Experience of an astrophysicist

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A short biography

I was born on 1st March 1976, and my permanent residence is at Khurai Thoudam Leikai, Imphal East, Manipur. I am an Associate Professor at the Department of Physics, Khalifa University in Abu Dhabi, UAE. My research field is Astrophysics and Astro-particle Physics, both theory and experiment. My main focus is to understand those phenomena happening in the Universe at extreme energies by studying high-energy particles coming from outer space such as cosmic rays, high-energy gamma rays and astrophysical neutrinos. I am currently an active member of the international collaborations that are involved with the LOFAR, SKA and KM3NeT experiments. In the past, I was a member of the TACTIC and MACE telescopes collaboration in India.

My primary education and childhood

I did my primary education at Don Bosco School, Chingmeirong (Imphal) until Class 8, and later completed Class 10 from Tiny Tots' Unique School, Imphal. During my high school, I used to prepare well all the subjects to get a good score overall, but it was during Class 9 and 10 that I started to develop a strong interest in physics and mathematics, in particular physics as I mostly like subjects that involves deeper understanding and reasoning, and that drives more curiosity. During Class 10, I often used to read more advanced level physics books particularly in optics, electricity and magnetism.

During my childhood, I was always fascinated with topics related to the cosmos. It was during mid-1980s, when I was about 8-9 years old (if I remember well), I learned about the news of India sending their first astronaut into space. At that time, there were no internet, and television was very rare. In a big locality (leikai), only one or two families used to have television. Only radio and newspapers were the main source of information which as a child hardly paid attention to. During those years, India and Soviet Union (now Russia) had a strong cooperation in science and technology, and there was one soviet science magazine (I don't remember the name exactly) which was quite popular, and people used to subscribe to it regularly through post. I still remember seeing pictures of Indian astronauts conducting training along with their Russian colleagues for the space flight. The magazine described details of their training sessions. For me, this whole event later turned out to be one main factor that drove my fascination to learn more about objects up there in the sky. Now, we all know that manned mission into space involves more of engineering rather than science. Nevertheless, such events always make a big impact on the society, especially the kids.

My fascination with space and cosmos grew when I got a little older. When I was about 13-15 years old, I used to read a regular science magazine that published pictures and articles about planets and moons in our solar system. I remember seeing impressive pictures of the surface of Venus and Mars as well as colourful close-up pictures of Jupiter and the nice clear rings of Saturn. Now, we know that those beautiful pictures of Venus and Mars were captured by several landers

from United States and Soviet Union sent during the late 1970s and early 1980s. Those close-up pictures of Jupiter and Saturn were captured by the Voyagers 1 and 2 satellites which were launched in 1977 to explore our solar system and beyond. Both these satellites have now crossed the boundary of our solar system, becoming the first and the only human-made objects to enter into the interstellar medium. These satellites are currently sending data that help us in understanding the properties of the interstellar medium. Never did I imagine at the time when I first saw the nice pictures of Jupiter and Saturn that I will be using data from the same satellite for my work later in my life. For my research, I currently use data from Voyager to study how cosmic-ray particles propagate in our Galaxy.

Higher Secondary to Master in Science (physics)

I completed Class 12 from Ramjas Senior Secondary school, Daryaganj, New Delhi. That was the first time I moved out of Manipur. Initially, I stayed as a paying guest in a Manipuri family at Minto Road. Then later, I moved away to stay independently in a rented room. However, living alone at such a young age in a new city was not so easy. I needed to do all my household things myself, and at the same time, focus on my studies. Sometimes, I got sick and unable to take care of myself, sometimes shortage of money, and sometimes, difficulty from language issues as I could barely speak a sentence in hindi at that time although I could understand the language. Overall, when I look back now and try to remember all the struggle I made and the experience I earned (both on my life and my studies), I cherish those memories. My stay in Delhi later became the most valuable experience in my life as a student. It was during this period that I developed a solid foundation in higher level physics and mathematics as well.

After completing Class 12 in 1994, I got shortlisted at some colleges in Delhi for Bachelor studies. But, I could not complete the admission processes as I was missing home, and went to Manipur for summer holiday soon after the result of Class 12 was declared. By the time I return to Delhi, it was too late and the deadline for the admissions was already over. Then, I decided to go back to Manipur, and took admission at Modern College Imphal for Bachelor in Science with physics as

the core subject. The Bachelor course was actually meant for 3 years, but there was a delay in declaring the final results because of which the course practically took 4 years to complete.

In summer 1998, I moved to Baroda (now Vadodara, Gujarat) to pursue Master in Physics at Mahajara Sayajirao University (MSU). MSU has an excellent campus with programs available for almost all the subjects in humanities, commerce, science and engineering. The academic programs in MSU are excellent, but from my observation, what sets MSU apart from universities in other states is that hostel facility was provided to every out-station student if the student got admission in any course. Moreover, both the admission fees and the hostel fees were extremely nominal. All the hostels were located within 10 mins walking distance from the department buildings.

The Master's course covered several advanced courses in Physics including Electronics and Mathematical Physics. During the first year, I started to develop a strong interest in Nuclear Physics. I got fascinated in learning the mechanism in which an atomic nucleus holds itself, and how high-energy radiations are produced from the nucleus. During the second year, I chose a specialization in Nuclear and Particle Physics to learn more about the subject. In addition to theory, I learned in detail about the practical applications of nuclear physics, in particular about nuclear reactors. For the first time, I also learned about the existing nuclear facility at Bhabha Atomic Research Centre (BARC) in Trombay, Maharashtra. This was a turning point in my career as it triggered me a strong motivation to work at BARC in the future. By the time I completed Master in summer 2000, I feel I developed a good understanding of the fundamentals of general physics with some advanced knowledge in Nuclear and Particle Physics.

Life after completing Master in Physics (2000)

After completing MSc., the real challenge began. Most students pursuing their Masters in basic sciences do not actually know what they want to do/become after their studies. Majority of the students use to appear for any available competitive exams mainly for the sake of getting a permanent job, but not really driven by their interests in the field. I was no different from the rest

in terms of uncertainty. But, what helped me was that I knew what I wanted to do. I already determined to enter a reputed research institute, especially BARC and pursue a career in nuclear physics.

One obvious career path after MSc is to pursue for PhD. But, PhDs are not so well-paid during our time, and more importantly, it has an uncertain future as there is no guarantee for a job after completing PhD. So, the best option would be a permanent position at an institute where you can perform research at the same time. But, the question is: are there any permanent jobs in institutes which students can apply immediately after MSc? During our time, I could sometimes see advertisements on newspapers about scientist positions from DRDO, ISRO etc. But, my aim was to enter BARC which was/is the most premier institute in India given its national importance. Remember, I am talking about the time right after India successfully conducted a series of nuclear tests in 1998. During my final year of MSc, I came to know from my seniors about BARC and one of its sister institute CAT Indore (now named as RRCAT) conducting a direct recruitment program of scientists (after MSc) every year through their well-known "Training School" program. This brought a lot of excitement to me that I immediately determined to get through the training program.

First attempt of exams (2000)

In addition to the direct recruitment program for permanent positions at some institutes I mentioned above, almost all other research institutes in India namely TIFR (Mumbai), PRL (Ahmedabad), IIA, IISc, RRI (Bangalore) and several others had a recruitment program for PhD positions. Normally, the selection process for PhD involved a written test, followed by an interview for the short-listed candidates. The written test was conducted jointly by several institutes through a common entrance (written) exam called JEST (Joint Entrance Selection Test). During my time, about 14 institutes were involved in JEST.

My first attempt for the exams was during the completion of the second year of MSc (year 2000). Most of the written exams were conducted in the month of February. Normally, the exams started

in the morning, typically around 9 am, which was a bit of a problem for me as there was no exam center in Baroda. The nearest center was in Ahmedabad which was about 2 hours by bus/train. I had two roommates who were also my MSc classmates. We always used to travel together for every exam. We normally got up around 5 am to catch a train at around 6 am. We used to travel without reservation as it was cheaper. Travelling with them made the journey easier as they were locals from Gujarat, and they knew all the whereabouts. I personally feel I did not prepare well enough during my first attempt of the exams as I also needed to prepare for my MSc course at the same time. Nevertheless, it served as a useful experience for me as I learned the nature of the questions which will be useful in my next attempt.

In my first attempt, I did not get a good score in JEST. I secured only about 75 percentiles. Based on this score, I did not receive any interview calls for PhD from any institute. However, I cleared the written test for the BARC Training School, and I was called for interview in July 2000 at the BARC campus in Mumbai. By that time, my MSc final exam was already finished. So, I had enough time to prepare for the interview. Mumbai is approximately 6 hours by train from Baroda. I still remember the heavy rain on the day of the interview. I took an auto rickshaw from the Bandra station to the BARC campus. That was my first visit to the campus, and I really felt so delighted to see the place! The interview was conducted in the Training School Hostel. My interview was started quite late, at around 3 pm. Typically, an interview lasted about 1.5 to 2 hours, and the results were declared on the spot immediately after the interview. That means every candidate know their results when they come out of the interview room! I could not perform well in the interview although I thought I was fully prepared. The main reason was that my preparation was not in line with the kind of questions they asked during the interview. BARC interviews mostly focused on the fundamentals of physics, but my preparation was mainly focused on the advanced topics covered in MSc. Although I did not succeed in my first attempt, I learned how and what to prepare for my next attempt.

By the end of 2000, I succeeded in the written test exams for the direct recruitment of scientist positions at IPR (Gandhinagar) and IGCAR (Kalpakkam) which is another sister institute of BARC.

Their interviews were pending at that time and scheduled in the early 2001 if I remember correctly.

Second attempt of exams (2001)

February 2001 came, and I again appeared all the exams that I appeared the year before. This time, I got 95 percentiles in JEST, and I also cleared written tests for the BARC and CAT Training Schools at the same time. Based on my JEST score, I received interviews calls for PhD from almost 12 institutes (out of 14). The interviews were mostly scheduled in July 2001. I also received interviews calls from BARC and CAT (Indore) to be held also in July 2001.

In the meantime, I appeared for the interview at IPR. Although I did very well, I was not selected. Later, I came to know from a friend that they had selected someone with a strong background in electronics. I also appeared for the IGCAR interview. The interview went very well, and I was still waiting for the result. When the result finally came out in May/June, I was offered a Scientist C position to work on something related to nuclear reactor. I was extremely excited as that was the first job offer of my life! Having one job offer in hand, my confidence grew and I was preparing intensively for the BARC interview focusing mainly on the fundamental concepts of physics rather than the advanced topics covered during MSc.

Sometime in the first week of July, I went for the BARC interview. There were 5/6 members in the interview panel. BARC interview is quite different from the interviews at other institutes, both in terms of the type of the questions and design of the interview. In other institutes, interviews were mostly verbal questions and answers, and they mostly asked what we were taught during BSc and MSc. But, in BARC, most of the questions were based on the basic concepts of physics, and several questions involved solving problems right in front of the panel. Few questions that I still remember were: (1) When you push a book lying on a table, explain what type of force are you applying? There are only four types of fundamental forces. Which one it belongs to? (2) Prove that the center-of-mass momentum is always zero. (3) Why do we generally choose light element (like water) to slow down neutrons in a nuclear reactor? Why not heavier elements? The whole

interview lasted for about 2 hours. At the end of the interview, I was given a piece of colour paper directing me to go for a medical test at the BARC hospital. This indicated that I passed the interview! I was extremely excited. That was the happiest moment of my career. I still consider the BARC interview as the toughest interview I have faced in my career. The next toughest was my PhD defense examination in the Netherlands.

As I already had two job offers for permanent position by that time (one from BARC and another from IGCAR), I did not appear the pending interviews for PhD positions at other institutes under the JEST exam.

BARC Training School (2001)

I declined the Scientist C position offer from IGCAR, and joined the BARC training school on 1st September 2001. Also known as OCES, BARC training school is a recruitment program that was started in 1956 to meet the demand for highly skilled scientists and engineers at the Department of Atomic Energy (DAE) under the Government of India. Every year, the program is recruiting candidates in almost all the fields of basic sciences and engineering.

Ours was 45th batch. About 120 students were selected in total (science plus engineering combined). In physics, only 9 students were selected from over 1500 students applied from all over India. Each student selected for the program was given a stipend of Rs 8000/- per month, medical facility at the BARC hospital and a free single-room accommodation at the Training School Hostel located within the campus. The program involved a rigorous training over 1 year on different advanced courses in physics with a focus on the mandate of BARC. For the physics students, we had a one-week tour to CAT Indore around the end of the program. The training was finally completed in August 2002.

Scientific Officer C & D, BARC (2002-2008)

After the training, I joined the Astrophysical Sciences Division (ApSD) as Scientific Officer C on 1st September 2002. In BARC, the designation was given as Scientific Officer, not Scientist. Both scientists and engineers were given the same designation. At ApSD, the major research was

focused on Astro-particle Physics (it means Astrophysics using high-energy cosmic particles which can be cosmic rays, gamma rays or neutrinos, instead of the traditional way of using visible light or other low frequency radiation). ApSD had two main projects: one was focused on the TACTIC gamma-ray telescope located in Mount Abu, Rajasthan and the other on the upcoming (now commissioned) MACE gamma-ray telescope at Hanle, Ladakh.

Left: The TACTIC gamma-ray telescope array at Mount Abu, Rajasthan (Credit: Sing & Yadav, 2021, Universe, 7, 96). *Right:* The MACE gamma-ray telescope at Hanle, Ladakh (Credit: Yadav et al. 2022, Current Science, 123, 12).

During the first 3 years, my major task was to develop a data analysis software for the TACTIC telescope, and use it to analysis the data collected from several gamma-ray sources in the sky. While working on it, I developed a strong skill in programming and advanced statistical methods. I also made several trips to Mount Abu to participate in telescope observations. Observations were performed only during clear and moonless nights. After 3 years, I got promoted to Scientific Officer D, and I was given the task to perform Monte-Carlo simulation work for the MACE telescope. I developed the required simulation code, and performed detailed simulation of the telescope to explore its expected performance and scientific potential. All these works were conducted as a member of the TACTIC and MACE telescopes collaboration.

In parallel to the experimental projects, I was also working on the theoretical study of cosmic rays and high-energy gamma rays. This was carried out entirely on my own, without any guidance. I learned a lot while working independently on the theoretical projects. But, at the same time, I have to admit that learning everything from scratch without a supervisor takes a lot of extra efforts and extra time. Things can move much faster when working under the guidance of a supervisor. For instance, when I first decided to step into the theoretical research on cosmic rays, I had no idea about the status of the field. So, at first, the hardest part was to find the problem that I wanted to work. I started by reading most of the research papers in the field and some advanced books, and I tried to reproduce several already published results. In that way, I gathered knowledge about the field as much as I could and developed the skills required to carry out research. The first topic I chose was the "GeV excess" problem of high-energy gamma rays from our Galaxy observed by the FERMI satellite experiment. It was an open problem at that time. This led to my first single authored paper in Astro-particle Physics journal in 2006. After the first paper, I started to focus on the study of propagation of cosmic rays in our Galaxy.

Decision to leave BARC (2009)

I will always remain indebted to my colleagues at ApSD. That was the place where I started my research career, and where I learned all the basic computing skills and knowledge needed to perform research in Astrophysics. Eventually, I also developed advanced data analysis and Monte-Carlo simulation skills/techniques for gamma-ray astronomy as well as advanced mathematical skills and physics knowledge for the theoretical study of cosmic rays. However, as years passed by, I started to feel a saturation in the skills and knowledge I could gather at BARC. Theoretical research on cosmic rays was my passion, and the unavailability of experts on cosmic rays in BARC (and in India!) to discuss or take guidance further push me to think for other options of my career. In addition, lack of opportunity to participate in international conferences limited interaction and establishing connections with experts in the field.

By the end of August 2008, I had completed 6 years at BARC (actually 7 years including the 1 year at the Training School). At that time, I had 11 papers in total in refereed journals, out of which 5

were single-authored papers all published in top journals in Astronomy/Astrophysics. Around September/October 2008, I made a final decision to leave BARC, and submitted my resignation letter. The resignation process was quite complicated as it needed to pass through different levels of approval with the final decision from the office of the President of India. In about 3 to 4 months-time, I received an acceptance letter of my resignation. I officially left BARC in March 2009.

The research outputs I delivered could easily earned me a PhD, but I did not register for PhD as it was never needed to remain in BARC, and I never had a plan to leave. In the BARC system, promotion is purely based on performance and the minimum years of service at a given position. Having a PhD does not add any advantage over other candidates. However, if anyone wants to join other institute/university, PhD is mandatory. So, after BARC, I had to start my career from PhD. Technically speaking, I was about to reset my career from the beginning.

PhD in the Netherlands (2009-2012)

Decision to leave BARC was the hardest decision I had ever taken in my life. That was my dream job during my MSc, and I never thought that I would decide to leave the job one day. Resigning from one of the best and most secured jobs to pursue a PhD knowing that there is no job guarantee after completing PhD? That's an obvious question anyone would ask. The decision was also very risky especially because I already had a family with one kid (3 years old) at that time. But, I had confidence in myself, and I knew that I can achieve much more.

After submitting my resignation at BARC, I accepted a PhD position offer at the Department of Astrophysics, Radboud University Nijmegen in the Netherlands to work on cosmic-ray measurements using the LOFAR radio telescope. My supervisors were Prof. Jörg Hörandel and Prof. Heino Falcke. Prof. Hörandel is a leading expert and well-known figure in cosmic-ray research who has made important contributions in several leading cosmic-ray experiments like KASCADE, TRACER and the world's largest Pierre Auger Observatory. Prof. Falcke is a distinguished theoretical astrophysicists and radio astronomer who has made several outstanding contributions

in astrophysics and who led the capture of the first image (shadow) of a black hole using the Event Horizon Telescope in 2019.

Left: A photo of the center of LOFAR at Exloo in the Netherlands (Credit: van Haarlem et al. 2013, A&A, 556, A2). *Right:* A photo of the LORA detector container box located at the Center of LOFAR (Credit: S. Thoudam, 2012, PhD thesis, Radboud University, The Netherlands).

I started my PhD in April 2009, and completed in 3 years in 2012. My thesis covers both theoretical and experimental works on cosmic rays. All together I published 4 first-authored papers during my PhD (plus 2 papers under submission), all of them in the top journals in astrophysics. During my PhD, I built the LORA cosmic-ray detector array as a part of the LOFAR experiment, developed its data acquisition software, and performed the data analysis and Monte-Carlo simulation of the detector. The development of the LORA detector array remains my major contribution to the LOFAR cosmic-ray project. The array contributed to the first detection of cosmic rays with the LOFAR radio telescope.

I was (and still) very proud of the development of the LORA detector, mainly for two reasons. First, it was the largest and the only cosmic-ray detector array built in the Netherlands dedicated for cosmic-ray research. Secondly, my expertise before joining PhD was mainly on theory, data analysis and simulation. I did not have any experience with instrumentation. So, it was a big challenge for me when I was given the task to build the detector. I was really working outside my comfort zone. At the same time, it was quite exciting. The detector array consists a network of 20 detectors distributed in a field of about 300 metre diameter, controlled by different computers which were communicating each other. The experiment was designed to run remotely and continuously without any interruption. Writing a data acquisition software that made the computers communicate each other, and collect data automatically was something really exciting. I still remember the first day I saw the experiment started running automatically and giving data. It took me almost two years to complete. The excitement it gave me was priceless! It was exactly the same kind of excitement kids got from successfully building a toy.

Postdoc in the Netherlands (2012-2015)

After completing my PhD in 2012, I got a Postdoc offer from Washington University in St. Louis, US. At the same time, my PhD supervisors offered me to continue as a Postdoc in the LOFAR cosmic-ray project. I finally decided to decline the offer from US, and continue as a Postdoc in the same department at Radboud University. During my postdoc, I worked on the theoretical study of cosmic rays and high-energy gamma rays while contributing on the measurement of cosmic rays with LOFAR at the same time.

During my span of almost 6.5 years at Radboud University (from PhD to Postdoc), I published 37 papers in total in top journals in astrophysics, including one in Nature and one in Physical Review Letters. Out of these, 10 were first or single authored papers and the rest were published as a member of the LOFAR collaboration.

I joined the LOFAR cosmic-ray collaboration in 2009. It has been almost 14 years now that I have been associating with this amazing experiment which has been pioneering the field of the measurement of cosmic rays using radio telescope. LOFAR results have significantly improve our understanding of radio emission from the interaction of cosmic rays with the Earth's atmosphere.

Postdoc in Sweden (2015-2018)

In Fall 2015, I moved to Linnaeus University, Växjö, Sweden to pursue my second postdoc. I had another postdoc offer from Liege University, Belgium, but I declined it and decided to move to Sweden. In Sweden, I was working on the ALTO detector array proposed for high-energy gamma-ray astronomy. My main task was to perform a detailed Monte-Carlo simulation to optimize the detector design and study the expected performance of the experiment. I developed an advanced detector simulation code for the project which incorporates almost all the characteristics of each of the detector components, their actual design and material properties as well as the different types of interactions high-energy particles can undergo inside the detector volume and the subsequent production of light.

I presented the ALTO project for the first time to the astrophysics community at the "Workshop on Southern Hemisphere TeV gamma-ray observatory" held at Puebla (Mexico) in 2016, and again at the "International Cosmic Ray Conference" in Busan (South Korea) in 2017.

My plan to return to India (2018)

By summer of 2018, I had spent more than 9 years in Europe, and I started to think of returning to India. I applied for faculty position to few institutes in India like the Tata Institute of Fundamental Research (TIFR, Mumbai), Indian Institute of Astrophysics (IIA, Bangalore) and Raman Research Institute (RRI, Bangalore). I was particularly looking for a position at the Associate Professor level given my experience and my family situation (13 years old son and 5 years old daughter). I contacted Indian Institute of Science (IISc, Bangalore) as well before applying. But, they said they don't hire at senior positions normally. So, I did not send my application there.

The nice thing about these institutes (and also several others) in India is that they have open application running throughout the year. So, there is no such thing as “vacancies”. Candidates can apply anytime, and the institute will invite potential candidates for interview on the campus. I received invitations for interview/visit from TIFR, IIA and RRI. For IIA and RRI, the visits were scheduled in November 2018. But, before my visit, RRI informed me that some changes had happened in their policy, and they were mostly looking for radio astronomers, and so, my visit would be treated as a visitor coming for seminar, not as a job applicant.

I first visited IIA, presented a one-hour seminar, and later had a meeting with the Director of the institute. One/two days later, I also visited RRI, presented a similar seminar although it was not related to a job application anymore. During these visits, I met and talked to several faculties in these institutes, and learned about their research activities.

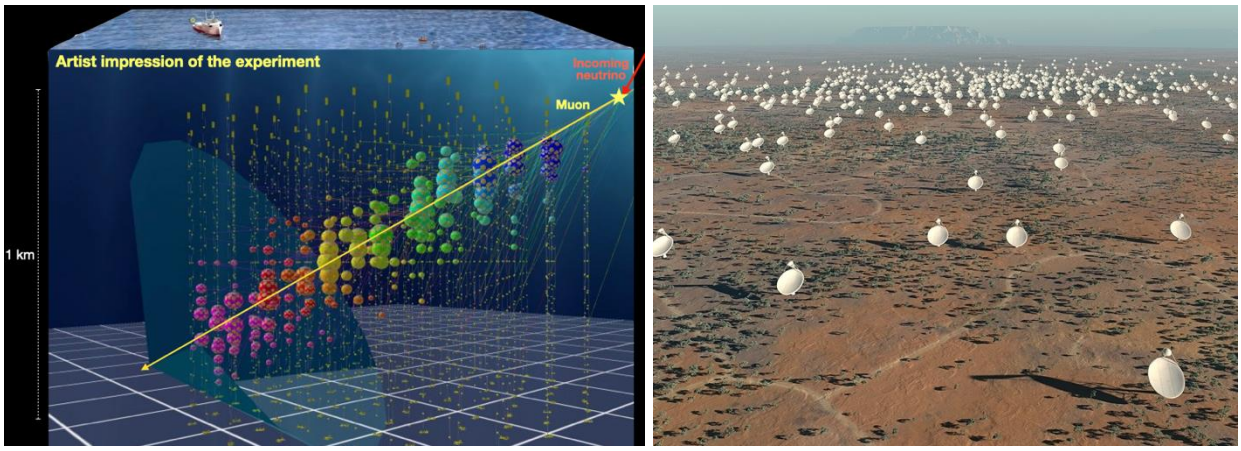
My visit to TIFR was in February 2019. Unlike at IIA, I was asked to present two seminars at TIFR, each for one-hour duration. As I work both in theory and experiment, I focused my first seminar on theory and the second on my experimental activities. After the seminars, I talked to several faculties from the Department of High Energy Physics which run the GRAPES cosmic-ray experiment in Ooty. The group leader of the experiment was Prof. Sunil Gupta who was about to retire soon at the time of my visit. The department was actively looking for an experienced cosmic-ray researcher to take over his position.

Faculty position offers (2019)

By summer 2019, I received offers from IIA and TIFR (unofficial), both at the Associate Professor level. I seriously considered both the offers. IIA was quite open to my own choices of research. They were happy with me bringing my existing collaborations (LOFAR and ALTO experiments), and at the same time, aiming for a stronger participation in the MACE experiment under my leadership. TIFR has their own focused project (GRAPES experiment), and my main task would be to lead the experiment with my expertise. Workwise, both the positions were quite attractive to

me. But, I also needed to consider my personal situations seriously. My son was in Class 9 at that time, and it was really hard to find a suitable school for him both in Bangalore and Mumbai. I inquired several schools, and found out that their school system would be really tough for him. My son did all his primary and middle school in Europe, and I could not find a school that would give him an easy transition, especially because of the language subjects which are mandatory in the Indian school system.

At the same time, I was also having an offer from Khailfa University, Abu Dhabi (UAE) for an Assistant Professor position. I inquired about the schools in Abu Dhabi, and it turned out that they had several options which could give my son an easy transition in his high school. So, I finally decided to accept the offer from Khalifa University, and declined the offers from IIA and TIFR purely on personal ground. As far as my work is concerned, I always take my collaboration with me. Abu Dhabi is a very clean, safe and friendly city with about 80% expatriate population. It is quite close to India with a flight hour of only about 3 hours to Delhi. Technically, that means travelling from Abu Dhabi to Imphal would take almost the same flight time as travelling from Mumbai or Bangalore.



Left: A schematic of the KM3NeT neutrino experiment in the Mediterranean Sea. (Credit: www.km3net.org).

Right: An artist impression of a section of SKA telescope (Credit: https://www.skao.int/).

Assistant professor, Abu Dhabi (2019)

In August 2019, I joined Khalifa University, Abu Dhabi, as an Assistant Professor. I brought the LOFAR and ALTO collaborations with me. In addition, I succeeded in taking Khalifa University to the KM3NeT collaboration in 2021. KM3NeT (the Cubic Kilometer Neutrino Telescope) is a next-generation neutrino experiment currently being built in the Mediterranean Sea. It involves about 250 members from 50 different institutes from 17 countries. The experiment is estimated to cost about 200 Million Euros. In 2022, I also succeeded in taking Khalifa University to the cosmic-ray working group with the SKA radio telescope. SKA (the Square Kilometer Array) is the largest radio telescope in the world which is under construction at two different locations in Australia and South Africa. It involves collaboration from many institutes from 20 different countries.

Since I joined Khalifa University, I succeeded in securing various research grants totaling around 2.5 million dirhams which is about 5.6 crores Indian Rupees. These grants were spent on the LOFAR, ALTO and KM3NeT projects.

Along with the teaching activities at the undergraduate and PhD levels at Khalifa University, I am also taking an active role in community service at the university and societal levels by organizing public events in astronomy, student trips to observatory and giving TV interviews on dedicated scientific programs in Abu Dhabi.

My current research profile

I have published a total of 153 publications so far, out of which 81 are in refereed journals. Based on Google Scholar, I have gathered a total citation of 7035 with an h-index of 36. I have delivered more than 50 invited/contributed talks and seminars at various international conferences and universities/institutes. I am currently an active member of the international collaborations that are involved with the LOFAR, SKA and KM3NeT experiments. I am also actively working on the theoretical study of cosmic rays in collaboration with researchers from RRI and IISc in Bangalore, Ruhr-Universität Bochum (Germany) and Vrije Universiteit Brussel (Belgium). I am a regular referee of top astronomy journals such as the Astrophysical Journal (ApJ) and Monthly Notices of

the Royal Astronomical Society (MNRAS). I have also served as referee for several research funding applications at the international level.

A short advice to the younger generation

As someone rightly said, the surest way to success is to determine to succeed. Take risks in your career, but only when you are confident in yourself. Be ready to work outside your comfort zone. No one is born intelligent, only training and experience make them intelligent. Training means training to think, training to understand, training to listen and training to raise questions. It takes time to gather skills and knowledge in life. Remember every expert in a field has invested an extensive amount of time to acquire his knowledge. You learn a lot more when working with your own hands rather than reading a text book. Keep both your personal life and professional life important. Work hard, but smartly. Most problems do not need long hours of work to solve, but a smarter way.

For those who want to pursue a career in Astronomy/Astrophysics, you need to be really good in computation/software skills mostly using python or c++ and statistical methods in addition to the basic knowledge in physics and mathematics. As far as faculty jobs in India are concerned, most research institutes in India are continuously looking for good people, and they are not readily finding the right candidate. If you are good, and your research and collaboration can be beneficial for the institute both in terms of research output and reputation of the institute, you stand a very good chance. Have the courtesy to cite relevant papers in your publication. This is a common mistake for young researchers. Keep your ego aside. Don’t be stubborn. Be polite in writing professional email. One day, you will cross each other in a conference or meeting. Astronomy/Astrophysics is quite a small community. Perform community service whenever you get the opportunity, and be humble to your juniors.