

DOWN MEMORY LANE:
Vainu Bappu's Dreams Revisited

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Opening remarks

I am deeply sensitive and extremely grateful to have this opportunity to pay homage to Vainu Bappu. I was very surprised when I received a letter from Professor Bhanu Das inviting me to deliver this lecture. My first reaction was to decline the invitation. There were two reasons for this hesitance. Although I deem it as a great honour, I am certainly not in the same league as the previous speakers. Further, I was very concerned about whether I could prepare a talk worthy of Bappu in the short time I had. Finally, Dr. Sreekumar persuaded me.

It seems appropriate therefore that I begin this lecture with the following quote from Henry IV:

First, my fear; then my courtsy; last my speech.

My fear, is your displeasure,

My curtsy, my duty, and

My speech, to beg your pardon.

I first met Vainu Bappu in 1964. I had just finished my M.Sc. and was working at American College in Madurai. My boss was Dick Riesz, a young American who had come the previous year from BEL Labs to start the PG department. Prof. Riesz knew Bappu since he had a cottage on the lake front in Kodai. He decided to take the M.Sc. students in our rickety old college van to see the Observatory. I vividly recall that first meeting with Bappu.

The next meeting was 12 years later, in 1976. I had been away from India since 1965 and had just returned. In July 1976, Govind Swarup organized a Summer School - now a famous summer school. Among the students were: Sunetra, Ashok Pati, Chanda Jog, Srinivas Kulkarni, Saikia,

Harish Bhatt, and many more? People are still arguing if Swarup was blessed with ‘beginner’s luck’ that so many of the students decided to pursue astronomy. Bappu spoke about ‘*Opportunities in Astronomy*’ at that summer school.

My next meeting with Bappu was in 1979 during the ASI meeting in Nainital. One morning, someone knocked on my door at 4 a.m. I opened the door reluctantly. There was Bappu, with JC Bhattacharyya at his side, complete with walking stick, torch light and binoculars! They had come to take me to Snow View to see the Himalayas at sun rise! I was rather touched by this gesture. I was nobody, not even working in astronomy. *I shall never forget that first spectacular view of the Himalayas!*

Vitaly GINZBURG’s visit

Bappu and I got to know each other well, as well as calibrate each other, only in 1980. The great Ginzburg was visiting RRI from Moscow. Since Radhakrishnan was away in CALTECH, I was the host. Ginzburg was perhaps the last of the great physicists who worked *simultaneously in ALL areas of physics and astrophysics!*

Ginzburg was a member of the very elite Soviet Academy; he was a super star. I requested Bappu to preside over Ginzburg’s most memorable lecture at RRI. Bappu was the Vice President of the Indian Academy of Sciences at that time. The next day, Bappu hosted a dinner at the West End. I showed up in my informal bright Swedish shirt. I was a bit taken aback because everyone from IIA whom Bappu had invited was ‘properly dressed’, wearing coat and tie. Apparently, Bappu had issued a strict dress code. But interestingly, Bappu made no such demand on me.

Thirty three years later, I am wearing a tie to correct that slip!

Lasting influence of Bappu's vision

My close interaction with Bappu was during a very short period from the beginning of 1980 to May 1982. But these interactions made a lasting impression on me. Many facets of him resonated in me:

- He loved teaching. He believed that our young students should be properly educated so that they will be adequately equipped to pursue research.
- He was a man with discerning taste.
- He had a fine sense of history of science and liked to talk about famous scientists.
- He was greatly influenced by CV Raman, particularly Raman's views on how to grow a scientific community in India. This included the need to foster a culture of building our own experimental equipment, publishing our results in Indian journals and being able to assess what we do.
- He also greatly admired Homi Bhabha.
- He advocated strong collaborations between institutions, not just within India, but internationally.
- Like many of his generation, he greatly valued the role played by the **International Astronomical Union** in furthering international collaboration in science.

In this talk, I shall revisit some of my interactions with Bappu.

Neighbourhood Astronomy Meetings

Early in 1981, I went to Bappu with a crazy idea! **Neighbourhood Astronomy Meetings:** A semi annual get together of astronomers at IIA, RRI and RAC, Ooty. I explained my motivation for suggesting such meetings. He warmly welcomed the idea but 'warned me' that idea would not be uniformly well received. The first one was to be at RRI.

Bappu was right! There were strong objections from many at IIA. A typical reaction was “*why can't he just read the Annual Report if he wants to know what is going on at IIA?*” But Bappu would have none of these objections. As many in this room will remember, he went from room to room and told everyone that he expects to see them at RRI!

As luck would have it, I came down with chicken pox just a couple of days ahead of the first NAM. But Bappu told me to go ahead with the plans and offered to personally take charge of the meeting. And then the big day arrived and the meeting began. He would send a messenger to my flat every hour, with a note filling me in on how the meeting was going, and asking for inputs from me. Since I had no telephone, someone – usually the RRI Librarian Ratnakar – would come on his bicycle!

NAM 1 was very well attended and a great success. Govind Swarup and his gang came from Ooty.

Six months later, Bappu hosted NAM 2 here at IIA. He renovated this Auditorium for it! He personally supervised everything, including the way lunch was served! Many in this room would remember that meeting.

After Bappu's passing away, Dipankar Mallik joined forces with me. Together we organized many memorable NAMs. **Nobel Prize for Chandra, in 1983; The Supernova of 1987; Remembering Jan Oort, in 1992; S. Chandrasekhar, in 1995** were some of the more memorable NAMs.

And then it died. I decided that it was time for some younger person to take charge. My younger colleagues – both here and at RRI - didn't think it was worthwhile. The Neighbourhood Astronomy Meeting was allowed to die.

Are such neighbourhood meetings needed?

YES! We go all over the world to attend conferences. We send our papers, theses, etc. to people and places abroad. But we don't attach much importance to institutions in our own environment. Whether we sink or flourish depends upon the 'DC-level' of the environment in which we function. And a healthy interaction keeps the DC-level up.

Please revive NAM. It is an extension of the In-House meetings. It is needed more today than in the past. Twenty years ago, RRI was only a 30minute drive from here. Today, it takes two hours to commute across the city! Periodic neighbourhood meetings are one way of keeping in touch with what is going on at other institutions in the city.

Please remember one thing. It is important that the neighbourhood meetings are not restricted to the scientists. The engineering and technical staff should also be involved. They should be encouraged to present papers and display posters.

Here is my suggestion. **Let the students run it!** They are organizing the YAM. Let them take charge of the NAMs also!

The Joint Astronomy Programme

It all started in 1980 when Professor Satish Dhawan, who was then both Chairman of ISRO and Director of IISc, asked me the following question: ***“Astronomy and Biology are the two most exciting subjects today. Should IISc not offer courses in astronomy for its undergraduate and graduate students?”***

But like many great ideas, this was killed in the Senate of IISc. But S. Ramaseshan, who succeeded Dhawan as the Director, was not about to give up so easily. He told me to go and discuss it Bappu. Interestingly, Bappu

was very excited about the idea. We had more than one meeting regarding this. Encouraged by Bappu's support, Ramaseshan set up a committee consisting of Professor Rajaram Nityananda , Prof. DCV Mallik, Prof. Chanchal Oberoi and me, to prepare a well thought out proposal for the Senate of IISc.

When the proposal was finally submitted, *teaching and collaboration with the Physics and Engineering Departments at IISc were to be the two pillars* of JAP. But the collaboration part never took off.

Today, there is a clamour to close down JAP.

It is my considered opinion that this is a short sighted view. Perhaps a common teaching programme is no longer required or even feasible. *But there could be other dimensions to the collaboration* – particularly between the institutions in Bangalore: **IIA, RRI, IISc and ISAC & SSIF**. This needs to be thought through, keeping in mind contemporary needs. Perhaps the phrase 'JAP' could be replaced with something else? "Advanced Instrumentation" could be the theme of the collaboration today, just as recruitment of students and their training was the theme of the collaboration forged in 1982.

I shall return to this towards the end of this talk.

The International Astronomical Union

Sometime during 1981, Bappu called me and asked me to serve on the Indian National Committee for the IAU. Since I had never served on any 'committee' before, I sought the advice of Professor Dhawan. This is what he said to me: "*your time is too valuable to be wasted. Ask Vainu what he expects from you. If he wants you to be a 'rubber stamp', decline. Do agree if you feel passionate about the mandate of the committee*".

So I met Bappu and asked him why he wanted me to be on this committee. He explained to me that he was unhappy with the way INCA was recommending Indian astronomers to the membership of IAU. They did not recommend anyone till they were well established. Bappu felt that this was wrong. He did not think that the membership of the IAU was an ‘award’! He wished astronomers to be elected to the IAU while they are still young so that they will have the opportunity to attend at least 3 or 4 IAU GAs. He wanted young Indian astronomers to belong to the international community of astronomers.

While I appreciated what he wanted me to do, I wondered how I could function in this committee *since I myself was not a member of the IAU!* I was not yet really into astronomy at that stage, let alone ‘well established’. He said *“I have bypassed this committee and just elected you! I am doing this as the **President of the IAU.**”* That is how I learnt that he was the current President of IAU; till then, I didn’t know!

I was a member of INCA for a few years and tried my best to be true to the promise I had made to Bappu, but it wasn’t easy. I was outnumbered by the old guards. I made myself quite unpopular in the very first meeting. But, as you will hear, in the end, I was able to keep my commitment to Bappu.

The “KODAI School”

In June 1975 I attended one of the **Enrico Fermi Schools** in Varenna, Italy. That historic school was on “Neutron Stars and Black Holes”. The binary pulsar, the first x-ray source in a globular cluster, etc. had just been discovered. I was at the Cavendish Lab in Cambridge at that time, working in Solid State Physics. I went there because Chandrasekhar had invited me. Chandrasekhar, Penrose, Martin Rees, Ostriker, Giacconi, van de Hulst, van den Heuvel, Anthony Hewish, they were all there. Two weeks there made a

lasting impression on me. I had read many of the Proceeding of the Fermi School, but this was the first time I had been there.

So I was obsessed with the idea of creating a place in India like Villa Monestero in Varenna in Lake Como in the Italian Alps, where the famous Enrico Fermi Schools are held, or the Ettore Majorana Schools in an ancient Monastery in the village of Erice in Sicily, or Les Houches in the French Alps. What was common between these places was that everyone stayed together, ate together, attended lectures, went for hikes, partied late at night, etc.

I talked to many senior people, but my idea of creating such a place in India did not resonate with them, *till I mentioned it to Bappu*. He told me to meet him on 12 May, 1982. He was leaving for Germany the next day.

So I hurriedly prepared a document outlining my vision and went to meet him. As I entered his Secretary's Office, Rajasekhar told me "Sir, your wife wants you to urgently call her back". So I did. She told me that she has to be taken to the hospital soon. We were expecting our first child, and the due date was imminent. I told her of my predicament. Bappu was leaving the next day, and I *had* to see him. I had already booked a room in Philomenas Hospital. I told her to ask one of our friends at RRI to take her, and that I would join later!

That conversation with Bappu lasted 3 hours! *He was extremely enthusiastic about my idea*. He liked my idea of involving the Indian Academy of Sciences. He assured me that he would support it and went on to ask if I had thought about a possible venue.

I mentioned that I had thought of Goa or Kodaikanal.

At the mention of Kodaikanal, he got excited! He talked about the Evershed Bungalow and Michie Smith Bungalow, went to the board and drew diagrams. He talked about Raju and Shanmugam, and how he had trained them to cook food suitable for foreigners. He talked about the Evershed Library there....

One of the reasons he was enthusiastic about my idea was the following. Much of the scientific activity had shifted from Kodai to Bangalore and Kavalur. *He was afraid that politicians would be eyeing the property. He was very afraid that there will be encroachments.*

He felt that establishment of a centre there, such as the one I proposed, would bring visibility to the Kodaikanal campus once again. He said

“It would justify my maintaining that establishment”.

He put two minor conditions: It should be called the KODAI SCHOOL. I told him that I wouldn't call it anything else!

The second condition was that I should bring out the lecture notes, so that generations of students will benefit. I had already thought about that and assured him that bringing out the lecture notes was one of my priorities.

Bappu was very happy. He said we would discuss the details of how to go about creating this centre after his return from the IAU General Assembly in Greece in August, over which he was to preside. As I mentioned, he was leaving for Germany the next day, where he was spending a sabbatical.

So I went to Philomenas Hospital a satisfied man. Little did I worry that my life would be transformed a few hours later with the arrival of our daughter!

IAU GA in Patras, Greece

In August 1982 I went to Greece to attend my first IAU GA in Patras.

Before going to Patras, I went sailing in the Greek Seas with Radhakrishnan and a couple of other radio astronomers who had earlier sailed with Rad across the Atlantic and Pacific. We rented a small sail boat in Athens and sailed for two weeks from one island to another – Crete, Santorini, Hydra, Agina, and so on.

One morning we reached Santorini Island. This was a childhood dream come true for me. The whole island was blown up in a gigantic volcanic eruption in the second Millennium before Christ, and the great Samoan civilization was wiped out. The town of Akrotri on the island, which was completely buried in ash, has been excavated. We anchored our boat and went ashore in a dinghy to see the excavations. There we ran into with Peter Shaver and his family (some of you will know Peter Shaver). He was working at ESO, in Garching, where Bappu was spending his sabbatical. That is how we learnt about Bappu's heart operation, the complications after the surgery and his death. You can imagine how shocked we were.

At the venue in Patras, there was great sadness. Bappu was to have presided over the GA. This was to have been the crowning moment of his life. My friends from IIA - Mallik was among them - were shattered. The future of IIA looked grim.

But life goes on. And so did the General Assembly.

I met many famous scientists for the first time, people I had read about. The high point for me was meeting the great Andrei Sakharov, Zeldovich and Shklovski. I almost fainted when Zeldovich gave me his business card, and told me a story about meeting Raman in Kapitza's lab in 1958

Bappu had invited the IAU GA to India in 1985. On behalf of the Indian Delegation, JCB pledged to honour the invitation. Seeing the scale of the meeting – 2000 delegates – I was nervous. But then, I had nothing to do with it! Famous last words!

The IAU GA in New Delhi in 1985

Now I shall tell you another story. The moral of this is “**Never give a sucker an even break**”. If you want to know how to blow two years of your life, this is how you can do it!

It all started sometime in November of 1983 when Professor MGK Menon requested me to attend the first meeting in Delhi of the LOC of the IAU GA. Apparently he was concerned that the LOC had not met at all; they had not booked the venue, made the budget, raised funds, etc. I was rather surprised at this call since I had nothing to do with the organization. *I was not a member of any committee.*

But a request from Professor Menon is a command. With Ms. Anna Mani’s help, I prepared a 20 page document on what needs to be done, and went to Delhi.

The first LOC meeting was a disaster! *No one had thought about anything.* They were shocked out of their wits when I distributed copies of my document.

The next day, Hanbury Brown, President of IAU, and Richard West, General Secretary, arrived. I was asked by Dr. AP Mitra, the Director of NPL and Chairman of LOC, to be present when they met.

AP Mitra told them that he had booked a taxi to take them to see the TAJ. Richard West’s response was characteristic “*Taj has been here for 300*

years and it will still be here next year. We want to discuss the following 17 points with you”.

I quietly slipped away after the meeting and went to my pick up my bag and head for the airport! There I was given a message from Rad: *Professor Menon had requested me to stay back, and take instructions from Hanbury Brown!* So I cancelled my ticket and stayed back. The next day, I took Hanbury Brown and his wife Heather, and Richard West, on a tour of the various venues. Hanbury Brown didn't like the idea of the meeting in a 5 star hotel. Instead, he picked Vigyan Bhavan. But to book that one required PM's permission. At Hanbury's request, Professor Menon met the PM and the concerned minister, and the venue was booked.

Hanbury Brown and Heather came to Bangalore with me. Hanbury told MGK Menon that he was very concerned about the meeting. He suggested to Professor Menon that the Head Quarters for the organization be created at RRI. Menon persuaded Radhakrishnan to do that, and Rad promptly dumped it on me! And thus it was that I spent the next two years planning and organizing the IAU General Assembly. Everything was done from here: Brochures (3), Applications, Registrations, tours and travels, bags, badges, absolutely EVERYTHING.

And what was the reward for doing all that? There was a great deal of resentment from the LOC and NOC to the 'war room' that Professor Menon had set up at RRI, particularly my involvement with it, since I was NOT—till the end - a member of any committee. What they didn't appreciate was that *I was just the sucker who didn't get an even break.*

But in the end, the New Delhi General Assembly was a GREAT SUCCESS. There were 2000 delegates, 1400 from abroad. 14 parallel sessions for 11 days! Astronomers still talk about the great Delhi Assembly.

How does this story of my involvement in organizing the Delhi General Assembly come into this lecture? Well, for one thing, it was my loyalty to Bappu that kept me going. **It was to have been Bappu's moment of glory – the IAU General Assembly in India!** This is something that he had dreamt about.

There was more to my involvement. In 1981, Bappu had instructed me that astronomers should be elected to the IAU while they are still very young. He was unhappy that the Indian National Committee for the IAU didn't project our young astronomers. Usually, only three or four persons from India would be elected every three years. In Delhi, I wanted to get an 'astronomically large number' of Indians elected to the IAU. This was unprecedented. The General Secretary was dead opposed to it. But over a dinner at the India International Centre I made an offer to Richard West that he could not refuse. *Quite simply, I told him that if he did not agree I was pulling out!* The next morning, there was a crisis meeting between Richard West, Hanbury Brown and Radhakrishnan. *Hanbury Brown over ruled Richard's objections.*

Thus, in the end, I kept my promise to Bappu.

A dream comes true!

If you recall, the last conversation I had with Bappu was about the establishment of a Discussion Centre in Kodai. Let us return to this again.

By cutting out a lot of frills, I managed to save 8 lakhs of the 26 that DST gave for the IAU GA. If this had been returned to the government, it would have gone to the *Consolidated Fund of the President of India*, where it would have been a drop in the ocean! I was very keen that there should be something long lasting arising out of the General Assembly. I had a secret

desire to use this money to create the Kodai School infrastructure, something that Bappu and I had dreamt about in 1982.

But first, I had to convince U.R. Rao, the Chairman of the Finance Committee, then Prof. Menon, the Chairman of the National Organizing Committee and, finally, the Secretary of DST. I managed to do all this, but it took three years.

At that time, I was the Secretary of the IASc. One of the many things that I was attempting to do was to bring visibility to the Discussion Meetings organized by the Academy. One way to bring visibility was to have an attractive venue, and arrange meetings *same time-same place-every year*. So I made a proposal to the Council of the Academy to accept the left over money from the IAU GA, and collaborate with IIA to create a centre at Kodai Observatory, as envisaged by Bappu. The Council agreed and DST transferred the 8 lakhs to the Academy to promote its discussion meetings.

The Council of the Academy authorized me to contact Professor JCB and enter into a MOU. JCB was most enthusiastic. He asked me to go to Kodai and explore two alternative locations suggested by him to build a dormitory, a modern dining room and kitchen. Girija and I went, and we liked what we saw. Of course, much renovation was needed. That was the idea!

JCB was to retire soon. He wanted me to organize the first workshop there before he retired. I did, and to please him I chose INTERFEROMETRY as the topic – a subject close to his heart.

The first workshop was a great success. There were participants from IIA, RRI, SAC, LEOS, IITs and so on. There were long discussions after every talk. Afternoons were free. Everyone went for long hikes. JCB knew the Palani hills like the palm of his hand. Lectures resumed in the evening and continued till late in the night. Just like in Varenna or Erice or Les Houces!

The only unfortunate thing was that some had to stay in the town. That had to be rectified.

After Prof. Ramnath Cowsik became the Director, the Academy signed an MOU, as planned. Some money was transferred to improve the infrastructure. Girija and I made about 8 trips, making detailed notes. On one such trip, Cowsik also came. JCB had suggested that some additional accommodation and dining facility could be created in the flat land adjacent to Evershed Hall. This was identified earlier for a low frequency radio telescope. There were no trees there, only wattle bushes. But Cowsik suggested remodelling the carpenter's store room, which was no longer used. I took Mr. Venkataramanan, RRI's Architect, to Kodai. We made a detailed drawing of how the stores could be converted to a dormitory. I submitted this to the Director of IIA. The renovation was done, and the dorm was inaugurated by Professor Sreekantan.

But for some unknown reason, IIA suddenly lost interest in collaborating with the Academy. Meanwhile, the money I had saved from the IAU GA had grown to more than 40 lakhs. Given IIA's lukewarm attitude, I began to explore other venues.

An upmarket time sharing resort - **The Orange County** – was coming up in Coorg. Wonderful Tudor cottages set in the forest, next to Cauvery River. For a measly 7 lakhs, I signed a lease for 33 years! This gave the Academy two weeks every year in the prime winter months with accommodation for about 25 persons. The place is most tastefully done. Absolutely fantastic.

Here is something that would have gladdened Bappu's heart. For the past 20 years, the Academy has been running several workshops every year at this venue. A committee set up by the Council of the Academy invites proposals. If a proposal is accepted, then it is the responsibility of the

convenor to arrange for the participants to gather in Bangalore. The Academy finds overnight accommodation for them. Next morning, they are taken by a special bus to Orange County, about 5 hour drive. Once they reach there, *everything is taken care of*: Accommodation, food, projection facility, etc. *No one has to pay for anything*, except some personal FAX, etc. When they clear out, the next organizer moves in, and the next workshop starts. It actually works! All the organizers have to worry about is the scientific programme. Everything else – yes, everything else! – is taken care of.

The first workshop was on “High redshift Universe”.

Roughly 4 workshops every year have been fully funded for nearly 20 years now from the interest earned on the money left over from the **IAU GA!**

Let us get back to the **Kodai School** that Bappu and I had dreamt about. I still have a dream that something like the **Saas Fee Schools** will be created at Kodai. Let me tell you something about the Saas Fee schools. They are organized by the *Swiss Astronomical Society*. It has been going on for nearly 50 years. I was invited to lecture in the 25th school in 1995. This is how it works. The venue is a ski resort high in the Swiss Alps. The ski lifts are right outside the lecture room. Every year the SAS invites proposals and selects one of them. The proposal includes the name of 3 lecturers; there cannot be more than 3 lecturers. Each of the three speakers is expected to give 10 lectures in 5 days; 30 lectures in all. The year I lectured, the theme was *compact stars*. Steve Kowaler gave 10 lectures on White Dwarfs, I gave 10 lectures on Neutron Stars and Igor Novikov, the distinguished colleague of the great Zeldovich, gave ten lectures on Black Holes. The afternoons were free for skiing. Lectures resumed late in the afternoon and went on till a late dinner. Discussions and partying continued till late at

night. Everyone stays in the same hotel. The lecturers have to produce the lecture notes – this is compulsory – which are brought out as a book. The Saas Fee books are a very impressive collection.

I wish to suggest that IIA, perhaps in collaboration with the ASI, start something like this at Kodai. I realize that IIA regularly arranges Summer Schools for M.Sc. students and so on. These must, of course, go on. In addition, there could be a high visibility school on contemporary topics in astronomy and astrophysics. These **Kodai Schools** would be at the *same time-same place-every year*. The participants would be senior research students, as well as others who want to learn about the latest developments in a topical subject. The lecturers would be chosen from an international pool.

A small team of two or three persons should run the show for a few years at a stretch. This is important. They must have a long enough innings to balance out developing areas. And they must be persons with a broad interest in contemporary astronomy. The legendary Les Houche Schools owes its success to Bryce and Cecile Dewitt, who nurtured it for decades. Similarly, Zichichi mentored the Majorana Schools in Erice, Sicily.

To hold such schools in Kodai, one will have to improve the infrastructure, and add to it. But it must be done with great sensitivity and architectural taste. If Bappu were to come alive, and take a walk, *whatever we do must satisfy him*. This is a criterion I always used at RRI, but sadly ignored now.

As Bappu told me, such an activity in Kodai *will justify maintaining that establishment*.

A Science Centre in Michie Smith Hall

Please permit me to touch upon another but related matter concerning the Kodai campus. As I mentioned, Bappu had a fine sense of history of science and great personalities. He was very proud about the two heritage buildings in Kodai campus: **Evershed** and **Michie Smith Bungalows**.

They should be renovated and restored to their past glory. It is great pity that all the original furniture has disappeared over the years. One should seek the help of professionals who specialize in restoration of Heritage Buildings. I know that such help is now readily available. One can get special funds from **INTACH** and other sources for this purpose. After the restoration, one should get a good interior decorator and restore the '*period look*'.

Bappu was an advocate of *Public Outreach*. The Public Lectures of CV Raman made a great impression on him. The last time I was in Kodai, already many years ago, I noticed that by 9 a.m. there was activity outside the main gate. Push carts were arriving to sell chips, ice creams, etc.! By 10 a.m., the first batch of tourists arrive; the observatory is the first stop in the 15 kilometre one-way tourist route that takes them to various spots such as Moire Point, Pillar Rocks and so on. During summer months, more than 1000 tourists come by every day! A good fraction of them are school children from rural areas. The next Ramanujan and Chandrasekhar are to be found among them, and not in elite colleges.

Unfortunately there is nothing much for them to see at the observatory. Yes, there is a small museum of some sort housed in a couple of rooms of Michie Smith Hall. But a much better museum deserves to be there!

A small but modern **Science Centre** could be created at Michie Smith Hall. Close collaboration with the National Council of Science Museums, VITM

and some of the Design Schools could result in a world class science centre. It doesn't have to be big, but it has to be interactive and top class.

Please pardon me for being presumptuous to suggest all this. You see, I may never get another chance to say these things!

Indian Astronomy at cross roads

For the final topic, I have picked the one that epitomises Bappu.

Bappu realized right at the start that his primary efforts should be directed towards activities which will help science to take root in India. And this meant, among other things, building our own observing facilities.

Let us have a quick flashback in order to better understand Bappu's vision. Soon after he assumed charge of the Kodaikanal Observatory in 1960, he and JC Bhattacharya initiated instrumentation activities so that they could pick up from where PK Das had left. It is often forgotten that he was only 33 years old at that time. And the memory of having unlimited access to the world's largest telescope in California must have been fresh in his mind. That was all in the past. Here in India he had to start fresh. By 1968 he had established a field station in Kavalur. The Indian Institute of Astrophysics came into existence in 1971. And the first thing Bappu did was to get the Council approval for a 2.34 m telescope. The key point was that it was going to be made in-house! *The audacity of that decision is still impressive.* He could have easily bought such a telescope. Why did he decide to build it? Because he knew that it was the only way to ***grow a scientific institution, the only way to grow young scientists, the only way to grow the community of astronomers who would use such a telescope.***

Bappu was inspired by Homi Bhabha, MGK Menon, Govind Swarup, Sreekantan and Radhakrishnan. Let us recall briefly. Homi Bhabha came home from Cambridge for vacation, but couldn't go back due to the outbreak of the Second World War. He had been working at the frontier of physics with giants like Dirac, Pauli, Fermi, Wenzel et al. – all theorists. Here in Bangalore he was isolated from the theoretical action. So he turned to experimental work on Cosmic Rays! Soon he founded the TIFR. And one of the first things he did was to invite Bernard Peters to come to Bombay and head an experimental group on cosmic ray research. Soon MGK Menon who was working Powell at Bristol joined. This group was undoubtedly one of the most renowned groups in the world working in elementary particles and their interactions. Please remember that this was the frontier of the new physics at that time. Then came the pioneering initiatives by Swarup in radio astronomy, by Sreekantan in X-ray astronomy, and Sreekantan and Ramanamurthy in ultra high energy gamma ray astronomy.

When the IIA established its head quarters in Bangalore, Bappu and his early team functioned for a while from the Raman Institute. Like Bappu, Radhakrishnan at RRI had the audacity to decide, around the same time, that he will build a millimetre wave telescope – like the one the great Bob Leighton had just built at CALTECH. This was a very high tech exercise. Leighton was ready to build one for Rad, but Rad said 'No, thanks. We will build it'.

It is about the rapid disappearance of this culture of instrumentation that I wish to now talk about briefly.

The trend these days is not to 'waste time' building instruments, let alone, observing facilities. Instead, the philosophy is '*get on with it*' using the data available in the public domain, and publish lots and lots of papers. It is

difficult to pin point the blame for this. In the ultimate analysis, people have been driven to it largely by the way they are assessed for promotions, awards, recognitions, etc. But one cannot blame the ‘system’ for this. After all, it is our peers who assess us.

But I want to argue that despite this culture shift we have no choice but to build instruments and keep alive the culture of innovation.

An important factor that should be kept in mind in this context is the following. The frontiers of science keep shifting with time. While it is natural that the more senior researchers may find it difficult and therefore unwilling to change their areas of interest, the younger scientists would be more attracted to areas and topics of contemporary interest and attention. This is as it should be! But this leads to a problem. Should the centre of gravity of interest of an *institution* keep changing with time? Assuming for a moment that it *should*, there is bound to be enormous *inertia* from the more senior and more established members. After all, they have more clout! This poses a major problem for the leadership of the institute. Perhaps the most effective way to comment on this is by drawing attention to what Freeman Dyson said some 40 years ago.

Freeman Dyson: In 1970, *PHYSICS TODAY* published a remarkable talk given by the great Freeman Dyson entitled ‘*The Future of Physics*’. He begins that talk reminiscing about Cambridge 25 years earlier, when he had gone there as a student in 1946. The World War had just ended. Sir Lawrence Bragg was the Head of the Cavendish Laboratory. He had succeeded Lord Rutherford in 1938. Soon after Rutherford’s death, Blacket, Chadwick and other ‘Star students of Rutherford’ left the Cavendish Laboratory to take up Professorships elsewhere. The famous ‘High Energy Group’ built by Rutherford had completely disintegrated. The leadership in

high-energy physics had decisively passed to Berkeley. To the consternation of those who remained in Cambridge, Bragg made no effort to rebuild. He was not seriously interested in plans for a new accelerator. He sat smugly in his office at the Cavendish and said: "*We have taught the world very successfully how to do nuclear physics. Now let us teach them how to do something else.*" Let me quote Dyson:

"The people Bragg was interested in supporting were a strange bunch, doing things that the high-energy crowd would hardly recognize as physics. There was Martin Ryle, who had come back from the war with truck loads of battered electronic junk and was trying to use this stuff to find radio sources in the sky. There was Max Perutz, who had already spent ten years on an x-ray analysis of the structure of the haemoglobin molecule and remarked quite cheerfully that in another 15 years he would have it. There was a crazy character called Francis Crick who seemed to have lost interest in physics altogether. Like most of my theoretical friends, I decided that I had nothing to learn from this bunch of clowns, and I came to America to be in a place where real physics was still being done".

"Seven years later Bragg retired from the Cavendish. By that time it was clear to everybody that when he said he was going to teach the world how to do something else he was making no idle boast. He left Cambridge a centre of furious activity and first-class international standing in two fields of research that are probably at least as important as high-energy physics in the overall scheme of things: radio astronomy and molecular biology. Neither of these new sciences had even a name when Bragg was appointed in 1938. By 1953 Ryle's careful mapping of the radio sky was providing a system of reference for astronomers all over the world. The most gigantic and mysterious energy sources in the universe, the radio galaxies and quasars, now usually have names like 3C9 or 3C273, where "C" stands for

"Cambridge." Also in 1953 the molecular biologists in Cambridge were not doing so badly".

Even by British standards that is an incredible understatement. More than ten Nobel Prizes went to the Cavendish in a very short span of time!

What has all this got to do with our discussion? A great deal. Analysing Bragg's astonishing success, Dyson says that there are three important things to learn from **Bragg's Theorem**:

- **Don't try to revive past glories.**
- **Don't do things just because they are fashionable.**
- **Don't be afraid of the scorn of theoreticians.**

Two years after Dyson's article appeared, I went to work in the Cavendish. The day I reached Cambridge was a momentous day; the Cavendish was buzzing with excitement. Two radio astronomers – Sir Martin Ryle and Anthony Hewish – had just been awarded the Nobel Prize!!

Sir Brian Pippard, the Cavendish Professor, did me the great honour by giving me a personal guided tour of the lab. I remember asking him the following question: *"Brian, what do you consider as your most valuable asset? And in which areas do you plan to inject major momentum?"* He replied in a flash. *"Srini, since JJ Thompson's days, the most valuable asset of the lab have always been the students. This is so because the best work is always done by the students. As to which areas I will strongly support, clearly, these will be the areas where the brightest young people are working."*

And he was not bluffing. Two months later, Brian Pippard took the momentous decision to wind up and close down three of the most famous groups of the Cavendish Laboratory:

- The Nuclear Physics group of Rutherford!
- The famous Fluid Dynamics Group.
- Ionospheric Physics group created by Ratcliffe, which was the cradle of radio astronomy in Cambridge and which produced Ryle and Hewish, who had just got the Nobel Prize!

No one lost their job, but these groups ceased to exist! The brightest young people were no longer going to these groups. That was that!

Is there a moral for us in this story? Yes! Institutions should move on. There should be no blind homage to past glory. The younger scientists should determine the future world line.

But it is also wise to remember Bragg's theorem. "Don't jump into something just because it is fashionable." And young people tend to be greatly enamoured by fashions. So the head of the institution has to make a wise judgement.

Whatever be the decision, it is perhaps worth appreciating that looking ahead we are unlikely to be able to build any major observing facility that would be competitive with the leading international facilities. In my opinion, GMRT and ASTROSAT are perhaps the last major observatories that we will have built. That is not to say that one will not attempt to establish major facilities by importing telescopes, etc. One should! The 3.6 m telescope at Devasthal – which will hopefully be up next year – is an example. Along with GMRT, and ASTROSAT (if all goes well), it will be a 'bread and butter' facility. These will be very important to grow the next generation of astronomers. But they are unlikely to silence the clamour for state of the art facilities. However, state of the art facilities are going to be beyond our reach for three reasons: technology, financial resources and time.

Indeed, it is already clear that no country is going to be able to afford to fund major facility by itself. In our case, money is not the only constraint.

Go international or bust!

So the new paradigm is ‘**international collaboration**’. Unless we want to quit big science like astronomy, we have to be able to participate in international projects. There has already been a beginning in this direction:

- LIGO-India
- The Square Kilometre Array
- The Thirty Metre Telescope

But to participate in such projects, we have to be in a position to ‘offer something’. In a rare case, we may be able to persuade our funding agency to just ‘buy observing time’. But they are very allergic to it, and rightly so. Therefore we have no option but to offer something concrete as a precondition for participation. And when I say ‘we’, I mean the astronomical community. This doesn’t include Indian industry. No industry is going to undertake to develop or build something for free. They will expect to get paid for it. Either we pay them or they will have to compete internationally to win a bid.

So there is no alternative but to develop some in house expertise. Since any new international project is likely to be at the cutting edge of engineering and technology, we not only have to keep our oven hot, we have to be baking something that would be relevant.

Which frontiers are accessible to us?

We have to ask ourselves the following question. Which frontier areas are really accessible to us in the sense that we can meaningfully aspire to have something competitive to offer in return for a partnership?

Let us first rule out certain areas. Millimetre and sub-millimetre wave astronomy is definitely running away from us superluminally! Making big mirrors for giant optical telescopes like the VLT are beyond our technological ability. The list is rather long and depressing.

But there are many areas where we can hope to compete.

Synergy with physics, engineering and technology community is essential.

In this context, it is important to remind ourselves that we should not try to reinvent the ‘wheel’. Often, there is a tendency to do that.

Today, if we are witnessing a glorious era in astronomy it is entirely due to astronomers cashing in on the current revolution in *detector technology, modern materials, digital signal processing*, etc. Astronomers are routinely using superconducting junctions, superconducting bolometers and micro calorimeters as *single photon detectors*. They are using dilution refrigerators and adiabatic demagnetization to cool detectors to sub milli-Kelvin temperatures. They are using nano technology to make x-ray gratings, and so on. *All this has been possible only because of a synergy between physics, engineering and technology communities.*

This has to happen in India, too. At the moment there is a reluctance to acknowledge that there are others who have gone ahead of the astronomical community in instrumentation and technology. There is often a smug attitude that our engineering community is not on par with those elsewhere in the world. But then, they can say the same about us also! ***So we have to learn to both challenge them and work with them.*** It is a boot strap process. There is much to be learnt from the experience of our space department. Right from the very beginning of our space programme, Satish

Dhawan introduced the culture of ‘outsourcing to the industry’. Every component that was outsourced was given to *two* independent contractors. Over a couple of decades, this has resulted in some of our engineering firms acquiring considerable capabilities, making them internationally competitive in certain areas.

This synergy I am advocating is beginning to happen. UVIT on the ASTROSAT was the first big project where collaboration with ISRO was an essential ingredient of the project. In the beginning, there was a great deal of reluctance within IIA to seek help to make the mirrors. It was, to some extent, a matter of prestige. But what matters in the end is that LEOS produced two absolutely top class mirrors. Given that LEOS commands far greater resources than what IIA can muster at the present juncture, it was a sensible decision to get them to make the mirrors. Since Leos had never done anything as sophisticated as ion polishing before, by rising to the challenge their own capability has been immensely enhanced. That is the beauty of such collaborations.

The next major collaboration between IIA and LEOS was struck when the ADITYA coronagraph was approved. This time, the demand on the mirror was even more staggering. The ‘roughness’ of the surface had to be less than a few Angstroms. This was a different ball game altogether and, again, LEOS rose to the challenge.

Around the same time, another situation arose where collaboration between astronomers and top class engineers was needed. This was in the context of a spectrograph for the 3.6 m telescope to be installed in Devasthal. The Project Management Board took the stand that this should be made in India. But the young astronomers at ARIES are quite inexperienced to undertake

something like this. So help was sought from the Space Application Centre in Ahmedabad to design the optics to meet the requirements of the astronomers. They did this, and the optics was manufactured in Pondicherry.

So, a new beginning has been made, one in which different institutions participate, each getting enriched in the process. Fortunately, despite **incredibly crippling embargos** many organizations in India have acquired world class expertise in certain areas. The Satellite Centre in Bangalore, Space Application Centre in Ahmedabad, VSSC in Trivandrum, all under the umbrella of ISRO; the DRDO Labs; the Materials Research Laboratory in Kalpakkam; the electronics group at BARC; CAT in Indore; and other places are very good examples.

Let me once again stress that a symbiotic development of basic science, engineering and technology is absolutely crucial.

What can be our ‘playing ground’?

Fine! We are all agreed that we shall resist the temptation of *reinventing the wheel and collaborate with industry*. But there must be some immediate and specific objectives to keep developmental activities going. If our instrumentation activities are not going to be directed towards the construction of a major Indian facility – I argued that it may not be wise for us to attempt to do that – then we have to ask ourselves the following question: do we have any alternatives?

The answer is a resounding ‘yes’. Thanks to ISRO, we have extraordinary opportunities in space. ISRO is offering a couple of small satellites of roughly the 500 kilogram class every year. If your proposal is accepted, then you do not have to run from pillar to post raising funds. Not only is the

satellite, and the launch, free they will pay for your payload also! This violates all laws of thermodynamics – you get something for nothing! *Nowhere else in the world astronomers have such opportunities.* You might say nothing worthwhile can be launched in a 500 kg satellite in which the payload cannot be more than about 170 kg. This may in fact be a blessing in disguise. If you are given a 1.5 tonne satellite, you will plan something like the ASTROSAT. And that, as we know, is a ten or twelve year exercise. After all these years, we are still not there. Lo Woltjer warned us about this more than ten years ago. With his characteristic sarcasm he said “ASTROSAT is four missions in one!”

If you are not convinced that worthwhile science can be done with small satellites, remind yourself of the spectacular progress made by the Japanese in the 1990s. After the end of the Second World War, severe restrictions were imposed by the international community on the kind of rockets the Japanese are allowed to build. And with these they could only launch 100 kg class satellites. While the Americans and the Europeans were struggling with big missions, the Japanese quietly assumed the leadership role in astronomy from space.

Returning to our scene, the next science mission after ASTROSAT will be a mission that would put a 500 kg satellite at the inner Lagrangian point of the Earth-Sun system. It will be dedicated to the study of the Sun. If everything works out, and if everyone delivers, the following instruments will be on board this satellite:

- A coronagraph [ADITYA I]
- A soft X-ray spectrometer
- A hard X-ray spectrometer, and possibly an imager
- An ultraviolet imager

- A couple of particle detectors.

IIA is a major participant in this mission. In addition to the coronagraph, IIA may have to play a big role in making the ultraviolet imager. I think this will be a wonderful mission. If all goes well, it should be launched in 2017/18. This is the sort of timescale we should be aiming at. If you want to know how demoralizing big missions with very long incubation period can be, look at ASTROSAT! Surely, we don't want to attempt something like that in the near future!

What else besides the L1 Solar mission?

Sommerfeld's advice: Let us spend a couple of minutes on what are possible new initiatives IIA might consider. In this context, let me recall an advice given by the great Arnold Sommerfeld. *He advised that one should work on problems in which one has 'an undue advantage'.*

Bragg picked areas of research in the Cavendish based on this principle. He was a master of crystallography. He realized that the use of crystallography in physics is unlikely to be as rewarding as in a newly emerging field of 'molecular biology'.

CV Raman did the same thing at IISc. Although he sent Harish Chandra to Cambridge to work with Dirac, and told Vikram Sarabhai to work with Homi Bhabha, his own group concentrated on crystal optics, in which he was the acknowledged master.

IIA has invested many years in building the UVIT. Ultraviolet astronomy is still virgin territory. Given the attractive opportunities to fly space borne payloads, *it would be a shame if ultraviolet astronomy did not become one of the thrust areas of research and development at IIA.*

Another area where IIA could take the lead in, in collaboration with LEOS, SAC, IITs and so on, is *Active and adaptive optics*. I vividly recall making an impassioned plea about this right here in this room in 1989. No one was listening. Twenty five years have gone by! I know that there are some laboratory scale efforts here and there. But they are all marginal and subcritical efforts. In the 1930s, 40s and 50s, we were world leaders in optics. We had giants like Raman, Pancharatnam, G N Ramachandran. Despite that we missed the revolution in spectroscopy after the LASER was invented. We still have a strong theoretical base in classical and quantum optics. I do not see why we cannot be world leaders in Active and Adaptive optics.

It is time to conclude. And while doing so, please permit me to take the liberty of addressing the young astronomers in this room. My friends, if I have walked down the memory lane, recalling some of Vainu Bappu's dreams, it was not entirely nostalgia. I seriously believe that some of his values are even more relevant today than, say, thirty years ago.

For example, Indian astronomers have no option but to keep instrumentation activity alive. As Lo Woltjer would put it, the 'technology of astronomy' has to be kept alive. That is our only insurance for the future.

You have to do this not despite big science becoming global, but because big science is global!

There is a corollary to this. We have to protect our astronomers and engineers who build things for us. They cannot be victims of this mania of papers, citations, impact factors of journals, etc. We cannot allow the theoreticians, virtual astronomers and, above all, our funding agencies, to

forget that astronomy, like all branches of physics, **is an experimental science.**

The second point I wish to make is this. The best way to do this is by quoting the title of one of the books about Richard Feynman: ***What do you care what other people think?*** Feynman never bothered. When someone told Lord Rutherford “Sir, you are always riding a wave in physics”, he replied “*I made those waves!*” The great Chandrasekhar never bothered about what was considered ‘important’ in astrophysics; he always walked in the by lanes of science. Closer to home, Professor Swarup – one of my heroes – told me this. When he was planning to return to India, at the invitation of Homi Bhabha, he met the legendary Jan Oort. Oort suggested that Swarup should build a big dish antenna to study the newly discovered 21 cm radiation – it was the hottest thing in astronomy. But Swarup decided to do his own thing. He built the Ooty radio telescope and his talented students made a great impact in cosmology!

If you have any worries about pursuing your own call, may I recall for you what Chandra said:

“On an occasion now more than 50 years ago, Milne reminded me that posterity, in time, will give us all our true measure and assign to each of us our due and humble place; and in the end it is the judgement of posterity that really matters. And Milne added: He really succeeds who perseveres according to his lights, unaffected by fortune, good or bad. And it is well to remember that there is in general no correlation between the judgement of posterity and the judgement of contemporaries.”

S. Chandrasekhar

As we remember Vainu Bappu on the eve of his birthday, let us recall another remarkable statement by Chandrasekhar:

“The pursuit of science has often been compared to the scaling of mountains, high and not so high. But who amongst us can hope, even in imagination, to scale the Everest and reach its summit when the sky is blue and the air is still, and in the stillness of the air survey the entire Himalayan range in the dazzling white of the snow stretching to infinity? None of us can hope for a comparable vision of nature and of the universe around us. But there is nothing mean or lowly in standing in the valley below and awaiting the sun to rise over Kanchenjunga.”

S. Chandrasekhar

I thank you for your kind invitation, and your patient hearing.