Office of the Principal Scientific
Adviser to the Government of India

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From the Office of PSA

May 2022

In Conversation

Space Missions, Policy Reforms, and Books: Interview with the DoS Secretary, S. Somanath

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Prof. Deepak Dhar, Boltzmann Medallist 2022

India in Focus

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Science and Technology Clusters

A New British Council–Telangana Partnership: Taking Education, Research, and Innovation to Greater Heights

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Members of the British Council, Telangana State Council of Higher Education (TSCHE), Govt. of Telangana, and Research and Innovation Circle of Hyderabad (RICH) signing the MoU

IN CONVERSATION

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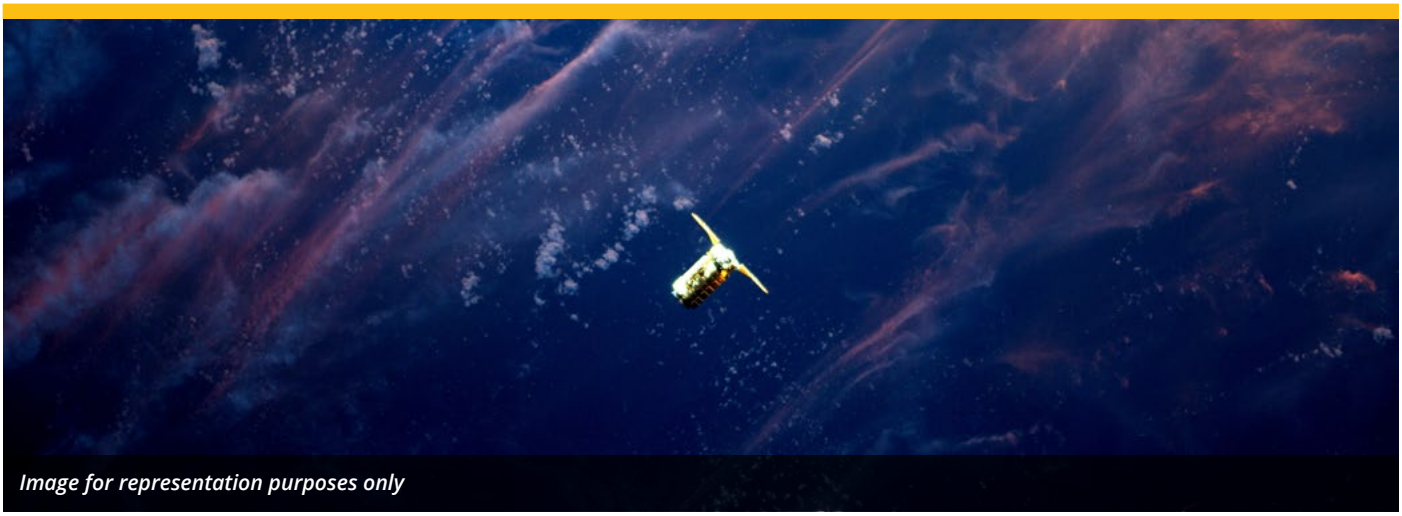

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"Technology creation is the prime mandate of ISRO and it will continue to be so to protect the national interest and steer the country's growth", reaffirms Mr. S. Somanath, recently appointed Secretary, Department of Space (DoS), and Chairperson, ISRO.

ISRO has several ambitious interplanetary projects such as Chandrayaan-3, Gaganyaan (human space flight), Aditya L1 (solar mission), and Shukrayaan in its pipeline. These missions are not merely fanciful pursuits that utilise public money, but define our identity as a technology-creating nation striving to lead one of the most powerful and influential space programmes in the 21st-century world. Mr. Somanath adds,

"These missions are opportunities to train a young scientific workforce that looks beyond routine tasks and drives fundamental knowledge creation. We aim to involve engineers, mathematicians, astronomists, astrophysicists, and entrepreneurs for building capacity for national missions and commercial economic ventures".

On Missions

ISRO's workforce is diligently preparing for Chandrayaan's return to the moon, this time with a strong-featured 'lander' to ensure an error-free landing. Key changes in configuration, software, and sensors are introduced to predict, measure, and regulate the off-nominal conditions (uncertain events) that may occur in space. The lander is equipped with enhanced power-generation capacity and instruments to measure its precise position and velocity. Redundancy features to ensure that if one of the components malfunctions another one can take over are built in to safeguard against any glitches. Simulation landing tests and software simulation tests are being carried out at test facilities in Sriharikota, Bangalore, and at Trivandrum centres.

"We hope to launch Chandrayaan-3 in 2022; hence, we need to carry out all the simulation tests successfully. We want to focus on success," Mr. Somanath comments.

The human space flight (Gaganyaan) mission is stirring plenty of excitement and challenge for ISRO. The idea of parking a human in a rocket adds an unusual and risky dimension to the mission. This is why the government approved Gaganyaan only after reviewing the success of experiments demonstrating the capability to send the craft to lower earth orbit and bring it back. ISRO has developed the technology to deploy parachutes for a sea landing. The plan is to launch two 'Failure simulation tests' called 'abort tests' for Gaganyaan in August and December 2022. An abort test involves an intentional failure of the rocket to study different elements of safety and operation.

Read all about Gaganyaan: www.isro.gov.in/frequently-asked-questions/gaganyaan

"The unmanned crew mission is to be conducted early next year," the Chairperson added. The uncrewed launch is conducted to confirm the proper functioning of the launch vehicle and to obtain measurements on the space environment and its dangers, such as radiation or excessive sun heating while the vehicle is in orbit. The launch further tests the efficiency of power generation units to ensure communication through various ground stations across the globe. It involves a demonstration of bringing the launch vehicle back to earth and landing in the sea.

"The last leg of Gaganyaan will carry four test pilots from the Indian Air Force who have already received their training in Russia. Currently, the crew is undergoing classroom training in India to understand the rockets involved and the operation of the whole mission. Simulator training to work inside the space vehicle and handle contingencies is planned for the crew," says Mr. Somanath.

He hopes to bring in civilians, students, professionals, and scientists in the future on the Indian human spaceflight programme. "This will be India's effort towards making a future with human presence in space", he remarks.

After the successful launch of PSLV-C52, ISRO is gearing up to launch three PSLV missions in 2022 — PSLV-C53, with a satellite for ocean observation; a satellite for New Space India Limited (NSIL), funded by commercial entities; and another for the Aditya L1 Mission. The maiden launch of a small satellite launch vehicle (SSLV) is also expected this year.

On space policy reforms

The DoS resolves to implement the recently introduced space policy reforms to increase private participation and enable India to leapfrog into a new-world space economy.

"The space sector has great expectations from startups and industries to invest in space. This will help create a backend strength in launch vehicles and satellites", says Mr. Somanath.

The Indian National Space Promotion and Authorization Center (IN-SPACe) and NSIL were created to enable entrepreneurs to obtain technologies made by ISRO, make use of facilities in ISRO, and foster collaborations to develop new applications. IN-SPACe will promote technology transfer from abroad, provided it creates jobs and economic activity in India. The NSIL is tasked with handling business operations.

Read all about In-SPACe: www.psa.gov.in/article/space-unlocking-indias-potential-space-sector/3353

In addition, the 'New Space Policy' is ready for vetting by the space commission. The policy draft provides the blueprint for regulations and guidelines for private players. For example, the space transportation policy provides the scope and permission for private industries to build rockets in India, an activity that is currently not allowed. Similarly, guidelines on technology transfers from ISRO to private entities and foreign direct investments (FDIs) are included.

The DoS is also working on a Space Law/Act to be passed by the parliament soon. Per this act, IN-SPACe will perform regulatory functions.

"Without a national law in place, nobody can manufacture or launch a satellite or a rocket owing to safety issues and the risks associated," says Mr. Somanath.

On the people behind all of it

"We know very little of the people who have worked for the organisation and the efforts they've put in over these years. Reading about these people and their work might make it a little easier to believe in the possibility of what we intend to achieve for India," Mr. Somanath says.

When asked about his pick of books on the space sector and its people, the Chairperson said that besides the more widely read works about Sarabhai, Dhawan, and Kalam, one could read U.R. Rao's *Inside the ISRO: Narrating the Indian Space Odyssey,* Kasturirangan's account of his life in ISRO and the Planning Commission, G. Madhavan Nair's autobiography, *Agnipareekshakal*, R. Aravumudan, and Geeta Aravamudan's *ISRO: A Personal History,* K. Radhakrishnan's *My Odyssey: Memoirs of the Man Behind the Mangalyaan Mission,* and books by bureaucrats like S.K. Das, Former Member (Finance), DoS (*Touching Lives: The Little Known Triumphs of the Indian Space Programme*). All these books are enriched with personal anecdotes, bringing out different perspectives on the organisation. *"One gets to know more about the culture of the Department of Space and ISRO than about technologies developed here," Mr. Somanath adds.*

On ISRO's strengths and his vision as the Secretary

"Developing applications for end users is ISRO's core strength and the primary goal—to serve the administration, the government, and the people. With the new space reforms, DoS aspires to increase the number of people participating in space activities from a few thousand (the current figure) to a few lakhs. There are immense opportunities for youngsters to work in space as we have at least fifty start-ups in the Indian space sector now. The youth can join a space company in India which will build rockets and launch satellites. I would like to see such a model coming out. I nurture this vision as Secretary, DoS".

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INDIA IN FOCUS

Prof. Deepak Dhar Honoured with the Boltzmann Medal

Prof. Deepak Dhar, Boltzmann Medallist 2022

Prof. Deepak Dhar's research in statistical physics has brought the first Boltzmann medal to India. He shares the coveted honour with American scientist Prof. John J. Hopfield, who is known for his invention of an associative neural network.

When asked about the significance of this accolade, Prof. Dhar states with utmost humility, *"While it is true that I am the first Indian to win the Boltzmann medal, I am not the first person whose work in statistical physics is significant". He emphasizes that the stellar contributions of Indian stalwarts in physics such as Meghnada Saha and Satyendra Nath Bose, while absolutely deserving, could not be decorated with awards as there weren't any in those times."*

Origins of his scientific temper

Prof. Dhar's interest in science was cultivated by his father, who would bring home popular science books and persuade him to read. He joined Allahabad University (AU) as a National Science Talent Search (NSTS) scholar for a BSc degree Course. His NSTS advisor Vipin Kumar Agrawal would encourage him to read science outside the textbooks. The 'summer camps' conducted for NSTS scholars drew his energy and interest in science. He recollects, "We would go to institutions to hear specially designed lectures by eminent scientists and professors, which helped me build scientific curiosity".

When Prof. Dhar moved to IIT Kanpur (IITK) to pursue a master's degree in Physics, he met several fellow students who were keen to pursue academic careers. This was a very different peer group from AU where most students were inclined toward Indian Administrative Services. At IITK, Prof. Dhar also got an opportunity to interact with lecturers such as H.S. Mani, D.C. Khan, and Kalyan Banerji.

From IIT to Caltech

After his Master's at IITK, Prof. Dhar choose the California Institute of Technology (Caltech), the USA for his PhD. He remembers, *"Caltech was very well known for research in high energy physics. I was not sure what I was going to do, but it seemed like a good place to try".*

As he arrived in the foreign country, he was picked up at the airport by a local host arranged by the student welfare office at Caltech. To facilitate acclimatisation, new students had to stay with the local hosts at their house for two-three days. Recalling how he struggled with the unfamiliar American accents during his early days at Caltech, Prof. Dhar shared what helped him, *"I remember the very important words of my host — Don't be afraid".*

Prof. Dhar started his PhD work at a time when the work of Prof. K.G. Wilson (Nobel Laureate, Physics, 1982), the first recipient of the Boltzmann medal in the year 1975, on renormalisation theory had just been gaining recognition.

Prof. Dhar emphasises, "Researchers were beginning to understand phase transition and were trying to answer intriguing questions. For example, why does ice turn into water on heating? What happens when two ions collide?" Smitten by such questions in high energy physics, Prof. Dhar chose to pick up phase transition studies for his PhD.

Setbacks and learnings

In hindsight, Prof. Dhar remarks that his attempts at solving a very difficult problem may have been a little amateurish. He worked on a model of 3D solid melting, which he would later discover to be not particularly applicable. Nevertheless, he gained many interesting insights while working on it. "The learnings from this experience are something that students can take away from", he remarks. "Certain aspects of research may not work all the time, but it always yields positive learning outcomes that may be useful in the future".

His advice to students is very realistic: "You must have confidence and should be aware that while a PhD may not necessarily be your best work, it is surely a period of skilled training". In research, one can always do better work post-PhD, so one must avoid getting trapped in any emotional anguish if their PhD work isn't as interesting as they hoped, he insists.

Prof. Dhar shares another experience that brought about a similar realisation. While working as a teaching assistant with Prof. Richard Feynman (Nobel Laureate, Physics) he had to perform the task of grading student assignments. "Though I followed the standard marking scheme", Prof. Dhar remembers, "Prof. Feynman didn't approve. He asked me to come up with a system to distinguish between students who get 9 vs 9.5 vs 10". Reflecting on that incident, Prof. Dhar comments, "I think the point is that even students who score 9.5 should feel that they can do better. The current state of grade inflation where some 15 students in a university get 100/100 is not very desirable. It gives a wrong message to students".

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A post-PhD career in India

Prof. Dhar returned to India to join the Tata Institute of Fundamental Research (TIFR) as a postdoctoral fellow in 1978. TIFR was a vibrant and free place where Prof. Dhar would have scientific discourses with peers from astrophysics, high energy physics, and even biology. He discovered a fellow scientist and friend in Prof. Mustansir Barma with whom he published several papers. While Prof. Dhar did not have any mentor per se, a strong peer group and the conducive atmosphere at TIFR anchored him to lead his own research.

In a four-decade-long career at TIFR, Prof. Dhar witnessed several changes to scientific research. *"Certainly, the money spent in science is huge now than it was 40 years ago. You cannot expect today's science to work at the level of funding that Raman got".* He opines that this has brought its own perils as more people in research results in competition and pressure to publish. *"People read much less and write much more, which I think is not always a good thing"*, he adds.

Currently teaching undergraduate students at IISER Pune, Prof. Dhar wishes the students to perceive statistical physics as a different way of looking at multi-component systems that possess multiple degrees of freedom. He clarifies that while one may not be able to predict exactly what happens to each individual constituent, still predictions about the bulk may be made quite reliably. This is the power of theoretical modelling.

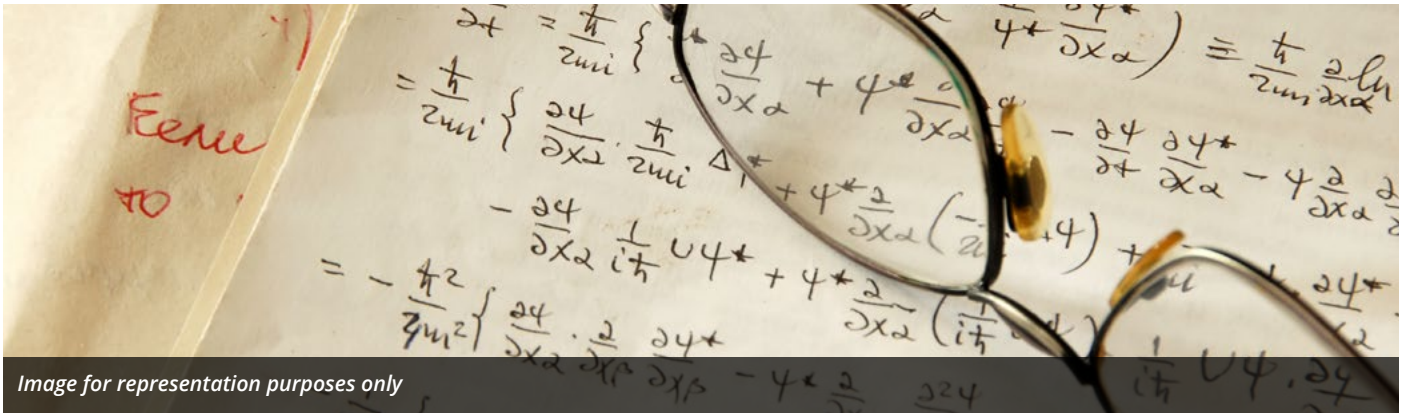
New frontiers in phase-transition research

When probed about the possible emerging areas in phase transition research, Prof. Dhar comments,

> *"There are phase transitions of consciousness. When one dies there is some kind of phase transition too. What is the difference between the living and dead when the hair/nail/beard keeps growing even after death? What kind of phase transition happens when a single cell divides into two?"*

Talking about one of his award-winning research works on self-organised criticalities (SOC), Prof. Dhar quotes the work of Per Bak and colleagues. He informs that many natural phenomena such as solar flares, earthquakes, biological evolution and firing of neurons in the brain can be potentially described using the SOC hypothesis. *"More research must follow for finding applications of SOC. For example: not only understanding how earthquakes happen but rather be able to predict them as well",* he adds.

As a theoretical physicist, Prof. Dhar describes 'simplification' to be the most intriguing aspect of theoretical modelling. As real-life problems are usually very complex, 'simplification' requires that one gets rid of unnecessary elements while retaining the essential details. This makes the problem tractable and easy to understand. He quotes the idiomatic expression 'don't throw the baby out with the bath water' and describes that the distinction between the baby and the bathwater is the key part of 'simplification' in theoretical modelling.



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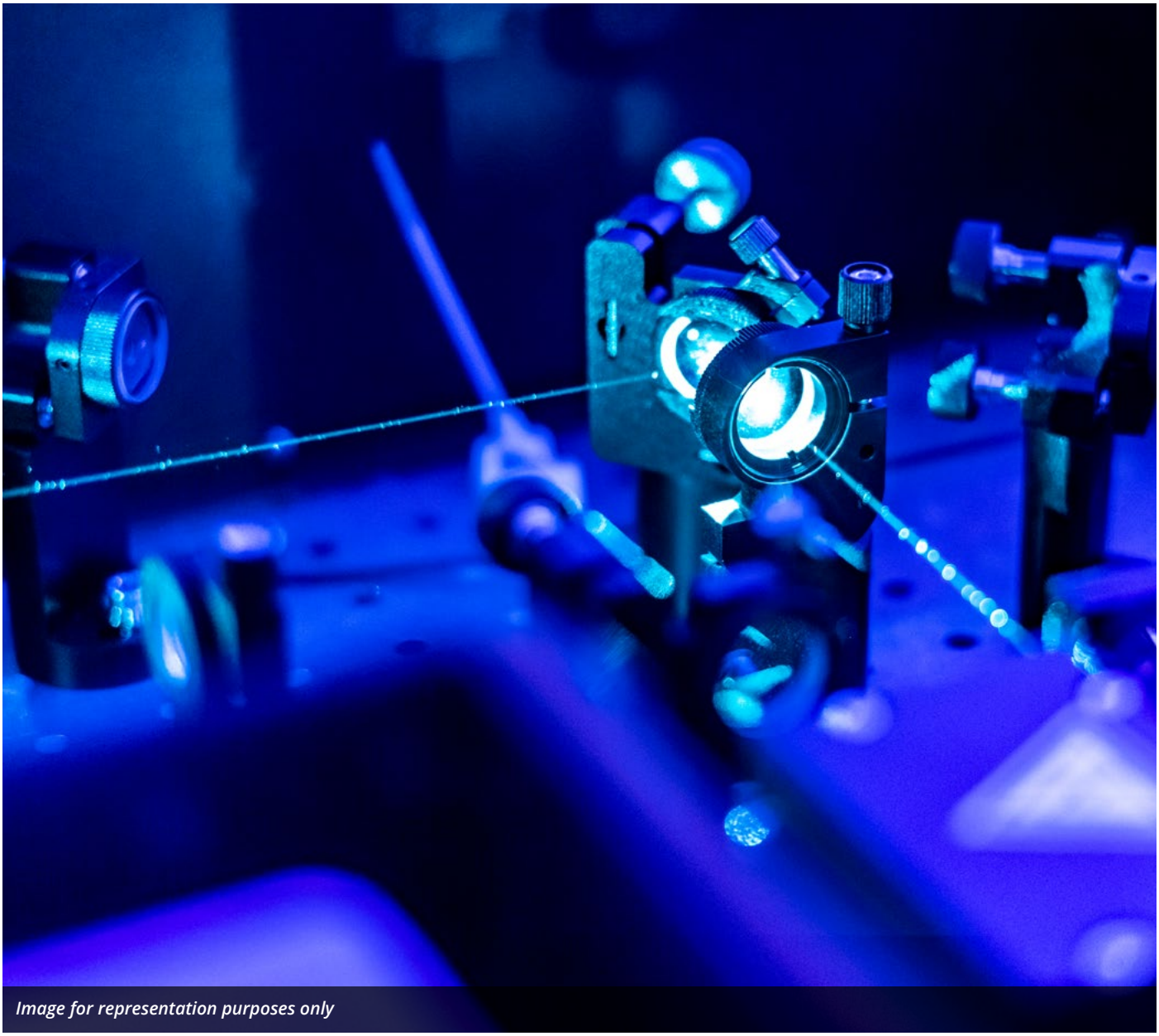
Upcoming statistics research in India

Prof. Dhar thinks that the recognition of his research may motivate students to explore statistical physics as a research career option and inspire the statistical physics community to take up more challenging areas with greater confidence.

He informs that the statistical physics community in India has been strong lately and clarifies, *"Most of the work which was cited in this award has been done 20 years ago. The work was always valuable".*

Prof. Dhar believes that one does not do science to get an award. It is rather an incidental side benefit that may come in time. For him, the actual benefit is the satisfaction that he has derived from doing interesting work and generating new knowledge.

As Prof. Dhar looks forward to the medal presentation ceremony at the StatPhys28 conference to be held in Tokyo in August 2023, the physicist in him is rather impatient to listen to conference presentations from the best researchers in statistical physics.



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SCIENCE AND TECHNOLOGY CLUSTERS

A New British Council–Telangana Partnership: Taking Education, Research, and Innovation to Greater Heights

From L to R: Prof. R. Limbadri, Vice Chairman, Telangana State Council of Higher Education (TSCHE); Ajit Rangnekar, Director General, Research and Innovation Circle of Hyderabad (RICH); Jayesh Ranjan, Principal Secretary, Information Technology, Govt. of Telangana; Janaka Pushpanathan, Director South India, British Council; and Andrew Fleming, Deputy High Commissioner to Andhra Pradesh and Telangana, British High Commission signing the MoU

In February 2022, a new memorandum of understanding (MoU) was signed between the British Council and the Research and Innovation Circle of Hyderabad (RICH), the nodal agency of the Hyderabad Science and Technology Cluster. The overarching goal under the MoU is to foster new partnerships between universities, research institutions, and centres of excellence in the UK and in Telangana, in the fields of aerospace, defence, life sciences, pharmaceuticals, food and agriculture, and sustainability. Initiatives that bolster innovation and entrepreneurship are also in the pipeline, such as sharing best practices and developing courses for skill-building.

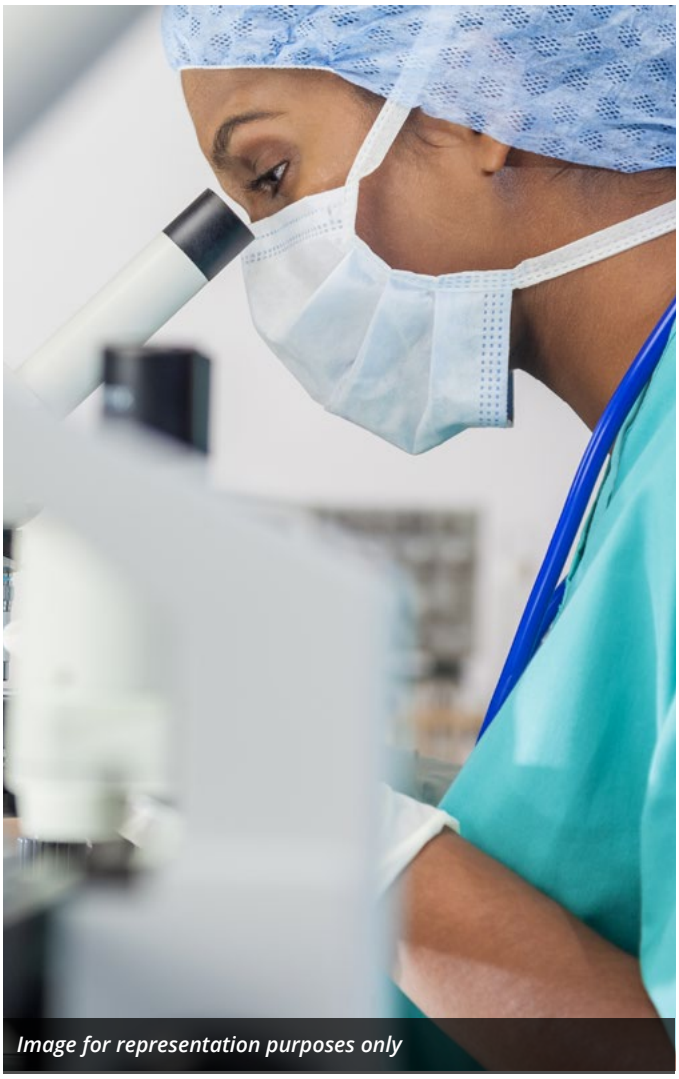
The MoU is the latest among a number of partnerships between Telangana and the UK which have tangibly strengthened education in the state and opened up opportunities for greater international exposure for researchers and innovators.

In 2018, the Telangana government and British Council signed an MoU to strengthen education and cultural co-operation between the countries. In 2020, the Telangana and Welsh governments signed an MoU under which two Welsh universities are working with two Telangana universities to enhance the latter's arts and commerce curriculums, in an initiative that is set to be extended to over 1,000 colleges, thereby impacting 8 lakh students. In 2021, Lord Tariq Ahmad, the UK Minister of State for South Asia and the Commonwealth, during his visit to Hyderabad, recognised Telangana's rich innovation and education ecosystem and oversaw an agreement between the University of Bolton in the UK and WE Hub in Hyderabad to enable WE Hub's women entrepreneurs to expand into UK markets.

These are only a few of the many collaborations between Telangana and the UK over the past decade, some of which have taken place as part of the larger tradition of mutually beneficial partnerships between India and the UK since 2006 under the UK India Education and Research Initiative (UKIERI) and other programmes.

Speaking of the great potential in this latest February 2022 agreement, Shri Jayesh Ranjan, Principal Secretary to the Government of India, said in a comment to RICH, *"Telangana is India's youngest state, but also the most advanced and progressive; internationalisation is in Telangana's DNA. Our vision for the state of Telangana is to be full of opportunities for its youth. We are glad to have found a partner in the UK that understands our philosophy and is able to work with us to achieve our vision."*

RICH, through its role as the nodal agency of the Hyderabad Science and Technology Cluster, has been key in helping Telangana realise the vision that Shri Jayesh Ranjan refers to. With its vast experience in enabling networking and resource access, particularly in the areas in which this latest MoU is focused, RICH is in a unique position to bring the benefits of the MoU to Telangana.



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Shri Ajit Ranganekar, Director of RICH, says, *"Our objective is to make Telangana a preferred location for academic partnerships for the life sciences, agriculture, and sustainability. Our partnership with the British Council is an initiative towards this objective and is aimed at creating synergies between the UK and India. Through these partnerships we hope to promote innovations and entrepreneurship in these sectors and create impact not just at a national, but a global level."*

The UK and India have been partners in progress for decades, supporting each other's changing visions in education, the arts, culture, and business. This new MoU under the ambit of the Science and Technology Clusters of India will deepen UK–India ties, broadening the scope of association between the two countries, expanding the horizons for education, research, and innovation in Telangana.

INDUSTRY–ACADEMIA ENGAGEMENT

Bringing Industry into the IITs: PSA Office Launches Crucial New Centres of Excellence for Industry–Academia Engagement

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When industry and academia collaborate, when the country's best minds and resources come together, their strengths are synergized, creating an efficient research and development (R&D) ecosystem for solving complex challenges.

This is why the Office of the PSA's Strategic Alliances Division was created to facilitate R&D collaboration between industry and academia, with the aim to tackle some of India's most pressing ground-level issues such as hygiene, sanitation, water shortage, waste management, and renewable energy.

The CoEs are hosted at premier institutions in the country, such as the IITs, NITs, IISERs, IISc, CSIR Labs, etc., but are driven by industry partnership.

They are tasked with developing, testing, and deploying technologies in real conditions—thereby providing comprehensive technological solutions from ideation to application—in addition to skill and capacity building.

The Strategic Alliances Division performs this function for two key areas—'emerging technologies' and 'science, technology, and innovation aligned with sustainable development goals (SDGs)'—through several mechanisms, a major one being the creation of centres of excellence (CoEs) to mobilise support from industry partners for academic research.

In 2022, the Office of the PSA launched new CoEs at three IITs:

Global Sanitation Centre of Excellence at IIT Palakkad

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The Global Sanitation Centre of Excellence at IIT Palakkad was established in January 2022 at the Technology Innovation Foundation (TECHIN) of IIT Palakkad, in collaboration with the International Association of Plumbing and Mechanical Officials (IAPMO), Toilet Board Coalition, Eram Scientific, and several NGOs working in sanitation and for the underprivileged.

Work at the CoE will involve reducing pollutants and pathogens in water; extracting energy, useful chemicals, and bio-fertilizers from sanitation waste; localising sewage water treatment technology; improving energy efficiency for these processes; finding safe, clean, and sustainable sanitation solutions; reducing the need for manual scavenging; and creating livelihood opportunities for the women and underprivileged in the sanitation sector.

Dr. Nimish Shah, Managing Director at IAPMO explained an additional role of the CoE: *"Our goal is to skill over 10,000 individuals in the next 5 years, scale technologies that contribute to reducing greenhouse gas emissions, harness nutrient and energy resources trapped in the sanitation value chain, and improve the efficiency of energy and water utilisation."*

AquaMAP at IIT Madras

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AquaMAP is an interdisciplinary water management and policy centre launched in March 2022 with support from IIT Madras Alumni. The aim at the centre is to tackle the numerous problems underlying chronic water crises in India through smart and sustainable technological and policy solutions.

For instance, Shri V. Kamakoti, Director of IIT Madras, noted that *one of the main focus areas of the centre will be agricultural water use efficiency because water consumption in the agricultural sector is the greatest of all.*

The faculty at AquaMap will develop and implement these solutions in collaboration with other water and sustainability research centres already present at IIT Madras, such as Sutram and the International Centre for Clean Water.

Over the medium to long term, the plan is pilot scalable solution models on the ground, set up a state-of-the-art hydro-informatics laboratory, and put in place an alumni and community engagement system.

Global Centre of Excellence in Affordable and Clean Energy at IIT Dharwad

While the aforementioned two centres will help India meet UN SDG 6—Clean Water and Sanitation—the Global Centre, launched in January 2022, will help meet UN SDG 7.

The centre is supported by Honeywell's corporate social responsibility arm and collaborates with SELCO Foundation for grassroots-level problem identification and implementation.

At the launch, Prof. S.R.M. Prasanna, Dean, Research and Development at IIT Dharwad, elaborated on the scope of work at the centre, *which is primarily to develop, optimise, and deploy affordable clean energy technologies from India's wealth of solar, wind, and biomass resources.*

This centre will be a key contributor the nation's larger goal of meeting 50% of India's energy needs through renewables by 2030.

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The industry–academia collaborations facilitated by the Strategic Alliances Division have yielded several success stories. With more CoEs already in the pipeline this year, and calls for applications for CoEs from stakeholders in various fields, the number of success stories will surely continue to grow in the years to come.

EVENTS

Stakeholder Workshop on E-waste Management in Smart Cities

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On May 10th, 2022, the Office of Principal Scientific Adviser and the Smart Cities Mission jointly conducted a workshop intending to create a draft zero of the working advisory for e-waste management in smart cities. Before the workshop, they surveyed 37 participants across government, research institutions, academia, and multilateral organisations. The survey had questions on the life cycle of e-waste, and its results helped initiate the discussion during the workshop.

The workshop provided a platform for stakeholders to share their strengths, priorities, perspectives, and expectations. The document developed as the draft zero of the working advisory will be continuously updated using feedback from experts. It is expected to direct a few pilots on e-waste management in smart cities.

Adventures of Dadu, Mitti, and Samosa

To learn more about

- Rich flora and fauna of India, visit the India National Biodiversity Mission
- Various butterfly species in India, visit the Butterflies of India website

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