CONNECT

WITH THE INDIAN INSTITUTE OF SCIENCE

Volume 11 Issue 3 September 2024

Bringing in Bourne
IISc's second Director

Gravitational lensing
Probing deep space

Happy Feet
Runners on campus

ISSN 2454-6232

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EDITORIAL

The cosmos is vast and boundless, with billions of objects and events that even our most advanced telescopes and probes cannot spot. Luckily, gravity can help. In this issue of *CONNECT*, we delve into the fascinating phenomenon of gravitational lensing and how it is helping scientists unravel mysteries in the deep universe.

In another feature, we explore how mathematical models are aiding biologists in deciphering life's complexities.

On the campus front, undergraduate students speak about how academic and social clubs have become their guiding stars, while other campus residents find solace and rejuvenation through running. Students also reminisce about their favourite teachers in this issue's *CONNECT* Asks.

Other stories include a day in the life of Amita Sneh who handles international relations at the Institute, and the fascinating life of Thresiamma Varghese who has documented and preserved numerous insect species. Geeta Ananth reflects on the origin and growth of the campus Hindustani music club. Psychologist Deanna Barch talks to us about all things mental health. We also dive into the drama behind Alfred Gibbs Bourne becoming the second Director of IISc.

Happy reading!

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Get, Set, Go

- Sindhu M

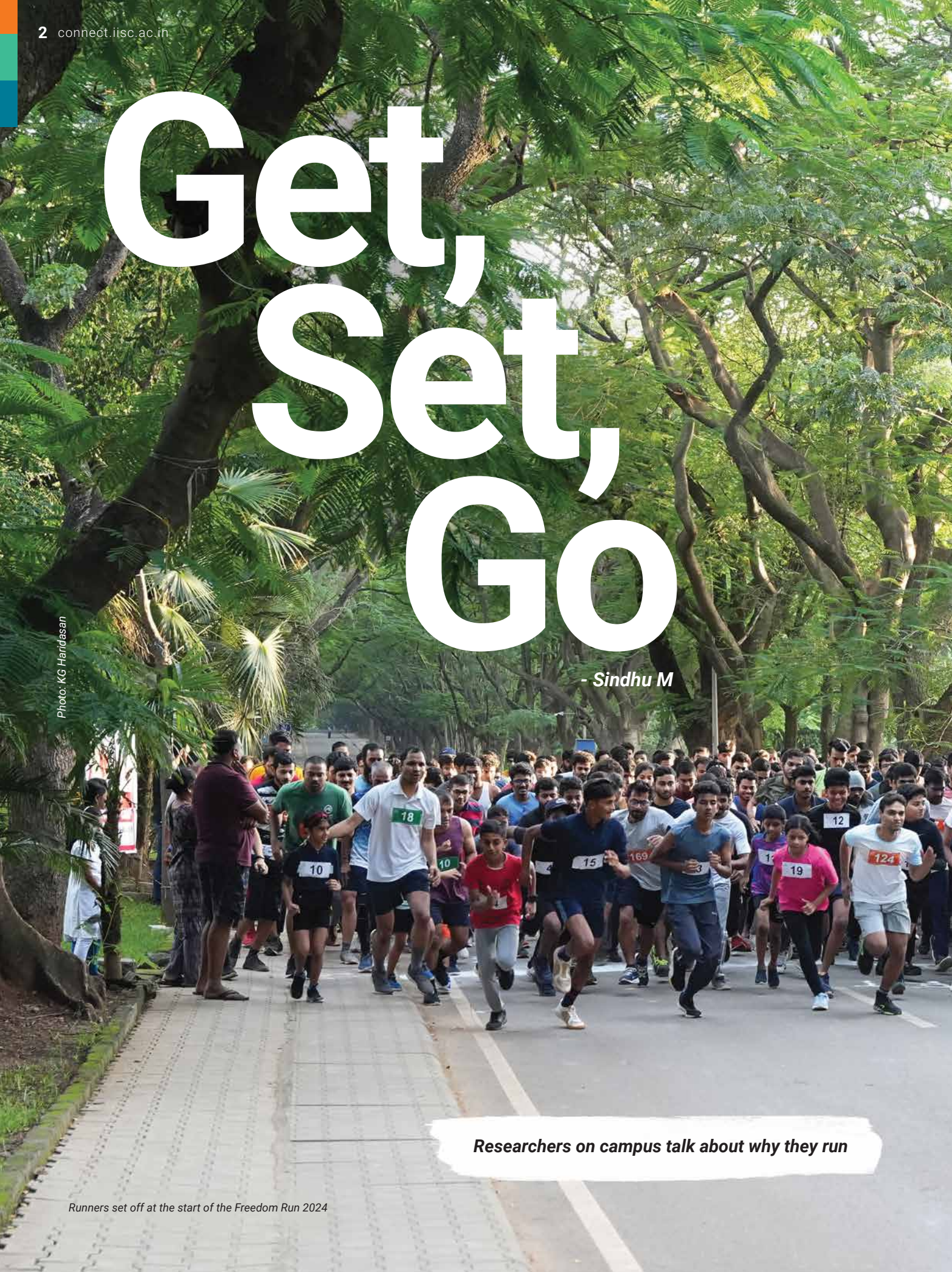


Photo: KG Haridasan

Researchers on campus talk about why they run

Runners set off at the start of the Freedom Run 2024

It was 6 am. The unrelenting blare of the alarm jolted me awake. An alluring voice in my head, forceful and convincing, suggested that I go back to sleep, the world can wait. But with Herculean effort, I heeded the other steely voice in my mind. "Just brush your teeth. If you're still groggy you can always go back to sleep," it said. One step at a time. I was out of my bed and off for a run.

The campus, usually quiet at this hour, was abuzz. Over 200 runners were gathered near the Main Building. Flags fluttered and cries of *Jai Hind* reverberated as the start of the Freedom Run, an annual event hosted at IISc on Independence Day, loomed. The four-kilometre run under the canopy cover on campus is a scenic one.

Over the years, the long, winding campus roads and facilities such as the Gymkhana ground had enticed many students and faculty members to take up running, either as a hobby or as a competitive sport. This race was a blue riband event on their running calendar.

> ***The four-kilometre Freedom Run, under the canopy cover on campus, is a scenic one***

After collecting my race number, I took my place at the starting line. Runners around me stretched and adjusted their gear. Nervous smiles were exchanged as anticipation heightened.

When the run was finally flagged off, a sea of humanity bolted, the first kilometre of the run moving from the Main Building to the Department of Mechanical Engineering via the food truck road. Many slowed down to a walk at the Silver Oak Marg which was a climb, unable to keep up the pace. Experienced runners, who had initially lagged behind the enthusiastic beginners, glided on at a steady pace.

The runners spanned a wide range in age and experience. Even school kids were running alongside IISc students and faculty members, some experiencing their first tryst with a four kilometre run. Just ahead of me was Supratim Ray, a faculty member and seasoned runner with over a decade of experience.

A Professor at the Centre for Neuroscience, Supratim started running in 2003. He also plays badminton, table tennis, and football, but running has his heart. “Running is something that I can do by myself,” he explains.

He caught the running bug during his PhD days in Baltimore, USA. He finished his first marathon, a distance of 42 kilometres, at three hours and 58 minutes, two minutes under his target of four hours. His second attempt aimed at qualifying for the famed Boston Marathon. The first half of the race went according to plan, but in the second half, he “hit the wall”, a phrase in running parlance that refers to physical and mental fatigue. He also picked up an injury along the way, which ended his hopes of making the Boston Marathon qualifying time. But he remained undeterred. Since joining IISc a year later, Supratim has taken part in two Ultra Marathons, more challenging than full marathons, in 2012 and 2013.

> ***‘Running helps with breathing and that can bring about a lot of changes in the body and mind’***

“Running helps with breathing and that can bring about a lot of changes in the body and mind,” explains Supratim. “Running regularly requires discipline which also translates to better work management.”

As I struggled with the uphill climb at the Silver Oak Marg, Supratim pushed on with ease. The race slowly moved on along Tala Marg, before another uphill segment at Madhura Marg. There, I came across Monica Alfred Henry, an alumnus of the Molecular Biophysics Unit. I first met Monica at *Spectrum*, IISc’s annual sports meet, in 2022 after my 100 m race, when she came over to congratulate me. It had spawned a long friendship.

Monica's relationship with running goes back to her childhood. "My father used to take me and my brother running at 5 am during school vacations when I was just six years old," she reminisces. Initially, she didn't enjoy it but she still ran, looking forward to the post-run treats. "It was difficult for me, but I enjoyed what followed it, like the time of rest, good food, and even some consequent rewards like becoming a sports champion in my school early on," she admits.

Her running habit took a hit during her high school years but she resumed it after joining IISc. Balancing running with research proved challenging. “The progress was slow but the consistency was rewarding,” she remembers. She gradually built up to running 3-4 times a week, starting with 15-20 minute sessions. She learned to incorporate running into her life by adjusting the intensity and duration based on her work and research schedules.

"Research in IISc is very demanding. Running is like a reset where you have nothing in mind but just to finish your workout goal for the time. That helps in the renewed start of the work,” says Monica. “The real reward is witnessing it [running] translated into all other spheres. I took my PhD thesis writing process as a 400m race. The last phase of writing and submission is like the final 100m in the race. Though you are exhausted, you keep up the pace and cross the finish line, and that’s how I did it!”

Monica and I ran side-by-side for a while, motivating each other. Her company through the challenging segment of the run distracted me from my aching legs and we made it to Gulmohar Marg together.

Photo courtesy: Monica Alfred Henry

Monica likes to unwind after a rigorous workday by going for a run

The flat terrain flanked with trees was a welcome change as was the downhill incline towards the D gate. We moved on to the bank road, a daunting uphill climb. I took a walking break of about a minute and made it up the slope. The race was almost over – just one left turn towards the library and the finish line was at the Main Building. I finished the race at a canter, feeling elated as I pulled ahead of the tired runners.

At the flag march after the race, I met some of my friends including Prem Singh Anant, a PhD student at the Department of Bioengineering.

Prem's journey as a runner had begun unexpectedly in his 12th standard. It was his classmates' reluctance, some of whom were national-level runners, in participating in the inter-house competition that opened the door for Prem to participate and win. It proved to be a turning point.

"I felt that I could run too," Prem recalls.

Where most recreational runners lean towards distance running, Prem found his calling in sprinting. It matched his personality, he felt a thrill in the short and intense burst of speed. It satiated his competitiveness. "I enjoy pushing my limits in a brief timeframe, and the quick recovery periods keep me engaged and motivated. It allows me to express my athleticism and provides an enjoyable challenge that longer runs don't offer to me," he explains.

He continued pursuing it during his Bachelor's studies and took part in college meets. When he joined IISc, he became the convener of the Athletics club, which unites runners on the campus by holding training sessions for the IISMs (Inter IISER Sports Meets), and the track and field events of *Spectrum*.

"A sprinting competition lasts for less than a minute but requires a lot of discipline and focus for that duration. It helped me become disciplined," Prem admits, adding that it makes him more productive at work.

The Independence Day run was my first road race. Until then, I had only been running at the Gymkhana grounds to avoid the hard surface of the roads.

Photo: KG Haridasan

Runners on Gulmohar Marg, a popular running spot on campus

Running on roads for long periods is fairly damaging to the body, especially the knees. Supratim, while training for his races, used to do 50 laps around the track at the Gymkhana. "I don't mind the repetition," he explains.

> ***The campus roads offer a delightful variety to runners, from relatively flat roads to climbs and descents***

However, to me, running in a loop feels monotonous. The Independence Day run made me realise how beautiful and refreshing running on the roads of IISc can be.

The campus roads offer a delightful variety for runners. From relatively flat roads to climbs and descents, there is something for everyone. There are also short trails through the overgrowth and wooded areas.

"The canopy of trees, serene paths, and fresh air make it [IISc] a runner's paradise. Every runner dreams of such a perfect green environment," Gaurav Sharma, Assistant Professor at IIT Hyderabad, had once posted on the social media platform X.

For time-targeted runs, the diverse roads keep runners engaged. Running under the canopy-covered roads with sunlight streaming through and birds chirping is a great way to start the day. Besides a few threatening growls from stray dogs, things are usually smooth. Evening runs, with lights put up for *Pravega*, the UG fest, and fireflies guiding the way, are also immensely popular.

Be it chasing down a sub-three-hour marathon or beating the morning blues, running offers a perfect respite from research. The health benefits that come with it are a bonus, especially for researchers who work hard in labs all day. The famous Alan Turing used to be an avid runner and ran consistently while trying to crack Enigma during the Second World War.

For me, personally, beyond the runner's high, running has always helped me clear my mind and get through the day better. It has also helped me forge enduring friendships that I will cherish for a lifetime.

Sindhu M is a PhD student in the Department of Bioengineering, IISc and a former science writing intern at the Office of Communications

Bend it like Gravity

- Ranjini Raghunath

Image courtesy: ESA/Hubble, Digitised Sky Survey, Nick Risinger (skysurvey.org), N Bartmann

The lensing of waves is helping us look deeper into space

Artist's impression of a black hole warping images of stars behind it, an effect called gravitational lensing

Arthur Eddington was growing anxious. It was nearly 2 pm on 29 May 1919. The British astronomer was standing on a plateau overlooking the Atlantic Ocean in the west African island of Príncipe. A rare solar eclipse, not seen in 500 years, was about to begin. It should have been a hot and clear day. But thunder was rolling across the overcast sky, threatening to ruin his plans.

Some years earlier, a friend had written to Eddington about a young scientist named Albert Einstein who had just published his theory of general relativity, making extraordinary claims about the nature of gravity. With World War I raging, few people outside Germany knew or cared about these ideas, more so because they defied theories proposed by the better-known Isaac Newton. But Eddington was impressed with Einstein's work and wanted to help him.

One of Einstein's claims was that the gravitational field around the sun would bend light rays coming from a distant object as they skirted the sun's rim. Eddington and Frank Dyson, Britain's Astronomer Royal, came up with a clever way to prove this. They would first take photos of a bright star cluster called the Hyades close to the sun, which was only possible when the sun was blacked out during a total eclipse. They would then cross-check this with the Hyades' position a few months later when the sun had moved away. If the sun bent the stars' light, their position during the eclipse should appear off by an angle of 1.75 arcseconds (about 1/60th of a millimetre on a photographic plate), according to Einstein's calculations. Two locations where the eclipse would be clearly visible were chosen: Príncipe – where Eddington and technician Edwin Cottingham set up camp – and Sobral, a city in Brazil where astronomers Andrew Crommelin and Charles Davidson were dispatched.

At 1.55 pm, miraculously, the clouds cleared over Príncipe. Five seconds past 2.13 pm, the eclipse's totality began, and the team managed to take 16 still photographs during the five minutes that the eclipse lasted. When they completed their calculations a few months later, the Príncipe team found that the star positions were off by about 1.61 arcseconds, while the Sobral data suggested around 1.98. On 6 November 1919, at a joint meeting of the Royal Society and Royal Astronomical Society in London, the researchers announced their findings, turning Einstein into a star overnight.

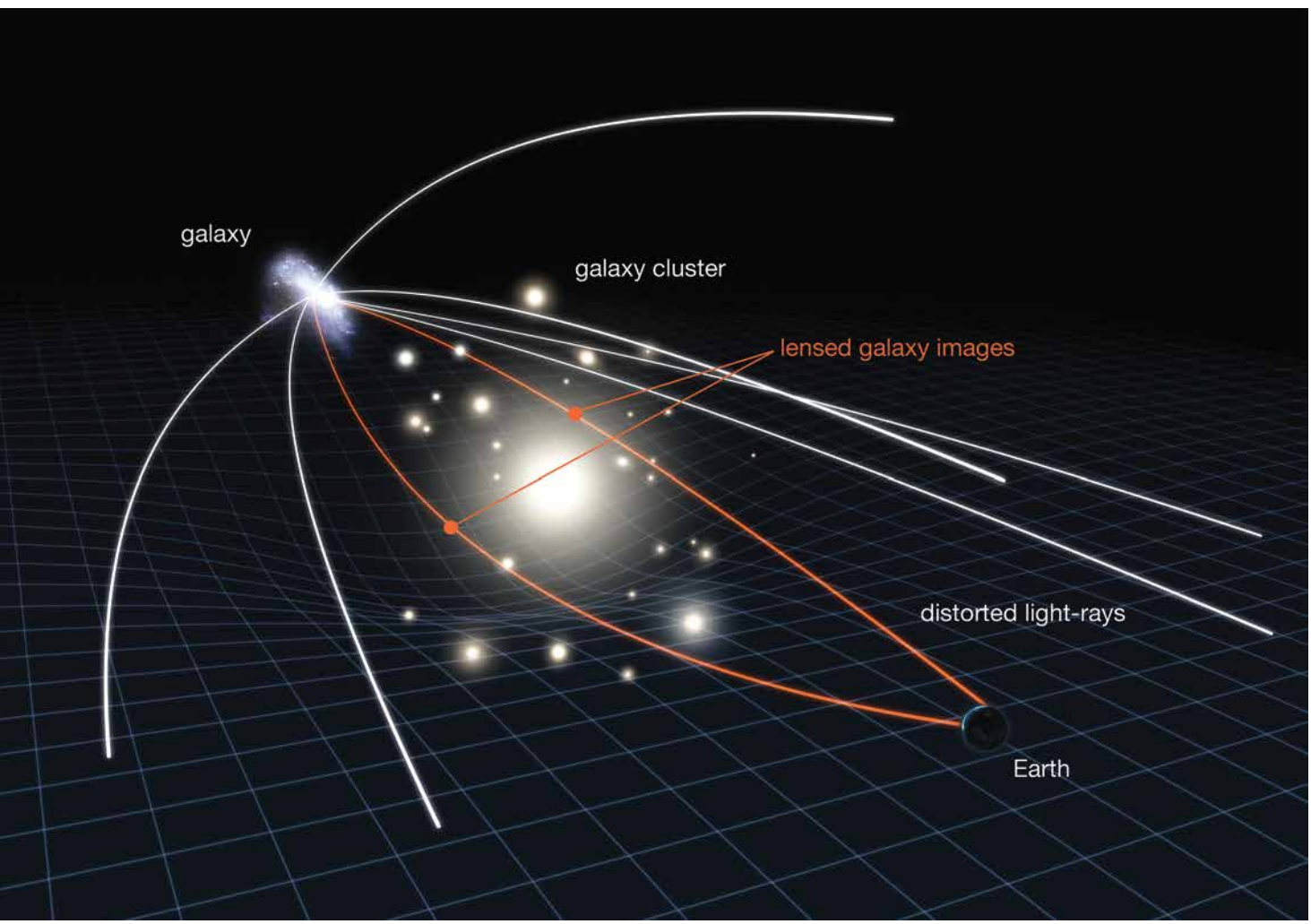
The eclipse experiment was not just a validation of Einstein's ideas. It was also the first demonstration of a phenomenon called gravitational lensing.

The universe is made up of billions of stars, planets, and galaxies. But many of these are either too faint or too far away for our telescopes to spot. Sometimes, by a stroke of luck, light rays from one of these objects encounter a massive body – like a galaxy cluster – en route to Earth. This body can act like a gigantic lens, curving the light rays around itself and magnifying their intensity. Instead of a pinprick of light or no light at all, what our telescopes might sometimes see are bright banana-like arcs of light surrounding the image of the lensing body in the centre. Each light ray can reach the Earth at different times, resulting in a time delay between different arcs corresponding to the same original object. Not just visible light – other parts of the electromagnetic spectrum like radio waves and gamma rays can also be lensed and magnified.

Gravitational lensing has helped astronomers pinpoint hundreds of new objects in the sky, map the distribution of matter across space, and even probe the origins of our universe.

> ***Gravitational lensing has helped astronomers pinpoint hundreds of new objects in the sky***

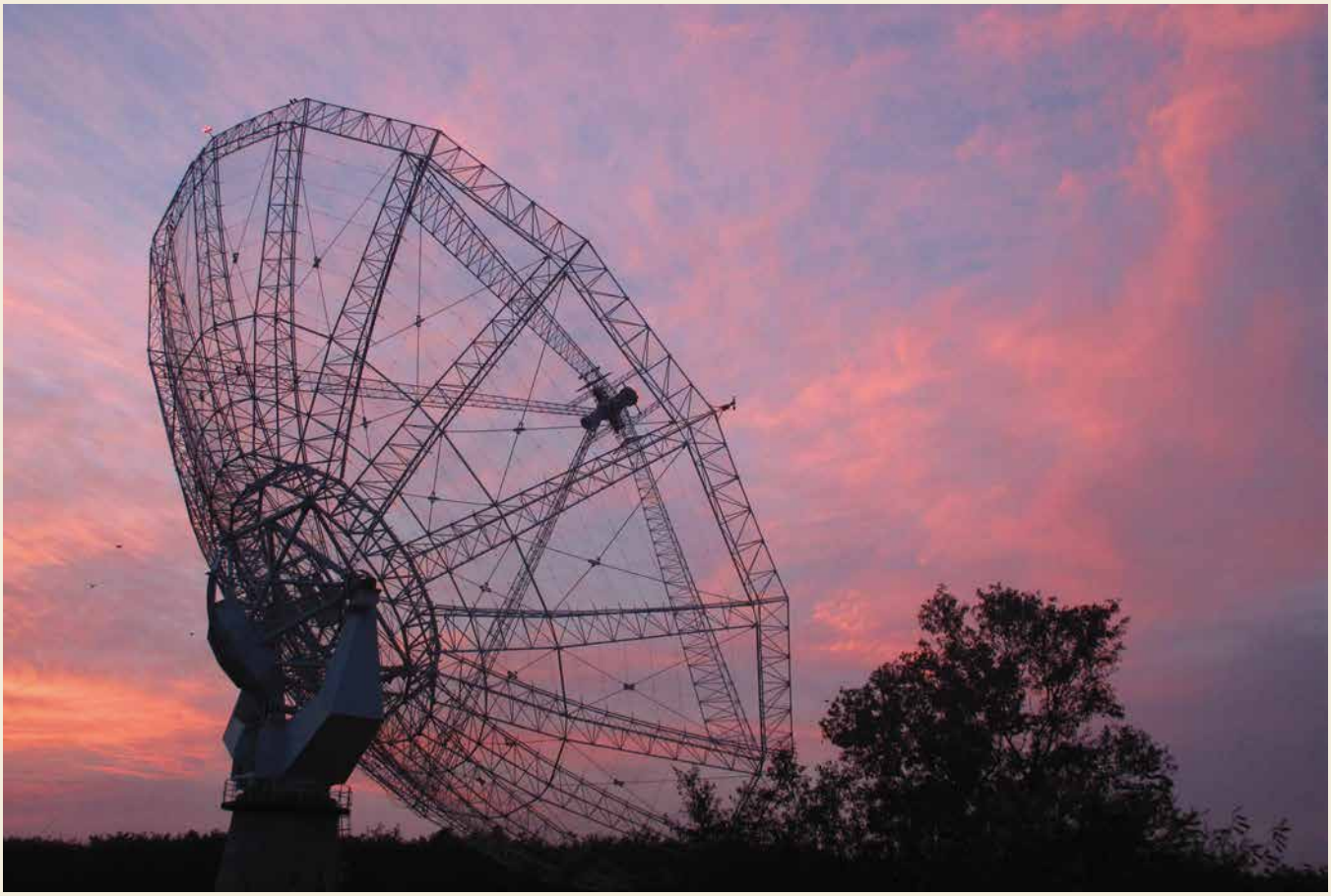
"It helps you study both the object that's being lensed and the one doing the lensing," explains Nirupam Roy, Associate Professor at the Department of Physics, IISc. For example, how much the light is bent can tell us how big the lensing body is – if it is massive, the bending can be extremely strong. Take Gargantua, the fictional supermassive black hole featured in the movie *Interstellar*. Streams of light are bent so strongly by it that they loop and curve around it several times, giving it an ethereal look. "This is effectively gravitational lensing," Nirupam says.



Depiction of gravitational lensing

Image courtesy: NASA, ESA & L Calçada

Photo: Nirupam Roy



One of the antennas that make up the Giant Metrewave Radio Telescope near Pune

Gases in galaxies

It was strong gravitational lensing that helped Nirupam and his collaborator Arnab Chakraborty detect a radio signal from a galaxy billions of light-years away from Earth.

A few years ago, while poring over images captured by the Hubble Space Telescope, Nirupam and Arnab chanced upon a far-off galaxy. Its light had been lensed so strongly by an intervening galaxy cluster that instead of arcs, it created a bright, nearly full circle of light, called an Einstein ring.

What the duo was more interested in, however, was the galaxy's gas composition, particularly atomic hydrogen gas, which is the fuel for star formation. But atomic hydrogen does not emit visible light. The only way to detect it is to look for a 21 cm spectral line – a radio wave of a specific wavelength generated when there is a change in the energy state of the atoms. To search for this line, the researchers used the Giant Metrewave Radio Telescope (GMRT) – an array of large parabolic antennas – near Pune, Maharashtra.

Detecting such radio waves is challenging, because they are weak compared to star light, and can also be disrupted by radio signals from earthly sources like cell phones. Normally, there was no way that even GMRT, among the most sensitive radio telescopes on Earth, could have picked up the signal.

Luckily, the same cluster that lensed the galaxy's light also ended up lensing its 21 cm line, magnifying the latter by nearly 30 times, allowing GMRT to pick it up. "[Otherwise], it would have taken us, say, 900 times longer observation time, or we would have had to build a telescope with about 30 times larger collecting area," explains Nirupam. It was and remains the farthest distance from which such a signal had been picked up. It was also the first time anybody had detected a strongly lensed 21 cm line from any galaxy.

Analysing the lensed radio signal gave the team several new insights. They found that it had originated about 8 billion years ago, but the galaxy was so far away that we were only now able to detect it. "You are [essentially] looking back into the past," says Nirupam. They were also able to work out that the atomic hydrogen mass in the galaxy at that time was twice as high as the mass of its stars – higher than one would expect to see in galaxies now. This led them to speculate that early-stage galaxies were probably more gas-rich because a lot more stars were forming in them.

> ***Analysing the lensed radio signal gave the team several new insights. They found that the signal had originated about 8 billion years ago***

"We are now planning to put in requests for observation time at different telescopes so that we can try to detect this gas in many more sources," Nirupam says. "If we can do this for a larger sample, we can make a more useful statement about the property of galaxies in general in the distant universe."

Ripples in spacetime

One hundred years after Einstein's theory of general relativity was published, on 14 September 2015, scientists gathered at twin facilities in the USA that together make up the Laser Interferometer Gravitational-Wave Observatory (LIGO), waiting anxiously for results that could prove another of his predictions.

Einstein had suggested that gravity arises when massive objects stretch the fabric of spacetime, like a bowling ball on a trampoline. During violent events, like two black holes smashing into each other, the stretching is so strong that it creates tiny, fast-moving ripples in this fabric called gravitational waves. These waves are not part of the electromagnetic spectrum, are extremely weak, and cannot be "seen".

To catch these waves, scientists at LIGO built two 4 km-long perpendicular vacuum tubes or "arms" with mirrors at each end. A laser beam split into two travels across each arm, keeping track of the distance between the mirrors. If a gravitational wave passes through, it would stretch the space inside the arm ever so slightly, changing the light's path length by an incredibly tiny amount – about 10^{-19} metres. It was this change that the team caught that day for the first time – it showed up as a 'chirp' or peak in the signal captured by LIGO's detectors. By analysing the chirp, they deduced that the waves had come from the collision of two black holes 1.3 billion years ago, which created a burst of gravitational waves in the final milliseconds.

Since then, about 100 gravitational wave signals have been detected, unveiling objects and events hidden from optical and radio telescopes. "For example, gravitational waves are probably the only way of detecting a double black hole merger because it doesn't emit any light," explains Parameswaran Ajith, Professor at the International Centre for Theoretical Physics (ICTS), Bangalore, who is part of the LIGO collaboration. "In the last eight years, observations of gravitational waves have told us that these collisions of black holes are rather ubiquitous in the universe." Studying gravitational waves can also tell us more about the universe's ancient past. "The earliest we can 'see' using electromagnetic waves is … about 300,000 years after the Big Bang," Ajith adds. "We cannot 'see' the universe beyond that because the universe was so dense that light could not travel. But gravitational waves could."

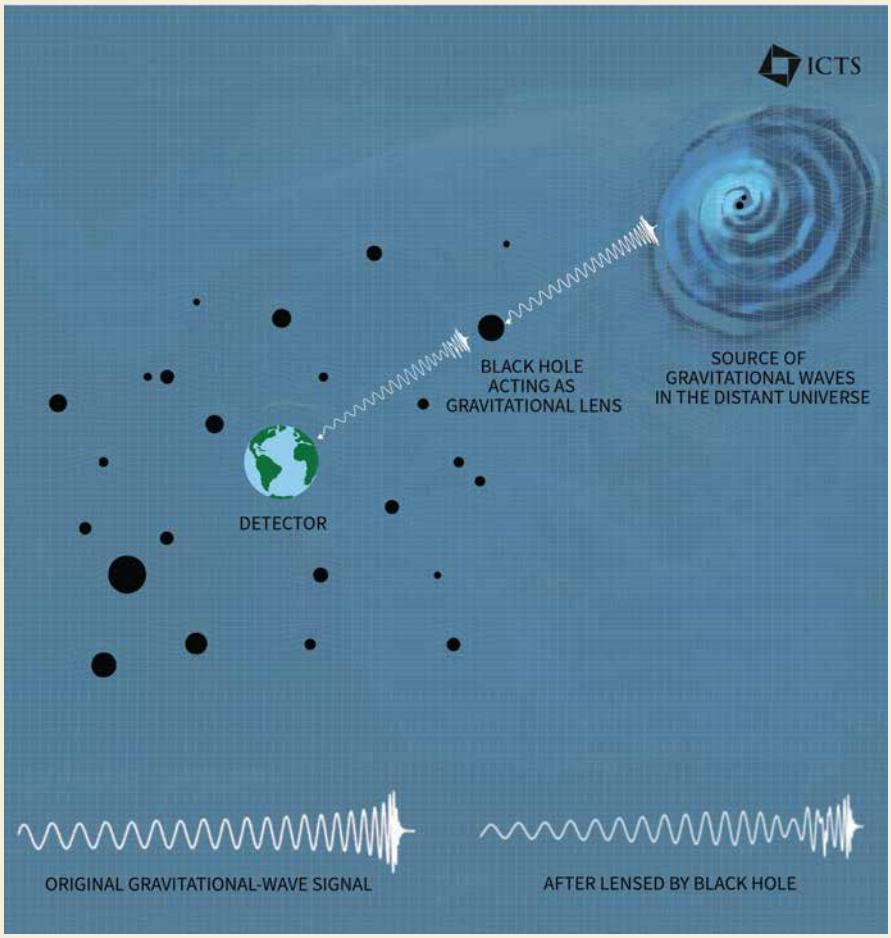


Image: Roshni Samuel/Parameswaran Ajith/ICTS

Gravitational lensing can change the shape of gravitational waves, making it easier to detect the lensing object

> ***Studying gravitational waves can tell us more about the universe's ancient past***

Crucially, gravitational waves can also be lensed, in theory. Magnified, repeated chirps echoing the same event can potentially appear at different times in the gravitational wave data. Ajith's research focuses on devising ways to find these chirps. "Our group has developed the first method to search for gravitational lensing of gravitational waves using a Bayesian statistical model," he says. The method provides a way to determine if repeated signals popping up in the LIGO data belong to the same event – which means that lensing is happening – or to two different events.

In another study, Ajith and others speculated that the time delay between lensed gravitational waves could be linked to the rate at which the universe is expanding, a value that scientists are yet to agree upon. The team modelled black hole mergers and galaxy clusters as the source and lens respectively. What they found was that if there are more lensed signals or the time delay is smaller than expected, it might point to a larger value of the Hubble constant, which is a measure of the expansion.

However, to validate such predictions, we would need to detect and analyse thousands of such lensed gravitational waves – we are yet to see even one. But scientists are already working on improving current detectors and building new ones, Ajith says. "We are on the verge of a discovery … there is a real possibility of detecting them in the next five years."

Darkness in the universe

Working late one night in 1963, astronomer Vera Rubin was eating ice cream and mulling over something strange in spectral data collected from the Andromeda galaxy, our closest neighbour. Stars at the edges of the galaxy – which were too far away from the gravitational pull of its core – seemed to be moving at the same speed as stars closer to the centre. She and her collaborator Kent Ford realised that there must be some invisible mass at the galaxy's fringes providing extra gravity to keep those stars stable. Her work – which many thought should have won a Nobel Prize – made the world wake up to the presence of this invisible mass that we now know as dark matter.

Scientists think that 85% of the universe's mass is made of dark matter. Although we cannot detect it directly, we know it exists due to its gravitational pull on stars and galaxies.

The biggest questions about dark matter are what it is made of, and how it is distributed in and around galaxies. Gravitational lensing is helping scientists answer both.

> ***The biggest questions about dark matter are what it is made of, and how it is distributed in and around galaxies. Gravitational lensing is helping scientists answer both***

For example, if we calculate the lensing object's mass based on telescope observations, and find that the lensing is much stronger than expected for that mass, the additional bending must be due to the presence of dark matter in the object. Sometimes, dark matter in the space between the Earth and a distant object can subtly bend light rays from the object, creating a smear or distortion instead of bright arcs, a phenomenon called weak lensing. If we compare the shape of the object to the shape of the smear, we can indirectly gauge how much dark matter is present between the Earth and the object.

"We are yet to have a definite answer on what exactly constitutes dark matter," says Anupreeta More, Research Faculty at the Inter-University Centre for Astronomy and Astrophysics (IUCAA), Pune. "There are various theories. Is it made of some exotic particles? Is it just ordinary matter that is not luminous enough yet?"

A few years ago, Anupreeta was part of an international collaboration that tested one hypothesis: Could dark matter be made of primordial black holes – extremely tiny black holes formed during the earliest seconds after The Big Bang? The researchers used a powerful telescope called Subaru located in Hawaii to first take a full-scale photo of the Andromeda galaxy. If primordial

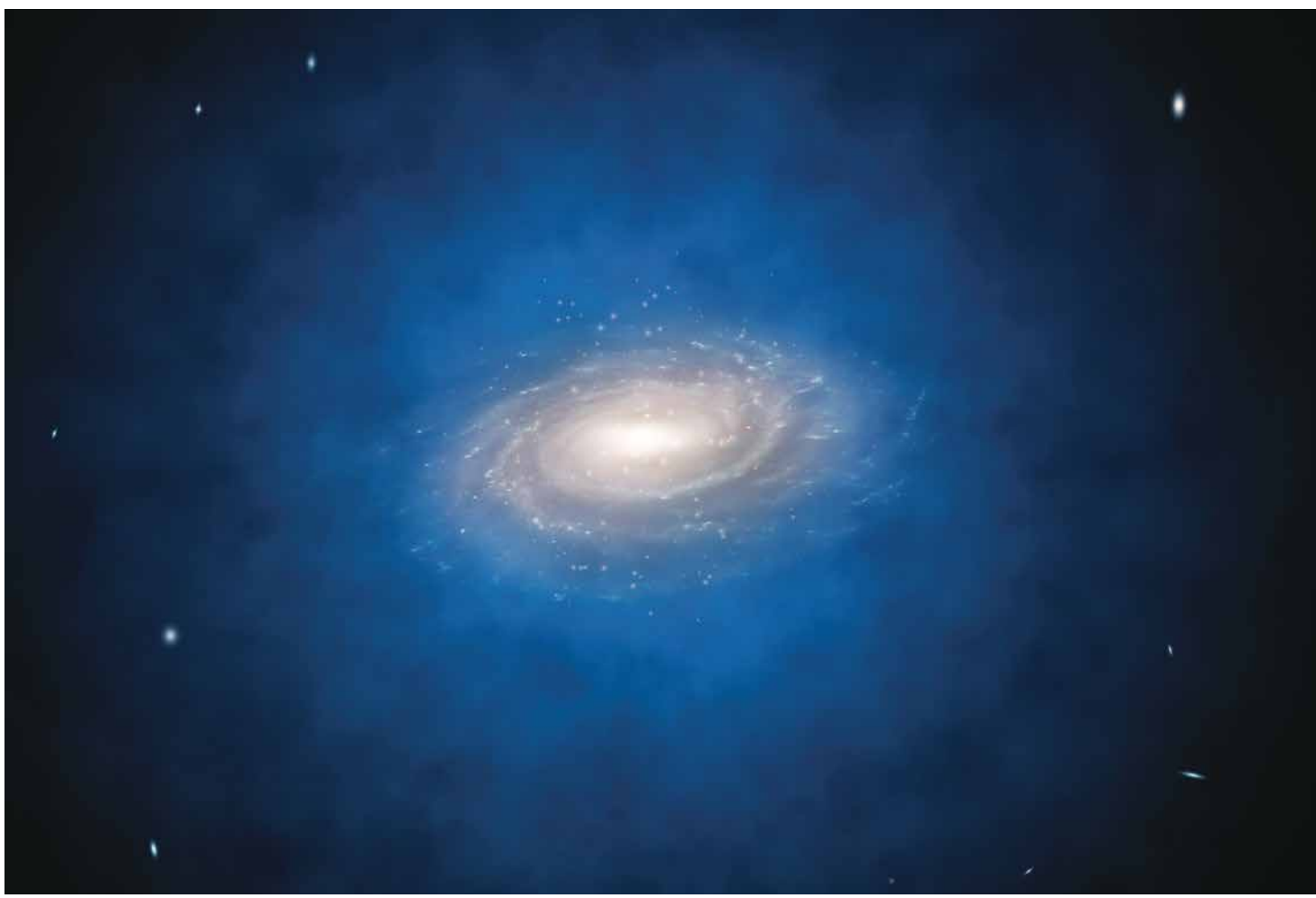


Image courtesy: ESO/L Calçada

Artist's impression of dark matter depicted as a blue halo surrounding the Milky Way galaxy

black holes pervaded the galaxy, they would have created many transient lensing events – a phenomenon called microlensing – that would appear as tiny blips. The team expected to see at least 1,000 such blips. Instead, they saw just one. This suggested that primordial black holes probably make up a very tiny fraction of dark matter.

Another theory, which Ajith's team tested very recently, was whether dark matter could instead be made of much more massive black holes – 100-100,000 times as massive as the Sun. "Our study suggests that because we have not seen any lensed gravitational waves in the last eight years, not more than about 80% of dark matter could be in the form of such massive compact objects," he explains. "It's a different way of probing the nature of dark matter."

Lenses across the sky

On 29 March 1979, astronomers Dennis Walsh, Bob Carswell and Ray Weymann were at the Kitt Peak National Observatory in Arizona, USA, where Rubin had made her groundbreaking observations. Looking through its telescope, they noticed what they thought were two quasars – bright objects found near galaxy centres – close to each other. When they compared the image with spectroscopic signatures, they realised that it was actually two images of the same quasar, lensed by a massive galaxy in between. That was the first official gravitational lens to be spotted. Since then, only a few thousand lenses have been found – a miniscule amount compared to the billions of objects in the universe.

"A lot of my work has been about how to find a large number of lens systems, and how to make sure that we are finding all of them," Anupreeta says. Her early work focused on developing algorithms to spot lenses in images obtained from large cosmological surveys, but they weren't efficient enough. In 2013, she and her collaborators launched a citizen science project called Space Warps – these images would be uploaded on a public portal and anybody could scan them to search for gravitational lenses. "Most of the time, the lensing galaxy tends to be an early-type or elliptical galaxy, and many of these look similar. Our eyes and brains are good at recognising such patterns," Anupreeta explains. Millions of volunteers from around the world have been helping researchers find new lenses.

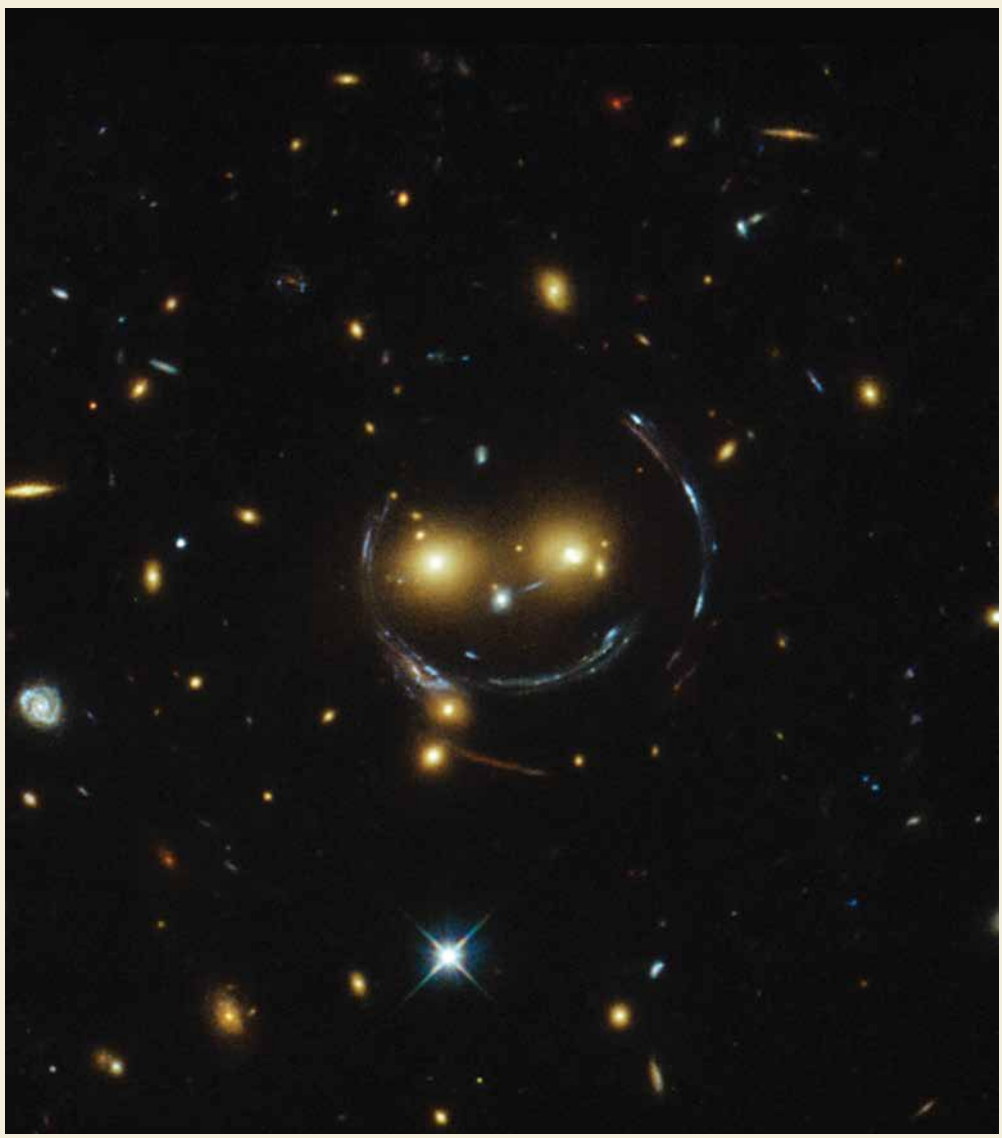


Image courtesy: NASA & ESA/Judy Schmidt (geckzilla.org)

"Happy face" made by two galaxies in the centre lensing light from distant stars behind, which creates arcs that look like smile lines

Finding new gravitational lenses will become more significant in the coming years as we enter an era of next-generation telescopes and detectors that will produce staggering amounts of data and images. In Chile, a new observatory named after Rubin will start sweeping skies across the southern hemisphere soon, snapping millions of photos each night. Construction of the Square Kilometre Array – thousands of antennas that will together make up the most sensitive radio telescope in the world – is nearing completion in South Africa and Australia. In India too, a state-of-the-art gravitational wave detector is being built in Hingoli, Maharashtra under the LIGO-India initiative.

Dozens of scientists in the country including Ajith, Anupreeta, and Nirupam are involved in such efforts. "We are very excited about LIGO-India. We haven't done projects of this scale in fundamental science in India," Ajith says. "This is a golden opportunity for us to be at the forefront of this research frontier."

Bridging Borders

- Bitasta Das

Photo: Bitasta Das

CONNECT *spent a day with Amita Sneh who coordinates international relations*

Amita enters her cabin with a hurried stride, carrying her big tote bag. Sanjeev, the contractor, was already waiting to have a conversation. He is in charge of renovating the new space for the Office of International Relations (OIR) at the Raman building. Amita insists upon a few things and presses on him to expedite the renovation. OIR has to shift to the new building in two days. Amita then responds to several emails and attends three phone calls back-to-back. At 9.30 am, OIR is already buzzing with activity, foreshadowing an eventful day. "Not just today, there are so many things happening at the office, every day, all the time," says Amita.

> ***'There are so many things happening at the office, every day, all the time'***

Amita Sneh is the Chief International Officer at OIR. Hailing from Himachal Pradesh, Amita moved to Bangalore in 2013 as a postdoc at DBT-InStem at the National Centre for Biological Sciences (NCBS). Before that, she had already completed two postdoc stints at the Nationwide Children's Hospital and Ohio State University, Columbus. After a year at NCBS, she realised that her interest veered more toward administrative roles than research and academics. She discussed her plan to shift careers with a couple of mentors at NCBS, who suggested that she apply for a role at the Office of International Relations, IISc. Amita took up their suggestion and applied, and was called to appear for an interview. She aced the job interview. For the past eight years, she has assumed various responsibilities at OIR.

It is almost 10.30 am now, and Amita starts walking to the Main Building for an interactive session with 12 high school students from the Royal Academy, Bhutan. As part of her work at OIR, Amita frequently interacts with student groups from various parts of the world who visit IISc with the prospect of getting admission. On her way, she runs into Abhishek Kumar Singh, the current Chair of OIR, and the two share several updates.

Recognising the role of international relations in improving the global outreach of its faculty members and students, IISc formed OIR in 1998. Currently, a nine-membered committee oversees its operations. The office staff includes Amita, two Assistant International Officers (AIOs), one Secretarial Assistant and an office boy. The induction of the two AIOs has considerably helped, as previously it was solely Amita's responsibility to shoulder most of the tasks. Amita says that work has now become "more structured and swifter than before."

By the time Amita arrives at the Main Building, the students from Bhutan have finished watching a short film on IISc. Before that, OIR had arranged an interaction with a Bhutanese student who is presently pursuing her PhD at IISc. The students were visibly enthralled by the natural beauty of the campus. They had several questions for Amita related to admission and student life on campus. Astrophysics and biotechnology were favourites for several of them. They were also curious to know if IISc had theatre, music and other cultural activities. Amita answered each question in detail.

The Bhutanese students were then provided with snacks and refreshments. They would now visit a few laboratories led by Debasmita Behera, one of the AIOs. The students did not miss clicking several selfies and group photos in front of the iconic Main Building before leaving.

IISc hosts foreign nationals through various graduate and postgraduate programmes such as BSc (Research), BTech, MTech, MDes, MMgt, MSc, PhD and MTech (Research) programmes, with admissions through entrance tests. OIR helps these foreign students settle into life on campus and encourages their participation in various activities.

Photo: Bitasta Das

Amita interacting with the students from Bhutan

Amita feels that international exchange is strategically crucial for a higher education institute. "International students often act as ambassadors for their institutions, enhancing their global recognition. They also bring diverse perspectives, enhancing the learning environment of the institute. The presence of international students boosts alumni networks, which further strengthens professional networks," she says.

Presently, IISc has international students from Nepal, Bangladesh, Sri Lanka, Iran, Turkey, Ethiopia,

Syria, Nigeria, Zambia, Bhutan, Egypt and Japan, plus a few students from the USA and UK with Overseas Citizenship of India (OCI) status. This year, students from Germany and Ecuador have also been admitted.

Amita proceeds to the Raman building to check on the progress of the new OIR office renovation. Carpenters are still working on the conference room table, and other furniture is yet to arrive. It looks like another week would be needed for the office space to become fully functional.

Amita recalls that as a new joinee back in 2016, one of her first tasks was to set up their present office space, the one that they share with the Office of Development and Alumni Affairs. She had made many trips to KR market to purchase the sofas, tables and chairs. The former OIR Chair, Usha Vijayraghavan, got the very aesthetic *Athangudi* tiles shipped from Tamil Nadu. The building was once Satish Dhawan's official residence – his daughter Jyotsna Dhawan was Amita's colleague at DBT-InStem. "When Jyotsna visited IISc, she fervently shared titbits about their stay in the building … where their living room was, which was their study room," Amita recalls cheerfully.

It is past 1 pm now, and it is lunchtime. Amita and the two AIOs, Debasmita and Swetha K, who share the same cabin, take out their lunch boxes containing home-cooked meals. Between mouthfuls, they share light personal banter as well as important official updates. Amita prefers to cook her own meals herself. Her morning starts at 5 am. She prepares her and her daughter's breakfast and packs their lunches.

> ***'International students often act as ambassadors for their institutions, enhancing its global recognition'***

Amita finishes her lunch, puts together a file and proceeds towards the DIGITS building for a meeting at 2.30 pm. This is with the Rankings committee – data on admissions and progress of international students play a crucial role in deciding the Institute's rank.

At the meeting, Amita provides an update on various activities of OIR. The focus of OIR has been on increasing the number of full-time and short-term students and faculty members on campus through targeted outreach plans, global networking, and wider advertisement of IISc's programmes. Venugopal S, Chief Data Officer at IISc; Suresh Balutagi, Deputy Librarian; GR Jayanth, faculty member in the Department of Instrumentation and Applied Physics, and Abhishek Singh, the Chair of OIR were the other members present in the meeting.

Photo: Bitasta Das

Amita inspecting the new office space in the Raman building

Amita's work at OIR covers a wide range. This includes exploring new academic partners, maintaining existing collaborations in education and research, and connecting with global scientific networks. She is also the nodal person for facilitating the Institute's full-time, co-supervised and joint doctoral programmes, as well as seed funds, exploratory workshops and seminars with partner institutes.

It is past 4 pm when the meeting at DIGITS ends. Amita walks back to her office. The next couple of hours are filled with telephone calls from students and faculty members. There have been days in her office when she has had to face emergencies, sometimes related to guidelines for foreign nationals and sometimes related to the health of international students. "As there are no said rules and we need to act on the spot, there is no chance of making any mistakes," Amita explains.

Amita feels that although OIR has come a long way, there is still scope to improve. "We need to advertise our fully-funded programmes, interdisciplinary ecosystem, continuously evolving curriculum, world-class facilities and internationally trained faculty through outreach and global networking," she says. She feels that all their present efforts need to be exponentially stepped up.

As another busy day at the office ends, Amita books a cab to go home. It is 6 pm now and booking a cab at this peak hour takes some patience. After a few cancellations, she receives confirmation from one of them. Amita re-organises the stationery on her table one final time and leaves to board the cab for the hour-long journey to reach her home in Yelahanka. Her calm demeanour masks the multitude of thoughts occupying her mind about the next day's schedule.

Bourne to Lead

- Pratibha Gopalakrishna

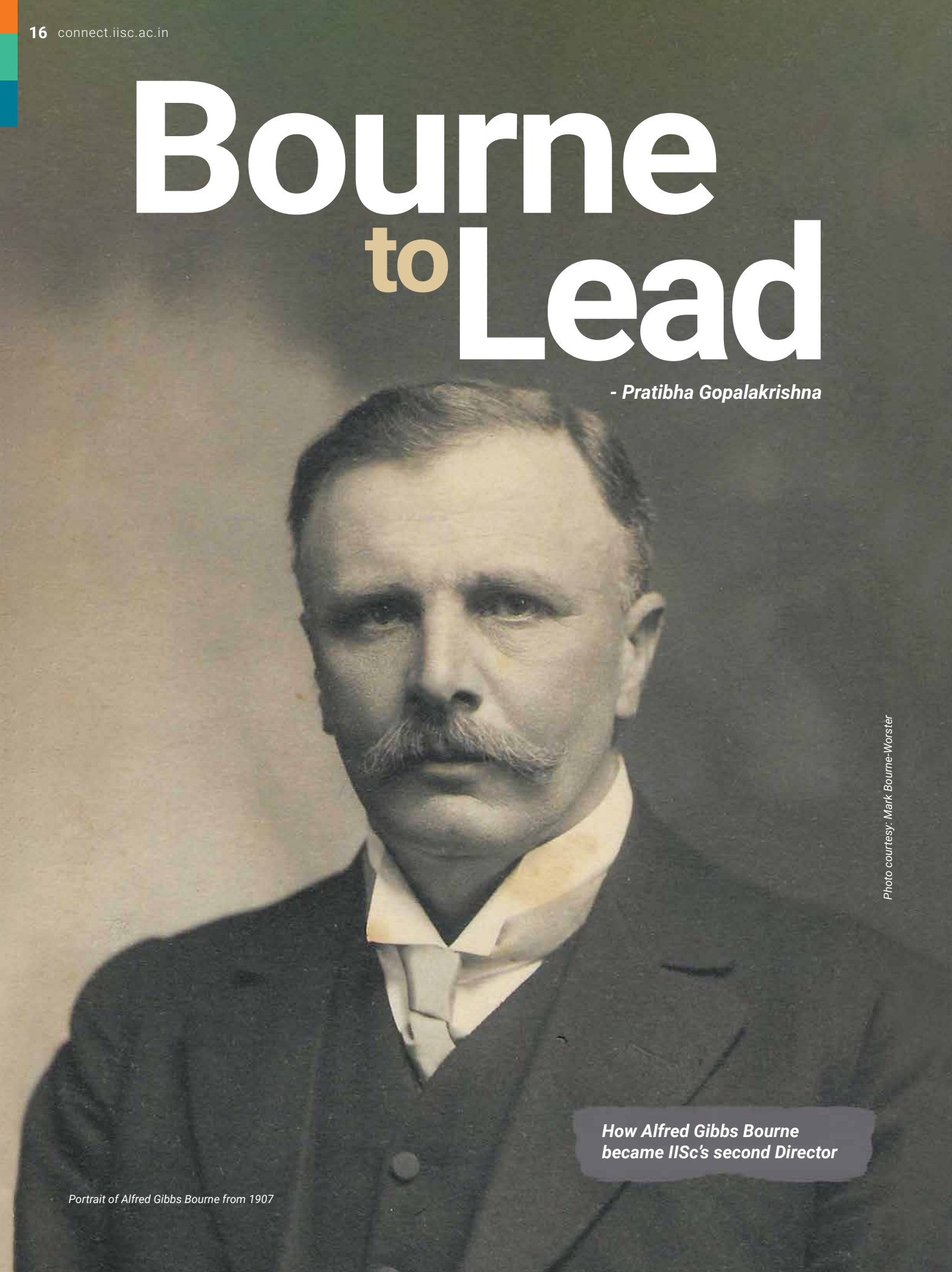


Photo courtesy: Mark Bourne-Worster

How Alfred Gibbs Bourne became IISc's second Director

Portrait of Alfred Gibbs Bourne from 1907

After overseeing the construction of several early buildings at the Institute and laying the groundwork for its growth, Morris Travers stepped down as IISc's first Director in 1914. What followed was a year-long hunt for the person to fill this role. Members of the IISc Council wanted to provide adequate laboratories for the applied chemistry department and increase equipment for other departments. The Council consisted of a mix of British officers like Hugh Daly, professors like Alfred Hay, Alfred Chatterton, JJ Sudborough, WF Smeeth, and Indians like M Visvesvaraya (the then Dewan of Mysore), HJ Bhabha, Dorabji Tata, and JD Ghandy, the Tatas' solicitor.

According to IISc's 1914-15 Annual Report, the Council decided against asking the colonial government for funds because of the ongoing World War I and made do with the resources at their disposal. However, these resources were not enough and so the Council decided to combine the offices of the Director and Professor of Applied Chemistry. They appointed a special committee in England to look for suitable candidates who would simultaneously assume both roles.

The members of the Council were divided in their opinions, which led to internal squabbles. Dorabji Tata wanted IISc to pursue pure science research, which would not yield immediate results. Visvesvaraya, on the other hand, wanted the Institute to become primarily a technical school that would train students for a few years and only then select some of them for research. Then there was Alfred Chatterton, a chemistry professor at the Institute who strongly objected to recruiting a new Director as had his eyes on the role.

The deliberations went on for months. Finally, the special committee recommended Robert H Pickard, a principal at Blackburn Technical School in Lancashire county, England. However, in a meeting held on 31 May 1915, the IISc Council rejected Pickard, ostensibly because he didn't have the right background they were looking for. Frustrated, the Council decided to invite one among the special committee to take up the Directorship. That person was Alfred Gibbs Bourne, a zoologist and plant enthusiast.

Before coming to IISc, Bourne had amassed considerable experience in administration while also pursuing his research in invertebrate morphology.

Bourne was born on 8 August 1859 in a small coastal town in England called Lowestoft. His father, also called Alfred Bourne, was the principal of the Stockwell teacher-training college. In 1876, the young Bourne joined University College School in London to pursue his Bachelor's degree. Like his contemporaries, he was influenced by the work of Edwin Ray Lankester – a celebrated invertebrate zoologist who was the Jodrell Professor of Zoology and Comparative Anatomy at the same college. Gradually, Bourne became Lankester's assistant and then junior colleague. In an obituary of Bourne, published by *The Royal Society*, zoologist John Stanley Gardiner writes that Lankester was impressed with Bourne's extraordinary resourcefulness when it came to designing lab equipment and keeping them in working order. Bourne fabricated large aquarium tanks in the lab in which he would collect and observe various animals to study their morphology.

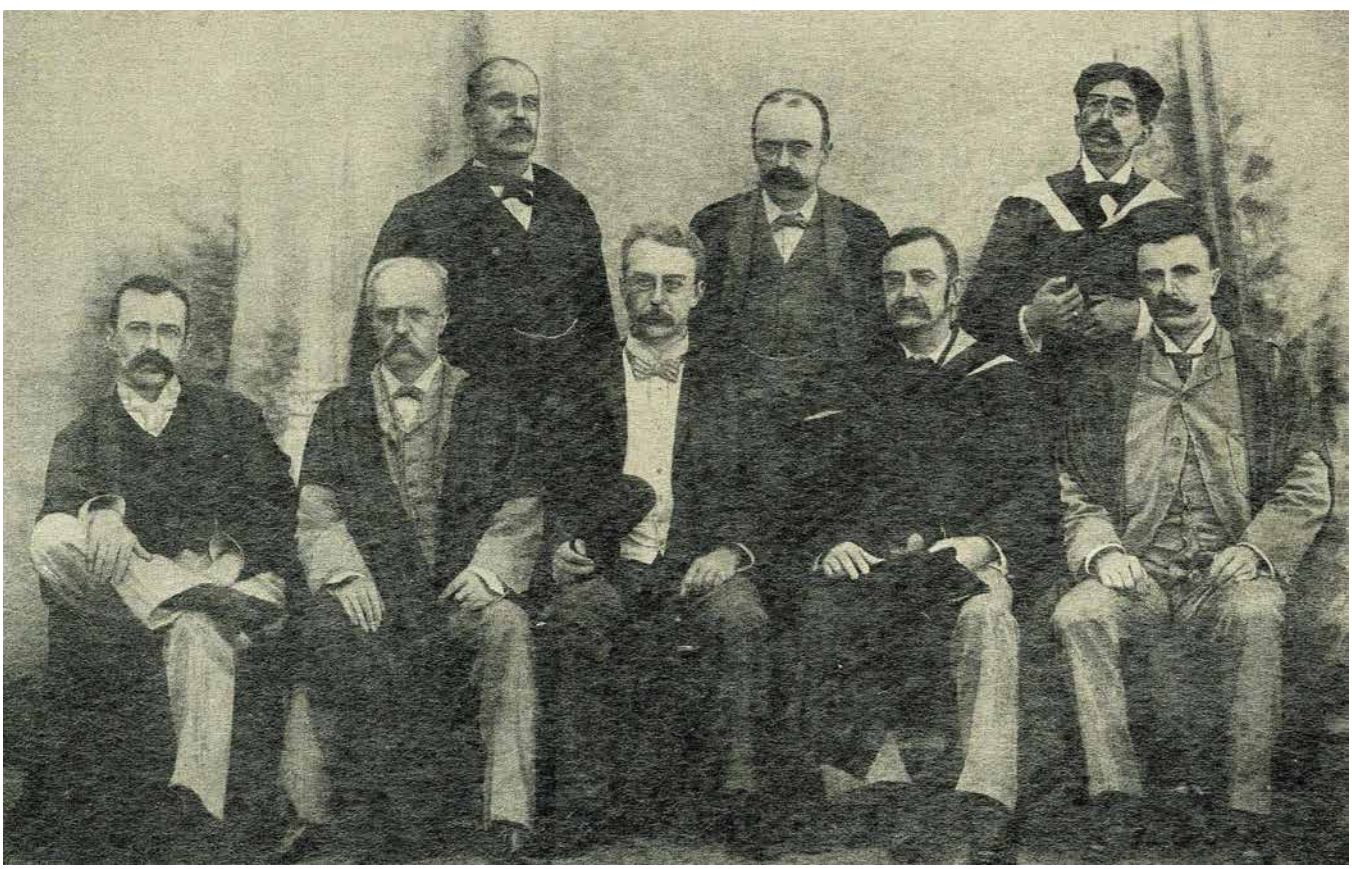


Image courtesy: History of Presidency College 1840-1940 by Papworth HC/Wikimedia Commons

The principal and senior professors of The Presidency College, Madras in 1895, including Bourne (bottom right)

> ***Bourne fabricated large aquarium tanks in the lab in which he would collect and observe various animals***

The papers that Bourne published with Lankester included accounts of molluscs like the pearly nautilus, and the anatomy of horseshoe crab eyes, scorpions and earthworms. In 1880, he published a detailed study of the nephridia – rudimentary kidneys – present in medicinal leeches. This, paired with Lankester's histological studies of the same organ and the circulatory system, created great interest among the science community. He was given the rank of assistant professor of zoology and awarded a DSc degree from the University of London. Bourne also published detailed papers on the anatomy of leeches – a study that lasted five years till 1885.

Photo courtesy: Mark Bourne-Worster

Alfred Bourne and Emily Bourne

"I inherited from my grandfather – who was the grandson of Alfred Gibbs Bourne – a Burmese chest full of photographs and documents, mostly personal items related to Alfred Gibbs Bourne and his wife Emily Tree Bourne," says Mark Bourne-Worster, a senior advisor at the UK Environment Agency. Among the collection are copies of letters exchanged between Bourne and his wife before their marriage, correspondence the Bournes received over the years, botanical paintings by Emily, and a biography put together by Mark's grandfather titled *A History of the Bourne Family 1577 to mid-20th Century*. Mark explains that once Bourne finished his doctoral degree, he was looking for a job and had applied to two positions. One was the curator of the Hunterian Museum of the Royal College of Surgeons, and the other was a Professor of Biology at the newly established University of Auckland in New Zealand.

In the meantime, Mark says, Randolph Churchill, secretary of state for India, approached Lankester asking him to recommend someone for a professorial post in Madras. Lankester recommended Bourne.

In 1886, Bourne was appointed as the chair of the biology department at Presidency College, Madras. Apart from teaching, he also made time for research. He borrowed an artificial lake tank on the college grounds to carry out his experiments. He studied earthworms, fishes and amoebae found in sediments at the bottom of freshwater ponds. In 1889, he visited Ceylon (now Sri Lanka) to study different species of earthworms and published a detailed study – his wife, Emily, made

intricate drawings of the worm for this paper.

As the years passed, Bourne had to take on more administrative duties, which meant that his research took a backseat. He was appointed as the Registrar of the University of Madras and later Principal of Presidency College. Gardiner refers in the obituary to Bourne's "successful organisation of games as a definite part of the college's activities, a development of immense psychological importance to the students and later adopted in every similar institute in India."

Bourne and Emily also nurtured a love for local flora and collecting botanical specimens. Keen to carry out a thorough botanical survey of the Madras presidency, Bourne offered his services as a botanist for the Madras government from 1897 to 1898. Apart from Madras, he also visited Palani Hills, Nilgiri Hills, Godavari, Coorg and Nilambur, scouting for specimens.

Image courtesy/copyright: RBG Kew

A herbarium of Strobilanthes urceolaris prepared by the Bournes' and preserved at the Kew Royal Botanic Gardens

In 1903, Bourne became the Director of Public Instruction and Commissioner for Government Examinations. He implemented wide-scale educational reforms that were replicated throughout the country. Gardiner explains that the university matriculation exams provided little indication to the employers about how qualified the candidates were. Bourne fixed the problem by coming up with a 'completed school certificate' that gave a snapshot of the student's educational background.

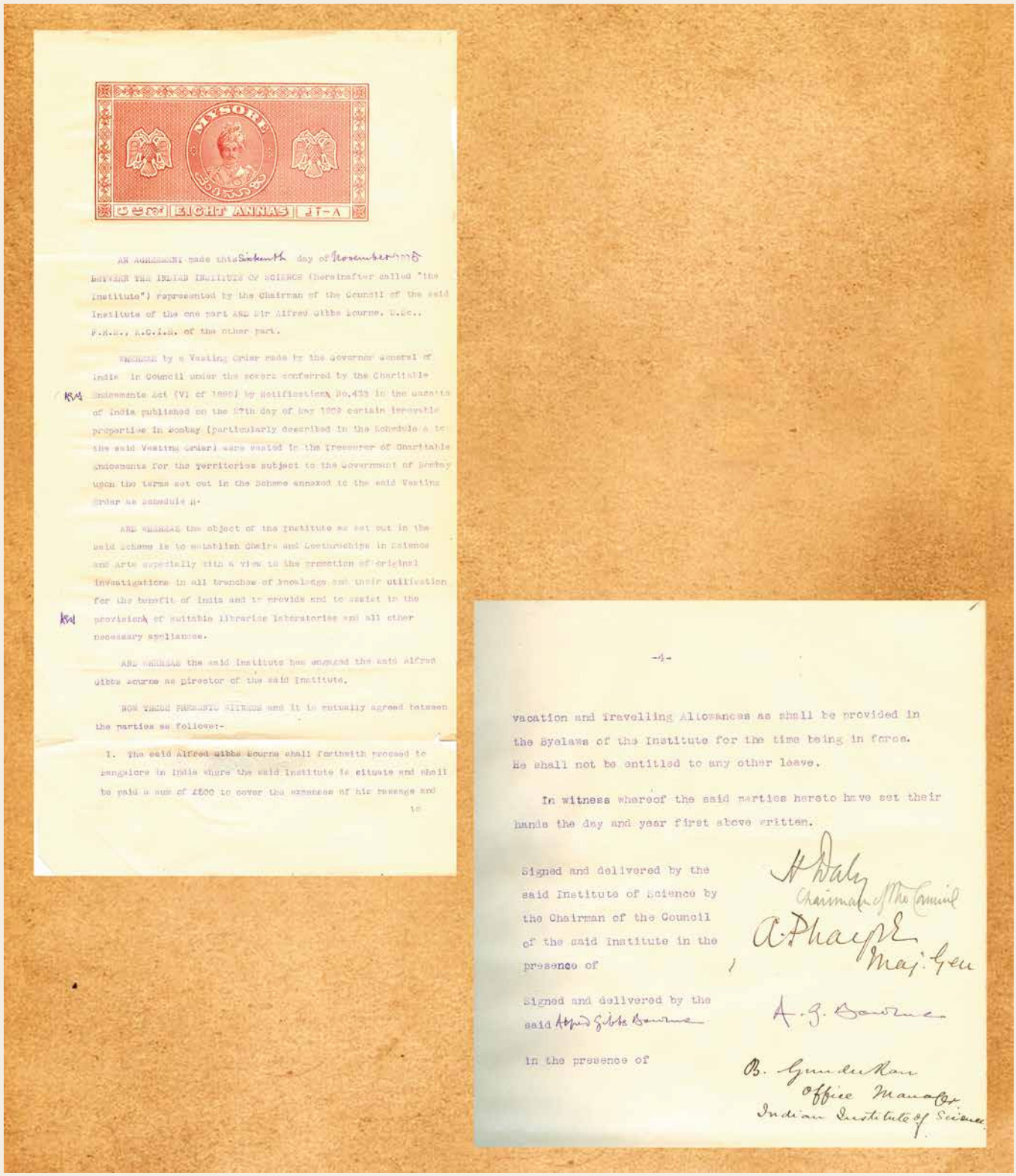
Even after his term as government botanist ended, Bourne and his wife continued travelling and scouting for different plant species, collecting and carefully preserving hundreds of specimens. Emily would write frequently to David Prain, the then Director of the Kew Royal Botanic Gardens in London, asking him to verify the identity of the specimens she and

her husband 'Fred' collected. In one of the letters sent in 1908 – now in the archives of the Kew Gardens – she thanks Prain for helping to identify all the "scraps of plants" she had sent to him. She also highlights a memorable week spent in Bangalore after some 'jungley' touring, before starting on another 3-4 week trip in the district of Bellary. "The monsoon is behaving badly this year – the rainfall is so poor everywhere; there is much crying for water," she writes.

The Bournes kept in touch with Prain and took the help of Philip Furley Fyson – who succeeded Bourne as professor of biology at Presidency College – to preserve, pack and ship off their entire collection of herbaria samples to Kew Gardens, where they are found to this day.

The Bournes also wanted to publish a detailed review of the specimens they

Photo courtesy: IISc Archives


MYSORE
EIGHT ANNAS
AN AGREEMENT made this Sixteenth day of November
BETWEEN THE INDIAN INSTITUTE OF SCIENCE (hereinafter called "the Institute") represented by the Chairman of the Council of the said Institute of the one part AND Sir Alfred Gibbs Bourne, K.C.S.I., F.R.S., A.C.I.S. of the other part.
WHEREAS by a Vesting Order made by the Governor General of India in Council under the powers conferred by the Charitable Endowments Act (VI of 1890) by Notification No.433 in the Gazette of India published on the 17th day of May 1902 certain movable properties in Bombay (particularly described in the Schedule A to the said Vesting Order) were vested in the Treasurer of Charitable Endowments for the territories subject to the Government of Bombay upon the terms set out in the Scheme annexed to the said Vesting Order as Schedule B.
AND WHEREAS the object of the Institute as set out in the said Scheme is to establish Chairs and Lectureships in Science and Arts especially with a view to the promotion of original investigations in all branches of knowledge and their utilization for the benefit of India and to provide and to assist in the provision of suitable libraries laboratories and all other necessary appliances.
AND WHEREAS the said Institute has engaged the said Alfred Gibbs Bourne as director of the said Institute.
NOW THESE PRESENTS WITNESS and it is mutually agreed between the parties as follows:-
1. The said Alfred Gibbs Bourne shall forthwith proceed to Bangalore in India where the said Institute is situate and shall be paid a sum of £500 to cover the expenses of his passage and to
-4-
vacation and Travelling Allowances as shall be provided in the Byelaws of the Institute for the time being in force. He shall not be entitled to any other leave.
In witness whereof the said parties hereto have set their hands the day and year first above written.
Signed and delivered by the said Institute of Science by the Chairman of the Council of the said Institute in the presence of
Chairman of the Council
Maj. Gen
Signed and delivered by the said Alfred Gibbs Bourne
in the presence of
Office Manager
Indian Institute of Science

Agreement signed between Bourne and the IISc Council, officially appointing the former as IISc Director

collected, especially grasses, for which they sought out many European herbaria. But these plans were put on hold when Bourne was called to head IISc.

Dorabji Tata, in a lengthy letter to CHA Hill, a government official, gave an account of the events that led to selecting Bourne as the next Director of IISc. He wrote that the Council rejected Pickard for two reasons. One was that two other professors, Alfred Hay and JJ Sudborough, considered themselves senior to Pickard and did not want a junior above them. The other was that many wanted Alfred Chatterton to be selected as the next Director. "This has been in the air since Travers retired," Tata wrote. This was probably also why the Council's sub-committee (of which Chatterton was a member) stressed that they should find a man with a "large Indian experience and working knowledge of some Indian industries." Tata deduced that Chatterton's vested interest was why the pay was bumped up from Rs 2,200 to Rs 3,000, as Chatterton was getting paid the latter amount in his temporary position with the Mysore darbar. "So if Chatterton could be transferred on the same pay to the Institute, it would be a good thing for everybody concerned – except the Institute; but nobody cares about that."

Tata wrote that under no circumstances would he accept Chatterton's nomination, a strong view that he also expressed to Hugh Daly, the Chair of the IISc's Council. After a lot of back and forth, the Council decided to split the Director and head of Applied Chemistry roles, and Daly suggested that Bourne be asked to take up the Directorship without any professorial duties. "I did not raise any objection, as I felt that by accepting Bourne, I was effectually blocking Chatterton," Tata wrote.

Bourne, who had retired from his government duties and gone back to England in 1914, initially declined the offer, urging the Council to choose Pickard. Daly privately wrote to Bourne again and requested him to reconsider. In a memo to Henry Sharp, the Joint Secretary to the Government of India in the education department, Daly writes, "He [Bourne] replied that he would reconsider and I subsequently received letters which, while expressing willingness to come out, showed that he was doing this as a matter of duty in the interests of the Institute."

> ***Bourne and his wife continued travelling and scouting for different plant species, collecting hundreds of specimens***

According to Daly, Bourne pointed out that he would be "put to considerable expense in getting rid of his house etc., and that his pension would be reduced if paid in India." Bourne asked for a lump sum of 500 pounds which would also cover his trip to India. The IISc Council unanimously agreed to this in a meeting held on 5 July 1915. While the Tata brothers heavily favoured Bourne, they also wanted the procedures for appointing a new Director to be done by the book. By then, Daly received another cable from Bourne on 31 August 1915: "Sailing eighteenth September. Later steamers full. Please expedite confirmation."

In the biography written by Mark's grandfather, a relative recounts the time when they joined Bourne during a visit to IISc in 1915. "We spent one morning inspecting a machine that turned liquid sewage into dry manure which can then be packed and dispatched to any area – one of the latest inventions and a far cry from the basic methods," the relative's letter to their family reads.

A couple of months after Bourne came to IISc, Gilbert Fowler was selected as a professor in the Department of Applied Chemistry. This was during World War I, at a time when Indian research was leaning heavily towards utilitarianism. The Institute was making strides in developing explosives like acetone, using oil from mahua trees for medicines, and extracting and distilling sandalwood oil.

Despite his skill and experience at building equipment, Bourne was equally firm in his support for pure science research. Nowhere is this more evident than in the presidential speech he gave at the fourth Indian Science Congress meeting held in 1917. He laments about how the word 'research' had been trivialised to a perfectly simple operation, and how newspapers spoke of it in "the lightest manner," whereas during his student days, the word was spoken "with almost bated breath". He fondly recalled his own excitement over his early research on unravelling the complex structure of the nephridia of leeches.

Bourne retired from the Institute in 1921, returned to England and settled in Dartmouth, where he immersed himself in his hobbies. He was adept in mechanical work and designing tiny little devices. Mark shares an account written by Bourne's granddaughter recalling her summers at Dartmouth. She wrote about the demonstrations given by Bourne on the working of machines like the Newcomen steam engine, of which Bourne had made a scale model. He later coached her to "play with the lathes … also the clockmaker's little treadle, and [work on the] beating of copper, the carpentry and joinery."

Her recollection continued, "The workshop was home to many clocks, some made by Alfred. Hardly any had any hands – it was the movements that were of interest. Later, it housed all the latest models of the wireless world and record players. Sometimes only on trial from the Dartmouth shop … Bourne was deeply involved, because of his hobbies, with all of the Dartmouth tradesmen and shopkeepers. Every day he walked down in his super jaunty way, with a cap, twirling his walking stick, to discuss the latest product or matter of interest."

Bourne was appointed the mayor of Dartmouth in 1933. In 1940, he succumbed to cancer at 81. According to an obituary in the August 1940 issue of *Current Science*, Bourne enjoyed a great reputation both as a teacher and as an investigator. The obituary says: "Sir Alfred Bourne may not have come into personal contact with a very large body of students in South India. Nevertheless, the few that came under his direct influence will remember the many excellent qualities of that brilliant scientist who commanded a raging popularity and widespread esteem."

CONNECT ASKS

What are some of your best memories of your teachers?

"When I first went to class 11, I wasn't sure if studying computers was good for me or not; we had an option to choose Hindi or computers. I chose computers. And till then, my marks were at around 70-80%; even if I came at the top, I didn't scrape for 100%. But my teacher inspired me to go for perfection. Not just as a class topper, or just on a percentile basis, but [aim for] 100%.

Apart from that she taught me everything. Not only academics, even to be a good man. She inspired me to participate in hackathons and I even won one. Till date, she is the best teacher I have had.

Kautuk Astu
MTech (Research) student, Department of Computational and Data Sciences

"In middle school, our maths teacher gave us a problem to solve, but we couldn't finish it and were told to continue it the next day. I slept with the problem and the solution in my mind and the next day, I told the teacher, "I had a dream about the problem you gave to us." It was a very nice bonding moment because she said, "Oh yes, sometimes I also dream about maths problems and I come up with solutions in the morning."

She motivated me to dig more into problem solving. I never forgot the good feedback and how excited she was for me, while also sharing her passion for maths.

Sofia Vilela
Visiting PhD student (Kyoto University), Center for Ecological Sciences

"There was a maths teacher I had in class 10. She was slightly influential, I think. She was really good at teaching stuff, and brought in practical things – I really liked that. I just thought that she was really good. It might have influenced me to go into theory, towards the theoretical side.

Alaap Surendran
MTech (Research) student, Department of Computer Science and Automation

"In school, I had a teacher from class eight to class 10 whom I used to study English with. He not only taught the subject, but also some life lessons. We used to talk about issues, about how life is going, and if we faced any problems. He inspired us to pursue science. He also helped us know what is going on in the outside world – not only in school, you know, politics, science, all those things. He wanted us to learn more. He inspired us to go higher.

Sanchari Mandal
BSc (Research) student

My teacher used to give us class 10 or 11 questions when I was in class 6, and my friends and I used to search different books at that time to find [answers]. Like, he used to give [questions on] DNA bases; I still remember the questions. He is one of the reasons I feel I like biology very much even now, and I will be a bio major. He was a very nice person.

Siddhartha Akuli
BSc (Research) student

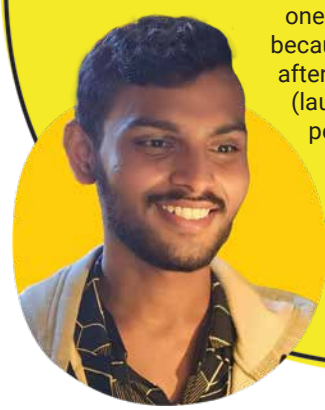
I had a professor in Applied Geology at IIT Dhanbad. He was not just a good teacher but an even better human being. He taught us the importance of teamwork and often reminded us, "Whatever you become in life, once you graduate, you have your own brand."

I remember him taking an extra class after the semester had ended. He spoke about how despite our different religious beliefs and ideologies, the most important thing to value is the time we have. He advised us to respect what we have and not to grieve over the things we could not achieve. He encouraged us to always support and help others. This is my lasting memory of him. I graduated in 2020, and even now, he continues to support me.

Nandu Krishnan
Senior Research Fellow (Climate Change), Divecha Centre for Climate Change

My principal during my class 10. We were planning to do something like JEE, but his idea of education was different from ours. He urged us to get a diploma. After one year of diploma, I realised that it would never allow you to get into IIT. The same principal told me, "OK, if you are not getting into IIT, go for Master's in IISc. IISc is the best thing in India."

That's how I learned about IISc.That time, as kids, we never knew this. Because IITs are a collective – there are 23 – so everyone knows about it. People don't know about IISc. At one point, I was criticising him, saying that because of him only I missed everything. But after getting IISc, it's changed 180 degrees (laughs). Sometimes, we hate the same people whom we then end up loving.



Krishna Kumar
MTech (Research) student, Department of Instrumentation and Applied Physics

In school, my class teacher, Honey, was my favourite. She was interested in discussing current affairs, politics, and even involved us children in arts and sports. She and her husband used to organise the drama scripts and dance performances for her class children for the annual day function, which people used to wait to see. Once, in class 8, she took a drama test among the girls for the role of a mother. She finally selected me. I remember even now – after completing that drama, I got down from the stage and she ran to me and hugged and kissed me!

Another teacher in college is my geology lecturer back in Kottayam. He did a lot of fun activities amongst us to teach crystallography. He used to throw and ask us to catch wooden crystals and even used to create crystal structures by using the hands of several students so that we could get an idea about the structure of crystals.

Arya Krishnan
Project Associate I, Divecha Centre for Climate Change

A life among insects

- Mohit Nikalje

Photo: Abinaya Kalyanasundaram

Thresiamma Varghese shares the joys of discovering and preserving critters

Thresiamma Varghese preparing insect specimens at the museum

It was a rainy day and piercing cold winds swept through the third floor of the new Biological Sciences building. I pushed open the creaky museum door, stepping into the big, dimly lit room. It was warm inside, and I could smell the ethanol used for preserving the insect samples. Walking through the long hall of the museum, I saw colourful butterfly specimens on display on one side of the walkway.

Perhaps the creaky door had given me away. Thresiamma Verghese, the person in charge of the museum at the Centre for Ecological Sciences (CES), came to greet me near the sliding door of her cabin. Inside, the space was crammed with books, files, and vials with insects like ants and wasps suspended in alcohol.

As I sat on one side of the table, I could sense that Thresiamma was energetic, even excited. I have known her for about a year now; the lab that I was a part of, headed by faculty member Kavita Isvaran, neighboured the museum in the B wing of CES. Thresiamma was always happy to speak to me and other visitors of the museum, sharing her vast knowledge of the specimens on display. But today, I had come to her cabin to learn more about her life.

Thresiamma was born and raised in the Kottayam district of Kerala before moving to the Malabar region for high school. Her parents owned coconut and rubber plantations and had five children before welcoming Thresiamma to the family. One of her fondest childhood memories of her home state was spending time amidst greenery.

> ***One of the fondest childhood memories of her home state Kerala was spending time amidst greenery***

"The place I grew up was surrounded by serene nature. During monsoons, we siblings used to go around the lush green fields and play in the water, and in summer, fishing and swimming used to be part of our daily ritual," Thresiamma recalls.

Her love for nature influenced her decision to pursue science in her pre-university studies at St Joseph School, Kannur. She excelled in her classes and aspired to become a doctor, but unfortunately, she did not make it to the merit list that year. Her older brother, who worked at the Bhabha Atomic Research Centre (BARC) as a SEWA Assistant Engineer, advised her to study chemistry, as it would improve her chances of securing a job. Another brother, now a retired bank manager, advised her to get into banking. In the end, she chose to study zoology for her Bachelor's degree; though botany was her favourite, the local college did not offer the subject.

> ***Her family was in favour of her studies, at a time when girls were not permitted to leave their homes on their own***

Her family was in favour of her studies, even during a time when girls were not permitted to leave their homes on their own. Her parents couldn't pursue higher studies due to societal pressures and therefore valued and encouraged their daughter's education.

With her parents' support, she finished her MSc in Zoology and pursued a PhD at Calicut University under the guidance of the late TC Narendran. Her research during her PhD focused on behaviour and ecology of orb web-building spiders.

In the last year of her studies, she moved to Bangalore after marriage. Two years later, she applied for a DBT research associate fellowship at IISc. Following the interview and presentation, she was offered the position. However, she faced a dilemma as none of the labs at IISc were focusing on the expertise she had gained during her PhD.

MRN Murthy, a professor at the Molecular Biophysics Unit (MBU) and a panel member for her interview, recommended that she join the lab of Raghavendra Gadagkar, who was then a professor at CES. Now retired, Gadagkar was doing research on the behavioural ecology of social insects such as paper wasps (*Ropalidia marginata*) and honeybees, which was closest to what Thresiamma was interested in working on.

As there were no openings in his lab, Gadagkar suggested that she become a visiting scientist for a year and then reapply for the fellowship. "At that time, there were already three postdocs working with him, and I believe there were limits on the number of students that professors could take. Nevertheless, I applied the following year and was accepted into his lab," remembers Thresiamma.

Although the main focus of Gadagkar's lab was on paper wasps and honeybees, there was also a significant project on ant behaviour and taxonomy. Thresiamma decided to join this project. Though she holds a MPhil in Taxonomy, working with ants was a new topic for her. "Padmini Nair, who

Photo courtesy: Thresiamma Varghese

Dilobocondyla bangalorica, *a new ant species discovered by Thresiamma on the IISc campus*

was a project assistant in Gadagkar's lab at the time, was the backbone of the museum. She was a wonderful person and taught me a lot about museum techniques, such as filling alcohol and identifying ants," Thresiamma recalls.

> ***She compiled a list of over 100 ants found on the campus, and also discovered two new species***

In 2006, on Gadagkar's recommendation, Thresiamma also attended a 15-day course to learn more about ant taxonomy in Australia, organised by the California Academy of Sciences, with full funding from the US National Science Foundation.

Thresiamma got so hooked onto the world of ants that she began exploring the campus and surrounding areas to collect and identify different ant species. She compiled a list of over 100 ants found on the campus and also ended up discovering two new species, including one on campus. She named one of the newly discovered species *Emeryopone narendrani*, in honour of her PhD advisor. She is now on the lookout for a new species that she can name after Gadagkar.

Recently, she also published a study describing a rare ant species, *Probolomyrmex procne* Brown, spotted on the IISc campus for the first time. The study also provided the first description of the species' queen ant, which was unknown until now. The worker ant of the species had been discovered earlier in the Palani hills in 1972, based on a single specimen, and was reported again in Mysore in 1990.

Encountering a new taxon is mostly by chance, but describing and publishing it is a challenge, she says. "Taxonomy means you must spend lots of time observing. Sometimes, you may have to spend hours, days, weeks and months. Sometimes, it will be very easy. It depends on what specimen you are looking at," explains Thresiamma.

While her primary focus was on the ant taxonomy project, she also helped PhD students working on paper wasps and honeybees. In 2011, her career took a new turn when the BSc (Research) undergraduate programme was introduced. Nearly all the postdoctoral researchers from Gadagkar's lab became teaching assistants and helped in structuring the practical course. Gadagkar himself designed the basic biology course.

On one occasion when Gadagkar and Thresiamma were strolling in front of the Main Building, he had asked her, "If you walk along the campus for one hour, how many species of ants do you think you might encounter?" She answered, "Maybe 15 to 20."

Photo courtesy: Thresiamma Varghese

Thresiamma with the 2012 batch of UG students during an ant collection practical on campus

Photo: Abinaya Kalyanasundaram

Thresiamma's work desk at the museum with a collection of spiders, mantis, butterflies and moths

This turned out to be true. During one of the UG biology practical classes, the students were asked to go on a field trip around campus and collect ants. "They were asked to record information such as the time of capture, the name of the species or genus, whether they found ants in a nest, and other ecological aspects. After returning, they would perform various analyses, including species diversity and abundance, using the collected data," says Thresiamma.

It was one of the few teaching experiences Thresiamma had. "I thought I might not make a good teacher. If you are going to teach, you should be a good teacher. Teaching is a noble profession," she says, adding that this was why she didn't take a permanent teaching job after her PhD.

In the past 11 years, the scope of Thresiamma's work has expanded. She is also involved in overseeing the biology practicals of the UG programme and collecting ants and other insect specimens for the museum. "The department extended their support through all subsequent chairpersons, including Professors Rohini Balakrishnan, Praveen Karanth, and the current chairman, Kartik Shanker," she says.

The museum at CES holds numerous specimens collected by Gadagkar and his first student, the late K Chandrasekhar, since 1982. There was no dedicated space for these specimens at that time. They all were stacked in a big room where Gadagkar's students sat in the old CES building which was simply called "the Museum."

It wasn't until 2012 that a dedicated museum space was established, following the relocation of all the labs to the new Biological Sciences building. Previously, the faculty members at CES had suggested the idea of creating a Natural History Museum, but the project was put on hold due to financial constraints.

The museum currently houses a vast collection of specimens, including visually stunning samples of ants, butterflies, and moths on display. These exhibits are a popular attraction for visitors, drawing in school and college students, researchers, and professionals from various fields. Thresiamma often facilitates discussions about these specimens, igniting curiosity amongst onlookers.

These specimens are also available to the general public during Open Day. "Many people are interested in butterflies. Some individuals from other departments have even asked me if these specimens are real, as many museums now display artificial specimens," says Thresiamma, laughing.

> ***The museum houses a vast collection of specimens, including ants, butterflies, and moths***

In addition to serving as an educational facility, the museum also lends its specimens to researchers for study. While the museum is not currently an officially recognised government repository, preventing the deposit and archiving of new specimens, this is a future goal of CES. Thresiamma also assists researchers who are seeking identifications of specimens upon request.

Although she enjoys her work at the museum and teaching undergraduate students, she rues that she is currently lagging on writing papers. Though, she admits, doing research now is far easier than in her early days. "Back then, if you needed a paper or any resource, you had to write to the IISc stock office, which would take a lot of time to process. Sometimes, we would provide a list of publications to Gadagkar when he travelled abroad, and he would bring those papers back for us," Thresiamma reminisces.

After our nearly two-hour-long conversation, one thing seemed clear: she truly valued her work here. I asked her why. She smiled and said, "Coming from a university background, I found this to be an exceptional place. Perhaps that's why I've stayed on, despite having a temporary role as a research associate for the past 20 years."

Mohit Nikalje is a former MSc in Life Sciences student at IISc, and a former science writing intern at the Office of Communications. He is currently with Decode Age

Photo: Abinaya Kalyanasundaram

The museum at CES holds a variety of specimens of butterflies, ants, moths and a wasp nest

Clubbing on campus

- Shloak Vatsal

Photo: Sheersh Sen

How clubs are helping UG students find their feet

Members of Ensemble club during Open Day 2024

School exams were done, and Abhishek Kundu could finally take a break. But not for long. He had yet to decide what he was going to pursue for his undergraduate studies. It was a tough decision, one that would shape his whole life.

He had always liked biology, so pursuing medicine seemed an obvious choice. But he also wanted to explore other sciences, especially physics – the theoretical rigour was very attractive to him.

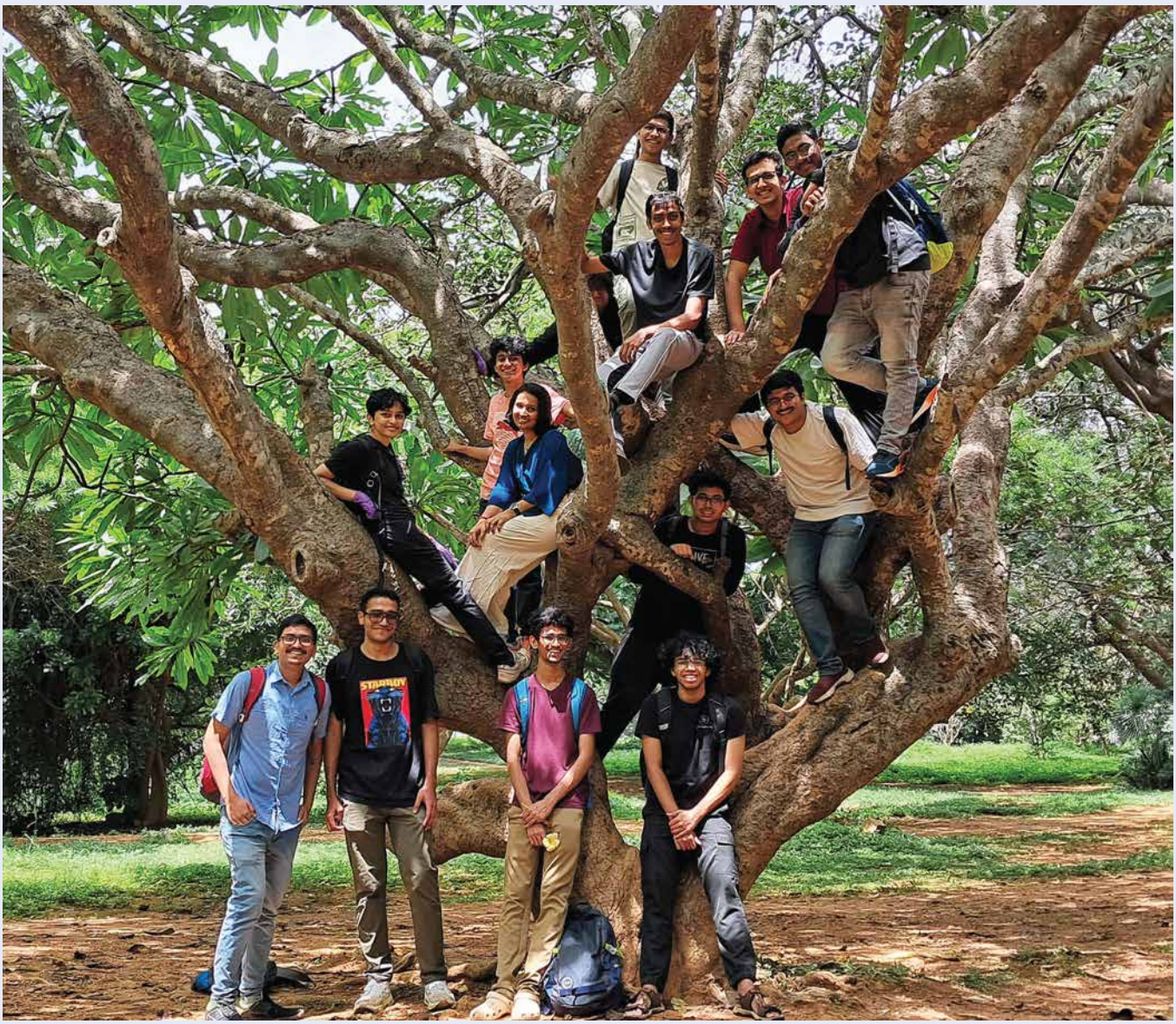
In the end, he decided to join IISc and pursue a biology major, but he still felt some misgivings about his decision. His uncertainties deepened as he had no one to talk this out with – his friends had all chosen medicine and engineering. One day, a few weeks after joining, he heard about campus clubs from a friend. Curious, he attended two of them on a whim – Naturalists and Ensemble, the biology and physics clubs. And his world changed.

> ***'Suddenly, you need to adjust to a new routine, new food, and find people you can rely upon'***

Abhishek found people just as excited about science and had long discussions with them. He explored the nitty-gritty of the subjects, discovering concepts beyond his school curricula. Eventually, realising that his real fascination lay in high-energy physics, he switched his major to physics. He never looked back.

Every year, more than a hundred students join the undergraduate courses at IISc. After spending years preparing for fiercely competitive exams, many struggle to settle in after the rat race. For most, being good at academics had defined their identity. But at IISc, where they meet equally excellent peers, it becomes daunting to find one's footing, a challenge only heightened by the fact that for most students, this is their first time away from home and support systems. "Suddenly, you need to adjust to a new routine, new food, and find people you can rely upon for any help. The comfort zone you were in since childhood is gone," says Abhishek, who is now in his third year of the Bachelor of Science (Research) programme.

Photo: Rahul Chavan



Members of Naturalists club during a nature walk at Lalbagh

In addition, coming to terms with the realities of the research process is often difficult. The grit needed for scientific rigour often shatters one's childhood image of spontaneous and stochastic discoveries in research, mainly driven by pop culture, forcing students to reorient their interests and rediscover a passion for familiar subjects. They must first find the apple tree and the perfect spot to sit, before expecting any fruit to fall.

"Learning in school stems from solving problems involving concepts you have already learned. Whereas in research, you have to [first] figure out the question and then try to answer it. We are not just trying to acquire known information from the books but create it," says Nikshay Chugh, a third-year Bachelor of Science (Research) student.

And that is where UG clubs help, by easing this transition for students. Unlike textbook-heavy high school curricula, the group of clubs collectively and colloquially called AASCEND – Astrae, Amalgam, Samasya, Catalysts, Ensemble, Naturalists, Debug – offer a plethora of opportunities for students to explore and experience cutting-edge research. The clubs span diverse subjects from astronomy to mathematics. Through talks, lab sessions and lectures, they introduce the UG community to the wonders of these fields and equip them with the necessary skills and exposure.

"Ensemble's sessions helped in broadening my horizons and understanding things which were not taught in class, which helped me approach research problems in a better way," says Nikshay.

A window into science

The AASCEND clubs were started about eight years ago by enthusiastic UG students in each field. At the beginning of each year, members are inducted together in a joint orientation. The meetings, lectures, and events are open to anyone interested in knowing more about the fields.

This flexibility of membership helps students experience interdisciplinary approaches to science. "It is difficult to explore subjects which aren't your majors, which may lead to a confinement of views. The clubs help us stay in touch with at least the recent happenings in different spheres of science, with regular talks that are accessible to most students, irrespective of their background," says Sheersh Sen, third-year Bachelor of Science (Research) student and a member of Ensemble.

Photo: Parth Kumar

A paper presentation session at the Naturalists club

Rahul Chavan, a third-year Bachelor of Science (Research) student and a member of Naturalists, the UG biology club, says, "A majority of students joining the UG programme haven't studied biology after 10th standard. Since the UG programme has three semesters of compulsory biology courses, our sessions focus on giving them exposure to research and techniques used in real settings." Members of this club have lab sessions exploring various techniques, talks by researchers on the latest developments in their fields, and member presentations.

> ***'You feel lost because you think others around you have secure ideas of what they want to do in life'***

The clubs also help students find internships through a database of various labs and research being conducted at IISc and scholarship programmes abroad. "We also want to set up lab rotations wherein each student will visit different labs to experience how lab work is conducted and what professors share similar research interests," says Nikshay.

Finding identity

Beyond just academics, students transitioning from high school to college face significant challenges in other aspects of life too, like finding a community and hobbies to fill their time. For years before joining IISc, Avani had dedicated all her time to preparing for NEET. A few months into her Bachelor of Science (Research) course, she heard about a book club on campus. She thought she would try out one session and ended up discovering a sense of belonging. She felt she was among her peers. They shared stories, discussed their favourite authors, and debated plot twists ... and Avani not only found community but also the motivation to take up reading again. Soon, she became the club's convenor, helping others on the journey that transformed her.

College years are when one starts to breathe a bit easily and take time to find one's own identity. "The deadlines here are always a week or a month away, so I can use my time for hobbies. This is unlike school, where all of it went back to studying more," says Abhiram M, a Master of Science student, who has been part of the Rhythmica, the music club, since his Bachelor's. Trained in classical music for 14 years before IISc, he started exploring Western music after joining Rhythmica and now plays a multitude of instruments.

But with this new freedom also comes a sense of insecurity. Making decisions

without constant supervision means the consequences also fall on their shoulders. “You feel lost because you think others around you have secure ideas of what they want to do in life. In contrast, you feel like you lack that stability,” says Anurag Sarkar, a second-year Bachelor of Science (Research) student.

The extracurricular clubs on campus allow students to work through these fears and meet like-minded people. Anurag joined the book club, just like Avani, and found his calling among peers who shared similar uncertainties and were open to talking about them.

These extracurricular clubs also engage beginners and help them acquire skills in different fields. Some clubs are even set up with flexible times so that students can balance academic work. “Rhythmica started an academy because people in college couldn’t start learning music from a proper teacher due to time constraints. We dial down the seriousness to match how much effort students can put in. It also helps us connect with the instrument, practise more, and return to our basics,” explains Abhiram.

Others formulate systems to reduce the barrier to entry. “We're planning to set up a repository where members can recommend books to others. When you have such a diverse crowd, where people like different styles and periods of literature, it makes sense to catalogue all these experiences in one place,” Anurag adds.

Meeting people with the same interests also helps students remain motivated about their hobbies. “Clubs, in a way, force you to make time for the hobby and rethink your priorities. You won’t want to miss practice before an important show; other people in the team motivate you to keep going,” says Abhiram.

Apart from being a space for networking and exposure, these clubs also provide leadership and management experience for UG students. “You need to coordinate a bunch of people to reach a consensus. There's no way to keep everybody happy, and you learn to agree and compromise such that no one feels left out,” explains Abhiram. “A club should strike a balance such that there is something for everyone. If it is elitist, it might scare the hobbyists away, whereas casual gatherings can do the same for a seasoned passionate.”

> ***‘A club should strike a balance such that there is something for everyone’***

With an ever-increasing population of undergraduates coming to the Institute each year, the clubs at IISc play a significant role in shaping the personalities of these young researchers. Education has to go beyond just academics, and these clubs provide the tools one needs to become the person that they want to be. Avani says, “Because of these clubs, the time here at IISc has been kind of a journey to discover who I am and what exactly I think I want to be.”

Shloak Vatsal is a third-year Bachelor of Science (Research) student at IISc, and a former science writing intern at the Office of Communications

Photo: Soumyadeep Sarma

Rhythmica performing during Bandish, its founder’s day show

Finding the geet

- Sandeep Menon

Photo: Ananthapathmanabhan MS

When Geeta Ananth walked into the IISc campus in 1995, after a lifetime of moving around the country thanks to her father's transferable job in the Railways, she didn't expect to set down deep roots in Bangalore. She had accompanied her husband Ananth Ramaswamy (now Chair of the Department of Civil Engineering), who was starting a new job at the Institute.

A music enthusiast, Geeta found her footing at IISc through her passion. She started a Hindustani music class with four people in 2001. "Geetanjali" is now a full-fledged music club with about 150 members. The club is set to start their 10th year of existence. Geeta speaks to CONNECT about the club's beginnings, its journey through the years, and how music is helping students deal with the challenges of their research.

How did you become interested in music?

Initially, I learned Carnatic music for two years when I was very young and when we lived in Delhi, but it did not appeal to me much. Later, when we lived in Hyderabad, I listened to Padma Bhushan awardees, Pandit Rajan Mishraji and Pandit Sajan Mishraji, whom I consider as my idols now. And I became interested in learning Hindustani music.

At that time, around 1986, which I consider a wonderful coincidence, Dr Ram Shinde had started teaching Hindustani music at the Railway Officers Club. So I started learning under him until 1994. From 1995, when I shifted to IISc after marriage, I continued my Hindustani Music training under Geeta Hegde.

Why did you decide to start this club at IISc?

In 2001, I started teaching Hindustani music on campus. Initially, it was a small group with four members, which included faculty members' children and students. I took classes from my home, which I continue to do. Slowly the numbers grew with research, MTech and UG students joining too, apart from the faculty members' families. It was a way for the students to disconnect from their work.

Around 2015, I was thinking about giving my students an opportunity to perform on stage. With very few years of training, I realised that it would not be possible for them to showcase their talent and professionally perform on stage. So, with a few of my students and with the support and blessings of my family and gurus, we started the group Geetanjali.

From there, we took off. Today, I can proudly say that I have taught more than 150 students, some of whom are all over the world and still continuing their training online with me.

How has being part of the club helped students tackle the rigours of academic life in IISc?

The classes are not just about learning music. I also encourage them to open up and share about their struggles and life in general. When they walk (or rush) into the class, before I start the classes, I speak to them for a while, as they catch their breath and settle down. The general feedback that I was and am getting is that they feel positive, confident and refreshed after the classes. That means a lot to me.

Also, I teach them that when they perform on stage, they should know how to perform, how to interact with the audience and how to keep eye contact with the audience. Many students have told me that this has, in turn, helped them gain confidence to speak at conferences and seminars.

Music also plays a vital role in their mental wellness. I speak to them about facing problems boldly – not to run away from them. It is similar to when some ragas do not come easily, we try some other method or approach till we get it right. I teach them to never give up, come what may! The music training also teaches them patience and discipline which in turn gets translated to their research and studies.

> ***'This group is unique because the entire community in IISc is involved and included'***

Was it hard to find students interested in Hindustani music?

No, I would not say it was hard because we got a lot of interest and outreach through word-of-mouth. This group is unique because the entire community in IISc is involved and included – research scholars, Master's and UG students, faculty members and their wives and kids, staff and their kids. All the classes that I take are one-on-one, not group classes. I have classes Monday through Saturday, with around 35-40 students right now. Some of the students who have gone abroad have resumed their classes online as well.

What other activities is the group involved in?

We have been part of two international conferences, part of the Students Symposium organised by the Department of Aerospace Engineering – AERES – every year. In partnership with SPICMACAY (Society for the Promotion of Indian Classical Music and Culture Amongst Youth), we help the IISc SPICMACAY coordinator, Professor Ananth Ramaswamy (Chair, Department of Civil Engineering) in organising the events every month at IISc. We help with the arrangements and look after the needs of the artists. This way we get to meet the artists, interact with them, and gain knowledge. Every month we have a music or dance performance. We have also had puppet shows, folk dances, jazz concerts and theatre.

Photo: KG Haridasan

Geetanjali members, including research scholars and faculty members' children, performing during an event

How often does the group perform in a year?

Twice for sure. Once in July or August and once in December, which is the group's anniversary. There might be one more in between. This year, we chose to do a ghazal show in May. It was the first of its kind on the IISc campus by an alumnus. Later, he brought out an album, again the first on the campus, which received rave reviews.

This year, on 10 November, we are having a programme by young members of Geetanjali, close to Children's Day, at the Satish Dhawan auditorium. About 10-11 kids will be performing ragas and they will be doing it solo.

The Geetanjali anniversary programme will be on 14 December at the JN Tata auditorium. It is a special occasion as we will be finishing nine years and entering the 10th year.

How important is the community aspect of the group?

Geetanjali is one huge family. If you see our performances, you will sometimes find father-daughter or father-son duos performing, or the mothers performing. You will also find that the entire family gets interested and involved. It is a totally different feeling altogether, one that words cannot express.

Are former members of the group still involved in its activities?

A correction here! Former students but not former members. All of them after leaving IISc are still members of the group. They were, are and will always be a part of this vibrant group. We had a programme two years ago on our anniversary for the alumni. They came in from Mumbai, Chennai, Delhi and even Qatar. A few of them, in the future, do have plans to pursue music in a big way.

Your motto is "music transcends all." Can you elaborate on this?

Yes! Music does transcend all in our group. We do not see anything other than interest and passion for and in music. There is nothing else that matters – age, gender, religion, how much music you already know ... none of these matter.

Photo: KG Haridasan

Members of Geetanjali along with chief guest Padma Bhushan Awardee B Muthuraman (second row, second from left), former vice president of Tata Steel, during their anniversary celebration in December 2019

How is learning music and teaching music different?

The main things that teaching teaches are patience and determination. That is the biggest difference [in being a teacher]. I do not breeze through ragas; it has to be perfect. I make them practise till they get the raga perfectly. I tell the students that the foundation has to be strong. I also keep telling them that quantity is not important but quality is. Learning ragas in a systematic and disciplined way is very important.

My advice to the students has been to perform and sing only for themselves and enjoy every moment ... to just let go of their feelings. In our group, we do not compete or compare. This group knows only one thing and one language, and that is music. I follow and instil the tradition of the *Guru-Shishya parampara*, which makes my students stand out. The other important factor that this group proudly shows is that the students or *Guru bandhus* are there for each other, no matter what.

What has been the most rewarding experience for you, being a part of Geetanjali?

Oh, there are many! There have been students who could not sing at all. But after a while not only did they learn but they also performed for Geetanjali and did a good job. Another experience is being invited to two international conferences and getting appreciation from the foreign delegates saying that the Geetanjali group showed India in its diverse forms in a short span so beautifully.

The first annual alumni reunion of IISc was organised in 2016. Our group was invited to perform, which was memorable because we performed and gave a presentation describing raga and the various moods. So, the appreciation for Hindustani music grew amongst the alumni who had come and the general public alike.

> ***'My advice to the students has been to perform and sing only for themselves and enjoy every moment'***

We have performed in front of so many great and successful people. I invited Pandit Rajan Mishra online [during COVID-19] to do a workshop for my students. Last year, Pandit Sajan Mishra came to IISc and conducted a workshop organised by our group. To get appreciated by such renowned people and get love and affection from all wherever we have performed is indeed very humbling and a moment of pride too.

We launched our website in 2023, which was a big moment. But the notable achievement was the release of Geetanjali's debut album of ghazals by my student, Dr Chinmay Anand, an alumnus of IISc, this year in July.

When I look back now, I feel so happy, humbled and proud about the Geetanjali IISc group. The group will continue doing its good work of spreading music and positivity amongst all. It would not be wrong to say that Geetanjali has spread the rich Indian classical music and culture amongst the people of IISc and has made the Institute more culturally vibrant too.

Modelling Life

- Amruth Deepak Bhat

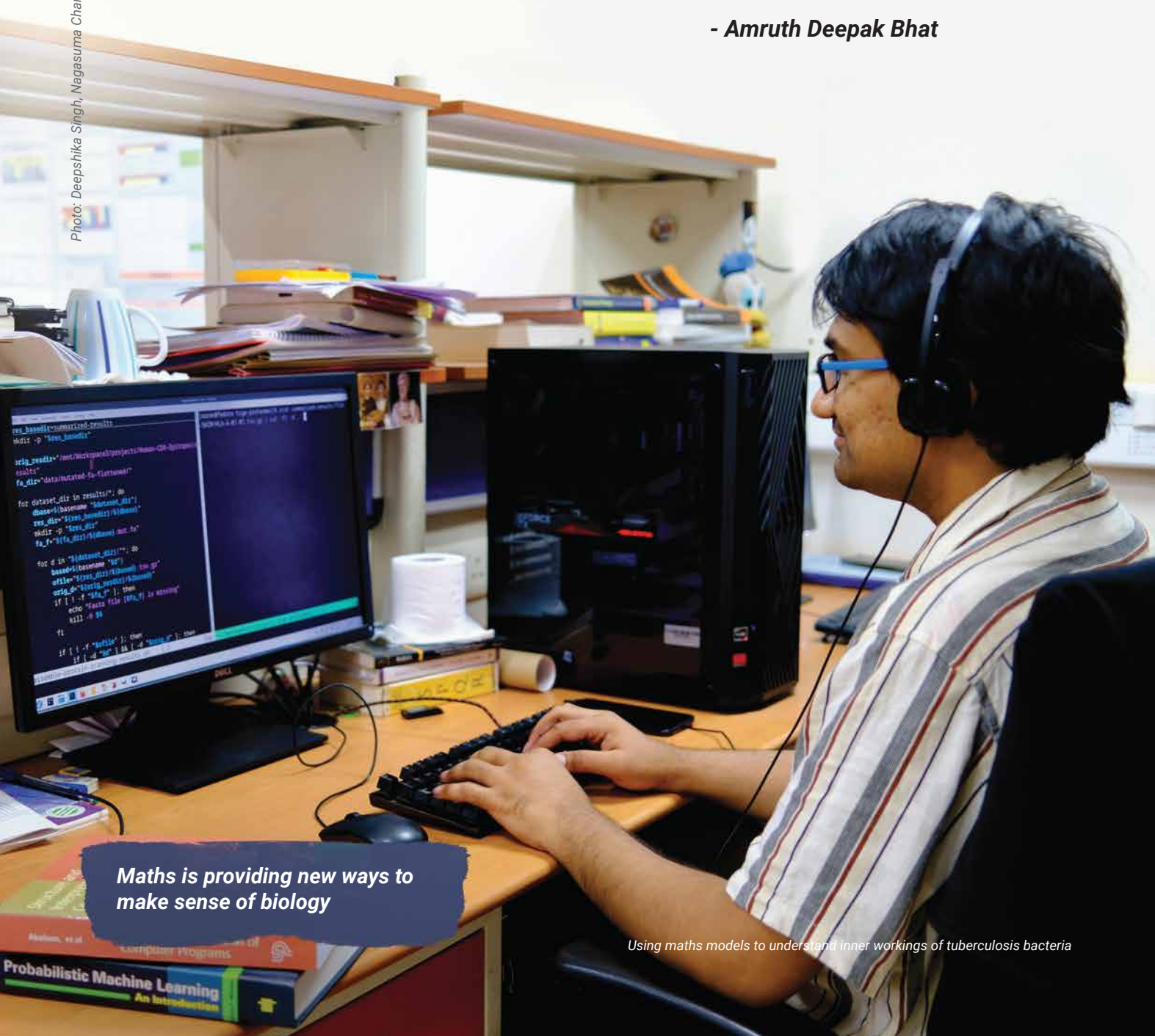


Photo: Deepshika Singh, Nagasuma Chandra lab

Maths is providing new ways to make sense of biology

Using maths models to understand inner workings of tuberculosis bacteria

In the early 2000s, a fierce debate was raging among health practitioners about when to start HIV patients on antiretroviral therapy. The standard approach at the time was to delay treatment until the disease had progressed to a critical stage. However, emerging mathematical models challenged that dogma. They showed that the virus could silently ravage the immune system even when the patient didn't show symptoms. These theoretical studies ultimately led the Centres for Disease Control and Prevention, USA, to change treatment guidelines – asymptomatic patients were also given antiretroviral therapy. This dramatic shift saved at least two million lives in the USA alone.

It was this story that hooked Narendra Dixit, Professor at the Department of Chemical Engineering, on mathematical and computational modelling. To him, it illustrated the power of modelling to illuminate the complexities of biological systems.

At its core, modelling is all about capturing the essential components and interactions of a system – whether it's a single cell, an organ, or an entire ecosystem – in the language of mathematics. By distilling these intricacies into equations and computer simulations, researchers can unearth hidden patterns, predict the outcomes of different interventions, and guide the design of new experiments. It's like constructing a virtual lab where you can test out ideas and make predictions about what could happen in the real world.

Since 2005, Narendra's lab has been using mathematical models to study infectious diseases, from investigating how HIV hijacks the immune system to designing better vaccination strategies for COVID-19.

One of their models focused on understanding the puzzling outcomes of hepatitis C treatment with a drug called interferon. Before 2012, hepatitis C was treated using interferon, but it worked in only about 50% of patients. Narendra's team set out to understand why.

They developed a mathematical model of the complex network of interactions between the hepatitis C virus, the immune system, and the drug. The model revealed that the effectiveness of interferon depended on the delicate balance between the strength of the patient's own response to interferon and the virus' ability to suppress it.

"It turns out, if you get into the details, that there was a network of interferon signalling [in liver cells] that displayed multiple steady states, which was at the heart of this outcome of treatments," Narendra explains.

> ***Modelling is like constructing a virtual lab where you can test out ideas and make predictions about what could happen in the real world***

This phenomenon, known as bistability, means the system can exist in two stable states: one where interferon controls the virus, and another where the virus persists despite interferon.

Using a model of viral kinetics, the researchers made a crucial discovery: there's a critical threshold in the proportion of liver cells that respond to interferon. When the fraction of cells refractory (resistant) to interferon in a patient exceeds this critical value, treatment fails.

In patients where the proportion of interferon-resistant cells is below the critical threshold, the treatment can effectively control the virus. However, in patients where this proportion exceeds the threshold, even high doses of interferon are ineffective.

The model also suggested a new approach: combining interferon with drugs that directly attack the virus. By reducing the overall viral load, these drugs can lower the number of interferon-resistant cells below the critical threshold, making the treatment effective again. This prediction aligned with the later success of combination therapies using both interferon and direct-acting antivirals.

By translating complex biological processes into mathematical equations, Narendra's team uncovered hidden patterns that could lead to more effective treatments for diseases like hepatitis C.

Defeating disease with data

A major problem in biology today is making sense of the deluge of data being generated by experiments, realised Nagasuma Chandra, Professor in the Department of Biochemistry, when she began her foray into mathematical biology two decades ago.

Photo courtesy: Narendra Dixit lab

Discussions and conceptualisations are an important part of model building

"There's data coming from all levels – molecules, cells, tissues, organisms," she says. "To synthesise it and find meaning in it, you need mathematical modelling. There's no other way."

Nagasuma's lab specialises in building multi-scale models that can zoom in and out on biological phenomena. They used this approach to untangle one of the most vexing problems in medicine – the rise of antibiotic-resistant bacteria.

> ***'There's data coming from all levels – molecules, cells, tissues, organisms. To synthesise it and find meaning in it, you need mathematical modelling'***

Nagasuma's team developed a mathematical model to simulate the evolution of drug resistance in the tuberculosis bacterium. By training their model on data from painstaking experiments that exposed the bacteria to different antibiotics over multiple generations, they were able to pinpoint a previously unknown mechanism of resistance.

"We found that resistance doesn't arise from a single mutation or a single gene, but from the complex interplay between different biological scales," she explains. "It emerges from the dynamic feedback between the metabolic state of the bacterial cell, its stress response pathways, and the external environment."

This type of holistic understanding is something that traditional, reductionist approaches to biology often miss – they typically focus on individual parts or processes. Mathematical models, on the other hand, excel at capturing emergent properties that materialise when all these parts come together. Learnings from these models can be taken back to the lab to test out new hypotheses, Nagasuma suggests.

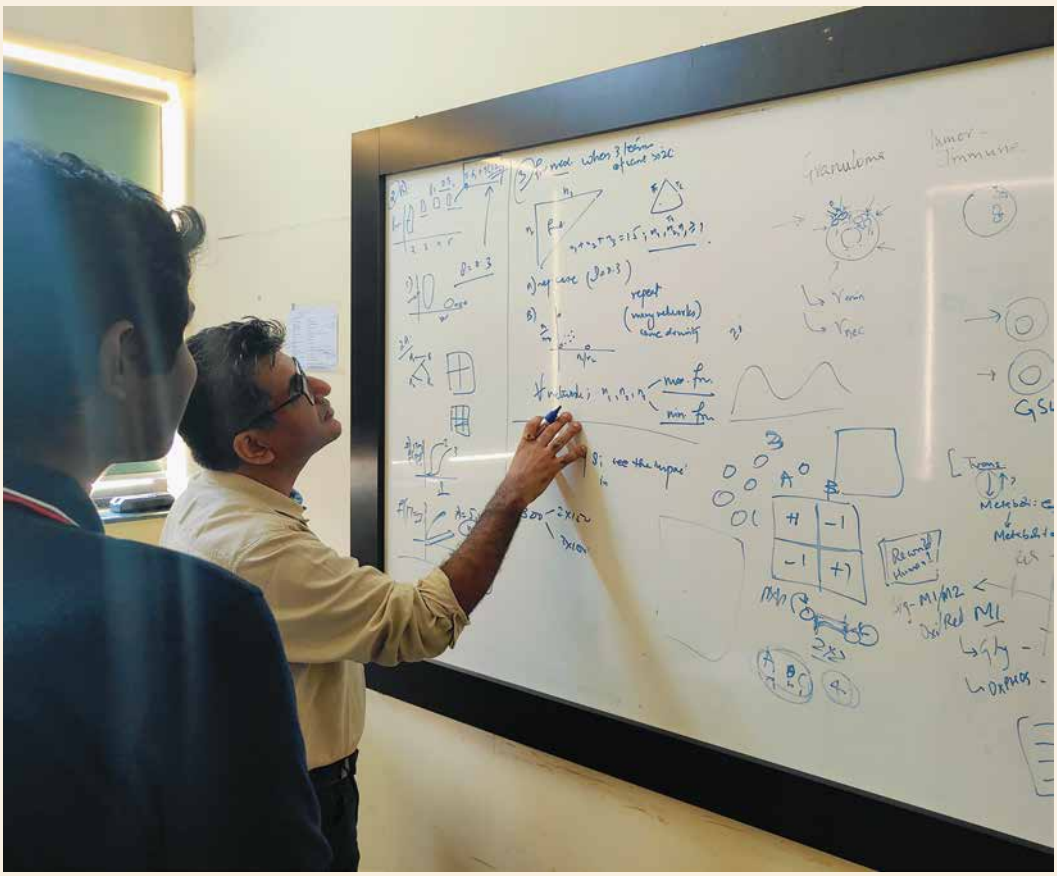
Unravelling complexities of cancer

Complex interplays between different cell types, molecular pathways, and environmental factors also underpin the development of diseases like cancer. Mohit Kumar Jolly, Associate Professor at the Department of Bioengineering, has been using mathematical oncology to dissect these dynamics.

A focus of his work is the epithelial-to-mesenchymal transition (EMT), a process by which cancer cells can detach from their neighbours, migrate to other parts of the body, and establish new tumours. Epithelial cells line the surfaces of our organs and body cavities, forming a protective barrier and maintaining the structure of tissues. They are typically tightly packed together and anchored by strong adhesive molecules. Mesenchymal cells, on the other hand, are more loosely organised and migrate freely, which is important for processes like wound healing and embryonic development. EMT was long thought to be an all-or-nothing switch – either cells were epithelial or they were mesenchymal.

"But we found [using models] that cells can actually exist in a continuum of states between epithelial and mesenchymal," Mohit explains. "And it's these hybrid states that are the most dangerous in terms of driving metastasis (the process of cancer cells migrating and invading other organs)." This is because hybrid cells inherit the worst of both cell types – they can adapt and travel more easily to other body parts.

Photo: Amruth Deepak Bhat



Mohit Jolly's lab uses math equations to better understand the growth of cancer

This insight has profound implications for cancer treatment. Rather than trying to block EMT entirely, therapies may be better off targeting the most metastatic cells while allowing other cells to remain epithelial. Mohit's lab is now using mathematical models to predict how different drugs might affect this delicate balance and to identify new therapeutic strategies.

Models are also helping researchers like Soundharya Ramu, a second-year PhD student at the IISc Mathematics Initiative (IMI), link our understanding of disease to clinical outcomes for patients. Working with Mohit and Annapoorni Rangarajan, Professor at the

Department of Developmental Biology and Genetics (DBG), she is using multi-scale modelling to explore how hypoxia (a low oxygen environment) influences cancer cell activity and its spread.

Her models incorporate data from experiments that profile the molecular landscape of cancer cells and figure out how they change over different tumour regions. By simulating how these molecular changes play out over the space occupied by the tumour, she is attempting to predict how tumours will evolve and identify the most promising treatment strategies.

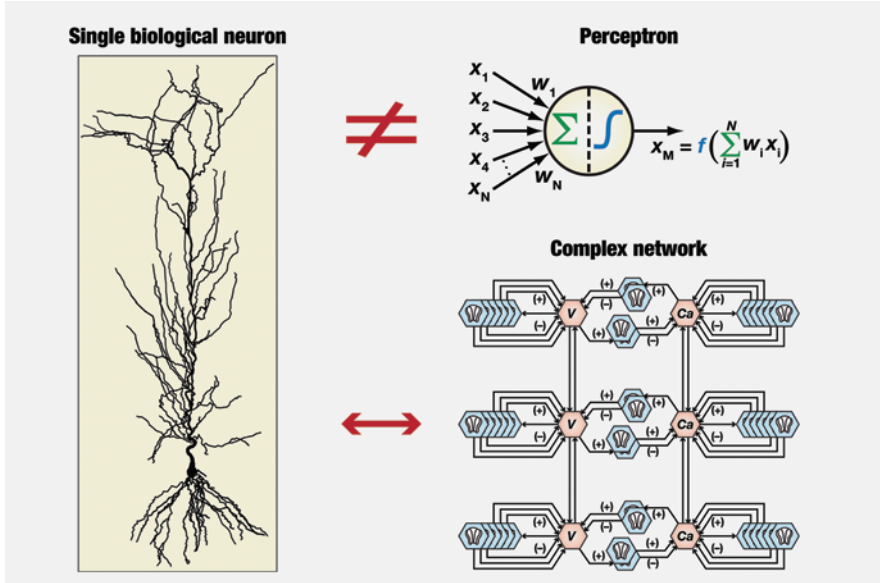
"What I find most exciting about this work is the ability to integrate data from so many different levels and build a coherent picture of the system as a whole," Soundharya says. "It's like putting together a jigsaw puzzle where you have to figure out how all the pieces fit together to create the final image.

Mimicking nuances of neurons

As an electrical engineering student, Rishikesh Narayanan, Professor at the Molecular Biophysics Unit (MBU), was drawn to neuroscience by the prospect of studying the brain as the ultimate computing device. When he delved deeper into the biology of neurons, a major type of cell in the brain, he was struck by their immense diversity. "Two neurons in the same brain region that have the exact same kind of activity can achieve it through completely different mechanisms," Rishi says. Neurons are also noisy – they generate a lot of signals at random.

This is why when Rishi's lab builds computer models of individual neurons as well as networks, they ensure that they account for both diversity and randomness. By comparing the behaviour of models with slightly different properties of neurons, they've been able to pinpoint key ion channels and signalling pathways that shape the activity of different cell types. "There was one particular potassium current that nobody would have thought was important based on the biology alone," he recalls. "But our model predicted that it would have a huge effect on multiple features of the neuron's activity, and subsequent experiments bore that out."

Image courtesy: Rishikesh Narayanan lab



Conceptualising neurons as complex networks

A key challenge in building such models, he points out, is to figure out which parameters matter for a given phenomenon, and which ones are just noise. "You can't just build a single canonical model of a neuron and expect it to capture all the important features," he says.

Blurring boundaries

Today, more and more researchers are embracing the use of mathematical models to guide every stage of the scientific process, from hypothesis generation to data analysis. These models can not only help solve specific problems but also have the capacity to change the way we think about life itself. The convergence of maths and biology is opening up new frontiers in fields like personalised medicine, synthetic biology, and regenerative medicine.

But there's a hitch: In India, maths and biology have long been cordoned off from each other. As high school students, how many of us have been asked: Do you want to become an engineer or a doctor? Do you want to study mathematics or biology?

"There is a dichotomy in our educational system – in 11th and 12th grade you are supposed to choose between maths and biology streams," explains Rishi. As a result, students somehow think that if they take biology, they are incapable of doing maths, or vice versa, he says.

"We need to create a scientific ecosystem where students feel empowered to follow their curiosity across disciplinary boundaries," says Narendra. "The most exciting discoveries happen when people from different backgrounds come together and share their unique perspectives."

> ***'Just because you have chosen biology or mathematics does not imply you cannot learn the other'***

Rishi echoes this as well; he suggests that the change has to happen at the school or early university level. "I make it a point to try and give a talk in small colleges wherever I visit … just because you have chosen biology or mathematics does not imply you cannot learn the other. Go where the question takes you."

"We need to systematically train students to be bilingual in maths and biology from an early stage," adds Mohit. "The major challenge right now is developing a critical mass of people who can speak both languages fluently."

As the boundaries between disciplines continue to blur, it is increasingly clear that mathematics is not just a tool for physicists and engineers, but an essential language for deciphering the complexities of life itself.

Amruth Deepak Bhat is an MTech student in the Department of Bioengineering, IISc and a science writing intern at the Office of Communications

‘People think talking about mental health will make it worse. That’s not true’

Photo courtesy: Deanna Barch

- Abinaya Kalyanasundaram

Deanna Barch is a well-known figure in the field of psychiatry. She has spent over three decades studying the psychological and neural mechanisms underlying the development of mental illness, particularly schizophrenia and depression. While her research primarily focuses on adults, she also studies the risks of mental illness in children due to early adversity, such as poverty, stress, and disparities in access to healthcare. Currently the Gregory B Couch Professor of Psychiatry and the Chair of the Department of Psychological and Brain Sciences at Washington University, she is the recipient of several awards for her pioneering work.

Deanna recently visited IISc for the sixth Bangalore Cognition Workshop organised by the Centre for Neuroscience, where she spoke to a packed Faculty Hall about how neuroscience approaches can deepen our understanding of mental illness. On the sidelines of the talk, she spoke to* CONNECT *about schizophrenia and its treatment and risk factors, misconceptions about mental health, and her choice of research over a clinical career.

Note: This interview contains sensitive topics, including discussions of schizophrenia, depression, and suicide.

What initially drew you to study mental health challenges and disorders?

Back in high school, I was a peer counsellor for kids with mental health challenges. My brother had dyslexia and really struggled in school. I wanted to become a school psychologist to help kids like him.

When I took psychology courses in college, a professor asked me to join her lab as an assistant, which I really enjoyed. After graduation, unable to decide between research or a clinical route, I took a year off to work for a pilot project in Chicago helping patients with chronic mental illnesses. It was a rough experience. I distinctly remember one young client who'd had his first psychotic breakdown in college and never really recovered. I had just graduated college, and I had the opportunity to think about my future. And here was this kid, with his own hopes and dreams, but unable to pursue them.

It struck me then that the one-on-one therapeutic relationship, though important, could only help a few people. But by doing research on mental illness, I could help a lot more [people].

So, I decided on graduate school. I knew I was interested in schizophrenia from early on, based on patients I saw in Chicago. My work has now certainly expanded far beyond schizophrenia, but that has been a thread from the very beginning.

How has the perception of schizophrenia changed, historically versus now?

Well, some things have changed and some haven't.

One of the early writers about schizophrenia, Emil Kraepelin, talked about schizophrenia as dementia praecox, that is, early onset dementia. He saw patients with dementia praecox that progressively got worse and became chronic. Elements of that are still true, but we now know that some of that was because of the absence of treatment at that time, and that it is much more of a spectrum. There are people with dementia praecox, but there are also people who are more stable and can recover. And that, I think, is hopeful for patients.

> ***By doing research on mental illness, I could help a lot more people***

By adopting neuroscience approaches, our understanding of symptoms is also changing. For example, some patients have disorganised speech. We are trying to understand whether the disruption is in their thinking, belief systems, or their ability to translate ideas into language.

What are some of the most common symptoms of schizophrenia?

There are two categories.

Positive symptoms are experiences patients have that other people normally don't, such as hallucinations, delusions, formal thought disorder – speech that is difficult to understand or follow – and disorganised behaviour, like odd motor movements and gestures.

Negative symptoms are the absence of things you would normally expect to have, such as asociality (missing social interests,) flat affect (missing expression or affects on the face), and alogia (a reduction in the amount of speech or slow pauses).

You also study early-onset mental illnesses in children. Could you talk a little more about that?

Some people acutely develop a psychotic episode in late adolescence or early adulthood. It's sometimes associated with substance abuse – like marijuana, phetamines, stimulants, or psychedelics.

But often, when symptoms develop in adolescence or early adulthood, you can retrospectively see some indicators from early childhood like motor abnormalities, cognitive challenges,

Photo courtesy: Deanna Barch

A participant's brain activity is measured during a memory task using electroencephalography (EEG) for a study as part of the Cognitive Neurocomputational Research and Clinical Assessment in Schizophrenia (CNTRaCS) consortium project

and social withdrawal. In rare cases, you see the development of full-blown psychosis at a very early age. I've seen it [in children] as young as seven.

In about 25-40% of adolescents, we are seeing the transient emergence of psychotic-like experiences, so mild that some people might not even call them psychosis – like having imaginary friends, magical thinking.

But in a subset of those kids, these experiences will continue and become stressful. We think those kids are more on a spectrum with psychosis and may be at risk for developing additional symptoms later on. In a project called the Adolescent Grading and Cognitive Development Study, we are studying such measurements starting at age nine.

What factors make children more predisposed to such conditions?

Schizophrenia has a significant genetic contribution. But there are definitely non-genetic factors. The risk among the general population for full-blown schizophrenia is 1% – it is not a very common disorder. Birth complications like anoxia or having the umbilical cord wrapped around the neck, and inflammatory infections in the mother during the second trimester can increase risk. For mothers in their second trimester who experienced stress during hurricanes and earthquakes in China, or great ice storms in Montreal – their kids were found at a slightly increased risk.

> ***The risk among the general population for schizophrenia is 1% – it is not a very common disorder***

There's also a host of environmental factors like social adversity, low socio-economic status, minority status in a majority country, first-generation immigrant status, pollution and toxins in the environment, and so on.

The big thing that everybody's trying to work on now is calculators that give a good estimate of the likely risk of developing schizophrenia. At the very least, they will help us design early non-invasive interventions.

Currently, what are the treatments for schizophrenia?

The best possible treatment is coordinated speciality care, which happens in places like Australia, the UK, and the USA.

It involves diagnosing as early as possible and providing multi-pronged treatment, which includes antipsychotic medication at appropriate dosage, educating family members, individual psychotherapy (like cognitive behavioural therapy), and vocational or occupational therapy.

But in reality, most people only get medication; the rest is a pretty expensive package. Medication is mostly helpful for positive symptoms, but doesn't really help with the negative symptoms. It also has its own side-effects like motor issues and weight gain. There is now a lot of focus on identifying new medications without some of these side effects, with some promising things in the works.

Working in mental health must be challenging. Did the shift from working personally with clients to a research route help you?

Even though I'm trained and licensed, personally, I don't think I'm well-suited for full-time clinical care. Partly because I have a really hard time "leaving it at the office (*laughs*)." It was emotionally draining for me.

I have so much respect for the people on the frontlines, working with clients every day. It can be very rewarding when people do well, but some people really struggle to follow the treatment plan or have relapses.

> ***If you ask a client with schizophrenia: What do you want to do better? ... A lot of times, they say: 'I'm lonely. I wish I had a bigger friend group. I wish I could work.'***

It was probably better for me to be more on the research side. But I also value one-on-one interactions with people, because sometimes it's easy as a researcher to lose track of what the daily experience is for people. Like, if you ask a client with schizophrenia: "What do you want to do better?" They're not necessarily going to say: "I want fewer voices and delusions." A lot of times, they say: "I'm lonely. I wish I had a bigger friend group. I wish I could work." They tend to focus more on quality-of-life issues because those are what cause a lot of distress.

That's true. Loneliness is one of the biggest things that people having mental health challenges deal with.

Yes, very much. They often have reduced opportunities for social engagement. In the worst-case scenario of a chronic illness, you may be living in a group home. Your friends may have very different lives than you now, with nothing in common.

I think there are two things we need to tackle – how to make it easier for people to have social connections, and how to ensure that they overcome loneliness. Is it a cognitive problem, an emotional recognition problem, or not being able to open up? Is it being absorbed by your inner anxiety so that you're not really in the moment in that social interaction?

Could support groups help?

Definitely. Because part of the discussion is not only how to get people to be social but also the logistics of how you help them to be – some people are maybe not working, don't have a lot of finances, maybe they can't drive. Sometimes the illness prevents people from being able to engage in some of those things. Peer support could help.

What are some major misconceptions about mental health that you have noticed?

About schizophrenia, there are three major misconceptions. One is that they don't suffer. But they are very much suffering. Delusions and hallucinations associated with schizophrenia are almost always negative in content.

Another misconception is that they are more violent than other people, and that really isn't true. People can be violent in response to delusional voices, but you don't need to be afraid of people with psychosis.

And the third is that people confuse schizophrenia with multiple personality disorder, now called dissociative identity disorder. I see this framing misused all the time in the media, literature, and in general conversation.

In general, I think that the biggest misconception about mental health is that people think talking about it will make it worse. That is just not true. I think that's particularly a concern in the domain of suicide. People are very afraid that asking someone if they are thinking about hurting themselves is going to *make* them think about hurting themselves. That's absolutely not true.

Photo courtesy: Deanna Barch

Graduate students and staff working on the Cognitive Control and Psychopathology Laboratory, co-directed by Deanna Barch, at Washington University

Photo courtesy: Deanna Barch

Deanna and her students working on data analyses of functional brain connectivity data collected from individuals with schizophrenia

The only exception to that is in schools, which have some evidence of social contagion; when one child hurts themselves, and then there's an intense discussion on social media, evidence suggests that that can increase rates of suicidal ideation.

But that's very different from you as a caring family member or friend asking someone about their thoughts.

There are quite a few TV series and movies that address this...

Like *13 Reasons Why*... which was terrible. That glorified suicidality in a way that was not helpful!

There's one more misconception ... which is that you have to be depressed in order to commit suicide. No doubt depression is a massive risk factor for suicide, but some people commit suicide even when not depressed, for a variety of reasons like despair or chronic health conditions, over family issues, and other things.

There's also been a lot of talk about the gut microbiome and mental health. You've also been involved in some studies related to that. Can you tell us more?

Truth be told, we haven't done a lot of research yet. The work that I've done is more related to how early social adversity influences the gut microbiome. And now we're looking at whether it predicts mental health concerns.

I am not an expert in this, but there's some work suggesting that ketogenic diets might help treat bipolar disorder. There's also evidence of the microbiome modulating the vagus nerve – we know that vagus nerve stimulation can also be a treatment for depression. It's a young field; not a lot of definitive answers yet, but a lot of excitement.

For example, in early development, the gut microbiome of breastfed children has a greater proliferation of anti-inflammatory microbes, which are good for the child. And kids who are not breastfed have a greater proliferation of pro-inflammatory microbes, which are not as great. There's a huge push for breastfeeding, but there are so many social factors that hinder it, like access to nursing rooms.

Compared to mental health issues, do you feel physical health issues are given more priority in society?

I mean, it is ridiculous, right? We're putting a disproportionate amount of money into physical health conditions compared to mental health conditions given their relative burden of disease. And that always gets me frustrated. I don't want to reduce the resources for physical health conditions, of course; I would just like to increase the resources for mental health conditions.

It's a shame because they're so intimately intertwined. There's evidence that cancer treatment itself causes mental health concerns – which in turn makes prognosis worse – and evidence about heart problems being exacerbated by depression. Paying more attention to mental health would actually help the physical condition.

I think this separation exists because there's still more stigma associated with mental health conditions. In many cultures, it's just not okay to talk about mental health.

Yes, in countries like India, it's improving, but not enough yet.

It's starting to change. I think the biggest reduction in stigma has been in more westernised countries. But I'm starting to see a lot of effort [in other places too], like in Africa. I'm involved in a few international groups and we're trying to promote discussion and ensure culturally appropriate measurements and assessments because different cultures talk about mental health in different ways. China too, interestingly, is spending a lot of resources on mental health, but they talk about it in a slightly different way, because there's still a lot of stigma.

> ***We're looking at how early social adversity influences the gut microbiome and whether it might predict mental health concerns***

Do you think social media helps or harms? How do you feel about the rapid rise of "wellness influencers"?

There are pros and cons, because it's not moderated. I think some people are putting out awful stuff that is not useful. But there are a lot of helpful online support groups for parents for different forms of mental illness. It has opened up a forum for people to feel like it's okay to talk about their concerns, and to understand that other people are having some of the same experiences. Some of them share accurate and valuable information.

I just don't know how to help people distinguish between the informed people and those putting out stuff that there's no evidence for!