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From the editors' desk

Welcome back to the second edition of the CARINAS newsletter! We had started this journey with three Indian women researchers across three academic generations. Through their experiences, we got a sneak peek of the evolution of gendered professional space in India in the last 3–4 decades. However, other countries are coping with the issue of the lack of gender balance in STEM as well. Often, local initiatives toward progress shape path-breaking global changes and vice versa. Some countries are ahead in this journey while some are behind. Despite such efforts, the "leaky pipeline" is a deadlock in most countries, due to which, STEM begins to lose women steadily beyond graduate level. There are different versions of gender-based hiring policies in many countries to address the problem. At CARINAS, we are eager to look for solutions that naturally retain women at all stages of their careers. What do we need to do collectively to create a space of growth and productivity for ourselves? It is necessary to open gates and let conversations flow across nations and respective women scientists. Such conversations will reveal the experiences as well as the science goals of a wider range of women scientists across the globe.

*In this edition, we are delighted to present **Prof. Jocelyn Bell Burnell** telling us the story of what a handful of senior women scientists were doing in the 90s to address the problem in the UK. She is famous for the discovery of pulsars, and her tireless efforts to be visible and to increase the visibility of women in science. We interview **Prof. Smita Mathur** who has lived and worked in two countries, India and the US, for several decades. Smita is primarily an X-ray astronomer and is well-known for her ingenuity in the field of AGN and missing baryons. She candidly chatted with us about her life and work. We will further hear from **Dr. Ramadevi M C**, who plays an instrumental role in XPoSat, the first X-ray polarimetry mission from India. Finally, our in-house humor columnist **Dr. Jestress** returns with the latest news, updating us on the fate of our favorite Radha stuck on the Moon!*

Athena SWAN – its birth

by JOCELYN BELL BURNELL
– Professorial fellow at Mansfield College (Oxford), Visiting academic at Department of Physics, University of Oxford, UK

In the late 1990s about half a dozen senior British women scientists got together to ask 'What could be done to improve the position of academic women in science in the UK?' The group included a physicist, a biologist, a computer scientist, and others, including myself. All of us were at or close to professorial status, all of us in a minuscule minority in our departments and universities, and **all of us experiencing (un?)conscious bias**.

It was good to be part of such a group in the sense that it showed each of us that we were not, actually, alone; that others in other universities had similar experiences and were equally frustrated by the additional difficulties that academic women seemed to experience, compared with their male colleagues.

> *"The Athena SWAN program has revealed a lot of unconscious bias and has been a factor in the growth of a diverse academic and research council workforce."*
>
> – Jocelyn Bell Burnell

We met in a borrowed room, at our own expense, but were assisted by a pair of extremely able women who were paid tiny amounts for their work. We floundered around, recognizing similar experiences but lacking good solutions or even a good way out of our situation. **We were all keen to see more women in our fields and see**

fairer treatment of women in our fields. At one meeting it was observed that men tended to be more competitive, so if we created a prize for the most women-friendly university, universities might respond. There could then be the makings of a genuine competition, with a focus on the position of women in academia. But what to do about a prize? We were penniless!

We found enough money to buy a glass rose bowl and announced the competition. Our colleague was correct – this attracted attention. In the first round, we did not have many, but sufficient, submissions to have a competition. **We identified a winner (not a high-profile university)** and had a small award ceremony. Next year we repeated the exercise (with rather more confidence) and had a larger field of submissions. Again we judged the applications, selected a winner, and had another prize ceremony to award another rose bowl (again, to a university that was not very high profile, nor well known).

By this time, from all the applications received, we were gathering ideas about what worked, and what did not, to improve the position of women in STEM in UK universities. We now felt we could identify more explicitly the kind of features we expected to see in a university that would be a good workplace for a female scientist or engineer. Putting together all we had learned through the previous exercises, we created our 'pro forma' and named it after the schemes of the first two winners, namely **'Athena' and 'Scientific Women's Academic Network' or 'SWAN'** hence the name "Athena SWAN".

We continued running the competition, and the field widened – more and more applications were received, and more and more universities were taking note, as were some other organizations outside universities. The burden on us, especially on our tiny secretariat, was increasing fast. When a Research Council expressed an interest in running it (effectively **making the women-friendliness of a university or department a factor in whether or not they received a research grant**), this was an offer we could not refuse! The Athena SWAN scheme spread to other academic areas (including those where the question might be 'Where are the men?') and has been taken up in other countries too.

Completing an Athena SWAN application is a huge amount of work; this was especially so in the early days when different departments and different faculties in a university would each have their own (mutually exclusive) databases. The systems are now standardized but there remains the risk that the organizer will say too often and too easily, 'We could also ask about…', thereby creating a lot more work for the applicants.

For all its flaws I feel the Athena SWAN program has revealed a lot of unconscious bias and has been a factor in the growth of a diverse academic and research council workforce. I believe this strengthens both the research and the higher education in those countries that have such a scheme.

Conversation with a scientist:

Prof. Smita Mathur, The Ohio State University, USA

by Manami Roy[‡], Sanskriti Das[†], & Prakriti PalChoudhury[*]

– Postdocs, ‡The Ohio State University, USA †KIPAC, Stanford University, USA *University of Oxford, UK

Work does not seem to be work to Prof. Smita Mathur, an astronomer and member of the faculty at the Ohio State University, United States. All she wants every day is to wake up, go to the university, and start a new adventure! **Smita feels the excitement of science even after many years of being a scientist just like she did at the beginning.** She is *jazzed* that she gets paid to do something she enjoys. We caught up with Smita and heard from her about the approaches to doing science in India and the US, based on her perception and unique life experiences across the two countries.

> "*… more than race and gender, the fact that I had an Indian Ph.D. was a major factor against my chances in the US…*"
>
> – Smita Mathur

MR, SD & PPC: Let us start from the beginning then. What was your childhood like? What motivated you to come to science? Did you find it easy to come to Physics?

SM: I grew up in Mumbai in a very supportive family, a wonderful school, and a supportive community. I could do everything I wanted to do. The culture was very academic in the school and the community. We did other things and not just school work, like singing, dancing, acting, and all those things. But it was all still very academic. My interest in science started with solving puzzles. **My father always gave me puzzles and I could not stop until I solved them.** That went on throughout school life. Previously, matriculation used to be after the eleventh grade. Ours was the second batch when it was changed and matriculation came after the tenth grade (age of 16). The junior college or last two years of high school with eleventh and twelfth standards were introduced. We were going through a transition phase. The curriculum was modified and a lot of the syllabus of the eleventh grade was moved to the tenth grade, especially geometry. There was a hefty book of **4000 *riders* or problems based on mathematical theorems.** One summer, I borrowed that book from someone one year senior to me and **solved all those mathematical problems**. No one forced me to do it. Why did I do that? For fun! For me, science was a love affair and has been so to date. Perhaps, I was not as deliberate about my career as I ought

to have been. Did it come easy? It came easy until college. However, once I was at IIT (Bombay) for an M.Sc. in Physics, I found it significantly harder.

MR, SD & PPC: Which college was it?

SM: It is called Ruia College in Mumbai where I did my BSc, I don't know if you have heard about it. It was a great place to be in. We had fantastic professors and I am still in touch with many of them.

MR, SD & PPC: Nice! So, you did Ph.D. in India, right? How was your overall experience during your Ph.D.?

SM: Many from IIT applied abroad for Ph.D. but I thought there are these lovely institutions in India so why not stay here? I was in the second batch of the Joint Astronomy Program (JAP). **I did Ph.D. with Ajit Kembhavi at TIFR (Mumbai). I was his first Ph.D. student.** I had many hurdles during my Ph.D. Most importantly, I did not realize that I was not cut out to do theory. I often worked alone with ideas of my own. Secondly, Ajit moved to IUCAA during my third year. Also, I got married and then had a child. Thus, it was all a very stressful time and I thought I did not do well. **But Ajit was very supportive.** Everybody else gave up on me once I was married. But he was not one of them.

> "*... Scientists are those who create new science. This comes from new ideas and the courage to follow them.*"
>
> – Smita Mathur

MR, SD & PPC: I see. Did things change when you started your postdoc?

SM: I moved to the east coast of the US with my husband who went for a postdoc. It was cold and I was miserable with **no job and the one-year-old to take care of. I was managing a household for the first time** which included, e.g., cooking for all. Finally, after a few months (in 1990), I went to CfA (Harvard) and talked to Martin Elvis. He had visited TIFR before. He had no money to offer me work. I needed only just as much to pay for the daycare for my baby. Martin took me around and introduced me to the gentleman, Ed Kellogg. He had a tiny amount of money to support me. Thus **I started to work on X-ray data... old *Einstein* data... of galaxy clusters** despite not knowing anything about it. It is a surprise that he (Ed Kellogg) gave me the task. It was not quite a postdoc and I do not know what it was. But I was super excited and came back home with manuals to learn data analysis. **I never looked back since then.** I was finally doing real research in an observational community. It was exhilarating!

MR, SD & PPC: Wow, that is quite inspiring! So where did you move after that? How long did it take to become a faculty?

SM: I stayed for **10 years** at CfA. Initially, it was not a postdoc. Later I joined Belinda Wilkes and that was my proper postdoc. I worked on optical data till she ran out of money. Then I worked with Martin (Elvis) for a while. Finally, I won a 5-year grant. I was a research staff at that time. Eventually, my husband got a tenured job in the Physics department of OSU. I came to OSU with that grant of my own. **We were naïve and didn't know about spousal hiring. So we didn't negotiate.** Also, it didn't seem right to negotiate. Sometimes it is not smart to be too righteous. However, it was not great to not be a faculty in the university setting. I started applying and then (the Astronomy Department of) OSU offered me a position. This happened two years after I moved to Ohio.

MR, SD & PPC: Tell us a little bit about your research, your students and collaborators. Have you been working on the same topic for a long time?

SM: During Ph.D., I was working on theoretical projects. I considered the effect of quasars in host galaxies...it is funny that **now AGN-galaxy connection has become fashionable...at that time people were not yet considering** that. I considered radiation only, how gas is heated. Then I came here (to the US) and worked with X-ray data from *Einstein* observations...it was a short project and did not lead to paper. But I learned new techniques in X-ray astronomy. Then after my Ph.D. thesis defense, I came back to working on AGN using optical spectroscopy, something completely different since it was ground-based data. Basically, at that time I picked up spectroscopy as a tool. Then I worked with Martin Elvis using X-ray again. I also learned CLOUDY ionization modeling at that time. **Real breakthroughs happened around that period. I discovered AGN outflows in X-ray**. All the outflows, even high ionization lines people were talking about were in the UV. They (UV astronomers) were making assumptions about the ionization state of the gas. And I thought if I am seeing an OVII-edge in my X-ray data and my model is predicting how much OVI is there then all their assumptions were incorrect! That was a breakthrough, the UV–X-ray connection (in outflows). Then I was working on a variety of topics – quasar absorption studies, narrow line Seyfert 1 galaxies – people were doing it separately in optical, UV, and X-rays and I synthesized all of that together, and my big single-author paper was on it: narrow line Seyfert 1 is a stage in the evolution of AGN. Then I worked on the M–σ relation and how black hole growth happens through secular channels. After *Chandra* was launched, I started working on the warm-hot intergalactic medium (WHIM) which eventually led me towards circumgalactic medium (CGM) due to absorption lines at redshift zero. Around 2005–2010 one of my students, Rik Williams, worked on this topic. But **I consider the 2012 work the real breakthrough** when my postdoc Anjali Gupta and I combined X-ray absorption and X-ray emission measurements to constrain the mass of warm-hot CGM of the Milky Way and **found the "missing *galactic* baryons"**. Then my student Sanskriti's work discovered a super hot phase in the CGM of the Milky Way and lots of exciting results started coming up following that. Currently, I am excited about XRISM and other

upcoming X-ray missions.

MR, SD & PPC: Did you ever think of settling in India, or was it a conscious choice to stay in the US?

SM: Yes for the longest time we did not plan to stay abroad. We kept pushing the transition to US citizenship. Maybe that was a mistake given that we finally settled in the US.

MR, SD & PPC: Do you think finding a faculty position in the US was difficult for you because of your gender, race, and/or educational background?

SM: For me, I think, more than race and gender, the fact that I had an Indian Ph.D. was a major factor against my chances in the US. **If there were any other implicit biases, I may have been oblivious.** I don't know of many Indian Ph.D.s who managed to become faculty members here. However, there are many Indians who did Ph.D. in the US and got great faculty positions.

> *"You see a lot of aggressive people around. But being aggressive and being assertive are different things."*
>
> – Smita Mathur

MR, SD & PPC: India is now participating in large international collaborations like LIGO and SKA, and launching successful indigenous missions like *Chandrayaan*, *Aditya-L1*, and XPoSat. As an observer, what would be your comment on this?

SM: I am a proud Indian and always happy to see success stories of ISRO! But I feel that we are playing catch-up with the rest of the world since India is much younger as a nation. We are taking time to get there in terms of economy and technology. **But radio astronomy of India was already on the world map when I was a student.** Govind Swarup was a visionary in that sense. Also, culturally, we value scholarship in India. We admire people who can go to the board, write down equations, and solve them. However, scientists are those who create new science. This comes from new ideas and the courage to follow them.

MR, SD & PPC: Do you think you had to be more outgoing or more vocal to prove your point in a scientific discussion than your male counterparts?

SM: You see a lot of aggressive people around. But being aggressive and being assertive are different things. You often see many quiet diplomats in meetings. They are not always trying to dominate. They say something well thought out, correct, and clear. Their words are taken seriously too. **You don't have to be loud-mouth but also you should not be shy to voice your opinions.** More than anything, be yourself.

MR, SD & PPC: Thank you Smita! It was great chatting with you. Lastly, what would be your advice to the younger generation who want to pursue a career in Astronomy? Especially the female students?

SM: You guys are doing great and you are far more deliberate about your careers than me! All the best wishes. Be yourself; you should be able to see yourself in the mirror when you get up in the morning. Career happens and a lot of it is randomness. **What defines you is your values, conscience, and work ethic**. On the scale of the Universe, we are a speck! Chance plays a big role from when we are born, the family, the country, etc. Just keep working! *Karmanye vadhikaraste, maa phaleshu kadachana* (You can only do your duty, the fruit of your labor is not in your hand – *Bhagavad Gita*).

XPoSat: X-ray Polarimetry Satellite; India's first polarimetry mission

by Dr. Ramadevi M C
–Scientist at ISRO

My journey towards becoming a scientist and making discoveries began when I joined ISRO in 2003 as a young research scholar. Completing my Ph.D. there marked a significant milestone. Since then, I have been deeply involved in various astronomy missions such as AstroSat and Aditya-L1. **Each of my roles in ISRO has been instrumental in shaping my career trajectory.** Over time, I have assumed the role of Principal Investigator for the X-ray instrument, Scanning Sky Monitor (SSM), aboard AstroSat. Additionally, I am engaged in extensive research concerning X-ray optics, instrumentation, and the study of X-ray sources in spectral and temporal domains.

X-ray astronomy is quite interesting with various kinds of objects emitting predominantly in X-rays in different timescales, making the X-ray sky highly variable and unpredictable. There have been many dedicated astronomical observatories around the world to study these sources in three primary domains: spectroscopy, timing, and imaging. In recent times, **the fourth domain in X-ray astronomy** that is gaining momentum **is Polarimetry.** X-ray polarimetry of celestial sources is largely unexplored, though there have been many theoretical predictions of the expected polarization from different classes of X-ray sources. The only positive detection until now with very few reliable observations, has been that of the Crab Nebula. Thus, **there is a huge discovery space in the field.**

The first detection of X-ray polarization in X-ray source Crab (in 1972) was followed by measurement of the degree of polarization as $19.2 \pm 1.0\%$ and polarization angle $\theta = 156.40 \pm 1.40$ in Crab by OSO-8 mission. After that, there have been a handful of polarization measurements of the Crab by a few others like that by POLAR, and CZTI onboard AstroSat. **There has not been any**

dedicated polarimetry mission for a few decades due to the limiting sensitivity of the possible instruments as polarimeters.

NASA launched the first dedicated polarimetry mission, the Imaging X-ray Polarimetry Experiment (IXPE) on December 9, 2021, which observes the X-ray Universe in the energy range 2–8 keV. Following this, **ISRO in collaboration with Raman Research Institute, launched the second dedicated polarimetry mission, X-ray Polarimetry Satellite (XPoSat)** on 1st January 2024. XPoSat comprises a polarimeter in medium energy X-ray (8–30 keV): POLIX (POLarimeter Instrument in X-rays) and a spectrometer in soft X-ray (0.8–15 keV): XSPECT (X-ray SPECtroscopy and Timing). XPoSat not only serves as a complimentary mission to IXPE by probing polarization at higher energy but also with a polarimeter and a spectrometer together on board, it becomes the first Spectro-Polarimeter mission internationally to carry out simultaneous polarimetry and spectroscopy of X-ray sources.

With the launch of XPoSat, a new horizon for X-ray astronomy has been opened to us. POLIX will provide polarization measurements of many X-ray sources, e.g., high mass X-ray binaries, X-ray Pulsars, Magnetars, Active Galaxies, etc., in medium energy X-ray for the first time. XSPECT will provide simultaneous high-resolution spectroscopy and timing studies of these X-ray sources in soft X-ray. These three domains of polarimetry, spectroscopy, and timing studies will be carried out for selected bright X-ray sources for the first time with XPoSat. It will help us unravel the accretion physics and geometry in these systems under the influence of strong gravity and extreme magnetism, which I am super-excited about.

> *“XPoSat becomes the first Spectro-Polarimeter mission internationally to carry out simultaneous polarimetry and spectroscopy of X-ray sources.”*
>
> – Ramadevi M C

I am engaged in the XPoSat community in various ways. I am a member of the Science Working Group of XPoSat. This group primarily focuses on the science goals of XPoSat and is responsible for testing and calibrating the payloads on XPoSat. I am part of the XSPECT team as well. I am also involved in science aspects, e.g., detector background modeling, response modeling, etc. Later, I am planning to do science observation with XSPECT to bring out the maximum science from the instrument. I am also a member of the XPoSat Time Allocation Committee (TAC) which is in charge of reviewing the proposals and approving them for observing with XPoSat.

The XSPECT team of XPoSat comprises numerous female members, both in the instrument and science teams. As the science data becomes public, I anticipate a growth in female participation among research scholars. **ISRO demonstrates a strong commitment to women's empowerment, with many female leaders heading teams and spearheading successful missions**. I have noticed a significant difference from the time I joined ISRO in 2003; the number of our female colleagues across various career levels has steadily increased. The organization and the country have duly recognized many female scientists of ISRO for their remarkable contributions.

> *“...from the time I joined ISRO in 2003; the number of our female colleagues across various career levels has steadily increased.”*
>
> – Ramadevi M C

Personally, my journey in ISRO so far has been invigorating. The work environment is incredibly stimulating and supportive. **Hierarchy**, in terms of experience, **plays a major role in our workflow, and expertise is gained gradually by the younger generation** over time. We collaborate with many international agencies as well, which has been an enriching experience for me. Many of us at ISRO handle multiple projects simultaneously, which sets us apart from international agencies and deserves recognition. Overall, to summarize, I take immense pride in being a part of ISRO.

Freshly baked news

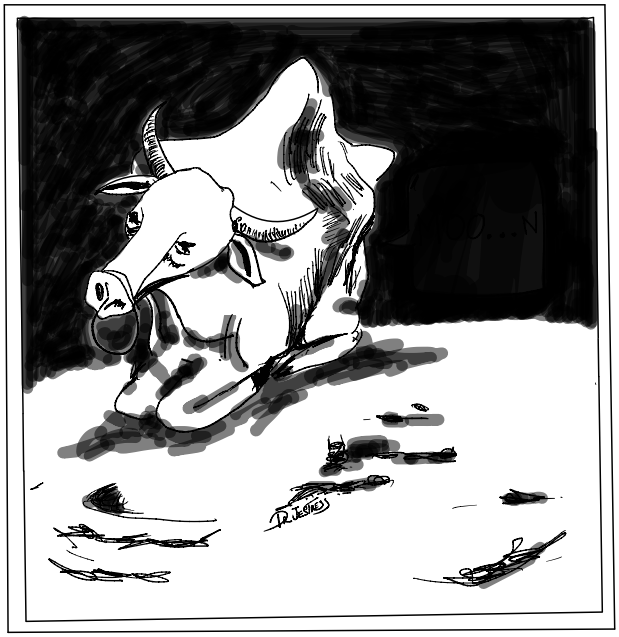
Clash of scientists: Rescue Radha War[1]

by Dr. Jestress

Will science save the day? *Radha*, the stranded Indian cow, is on the Lunar South Pole for several days! The latest photographs onboard lunar rovers show her getting snug in *Vajrasana* pose. That is against the United Nations's *Clause of Settlement* for stray and pet animals on the lunar surface or any lunar real estate. The President of the United States has set up a special task force, named RAdha's Dilemma Hollers Action (RADHA), with the brightest scientists across the globe. Being experts in theoretical physics, observational astronomy, and astronomical instrumentation, the scientists and engineers gathered at the first Meeting Internationale de RAdha (MIRA) in Delhi (New York, USA) to devise a new strategy and bring *Radha* back to Earth.

"The first meeting was a disaster!" the committee's chair scoffed, during a correspondence with the press post-meeting. The technical discussion went haywire after the scientists clashed in opinions. When asked about the cause of debate, she further clarified, "The shape and volume of *Radha* were the main issues. While modeling

[1] This is meant for pure humor. Everything here is fictional. Apologies in advance if any individual/community/nation finds it offensive.



her *baryonic* mass, theoretical physicists were pushing the case for a spherical *Radha*. They claimed that this would give a good estimate of her mass. The astronomers said that it's a rubbish idea. One of them wanted to deproject and deconvolve the latest image of *Radha* and draw Bayesian parametric inference on her 3D morphology aka shape. Another proposed to employ *cowseismology* to empirically construct *Radha*'s core and extrapolate it to predict her outer surface, i.e., shape. This would also provide a better description of her 3D mass distribution and hence the total mass. The theorists called these exercises to be a fool's errands. They proposed that it is time to return to the classic three-body problem (Moon, Earth, and *Radha*) and again attempt a closed-form solution first. Following this suggestion, there was nothing short of war between the two groups of scientists."

While the engineering team of RADHA is forced to sit idle in Delhi with no clear strategy from the science working groups, thousands of miles away, the Prime Minister of India called an urgent classified meeting in New Delhi. Adding to the tense atmosphere, animal rights activists are protesting all over the country. The opposition grabbed this chance in the nick of time before the election to openly criticize the ruling party for being insensitive and inactive so far. Last but not least among the global ordeals, the well-meaning BBC report titled "Saving Radha's bacon" got into controversy.

Editorial board

Other acknowledgements

The Milky Way photograph used for creating a woman's silhouette by Prakriti Pal Choudhury is provided by Sangram Biswas photography.