Scientists take to the ramp

A GROUP OF YOUNG RESEARCHERS DISPLAYED THEIR SKILLS IN REACHING OUT TO THE UNTUTORED AT THE INDIA FINALS OF SCIENCE SLAM IN BENGALURU RECENTLY, REPORTS **S ANANTHANARAYANAN**

Science Slam is an international communication competition that is conducted by Euraxess, a European Union-funded resource of information and support to researchers who are working or intending to work in Europe. The competition challenges young scientists to create a live, multimedia-assisted presentation that captures the interest of a mixed audience and explains an area of research to them in simple language with precision and imagination. The contest, which is in its third year, is open to early career researchers in any discipline, including social sciences and humanities. Winners are selected from each of six regions — the Association of South-East Asian Nations, India, Japan, China, Brazil and North America — and the worthy one in each region travels to work and interact in one of Europe's top research institutes.

The inspiration, as Ainhitze Bizkarralegorra Bravo, Euraxess country head, Denis Dambois, head of research and innovation, EU delegation to India, and Arnab Bhattacharya, scientist and science communicator at the Tata Institute of Fundamental Research, Mumbai, explained, was to get scientists to move out of their labs and talk to common people in ways that they would understand, so that everybody could share in the work of scientists, and, as Bhattacharya put it, people could know where their taxes were going.

The live event at Bengaluru was the finals of the contest for India, held in the auditorium of Alliance Française, after many rounds of reviewing videos of presentation by researchers from across the country. Proceedings were judged not by the review committee but by a live audience consisting of students, other researchers, teachers, industry persons and also those from other walks of life. The grading was in respect of clarity, structure, imagination and creativity and originality. A brief account of the presentations of the six finalists follows.

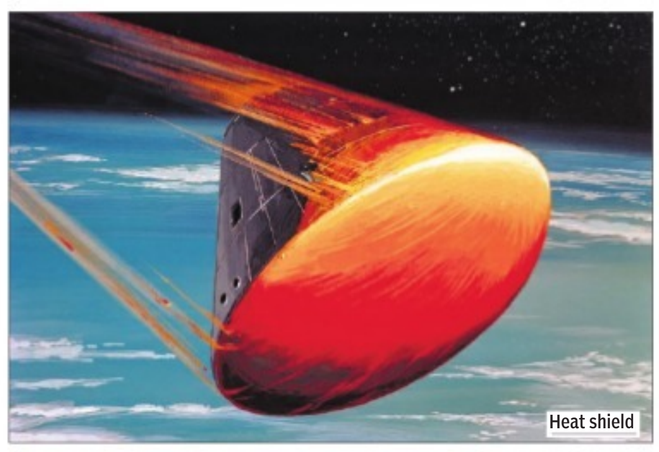

Sumeet Kulkarni (left to right), Varsha Varnakantha, Abhilasha Kumar, Naresh Salokar, Souvik Manda and KKN Anbuselvan.

KKN Anbuselvan from the Indian Institute of Science, Bengaluru, opened with asking who in the audience would like to travel in space.

While there were many daring ones who responded, he wished them a happy flight but said that re-entry to earth was perhaps more challenging. This brought him to the topic of his work, the heat generated when a spacecraft returns to earth. Although the atmosphere is thin at high altitudes, the returning craft moves so fast that the temperature rises to many thousand degrees, which no known material can stand for long. But the instruments in the craft, as well as the astronauts, are protected by the "heat shield" that has special refractories and insulators. At these temperatures, Anbuselvan explained, the molecules in the air broke up into bits of charged particles and the flow of these charges jammed radio communications, anyway.

The subject of his research, he explained, was to see if the heat shield could be magnetised so that it affected the flow of charged particles, which could lead to less generation of heat. Theory said this could be done, but they were working on doing it in practice, he said.

Sumeet Kulkarni from the Indian Institute of Science Education and Research and also the Inter-University Centre for Astronomy and Astrophysics, both at Pune, works in the area of detecting gravity waves. Explaining Einstein's conception of the force of gravity being, in fact, a distortion of the fabric of space because of the presence of bodies that have mass, Kulkarni explained that when masses moved back and forth, or oscillated, they set off feeble waves of gravity. But these were feeble indeed, even when the objects were the most massive in the universe, the black holes or neutron stars, the changes in distance because the gravity waves were of the order of a millionth of a billionth of a millimetre. Measuring such a change to check if it happened at the time a pair of black holes somewhere in the universe had collided and exploded called for an arrangement with sensors placed over 3,000 km apart, an arrangement called Laser Interferometer Gravitational-wave Observatory. And as a blip in the distance being measured could occur at any instant, Ligo was linked to synchronised telescopes to catch a visual glimpse of the fleeting cosmic event, Kulkarni said.


Heat shield

Abhilasha Kumar from Ashoka University, Sonepat, studies the nature of dysnomia, or a marked difficulty in remembering names, which could be an early stage of Alzheimer's disease. Kumar explained that objective testing for memory loss was not possible through recall of general lists of objects, words, etc, but had to be in respect of what actually mattered to individuals. A special software package, called Cell, developed by Stanford University, was able to analyse the email record of a person to arrive at a list of words whose recall could more accurately reflect the working of the person's memory. A great problem in Alzheimer's was that physical changes were at advanced stages by the time these were detected. The use of Cell may be able to clinically detect dysnomia or features of memory loss at the very early stages to help possible victims of Alzheimer's to take measures to adapt and, hopefully, to alleviate symptoms, Kumar said.

Varsha Varnakantha from the National Institute of Nutrition, Hyderabad, works on genetic features that make people likely to develop high blood pressure. Explaining that more than 25 per cent of Indians suffered from this disease, she said that one positive role played by Vitamin D, in which 68.5 per cent of Indians were deficient, was to control blood pressure. She then explained that the tendency to lack Vitamin D was associated with features in certain portions of the DNA, the profiling of which in people may then be a good way to alert those at risk and help them take measures, like exercise and exposure to sunlight, she said.

Naresh Salokar of the Central Institute for Research on Buffaloes, Hissar, is involved in animal cloning to make the best stud bull available to the dairy industry. It was by selecting the best mate for the female that the best quality and quantity of milk could be assured, he said. The audience was visibly surprised to hear that the prize bull from the Sonepat Institute was valued at Rs 7 crore and that Rs 25 lakh had been paid for a female buffalo.

As the prices would indicate, the best strains of buffalos and, particularly, studs were in short supply, he said. The institute was, hence, perfecting the techniques of transferring genetic material, body cells, of prize stock, into egg cells from a female to create embryos that would grow to term.

Souvik Mandal from the Centre for Ecology at Indian Institute of Science, Bengaluru, described his work on how the common wasp was able to find its way back to its nest. Unlike the bee, which was a honey collector that moved from flower beds to the nest, the wasp was a predator that found prey over a wide area and its navigation, usually over distances of 300-500 metres, was more complex, he said. The wasp was even able to get back to the nest when released 1,000 metres away and, considering the size of the wasp, such a distance was like 175 km for a human, he said.

Mandal described his research, which involved marking wasps with coloured spots and then releasing them at different places, and then taking a census when they were back in the nest. He described a spiral flight pattern of the wasp as it moved away from the nest, which helped it navigate. It was also found that wasps appeared more confident when they were in familiar surroundings and also as they grew older, he said. "The research has the potential of showing how the simple brain of the wasp functions, which would have lessons for application in other navigational problems," he added.

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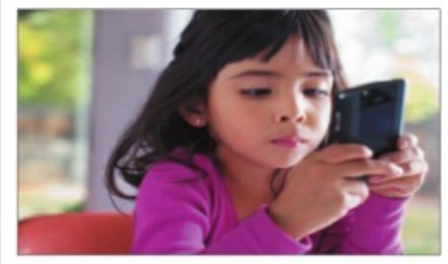
Cloned buffalo

PLUS POINTS



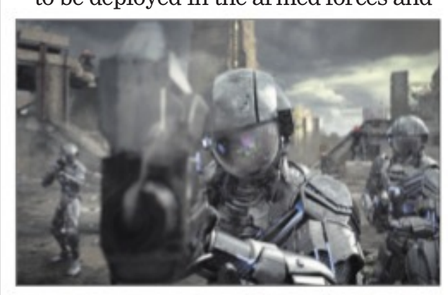
Digital parenting

It can be argued that digital information is inadequate to generate solutions for the complications faced by parents these days. But it can help to a degree especially with the advent of advanced technological platforms like the Kid Social Shell app. Hemant Soni, co-founder of KIDSS says, "At a time when every third individual in the world is under 15 years of age and 75 per cent of children below 8 years are using smart phones, mobile phone-based learning is the way forward."

KIDSS is a one-stop solution for all those who are invested in a child's growth—parents, grandparents, teachers and caregivers. With such a platform, parents can keep a tab on their performance and discuss their progress with experts, even from foreign shores. Digital platforms also help in tracking activities and safeguard children from malicious channels as unrestricted access to the Internet can often adversely affect a child. In KIDSS, parents can connect with people who have specialisation degrees on child behaviour, counselling, dietary planning, pre and post pregnancy fitness and child nutrition among others.

Robot runners

A team of researchers from the USA and Germany has now found a way to make robots walk and run just as we do, thereby opening the doors for them to be deployed in the armed forces and



in other services. "We have basically demonstrated the fundamental science of how humans walk," said 0Jonathan Hurst, professor at Oregon State University. "Other robotic approaches may have legs and motion, but do not really capture the underlying physics."

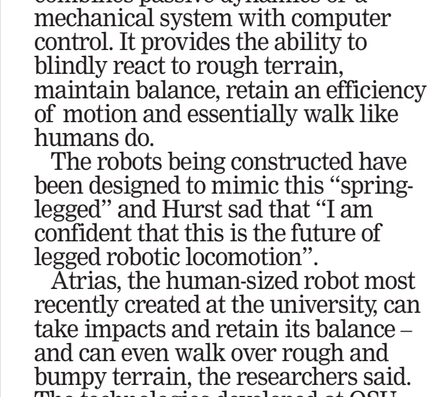
The system is based on a concept called "spring-mass" walking that was theorised less than a decade ago and combines passive dynamics of a mechanical system with computer control. It provides the ability to blindly react to rough terrain, maintain balance, retain an efficiency of motion and essentially walk like humans do.

The robots being constructed have been designed to mimic this "spring-legged" and Hurst sad that "I am confident that this is the future of legged robotic locomotion".

Atrias, the human-sized robot most recently created at the university, can take impacts and retain its balance – and can even walk over rough and bumpy terrain, the researchers said. The technologies developed at OSU have evolved from intense studies of both human and animal walking and running, to learn how the latter achieve a fluidity of motion with a high degree of energy efficiency. The current technology, Hurst said, was still a crude illustration of what the future may hold. The findings appeared in the journal *IEEE Transactions on Robotics*.

Sonic tractor beam

Researchers, including one of Indian-origin, have built the world's first sonic tractor beam that can lift and move objects using sound waves. These beams are mysterious rays that can grab and lift objects and the concept has been used by science-fiction writers and programmes like *Star Trek* that since came to fascinate



scientists and engineers.

A working tractor beam that uses high-amplitude sound waves to generate an acoustic hologram has been created that can pick up and move small objects. "In our device we manipulate objects in mid-air and seemingly defy gravity," said one of the researchers, Sriram Subramanian, professor of informatics at the University of Sussex in England. "We individually control dozens of loudspeakers to tell us an optimal solution to generate an acoustic hologram that can manipulate multiple objects in real-time without contact," Subramanian explained. The findings were detailed in the journal *Nature Communications*.

CANCEROUS PROTEINS

MOST ONCOGENES CODE FOR COMPONENTS OF GROWTH SIGNALLING PATHWAYS, WRITES **TAPAN KUMAR MAITRA**

How do oncogene-encoded proteins cause cancer? Although more than 100 different oncogenes have been identified till date, most of the proteins they produce fit into one of six categories— growth factors, receptors, plasma membrane GTP-binding proteins, non-receptor protein kinases, transcription factors, and cell-cycle or cell-death regulators. Let's cast a glance at how these oncogene-produced proteins, all related to steps in growth signalling pathways, contribute to the development of cancer.

First, in a normal scenario cells will not divide unless they have been stimulated by an appropriate growth factor. But if a cell possesses an oncogene that produces such a growth factor, it may stimulate its own proliferation. One oncogene that functions in this way is the v-sis gene ("v" means viral) found in the simian sarcoma virus that causes cancer in monkeys. The v-sis oncogene codes for a mutant form of platelet-derived growth factor. A PDGF-related oncogene has also been detected in some human sarcomas.

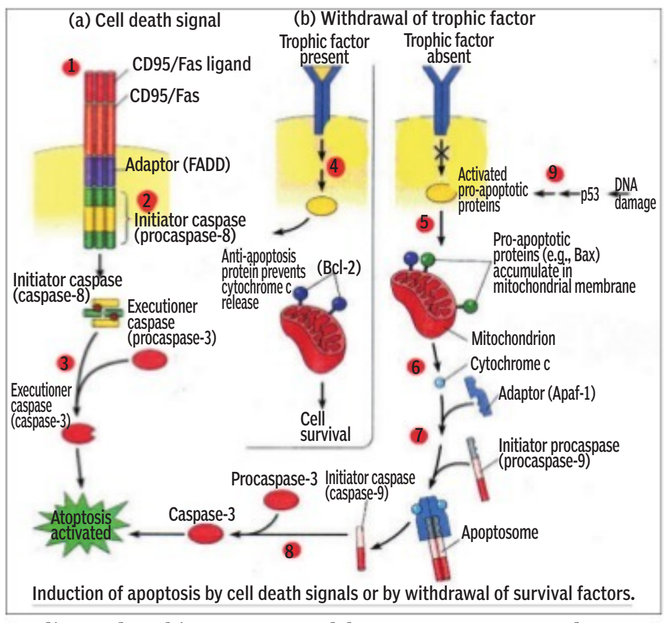
Thereafter, several oncogenes produce receptors that are involved in growth signalling pathways. Many receptors exhibit intrinsic tyrosine kinase activity that is activated only when a growth factor binds to the receptor. Oncogenes sometimes code for mutant versions of such receptors whose tyrosine kinase activity is permanently activated, regardless of the presence or absence of a growth factor— the TRK oncogene is one. Another is the v-erb-b oncogene, which is found in a virus that causes a red blood cell cancer in chickens. Other oncogenes produce normal receptors but in excessive quantities, which can also lead to hyperactive growth signalling. An example is provided by the human ERBB2 gene.

Next, the binding of a growth factor to its receptor leads to activation of the plasma membrane, GTP-binding protein called *ras*. Oncogenes coding for mutant *ras* proteins are the most common type of oncogene detected in human cancers. The point mutations that create *ras* usually cause a single incorrect amino acid to be inserted at one of three possible locations within the protein. The net result is a hyperactive *ras* protein that retains bound GTP, thereby maintaining the protein in a permanently activated state. In it, the *ras* protein continually sends a growth-stimulating signal to the rest of the pathway, regardless of whether the growth factor is bound to the cell's receptors.

A common feature shared by many growth signalling pathways is the use of protein phosphorylation reactions to transmit signals within the cell. The enzymes that catalyse these intra-cellular phosphorylation reactions are referred to as nonreceptor protein kinases to distinguish them from the protein kinases that are intrinsic to cell surface receptors. For example, in the case of the *ras* pathway, the activated protein triggers a cascade of intracellular protein reactions, beginning with phosphorylation of the *raf* protein kinase and eventually leading to the phosphorylation of *map* kinases.

Some of the activated non-receptor protein kinases subsequently trigger changes in transcription factors, thereby altering gene expression. Oncogenes that produce mutant forms or excessive quantities of various transcription factors have been detected in a broad range of cancers. Among the most common are oncogenes coding for *myc* transcription factors, which control the expression of numerous genes involved in cell proliferation and survival. For example, *myc* gene amplification is frequently observed in small-cell lung cancers and, to a lesser extent, in a wide range of other carcinomas, including 20-30 per cent of breast and ovarian cancers.

In the final step of growth signaling pathways, transcription factors activate the expression of genes coding for proteins involved in cell proliferation. The activated genes include those coding for cyclins and cyclin-dependent kinases— several human oncogenes produce proteins of this type. For example, a cyclin-dependent kinase gene called *cdk4* is amplified in some sarcomas, and the cyclin gene *cycd1* is commonly amplified in breast cancers and is altered by chromosomal translocation in some lymphomas. Such oncogenes produce excessive amounts or hyperactive versions of *cdk*-cyclin complexes, which then stimulate progression through the cell cycle (even in the absence of growth factors).



Induction of apoptosis by cell death signals or by withdrawal of survival factors.

In a few cases, oncogenes contribute to the accumulation of dividing cells by inhibiting cell death rather than directly stimulating cell proliferation. One example involves the gene that codes for the apoptosis-inhibiting protein *Bcl-2*. Chromo-somal translocations involving this gene are observed in certain types of lymphomas. The net effect of such translocations is an excessive production of *Bcl-2*, which inhibits apoptosis and thereby fosters the accumulation of dividing cells.

Most oncogenes code for a protein that falls into one of the six preceding categories where the net result is a protein that stimulates the uncontrolled accumulation of dividing cells.

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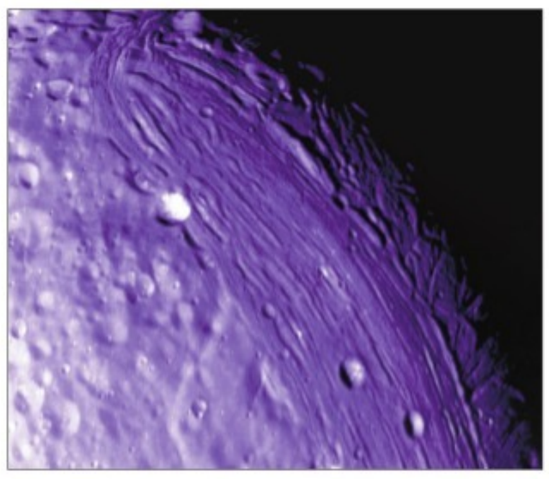
A 'Frankenstein moon'

MATT WILLIAMS PROFILES ONE OF URANUS' MYSTERY SATELLITES



Ever since the *Voyager* space probes ventured into the outer Solar System, scientists and astronomers have come to understand a great deal. In addition to the four massive gas giants that call this region home, a great deal has been learned about the many moons that circle them and, thanks to photographs and data obtained, humans as a whole have come to understand just how strange and awe-inspiring the Solar System really is.

This is especially true of Miranda, the smallest and innermost of Uranus' large moons — and some would say, the oddest-looking! Like the other major Uranian moons, its orbits close to its planet's equator is perpendicular to the Solar System's ecliptic and, therefore, has an extreme seasonal cycle. Combined with one of the most extreme and varied topographies in the system, this makes Miranda an understandable source of interest!

Miranda was discovered on 16 February 1948 by Gerard Kuiper using the McDonald Observatory's Otto Struve Telescope at the University of Texas in Austin. Its motion around Uranus was confirmed on I March the same year, making it the first satellite of Uranus to be discovered in almost a century (the previous ones being Ariel and Umbriel, which were both discovered in 1851 by William Lassell).

Consistent with the names of the other moons, Kuiper decided to the name the object "Miranda" after the character in Shakespeare's *The Tempest*. This continued the tradition set down by John Herschel, who suggested that all the large moons of Saturn — Ariel, Umbriel, Titania and Oberon — be named after characters from either *The Tempest* or Alexander Pope' *The Rape of the Lock*.

With a mean radius of 235.8 plus or minus 0.7 km and a mass of 6.59 plus or minus 0.75 $\times 10^{19}$ kg, Miranda is 0.03697 times the size of earth and roughly 0.000011 as massive. Its modest size also makes it one of the smallest objects in the Solar System to have achieved hydrostatic equilibrium, with only Saturn's moon of Mimas being smaller.

Of Uranus' five larger moons, Miranda is the closest, orbiting at an average distance (semi-major axis) of 129,390 km. It has a very minor eccentricity of 0.0013 and an inclination of 4.232° to Uranus' equator. This is unusually high for a body so close to its parent planet — roughly 10 times that of the other Uranian satellites. Miranda is also the most diverse and extreme of all moons in the Solar System, with features that appear to be jumbled together in a haphazard fashion.

This consists of huge fault canyons as deep as 20 km, terraced layers and the juxtaposition of old and young surfaces seemingly at random. This patchwork of broken terrain indicates that intense geological activity took place in Miranda's past, which is believed to have been driven by tidal heating during the time when it was in orbital resonance with Umbriel (and perhaps Ariel).

This resonance would have increased orbital eccentricity and, along with varying tidal forces from Uranus, would have caused warming in Miranda's interior and led to resurfacing. In addition, the incomplete differentiation of the moon, whereby rock and ice were distributed more uniformly, could have led to an upwelling of lighter material in some areas, thus leading to young and older regions existing side by side.

Another theory is that Miranda was shattered by a massive impact, the fragments of which reassembled to produce a fractured core. In this scenario — which some scientists believe could have happened as many as five times – the denser fragments would have sunk deep into the interior, with water ice and volatiles setting on top of them and mirroring their fractured shape.

Overall, scientists recognise five types of geological features on Miranda, which includes craters, coronae (large grooved features), regiones (geological regions), rupes (scarps or canyons) and sulci (parallel grooves).

But given Miranda's "Frankenstein-like" appearance and the mysteries that still surround its history and geology, any future missions to study Uranus and its system of moons would be well-advised.