dr Ipe Pucadyil, who had a hospital in Tintoi, Sabarkanta. Minnu became friendly with his large family. It was in his hospital that my second son, Thomas, was born in 1976. Almost immediately, we moved into Dr Pucadyil's house in the Chitaranjan Society near St. Xavier's School in Navrangpura.

Minnu is fond of shopping. When we came to Ahmedabad in 1972, one of the monthly rituals was to go to Manek Chowk and buy groceries for the month. She would never enquire about the prize: her logic was that we must buy what we need, irrespective of the price. The municipal market at

Navrangpura with its Italian Bakery and Rasranjan sweetshop became favourite places.

Another shopping experience she enjoyed sharing with visitors from Kerala is the Law Garden Night Market with trinkets, jewellery, dresses, accessories and much more. Most of the wares come from the artisans of the Rann of Kutch. The bead and mirror work, all done by hand, are exquisite. Long, traditional skirts are awash in colour. The prices are shocking, and bargaining is the norm. The markets extend over the road and are always busy.

We came across the quaint Sunday market on the riverfront between Ellis Bridge and Sardar Bridge. The market, which started in the 15th century, had moved many times, finally settling down on the riverfront in 1954. The market sells all sorts of things, household articles, kitchenware, agricultural tools, electronics, jewellery, etc. Ravivari Bazaar is heaven for book lovers. An assorted collection of books, even rare books, are available.

When we built our house in Bopal, Minnu's gardening instincts flowered fully. Her compulsive watering of the gardens to fight against the Ahmedabad weather prompted me to write the following piece, an imagined conversation I over-

heard while sitting under the cool shade of the Cassia tree:

“Don’t look! she is coming again with the water hose”, the Raat ki Rani whispered to the Hibiscus.

“Oh my God!” Hibiscus exclaimed. “I am up to my neck with water. She will now push the hose into my roots and start watering. Don’t be surprised if water sprouts through my flowers.”

“This is third-degree. What has she got against us poor plants?”.

There was a collective murmur.

“Water torture is nothing. Look what she did to me”, Monstera cried.

“What happened?” All the plants eagerly asked.

“I was growing nicely along the boundary fence. I could look across and see the neighbor’s children playing. I could swing in the wind and play catch with the butterflies. I could...”

“Enough of that!” exclaimed the other plants. “Tell us what she did.”

“Oh. She unwrapped me from the fence, twisted me and tied me up on this monster tree. That too with a yellow plastic strip. All that I can do now is

to look up. My neck is paining, and my itching where she tied me with the plastic has not stopped", Monstera whimpered.

"She is a control freak. That is what she is," the ordinarily calm Din ka Raja said. "I have these long stems which tend to grow wild. But not in this garden. She makes sure that the stems are twisted together. Sometimes the twisting hurts"

"What you get is nothing compared to what I suffer every time I sit here grooming my baby," said the monkey sitting on the branch of the Cassia tree." She creeps behind me and lights a cracker. The noise is so frightening that I fell off the tree once".

"Whatever you guys say, she loves us and is really proud of us" the Geranium plant gushed.

"That is nonsense! How do you know?" asked Chameli, who is always contradicting others.

"I heard her speak to her cousin the other day. She said the plants were like her children and that we were the bestest plants in the whole of Ahmedabad" The Geranium said.

"Then why does she try to drown us? This is a strange kind of love" murmured Lantana.

"Yes yes, she seems to be loving us to death", many plants spoke at the same time.

"Stop talking and drink up this water", I heard my wife shout in the garden.

Minnu is obsessive about keeping the house spick and span. Her dream of putting her Feng Shui principles into practice arrived when we moved into our own house at Bopal. In feng shui, your entrance area is the path through which energy enters your home. In our home in Bopal, the architect had built a wall near the entrance. On Minnu's insistence, the top half of the wall was removed, opening it up. My friends commented on the beauty of the small house and the perfect arrangements inside. Minnu's fascination with Feng Shui led me to write the following poem:

"The rocking chair where I sit and read the morning paper under the hanging lamp

has been moved to the other corner of the room, near the ramp.

I do not understand the reason, until my wife explains

that the position is far more auspicious, according to her book.

This also explains why there is a bunch of red flowers in the pot on the table

and a red sash tied to the bathroom window on the southside gable.

On my bedside table on the east there is a huge, green pot

which comes in my way as I rummage in the morning to turn off the alarm.

Surely there is a better place for it, I beseech my wife.

to no avail as the book commands that the east needs green.

Spirits roam my house, if I were to believe the earnest urging,

looking for mischief and a corner to hide before pouncing.

The wind chime giggles in constant merriment as Chi, both good and bad tickle and tease it as they fly through the house.

Feng Shui reigns in the garden, green with bamboos,

and the jade plants tumble from pots trying to tickle the earth.

You may say that I live a charmed life, in harmony with spirits

except that Feng Shui determines where I shall rest and repose."

Minnu's tailoring skills are amazing. She would design and make her dresses and even help her friends in their sartorial experiments. She converts old saris into churidars with amazing ease.

Minnu is highly compassionate and empathetic. In our Kottayam apartment, She happily spends time with the old women, suffering from various forms of old-age afflictions and offers friendship, compassion and hope.

Hour-long meetings on ZOOM keep contact with children and grandchildren very alive. In the weekly meetings, we share the events of the week and its ups and downs.

Minnu loves music competitions held as reality shows by Sony TV and can spend hours watching the young performers.

Minnu's skills in hospitality flourished when a few of our friends decided to meet occasionally and

have a potluck lunch, each bringing something to the table. Though not very fond of cooking, the event gives her a good reason to experiment with exotic dishes, the recipes taken from YouTube. These sessions have been enriching, enabling us to enjoy each other's company and share stories.

My elder son Joseph's (Jiju) 50th birthday in 2021 gave me an occasion to speak about him. I was not around when he was born. When I came home from Aligarh and when I first held him in my hands, there were very strange emotions: pride, possession, and vulnerability.

I recently came across a photograph of the Aligarh days with me holding little Joseph in my arms. My Malayali friends from the South Indian mess who visited us frequently, were fond of little Joseph. When we moved to Ahmedabad and set up a home at the Kuldeep Society. Joseph grew up to be a friendly, confident and strong-willed boy and loved the clothes I brought back from my foreign trips.

Joseph started going to Mrs. Sequerra's school and later to Mrs Fisk's school and St Xavier's School. He was well-liked by teachers. To my brother Rajan's question whether there was school the next day, his answer was "Richawala paranjoo, skoolillannu



(Rikshawwala said there was no school)". This was remembered fondly and repeated by Rajan many times. I discovered Joseph's genius for creating unique words: helicopter became allycoopen, cooling glass became coodingas, an elephant became an appletant. On a train journey to Kerala, tunnels became "Rathrikunnu (Night Hill)" apparent when you remember that they go through hills, and there is a transition to darkness while entering them. He was convinced that ice cream was made by adding eggs to payasam, the traditional Kerala porridge.

When my second son Thomas came, Joseph was reluctant to facet the change, though there was finally acceptance and affection for his kid brother. As a student, he was a good all-rounder.

When we moved to Chittaranjan Society, Nicky and Pinky be- came his friends. Always curious about what I do, he liked to sit with me when I was writing something or painting. This association would invariably end up in my giving him parental advice. In any test of will between my adamance and his nonchalance, I was invariably the loser.

When he joined St Xavier's College, I bought him a scooter and he became very mobile. He made more friends and his active role in the election

campaign at the college for the Rasna heiress is something I remember.

When we moved to our house in the distant Bopal, I started to depend on him for support in managing the problem of living in a very remote place. With his usual thoroughness, he started enquiring among his large circle of friends where to get a puppy. He finally succeeded with the help of Devansh in getting a terrier puppy, which he brought home. We called her Tania. Tania was full of energy, constantly wandering around the house, examining everything. Creeping on unsuspecting people and jumping on them was her thing. She gave moral courage to my wife when she was left alone during the daytime.

When Joseph joined M S University in Baroda and went on to live in the hostel, he became something of a dandy in his dress sense. This was remarkable because of the modest support I could provide due to my financial constraints as I was paying off the housing loan. I learned later that his nickname was Angrez, quite appropriate because of his style and deportment.

Lightning struck when he met Priya, a Tamil Brahmin girl in his class. He brought her home once,

presumably to make her acquainted with her future family. In his twenties, he showed amazing persistence in pursuing his goal of wooing Priya much against her family's wishes. Joseph's goal was to find employment as soon as he passed out of MSU as he was intent on marriage without delay. One of his Professors was instrumental in getting him a position with Miles India Ltd. as a Technical Specialist.

He finally succeeded in marrying Priya and bringing her into our lives. This was a test for me in one sense. I, as a liberal intellectual, believed that true national integration would come only if we allowed all the religious, linguistic and social boundaries to merge. Will I accept in my heart the impending marriage between the Tamil-speaking Brahmin that is Priya and the Malayali Syrian Christian - at least by birth - Joseph? I am proud to say that my liberal thinking won over traditions.

The marriage took place in Ahmedabad. Joseph planned everything to make sure that the bride's entourage was received at the railway station, brought to Bopal and accommodated at the Sterling City Club. My brothers joined me from Kerala for the marriage and the celebrations which followed on the

beautiful lawns of the Sterling City Club, in our neighbourhood.

Priya complements Joseph in many ways. Very friendly and sociable, always full of laughter, and empathetic. She is a highly accomplished psychiatric counsellor with a sizeable clientele. Joseph and Priya showed an amazing ability to mobilize resources to create wealth. Soon after they settled down in Thane after marriage, Priya's remarkable financial sense prevailed.

They decided that living in rented houses did not make financial sense and managed to find capital to join a housing society. Joseph went to amazing lengths to make his two-bedroom apartment look elegant; I remember particularly the pain he took in ensuring that the handle of the entrance door was just so.

Settling down in Thane with his young wife did not deter Joseph from pursuing excellence in his professional commitments. Within a short time, he was appointed as Area Sales Manager at Wipro Biomed. He went on to become a Product Manager with Ranbaxy Diagnostics and moved to Delhi. Then he joined Roche in their Mumbai office. He is at present International Business Leader at Roche

Diagnostics Rotkreuz stationed at their headquarters in Rotkreuz in the Canton of Zug, Switzerland. I

was always amazed and was indeed proud at the speed and regularity with which he changed jobs and climbed the professional ladder.

His colleagues consider him a very gritty, determined and hard- working person and that his 'must do' attitude has brought him where he is now and will take him a long way. His loyal lady assistants - someone called them Joseph's angels - a team which he built, give him excellent professional support. The meticulous planning I have seen him make for our road trips convinces me that he must be planning his work also quite well.

Joseph is good at quick repartees. When I told him that I was planning to add a back up folder for my document folder on Google Drive, which was called John Drive, he suggested that I could call it John Park.

Surprisingly, I know little about his work and professional life. This is because Joseph likes to keep all this confidential, even from his family, despite my persistent attempts to learn more about this aspect of his life.

Joseph is a self-taught photographer who is on a constant endeavour to create fresh, vibrant images that capture the essence of his subjects. His photography website [[www.josephpucadyil.com](http://www.josephpucadyil.com)] is indeed a beautiful place. My appreciation of the richness of the website made me compose the following poem, which I posted on his website:

"Captured here permanently in pixels

Nature caught in vision that excels

Monet's impressions and Matisse's movements,  
Cezanne's violets and Miro's magic

Caught through my Nikon brightly

On a lazy day in Cham under the sun, I zoom,  
therefore, I am!"

He has also taken to carpentry as a hobby and has a fully-fledged workshop at home, where he turns out boxes and trays of exceptional finesse.

We had irreconcilable differences on what he considered my 'junk'; the stuff I had collected over the years on my travels in India and abroad. He was persistent in his advice that I should throw it all away, to recover the 'positive energy' of the house. I always refused to do this as they had great sentimental value for me. Joseph's obsession with perfection has

led to much light- hearted banter between us. The way he would ensure to within millimeters the placement of a grid of photographs on the wall of his house in Switzerland is a recent memory.

When I received the videos of him dancing with my niece Susan's children while they visited from the US, I suddenly recalled his skill and passion for garba dancing. On Garba days, he would disappear for entire nights, dancing away with his friends. The video showed that he had developed some intricate footwork which he was always willing and generous to teach others.

Minnu and I visited Joseph's family in Switzerland in 2009. Joseph arranged carefully planned trips to Salzburg, the home of the great music festival. The Swarovski Museum, with its brilliant glassware collection, was another high point. Finally, we drove into Innsbruck in Austria to commemorate my earlier visit to this town to attend the International Conference of Plasma Physics in 1992. We also made extended trips to Paris and later to Camargues in the South of France.

Priya and Joseph have a son, Rahul, born in April 1996. His early interest in Astrophysics had made me very happy. However, he shifted his field to

computers and software and is a passionate game developer. He went to study at the Toronto University in Canada but returned to pursue studies at the ETH, Zurich. He is now employed with the University of Biele but has dreams of setting up his own company to develop games.

My younger son, Thomas was born in November 1976 in my uncle's hospital in the Tintoi village in Banaskantha, on the Gujarat-Rajasthan border. A few weeks after he was born, I brought them home to be taken care of by Aleykutty, our maid servant. We lived in Kuldip society, near the Commerce College Junction in Ahmedabad.

Thomas grew up to be a quiet, brooding boy, always immersed in some thought or the other. His eyes were very expressive and indicated where he wanted to go when he was carried. Shortly after his birth, we moved to Chitranjan Society, to a second-story apartment. He was fond of playing with my lens, focusing the Sun on a piece of paper to burn it. He was quiet and reserved in school but was a good student. His artistic skill came to light when he created a large panel with drawings of Dinosaurs and prehistoric animals for a school event. Later, he created a painting of Jesus in the Gethsemane



garden for the house I built in Bopal, which still adorns our home in Kottayam.

From my trips abroad, I used to return with boxes of Lego. As a child, Thomas enjoyed playing with the Lego pieces with Joseph, his brother and his cousin Smriti. It was a pleasure to see them sitting together, immersed in building something with their Lego pieces.

Noticing his tendency to drum on tables, we enrolled him in a Tabla class organized by a Tabla guru in the neighbourhood. My wife would walk him to the school and bring him back. The high point of his tabla career came when he performed solo in my institute's annual function. There he was, sitting confidently on the stage and drumming away! My colleagues commented on his self-possession and confidence.

After passing out of the St Xavier's in Ahmedabad with a first- class degree, he followed his brother to the MS University in Baroda, where he did his M. Sc in Biochemistry, passing out with a first-class. He told me later that the first thing he did on the campus was to go around the places where he believed that his brother had courted Priya. I happened to meet Prof Bela Mehta, his Professor

after both my children had passed out of the MSU and I asked her what she thought of them, and her reply was revealing. She said Joseph was carefree, outgoing, cheerful and had many friends. Thomas was intense and passionate about things.

An incident comes to my mind, reflecting Thomas's noncompromising character. Thomas was studying at St Xavier's College, Ahmedabad. I had bought him a 'Sunny' moped to travel from Bopal to the college, about 5 kilometers. I knew he was a careful driver and did not worry much about his daily commute. One day, while I was in the office, I got a message from him, saying that I should meet him at the Panjrapole junction. He said that he met with a minor accident, a collision with a lawyer's scooter. When I reached the place, I found that the lawyer was threatening legal action unless I settled with him on paying some money. Thomas believed that the fault was on the lawyer's part

as he had hit him from behind. Much against Thomas's conviction of being right, I finally paid him, wanting to avoid a criminal case. Years later when I asked Thomas about the impression this incident left on him, he said he was indeed disillusioned at the

dishonesty of people, in their greed to make a few rupees.

He was able to get admission to the Centre for Cellular and Molecular Biology (CCMB) at Hyderabad for a summer research programme under Dr Amitabh Bhattacharya. He worked with Kaleeckal Harikumar, a postdoc in Amit's laboratory, who was a very patient and gifted mentor. They worked on understanding how a G protein-coupled receptor would respond to covalent modification. It was a short project, but it resulted in his first publication. That was an eye-opener for Thomas. Suddenly, he realized that science was within reach. His earlier connection with science was through reading research articles, and reviews, and for some reason, all of that seemed very distant. But it was a remarkable and motivating experience to see his name in print in a reputed journal.

His excellent performance in the summer programme at CCMB helped him to get an opportunity to do his Ph D under Prof Amitabh Chattopadhyay. His PhD thesis evolved from the summer project, studying how membrane lipids influence receptor function. His thesis was on the Modulation of the Serotonin Receptor function and

Organisation through lipid-protein interactions, and he received his Ph.D. degree in 2005.

Thomas met his partner, Shanti, while he was at CCMB. She is a soft-spoken, shy, caring girl belonging to an Andhra Brahmin family settled in Hyderabad. My family gathered in Hyderabad to take part in the wedding. My brothers also came from Kerala to attend the event.

Shanti holds a Ph. D from CCMB and joined the University of California in San Diego for her post-doctoral work. However, she became attracted to science writing and did a course at the UCSD. She is at present a Senior Professional in the Director's Office in IISER and manages the IISER website among other responsibilities.

Thomas wrote to many reputed cell biologists proposing to do his postdoctoral work on some aspects of cell biology focusing on membranes. Most of the people he applied to responded positively to the idea but could not fund this or did not want to invest in this unconventional direction. He eventually got accepted by Sandra Schmid from The Scripps Research Institute, who said 'This idea is perfect because I have no clue what you're talking about, but you apparently do, so let's do this!' Scripps Research

Institute, San Diego, USA is one of the world's largest private, non-profit research organizations. He started working on dynamin, a protein known to be involved in membrane fission to form synaptic vesicles.

Thomas was certain that he would return and work in India. Declining offers from established organizations, he joined the newly created IISER in Pune, where he set up the Reconstitution Biology lab. What directed him to do this was his belief that the new place would give him the independence to do what he wanted. His research is based on a novel approach to address questions in membrane biology that he pioneered during his postdoctoral work. His techniques have found great success, as evidenced by the many accolades he has received. He says, "Compared to my peers who have now found positions in established institutions, I find I can induce more change but with more responsibility."

He made rapid academic progress in IISER. After becoming an Associate Professor in 2016, he became the Chair of the Biology Department in 2019. He rose to assume the Rahul Bajaj Chair Professorship in 2021. In 2021 he became a Fellow of both the Indian Academy of Sciences and the Indian National Science Academy. He received the

prestigious Shanti Swarup Bhatnagar Prize in Biological Sciences in 2018. He has more than 60 publications in reputed journals and has supervised 16 students for their Ph. D degree.

In 2018 Thomas was selected for CSIR's Shanti Swarup Bhatnagar Prize in Biological Sciences. The prize recognises outstanding contributions to science and technology.

The award was given for his work on cell membrane fission or how cell membranes split, and the transport of cellular material is relevant to understanding how the process affects the human immune system. At his lab, he and his team of researchers study biochemical reconstitution to record how cells form vesicles, which are membrane-bound vehicles that transport proteins.

Thomas is one of the 41 young scientists, selected from across the world by the US-based Howard Hughes Medical Institute and the Bill & Melinda Gates Foundation for support in research funding. They fund exceptional early-career scientists, enabling discoveries that advance human health and the fundamental understanding of biology. The 41 scientists selected from 1400 applicants will receive a total of \$26.7 million and

each member will receive a grant of \$6,50,000/- over 5 years. Thomas is the only Indian among the 41 scientists.

In 2021, when I attained 80 years of age, my institute organized an event to felicitate me. Thomas was one of the speakers. He spoke beautifully about his childhood and his interaction with me and how that was one of the things which influenced him to choose a career in science. It was a very perceptive talk which moved me deeply.

He thinks deeply about the communication of his work and has always been excited by the storytelling aspect of putting together a paper. He believes that by using data to create a sequence of schematics and results, the presentation of information in a manuscript is an art form.

He likes reading science fiction. His favourite author was Arthur C Clarke, and his favourite novel was Clarke's "Childhood's End", a story about what happens when humanity encounters an advanced alien civilization. He also enjoys gardening, and collecting exotic plants, probably because his mother, Minnu is an avid gardener.

Thomas's son Nikhil is a skilled basketball player and enjoys performing stand-up comedy, with stories about his science-minded family.



## 52 Looking Back

Thoughts about my life lead to a recurring realisation that I have been very fortunate to be at the right place at the right time on many occasions. An accident of going to Aligarh made me choose Plasma Physics as a career discipline. It was also an accident that PRL was planning to start work in Experimental Plasma Physics when I was beginning to be disillusioned with continuing to work at Aligarh. After a decade in PRL, the Plasma Physics Programme and Aditya happened through the collective efforts of many people. An understanding Director and a supporting Council made Plasma Processing and FCIPT possible. The exposure to IAEA made me aware of the importance of ITER. The DAE dispensation supportive of Indian participation in ITER also happened at the right time. All these opportunities presented themselves, and one needed only a reasonable competence and an honest commitment to fulfil the demands these opportunities made.

It does not mean that all these things just happened. I can honestly say that I put in a lot of hard work. But I must also acknowledge that many

students, colleagues, mentors and friends contributed significantly to help make these things happen. I would like to acknowledge here some of these names.

Prof Rais Ahmed, former Head of the Physics Department at the Aligarh Muslim University, made me realize that science transcended the task of creating new knowledge to drive economic advancement and social change. Prof M S Sodha, former Professor of Physics at IIT Delhi, had always supported my efforts in what he called “getting literate in Plasma Physics”.

Professor P K Kaw at the Institute for Plasma Research is a mentor I have seen in many roles; as a great plasma physicist, as a powerful motivator, as an interpreter with great clarity of thought, as a person with profound philosophical and spiritual moorings, as a clever and nuanced strategist, and above all as a person with a grand vision of the role of India in fusion and plasma physics. Prof Abhijit Sen was always a patient listener to my problems when I undertook a risky effort to convert plasma physics knowledge into products of industrial value and offered me sage advice. Prof Devendra Lal, though somewhat ambivalent about Plasma Physics, would

constantly send me a stream of reprints and news on Plasma Physics as if to spur me on to higher ambitions.

Dr P K Iyengar and Prof S Ramaseshan, former members of the Governing Council of the Institute for Plasma Research gave me great support, especially during the development of the Plasma Processing Programme and the setting up of the Facilitation Centre for Industrial Plasma Technologies (FCIPT). Dr Anil Kakodkar, former Atomic Energy Commission Chairman, encouraged the concept of the National Fusion Programme and the Board of Research of Fusion Science and Technologies (BRFST) for drawing University faculty into Fusion research. Prof P Ramarao, former Secretary, Department of Science and Technology (DST), helped the Plasma application programme by making it part of the Indo-German initiative in Surface Engineering. Prof V S Ramamurthy, former Secretary, DST, enabled the development of a vital plasma technology for medical waste destruction. I owe great gratitude to my colleagues in the Plasma Physics Group at PRL and IPR. Prof Yogesh Saxena was an early collaborator in the experimental work where his skills in computation- based design and data analysis

made a huge impact. Prof Shiban Mattoo brought a critical mind to our efforts in setting up complex experiments. Dr Dhiraj Bora and Dr Venkat Ramani joined the group as students and took on extremely demanding responsibilities later.

Prof Igor Alexeff, University of Tennessee, and Prof Charles Wharton, Cornell University, made it possible to create the PRL-NSF programme on Intense Electron Beam Experiments.

I am deeply obliged to my students Kamlesh Jain, Chenna Reddy, Vijay Shankar, Deepak Gupta, Purvi Zaveri, Sambaran Pahari, Subroto Mukherjee and Shantanu Karkari for being willing fellow practitioners in the art of building complex plasma devices and making them yield exciting data. I thank Dr Avinash Khare for contributing to our understanding of the nonlinear sheath evolution and the dynamics of non-neutral plasmas. Dr Hari Ramachandran's deep insight helped to make sense of the non-neutral plasma observations. With his characteristic enthusiasm, Ganesh Prasad enabled me to take on many ambitious projects in plasma application development. Sudhir Nema made me appreciate the power of Plasma Chemistry. Ashish Chainani made me realize that science can be

gleaned from mundane work in application-driven research.

I thank Dr Shashank Chaturvedi for his continued support of the application programme at IPR and for his efforts to link it to the ATAL start-up programme. Dr Ravi Kumar provided great administrative support in the conception and realization of the National Fusion Programme (NFP). Dr Ashish Ray and Dr Amit Roy of the BRFST Advisory Board made the difficult task of identifying promising investigators from Universities to fulfil the NFP objectives.

My family consists of my wife Minnu, my children Joseph and Thomas and their wives Janaki and Shanti and my grandchildren Rahul and Nikhil who gave me their love, support and loyalty in all my endeavours in the period after acquiring a family. I wrote these pieces primarily to convey to them the transitions I have gone through, as a person, as a scientist and as a parent. My eternal love and gratitude to them!