Reaching out with science

Here's a look at the five Indian finalists of the *Science Slam*, an annual international science communication competition funded by the European Union

Padma Narayanan, Priyanka Dasgupta, Ananya Rakshit, Mayur Bonkile and Calvin Warjri (*front row*); Prof N Rajendran (Anna Univ, Chennai) Ainhitze Bizkarralegorra Bravo (EURAXESS India), Prof Arnab Bhattacharya (TIFR Outreach) and Dr Sabeena Mannilthodi (Cochin Univ, trainer)

S ANANTHANARAYANAN

On Friday, Kolkata will see five young scientists displaying skills in presenting their work to a lay-person audience. The event is the India finals of Science Slam, an annual international science communication competition that is conducted by *EURAXESS*, a European Union-funded resource of information and support to researchers who would like to work in Europe.

EURAXESS has centres for the Asean, Latin America and the Caribbean, India, China, Japan and North America and the centres work to link researchers in the regions with institutes in Europe. The centres are resources of information, a place to seek or advertise academic or job positions, to find support for relocating to and integrating with Europe and to seek funding. While applicants need to manage their admission to institutes of their choice, it is significant that *EURAXESS* selects the researchers to be hosted to network, and awarded a fellowship to work in Europe, each year, through a contest not of science but of science communication.

The contest is open to researchers, or students pursuing a doctoral programme or a Masters' with a research component, in a swathe of disciplines, including the social sciences and humanities. Participation is through multimedia presentations that describe the fascination and importance of the field of work in a manner that has originality and impact, before a group of mixed, essentially non-specialist viewers. The presentations are bundled in videos and submitted for shortlisting, before they are presented in person, at the finals.

In Science Slam India, the best videos from different zones have been selected by a specialist jury and in the finals in Kolkata on 8 December; the winner would be decided not by a panel of judges but by the vote of the audience.

At an all-day event in Chennai in November, the five finalists and over 70 others attended a workshop on science communication, conducted by Professor Arnab Bhattacharya of Tata Institute of Fundamental Research, Mumbai. The contest is now to convey the science behind an area of research in a way that takes the viewer by surprise and conveys to her the excitement and the fascination of the field, all in one racing, gripping presentation. The paragraphs that follow are about the five finalists in India, from institutes at Mumbai, New Delhi, Bengaluru and Shillong, selected for their superlative skill in communicating their science.

Mayur Bonkile is a mechanical engineer working at IIT-Mumbai. His abiding interest is simulation and building models of systems that store energy, and he would present the story of his work with the lithium-ion battery. This device, which powers our cell phones and electric automobiles,

has a large storage capacity which can be recharged quickly and time and again. Such a device is clearly the answer to the problem with solar and wind energy, which are emission-free but intermittent.

While electric cars can be only as efficient as the plants that generate the electricity to charge batteries, better batteries enable taking advantage of the efficiency of generating electricity in large power plants, compared to the efficiency of the petrol or diesel engine. With such an important role to be played, the very limits of efficiency, cost and safety of Li-ion batteries need to be attained. There is hence intense research the world over and manufacture and maintenance of the Li-ion battery will soon be a huge industry. A major concern is the cost of the Li-ion battery whose replacement cost can be as much, per kilometre of use, as the cost of the electricity consumed.

Priyanka Dasgupta is a zoology student in Delhi University and she is passionate about collaborative research, science communication and being with nature. She is clearly a reflective, communications person and the title of her presentation: Inside the brain - the effect of theatre language, literature, art, psychology and intense communication with a dynamic group and within a short spell, usually less than a couple of hours. And then, the advances in neurology and psychiatry and studies on the brains of birds and animals have discovered pathways within the labyrinth of cognition.

A presentation by one who dabbles in all these areas, to discover a link of expression in theatre with the development of the brain and understanding and then creativity is sure to prove fascinating. Would she answer the question of whether the reaction of a responsive audience affects the brain of a theatre person?

Padma N is an experienced teacher and popular senior lecturer in chemistry at New Horizon College of Engineering, Bengaluru. Her presentation, "Correlation of Soil and Corrosion Science", suggests something multidisciplinary and relates at once to a resource under pressure and effects that attack things and materials. We speak, of course, of soil and contaminants or harsh media that wear things away.

Calvin Warjri, from North Eastern Hill University, in Meghalaya is a gifted photographer and wildlife and nature enthusiast. We live in troubled times, when too many people and industries are filling the air and our waters with waste and pollution. A diet, which includes fish, would help us combat much of the stress that our health is under and fish is also a source of necessary protein in many parts of the world.

Calvin is a researcher whose work is close to the environment. When he speaks about how the environment has affected an important dietary component, his lens is sure to take in different viewpoints — biological, public health, responsible living and the environmental.

Ananya Rakshit is a doctoral student at TIFR, Mumbai. Her work is with Alzheimer's disease, a progressive degeneration of neurons in the brain. The disease affects the cognition and motor ability of nearly 30 million people worldwide. About six per cent of people over the age of 65 are said to be affected.

Alzheimer's, along with other conditions like Parkinson's and ALS, arises from changes at the molecular level in nerve cells and answers could be useful in many areas of medical science and even outside the medical field. The presence of trace elements like manganese, iron, copper, and some others are sometimes pivotal in the initiation and progress of life processes.

Ananya's take, entitled, "Catch the excess copper", by a person engaged in this field since the last five years should set us thinking!

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PLUS POINTS

Expectation defying

Nasa just spotted a planet that they didn't think could exist. The world, known as Wasp-18b, is wrapped in a stratosphere full of carbon monoxide and with no water at all. That suggests that it might have formed in an entirely different way from the gas giants we have known before.

"The composition of Wasp-18b defies all expectations," said Kyle Sheppard of Nasa's Goddard Space Flight Center in Greenbelt, Maryland, lead author of the paper published in the *Astrophysical Journal Letters*. "We don't know of any other extra solar planet where carbon monoxide so completely dominates the upper atmosphere."

On Earth, the stratosphere keeps us safe from dangerous rays from the Sun. Ozone absorbs UV, which means that much of the otherwise harmful radiation is kept out and doesn't land on us. Other planets tend to have a different molecule like titanium oxide, which is used for a variety of different purposes on Earth.

Nasa scientists examined the surface of the planet by looking at the light that comes to us from it, which is found 325 lightyears away. From that light they can work out the "spectral fingerprints" of the makeup of the planet — looking out for signatures that could suggest the planet has water or other important molecules.

But they didn't find any water on the planet, even after repeated looks at it from the Hubble space telescope. The fingerprints they got back didn't match any of the materials they expected to see there — and challenge their current understanding of how planets can form.

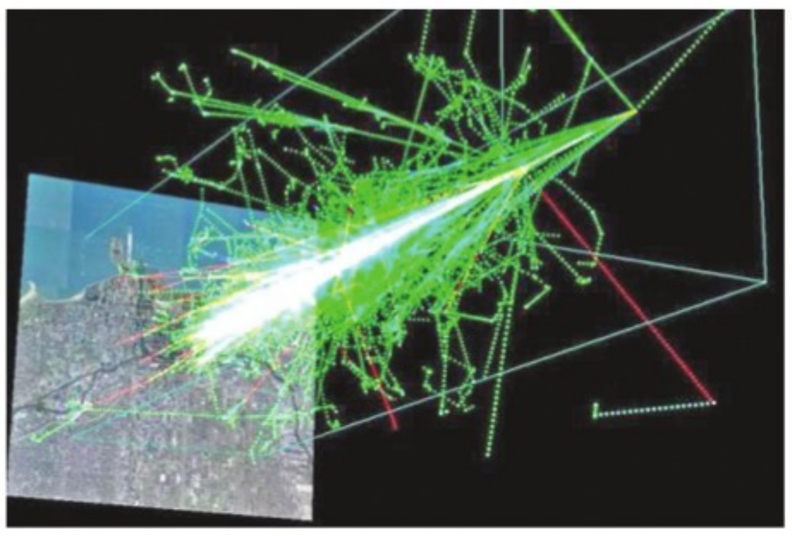
"The only consistent explanation for the data is an overabundance of carbon monoxide and very little water vapour in the atmosphere of WASP-18b, in addition to the presence of a stratosphere," said Nikku Madhusudhan a co-author of the study from the University of Cambridge. "This rare combination of factors opens a new window into our understanding of physicochemical processes in exoplanetary atmospheres."

Scientists now hope that they can find out yet more about WASP-18b and other planets like it. If they can understand more about the make-up of the strange world, then it might change their understanding of how gas giants can form.

The Independent

When lightning strikes

This is how thunderstorms trigger nuclear reactions in the atmosphere



A simulation of a cosmic ray shower formed when a proton hits the atmosphere about 20 kilometres above the ground

JIM WILD

Thunder and lightning have sparked awe and fear in humans since time immemorial. In both modern and ancient cultures, these natural phenomena are often thought to be governed by some of the most important and powerful gods — Indra in Hinduism, Zeus in Greek mythology and Thor in Norse mythology.

We know that thunderstorms can trigger a number of remarkable effects, most commonly power cuts, hailstorms and pets hiding under beds. But it turns out we still have things to learn about them. A new study, published in Nature, has now shown that thunderstorms can also produce radioactivity by triggering nuclear reactions in the atmosphere.

This may sound like the plot of a blockbuster science-fiction disaster. But in reality, it's nothing to worry about. Since the early 20th century, scientists have been aware of ionising radiation — particles and electromagnetic waves that can damage cells — raining down into the Earth's atmosphere from space. This radiation can react with atoms or molecules, carrying enough energy to liberate electrons from either atoms or molecules. It therefore leaves behind an "ion" with a positive electrical charge.

Just over a century ago, the Austrian physicist Victor Hess made measurements of ionisation in a hot air balloon five kilometres above the Earth's surface. He noted that the ionisation rate increased rapidly with height, the opposite of what might be expected if the source of the ionising radiation was coming from the ground. Hess therefore concluded that there must be a source of radiation with very high penetrating power located above the atmosphere. He was named co-recipient of the Nobel Prize in Physics in 1936 for his discovery, later dubbed 'cosmic rays'.

We now know that cosmic rays are made up of charged particles: primarily, electrons, atomic nuclei and protons — the latter make up the nucleus along with neutrons. Some originate from the sun, while others come from the distant explosions of dead stars in our galaxy, known as supernovas. When these cosmic rays enter the Earth's atmosphere, they interact with atoms and molecules to produce a shower of subatomic particles. Among these are neutrons, which have no electric charge.

It is these neutrons that make radiocarbon dating possible. Most carbon atoms have six protons and either six or seven neutrons in their nuclei (dubbed isotopes 12C and 13C respectively). However, neutrons produced by cosmic rays can react with atmospheric nitrogen to create 14C, a heavy and unstable isotope of carbon that, over time, will radioactively decay (split up while emitting radiation) back into nitrogen.

In nature, 14C is incredibly rare and makes up only about one in a trillion carbon atoms. But, apart from its weight and radioactive properties, 14C is basically identical to the more common carbon isotopes. It oxidises to form carbon dioxide and enters the food chain as plants absorb the radioactive CO_2.

The ratio of 12C to 14C in a given organism will start to change when that organism dies and ceases to ingest carbon. The 14C already in its system then starts to decay. It's a slow process since 14C has a radioactive half-life of 5,730 years, but it is predictable, meaning that organic samples can be dated by measuring the ratio of 12C to 14C still remaining.

In this way, cosmic rays are responsible for nuclear reactions in the Earth's atmosphere. Until today, we thought it was the only natural channel producing radioactive elements such as 14C. The word "nuclear", so sinister when partnered with "bomb" or "waste", simply refers to the changes that are brought about in an atomic nucleus.

Almost 100 years ago, the renowned Scottish physicist and meteorologist Charles Wilson proposed that thunderstorms could also trigger nuclear reactions in the atmosphere. Wilson, who undertook fieldwork at the isolated meteorological observatory on the summit of Ben Nevis, Britain's highest mountain, was fascinated by thundercloud formation and atmospheric electricity. However, his suggestion predated the discovery of the neutron — one of the tell-tale products of nuclear reactions — by seven years, so his proposal could not be tested.

Since Wilson's time, there have been many studies that have claimed to have detected thunderstorm-produced neutrons, but none have proven to be definitive. Others have searched for energetic electromagnetic radiation (X-rays and gamma rays) that accompanies the avalanche of high-energy electrons that we know is produced by lightning in thunderclouds. Calculations show that these electrons and gamma rays can knock neutrons out of nitrogen and oxygen in the atmosphere. But although the X-ray and gamma rays have been observed, there has never been a direct observation of the consequent nuclear reactions taking place in a thunderstorm.

The new study uses a different approach. Instead of searching for the elusive neutrons, the authors rely on other by-products of the nuclear reactions. If electrons and gamma rays cause unstable isotopes of nitrogen and oxygen to be formed by nuclear reactions following a lightning stroke, these should decay after a few minutes to form stable isotopes of carbon and nitrogen.

Crucially, this decay produces a particle known as a "positron", the "antimatter" version of the electron. All particles have antimatter versions of themselves — these have the same mass but the opposite charge. When antimatter and matter come in contact, they annihilate in a flash of energy. This is the energy the researchers looked for. Using radiation detectors looking over the Sea of Japan, they observed the unambiguous gamma-ray fingerprints of positron-electron annihilation taking place immediately after lightning strikes in low winter thunderclouds. This is clear evidence of nuclear reactions taking place in thunderclouds.

These results are important as they demonstrate a previously unknown source of isotopes in the Earth's atmosphere. These include carbon-13, carbon-14 and nitrogen-15 but future studies may also reveal others, such as isotopes of hydrogen, helium and beryllium.

The findings also have implications for astronomers and planetary scientists. Other planets within our solar system have thunderstorms in their atmospheres that might contribute to the composition of their atmospheres. One of these planets is Jupiter, which is fittingly also the god of thunder in ancient Roman mythology.

The writer is a professor of space physics at Lancaster University, UK

The Independent

Stronger then

Prehistoric women had stronger arms than modern-day rowers, likely due to the rigours of early farming, which included tilling fields and grinding grain by hand, researchers said last week.

The study in the journal *Science Advances* is the first to compare the bones of women who lived 7,000 years ago in Central Europe to women of today — specifically championship rowers and British college students. Previous studies have compared female to male bones, but this approach likely underestimated the workload of women because men's bones "respond to strain in a more visibly dramatic way than female bones," said the report.

Repeated exercise, or lack of it, can affect bone density, curvature and shape. Researchers found that the arm bones of Neolithic women — who lived from 7,000 to 7,400 years ago — were 11to 16 per cent stronger for their size than rowers from the elite Cambridge University Women's Boat Club. These rowers are mostly in their early twenties and have been training for seven years. Each week they practice for 21 hours and row an average of 120 km.

The primitive female farmers' arms were almost 30 per cent stronger than typical Cambridge students, said the report. "By interpreting women's bones in a female-specific context we can start to see how intensive, variable and laborious their behaviours were, hinting at a hidden history of women's work over thousands of years," said lead author Alison Macintosh of Cambridge University.

The Straits Times/ANN