

Education, Research and Innovation News from India

September 2014

Introduction

Welcome to the September 2014 edition of the Education, Research and Innovation News from India. In this edition we inform you of the successful introduction of an Indian spacecraft into orbit around the planet Mars, news from the fields of education, health, agriculture, materials and the environment. An opinion piece on India's education system, and suggestions on what has to be kept in mind if massive changes are to be envisaged, is also included. If there are other areas you would like to see covered in this newsletter, please let us know. *Happy reading!*

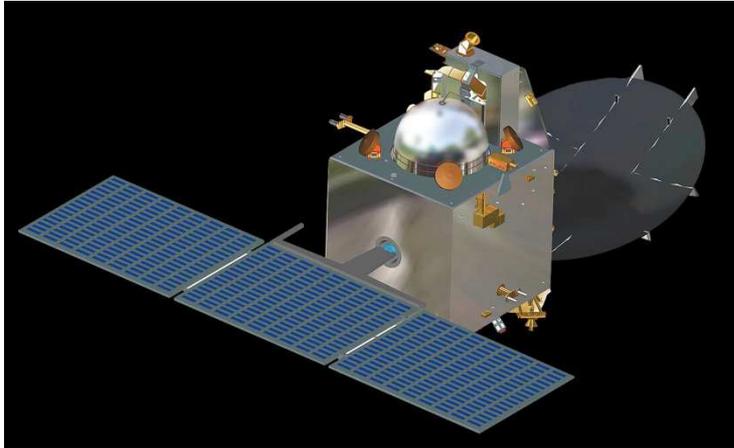
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Top news from India

Indian spacecraft enters Mars orbit

After a journey of 680 million kilometres, which lasted 10 months, India successfully placed its indigenously developed spacecraft, *Mangalyaan* (meaning Mars craft), in orbit around the Red planet on 24 September 2014. The journey began on 5 November 2013, when the Polar satellite Launch vehicle launched the Mars Orbiter Mission Spacecraft from India's satellite launch pad at Sriharikota on India's eastern seaboard.



India's Mars Orbiter Mission spacecraft
Photo: Indian Space Research Organisation

The objective of the first Indian mission to Mars is to develop the technologies required for design, planning, management and operations of an interplanetary mission. The technological objectives include designing and building a spacecraft which would cruise over 300 days in deep space, be captured by Martian gravity and orbit the planet. Deep space communications capabilities were also to be demonstrated (the one way communication delay is 718 seconds or approximately 12 minutes) as was the incorporation of autonomous features to handle contingencies.

The project took two years from conception to the capture of the spacecraft by Martian gravity and with this success the Indian Space Research Organisation (ISRO) joins the National Aeronautics and Space Agency (NASA) of the USA, the Russian Federal Space and the European Space Agency is having successfully placed a spacecraft on Mars or in orbit around it. The ISRO is the first agency to have succeeded on its first attempt. Built at a cost of INR 450 crores (US\$ 69M), this is also one of the cheapest missions to Mars. As a comparison, NASA's Mars Atmosphere and Volatile Evolution (MAVEN) spacecraft, which reached Mars two before *Mangalyaan*, cost US\$ 671.

ISRO's Mars mission has scientific objectives as well. The spacecraft carries five scientific payloads:

- Mars Colour Camera for optical imaging and providing information about the surface features and composition of Martian surface
- Thermal Infrared Imaging Spectrometer for mapping the surface composition and mineralogy
- Methane Sensor for detecting the presence of methane in the Martian atmosphere at the PPB level and detect its source.
- Mars Enospheric Neutral Composition Analyser to study the composition of Martian upper atmosphere and
- Lyman Alpha Photometer to measure the study the relative abundance of deuterium and hydrogen in the Martian atmosphere, which will allow us to understand especially why

Mars lost the liquid water that other observations have shown to have flown on the Martian surface in the past

Already the first images have arrived from *Mangalyaan*.



First image taken by *Mangalyaan* from a height of 7300 km; with a spatial resolution of 376m
Photo: Indian Space Research Organisation



Regional dust storm activities over Northern Hemisphere of Mars - captured by the Mars Color Camera from altitude of 74,500km
Photo: Indian Space Research Organisation

Mangalyaan has a planned life of 6 months. However, by not keeping to a very precise orbit around Mars, the saving in fuel may enable extending the operational life of the spacecraft to a year.

For more about the Mars project please visit <http://www.isro.gov.in/mars/home.aspx>

Education and skills development

India to revise its skills development policy

India will revise its national skill development policy of 2009 so that schemes of different ministries and portions of the INR 10,000 crore (CHF 1.5B approx.) earmarked to encourage entrepreneurship are routed through the newly formed skills ministry. Skill development is a focus area of the new government in India. The revised policy should be ready by the end of the year. Although no details were given on whether the government is going to scale up its 2009 target of providing vocational training to 500 million people by 2022, a numerical target was part of the inter-ministerial consultation.

The new Government has also *created* a new Department of Skills Development and Entrepreneurship within the Ministry of Skill Development, Entrepreneurship, Youth Affairs and Sports. The department has started work but is still in the ramping up phase. Decisions on which sections from other ministries will move to this Department have not all been taken yet. For example, the Skills Development Initiative of the Ministry of Labour will move, but the formal decision is still awaited. The responsibilities of this Department include the evolving an appropriate skill development framework, removal of disconnect between the demand for and supply of skilled manpower through vocational and technical training, skill up-gradation, building of new skills; mapping of existing skills and their certification; expansion of youth entrepreneurship education and capacity and setting national standards for it; doing market research and devising training curriculum in important sectors; providing industry-academia linkages; developing Public Private Partnerships; making broad policies for all other Ministries/Departments with regard to market requirements and skill development, framing policies for soft skills, the National Skill Development Corporation, the National Skill Development Agency and the National Skill Development Trust.

Source: LiveMint. For full text please visit

<http://www.livemint.com/Politics/TWjYw5qzFD5v6E6xqJfjtK/Modi-govt-to-revise-national-skill-development-policy.html>

India devising its own ranking system for higher academic institutions

Considering that Indian universities fare badly in international rankings, the Indian Ministry of Human Resource Development along with Indian Institutes of Technology will frame a ranking system exclusively for Indian institutions. An initial proposal is expected by the end of the year. The need to develop an India specific ranking system has been felt as the feeling is that top institutions do not figure in international rankings as they are felt to be skewed to technical and humanities universities and international parameters not being applicable to the Indian system. In addition to international parameters such as faculty-student ratio, publications, citations into account, weightage will also be given to industry-academic collaborations and social development, such as initiatives for people from diverse social backgrounds.

Source: Times of India. For full text please visit

<http://timesofindia.indiatimes.com/home/education/news/IITs-to-frame-India-specific-ranking-system/articleshow/43200590.cms>

Just 2% of ISRO's engineers are from IITs, NITs

While the Indian Space Research Organisation has made great strides in space, only 2% of its employees come from the premier Indian Institutes of Technology and the National Institutes of Technology. It would appear that ISRO's centralised recruitment system does not differentiate between an IIT graduate and one from another engineering college, looking instead at the fundamental strengths of the candidate and not the institution. Moreover, the Indian Institute of Space Science and Technology has been getting toppers as applicants since its inauguration in 2007. Collaborative research with colleges other than IITs and NITs have deepened engagement with students and made students aspire for a nationalist career at ISRO.

Source: Times of India. For full text please visit

<http://timesofindia.indiatimes.com/home/education/news/Just-2-of-Isros-engineers-are-from-IITs-NITs/articleshow/43458127.cms>

Health

High-sensitivity ferritin sensor

Researchers have fabricated a sensitive sensor that can detect minute traces of ferritin, a protein that stores iron in human blood¹. They developed the sensor by modifying nanoparticles consisting of silver and cadmium sulphide with ferritin molecules.

This sensor is potentially useful for measuring blood ferritin levels, which can be used to diagnose anaemia, iron overload, cancers and other diseases.

Existing sensors for detecting ferritin have low sensitivities. To develop a high-sensitivity ferritin sensor, the researchers synthesized nanoparticles with silver cores and cadmium sulphide shells. They then modified these nanoparticles with cysteine and imprinted them with ferritin molecules. Finally, they coated a pencil graphite electrode with the ferritin-imprinted core-shell nanoparticles.

They compared the ferritin-sensing efficiency with that of a sensor without ferritin. The researchers performed electrochemical measurements on the sensor by exposing it to phosphate buffer solutions with various ferritin concentrations. They found that the ferritin molecules in the solution bound to cavities on the sensor surface, which caused the current to increase with increasing ferritin concentration up to a concentration of 23 micrograms per litre.

When ferritin concentrations exceeded 23 micrograms per litre, the current became constant, indicating that all available cavities on the sensor surface were occupied by ferritin molecules. In optical measurements, the researchers found that the fluorescence intensity of the sensor decreased with increasing ferritin concentration. The sensor retained 95% of its initial sensing ability after three weeks.

Furthermore, the sensor selectively detected ferritin even in the presence of interfering agents such as amino acids and salts, which are usually present in human blood. The researchers successfully used this sensor to measure ferritin levels in blood samples from five men and women, suggesting its potential application in a clinical set-up.

Reproduced from Nature India

<http://www.natureasia.com/en/nindia/article/10.1038/nindia.2014.122>

Patra, S. et al. An imprinted Ag@CdS core shell nanoparticle based optical-electrochemical dual probe for trace level recognition of ferritin. Biosens. Bioelectron. 63, 301–310 (2015)

After eliminating polio, Indian Government targets measles

An ambitious drive to eliminate or control a host of diseases, including measles, which affects lakhs of people and leave many killed every year will be launched, India's Health Minister Harsh Vardhan has said. He said that the government was already working towards eliminating measles by 2015 and Rubella, also known as German measles, and 'Kala-azar' or black fever by 2015, filaria by 2015 and leprosy at the district level by 2017.

Source: the Hindu. For full text please visit

<http://www.thehindu.com/sci-tech/health/govt-to-launch-drive-to-eliminate-measles-other-diseases/article6457895.ece>

Agriculture

Wheat genome opens up new possibilities

The draft genome of wheat was recently sequenced by an international consortium of geneticists. The 'gold standard' sequence is expected to be created in three more years. In the meantime, Indian scientists are digging up some fascinating genetic traits of the cereal crop.

Following the release of the draft sequence of the wheat genome by the International Wheat Genome Sequencing Consortium in July this year, Indian scientists are now trying to pinpoint genes that make the cereal heat- and drought-tolerant. They are also looking for genes that will improve the grain to make better flour for chapattis and breads.

Scientists at the Ludhiana-based Punjab Agricultural University (PAU), National Research Centre on Plant Biotechnology (NRCPB) in New Delhi and University of Delhi, South Campus (UDSC) – all involved in the draft sequencing – are looking for genes that confer heat tolerance to wheat.

Kuldeep Singh, Director of PAU's agricultural biotechnology school and the project leader of the Indian team that sequenced chromosome 2A of the wheat genome says wheat, a staple crop world over, faces continuous challenges from diseases and environmental stresses. "With the sequence now available, these challenges can be targeted in a more efficient and specific way", Singh told *Nature India*.

Wheat is a heat sensitive plant, especially during the flowering and seed development stages. Estimates show that a 2°C rise in temperature could reduce wheat productivity by half. Global warming, therefore, poses a serious threat to wheat productivity. The draft genome has yielded a large number of very specific DNA sequences which can be used as 'tags' for identification of economically important genes such disease resistance genes, yield enhancing genes, nutritional quality genes and abiotic stress tolerance genes. These genes can be transferred from one wheat variety to another at costs much lower than prevalent, Singh says. India has spent about Rs 35 crore in the wheat genome project.

The PAU team is simultaneously trying to identify new genes that make the plant resistant to rusts and powdery mildew. The team is also looking at how to increase the iron and zinc content in wheat for nutritionally-rich varieties.

Meanwhile, NRCPB scientists are looking for genes for drought tolerance and genes that enhance the bread and chapatti-making quality of wheat. National professor at the centre and member of the sequencing team Nagendra Kumar Singh says they have identified several genomic regions associated with these traits.

"Heat tolerance is one aspect that needs urgent attention. After identification, the genes will need to be functionally validated, for which transgenic varieties will have to be raised," says Jitendra Paul Khurana of UDSC's Department of Plant Molecular Biology. The department has developed some protocols for wheat transformation and will compare some families of wheat genes encoding transcription factors and signaling components with other cereal crops. The studies will further basic understanding of the wheat biology, Khurana says.

The wheat genome has been considered a difficult sequencing candidate owing to its very large size – it is about six times the size of human genome. Chromosome 2A alone, on which the Indian scientists worked, is about 2.5 times the size of the whole rice genome. The wheat genome is an amalgamation of three different genomes from three different species, making it more complex.

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<http://www.natureasia.com/en/nindia/article/10.1038/nindia.2014.125>

Genome of nasty crop pest sequenced

Researchers in New Delhi have sequenced the draft genome of 'army worm' *Spodoptera frugiperda*, one of the most destructive agricultural pests responsible for crop damage in tropical and subtropical regions of the world¹.

This is the fourth genome publication from India (non-microbial) and the first without foreign collaboration, according to the researchers.

S. frugiperda belongs to the second largest order of insects called Lepidoptera that include butterflies. While the biology of other lepidoterans, such as *Danaus plexippus* and *Heliconius* had been studied earlier, there has not been much focus on the important pest *S. frugiperda* due to unavailability of its genome. A major limitation in obtaining extensive genetic data was the prohibitive costs associated with sequencing and assembling large eukaryotic genomes.

Now scientists at the International Centre for Genetic Engineering and Biotechnology (ICGEB) in New Delhi have generated and assembled a draft sequence for *S. frugiperda* using 'cost effective' Next-Generation Sequencing (NGS) platforms. They have annotated the sequenced genomic libraries against Reference Sequence Protein Database at the U.S. National Center for Biotechnology Information. "The use of three different NGS platforms significantly improved sequencing throughput and reduced costs," says Madavan Vasudevan of Bangalore-based Bionivid Technology that provided the NGS services to the ICGEB scientists.

"Globally this is one of the few publications where the whole genome sequencing and data analysis strategy involved multiple platforms enabling the scientists to complete the whole work in just 20 months," he told *Nature India*.

The researchers say their work would help understand the genetic basis of *S. frugiperda* biology and facilitate studies of comparative genomics and basic research leading towards genome based approaches for the control of this pest.

Reproduced from Nature India

<http://www.natureasia.com/en/nindia/article/10.1038/nindia.2014.121>

Kakumani, P. K. et al. A draft genome assembly of the army worm, *Spodoptera frugiperda*. *Genomics* 104, 134-143 (2014) doi: [10.1016/j.ygeno.2014.06.005](https://doi.org/10.1016/j.ygeno.2014.06.005)

Environment

Low oxygen triggers massive bloom outbreak in Arabian Sea

Scientists studying massive outbreaks of a new type of phytoplankton *Noctiluca scintillans* in the Arabian Sea report that the unnatural blooming event could be a result of oxygen-deficient waters and the plankton's ability to survive in such adverse conditions.

As to why the water is turning oxygen-deficient or hypoxic, the scientists have no clear answers but they suspect that rampant discharge of untreated sewage and other forms of polluted water into the sea could be the reason.

The team of scientists from Columbia University's Lamont Doherty Earth Observatory and Goa-based National Institute of Oceanography (NIO) and Goa University has been studying the flourishing *Noctiluca* population since 2009. They say the main drivers of the outbreak are the low oxygen waters and *Noctiluca*'s ability to photosynthesize food efficiently with the help of an organism that lives within its body – the 'endosymbiont' *Pedinomonas noctilucae*.

Menacing *Noctiluca* blooms have been appearing every year from January to March in the Arabian Sea with predictable regularity. First noticed in the early 2000s, the blooms have been spreading at a fast rate. *Noctiluca* is a large plankton which gets its green colour and unusual photosynthetic abilities from its endosymbiont.

The scientists sifted through historical data to find that *Noctiluca* was not prevalent in the Arabian Sea before the 2000s and common diatoms were the dominant phytoplankton during winter months. The appearance of *Noctiluca* in early 2000s coincided with oxygen deficiency in the Arabian Sea waters.

Between 1965 and late 1990s, oxygen saturation was always close to 100% or higher in this region. Since early 2000s, the saturation has fallen to below 70%. The scientists also found that *Noctiluca*'s ability to photosynthesize increased by 25-300% in hypoxic waters, in contrast to diatoms that showed a 3-fold decrease in photosynthetic ability in such waters. Apart from deriving its nutrition from photosynthesis, *Noctiluca* also feeds on the diatoms, directly competing with other predators of diatoms, the scientists report.

Globally, various such examples of change in the composition of marine habitats and species have been studied but they are mostly in the coasts. The "special cause for concern" in the Arabian Sea is that changes in its biota are occurring offshore and on a basin-wide scale, the scientists point out.

The biggest impact of the emergence of *Noctiluca* is a threat to the regional fishery-based livelihoods. The blooms are disrupting the traditional food chain. Earlier, diatoms were eaten by zooplanktons, which in turn were the food for small fish. Now, diatoms are being eaten by *Noctiluca*, which becomes the food for salps or jelly fish, explains S G Prabhu Matondkar, Emeritus Scientist at NIO, Goa.

Small fish prefer zooplanktons over salps or jelly fish, so this change affects their diet and yield. These small fish are a staple coastal food as also a means of livelihood for the local fishing community. A coastal population of 120 million people could be threatened if the region's fishery collapses, the researchers estimate.

Reproduced from Nature India

<http://www.natureasia.com/en/nindia/article/10.1038/nindia.2014.134>

Gomes, H. do R. et al. Massive outbreaks of *Noctiluca scintillans* blooms in the Arabian Sea due to spread of hypoxia. *Nat. Comm.* (2014) doi: [10.1038/ncomms5862](https://doi.org/10.1038/ncomms5862)

Antibacterial membranes for purifying water

Researchers have developed porous, antibacterial membranes from graphene oxide film and the common plastic polyethylene. These membranes are promising for purifying water contaminated with disease-causing bacteria.

The researchers used a technique called melt mixing to synthesize two membranes: one made from modified graphene oxide and polyethylene and the other from modified graphene oxide, maleated polyethylene and polyethylene. They then created microscopic pores in the membranes by mixing the membranes with polyethylene oxide, which they later rinsed out using water.

The researchers tested the efficiencies of the membranes to filter harmful bacteria such as *Escherichia coli* from contaminated water and compared them with that of a control membrane made from polyethylene and polyethylene oxide. They performed the experiments by dipping the membranes in phosphate buffer solutions containing the bacteria.

They found that the membranes with graphene oxide filtered bacteria more efficiently than the control membrane. The membrane containing modified graphene oxide and polyethylene exhibited the highest efficiency for filtering bacteria.

The researchers found dead bacteria on the graphene-oxide-based membranes. They attributed the antibacterial properties of the membranes to modified graphene oxide, which probably ruptured the membranes of bacterial cells by generating reactive oxygen species. The pore sizes of the graphene-oxide-based membranes are between 0.5 and 0.7 micrometres, enough to remove bacteria and colloids bigger than 1 micrometre.

“Given their small sizes, the membranes could potentially be used to increase the efficiency of a water purification technique that employs reverse osmosis system,” says Suryasarathi Bose, a senior author of the study.

The authors of this work are from: *Center for Nano Science and Engineering, Department of Chemical Engineering and Department of Materials Engineering, Indian Institute of Science and Polymer Science Diagnostic Center, Steer Engineering Pvt. Ltd, Bangalore, India.*

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<http://www.natureasia.com/en/nindia/article/10.1038/nindia.2014.128>

Mural, P. K. S. et al. Polyolefin based antibacterial membranes derived from PE/PEO blends compatibilized with amine terminated graphene oxide and maleated PE. J. Mater. Chem. A (2014) doi: 10.1039/C4TA03997A

Materials

Nanotube-based scaffold for growing muscle tissue

Researchers have developed an efficient hybrid gel that can be used as a scaffold for growing muscle fibres, known as myotubes. They prepared the gel by blending gelatin fibres with multiwalled carbon nanotubes. The gel is potentially useful for artificially growing muscle cells, which can be harvested to replenish lost muscle tissue.

An ideal scaffold for engineering muscle tissue should mimic the cellular microenvironment, which contains extracellular matrix, neighbouring cells and growth factors, as such an environment facilitates cell proliferation, migration and differentiation — processes that lead to tissue formation.

To artificially replicate a cellular microenvironment suitable for tissue engineering, the researchers synthesized hybrid fibres by blending gelatin with different concentrations of multiwalled carbon nanotubes. They then tested the effectiveness of these fibres as scaffolds for growing myotubes from mice myoblasts — embryonic cells that give rise to myotubes. They also compared the effectiveness of the hybrid fibres for forming myotubes with that of pure gelatin fibres.

The researchers found that after culturing for four days, myoblasts formed myotubes on the pure gelatin fibres. They observed that hybrid fibres containing carbon nanotubes were better than pure gelatin fibres for forming myotubes from myoblasts and for growing longer myotubes. The hybrid fibres improved the interaction between the myoblasts and the scaffold, triggering tissue formation. The researchers noticed that the hybrid fibres activated specific genes in myoblasts, accelerating the fusion of myoblasts, which is essential for forming myotubes.

The researchers say that the hybrid fibres combine the ability of gelatin to support cellular activity with the mechanical properties of carbon nanotubes. They say that this combination of properties could potentially be used to develop three-dimensional cell cultures for tissue engineering.

Reproduced from Nature India

<http://www.natureasia.com/en/nindia/article/10.1038/nindia.2014.131>

Ostrovidav, S. et al. Myotube formation on gelatin nanofibers – multi-walled carbon nanotubes hybrid scaffolds. Biomaterials 35, 6268–6277 (2014)

Versatile semiconducting material

Researchers have synthesized a versatile semiconducting material that exhibits charge transport and an ultralow thermal conductivity when subjected to controlled temperature changes¹. The material is made from highly pure silver, copper and sulfur, and it is promising for fabricating devices such as diodes and transistors.

Semiconductors are essential for making transistors, memory and energy-storage devices, sensors and resistive switches. Previous studies have shown that inorganic semiconducting materials can be tuned by varying their temperature. To explore the semiconducting properties of a single inorganic compound, the researchers synthesized a crystalline metal sulfide semiconductor by heating highly pure silver, copper and sulfur in a quartz tube.

The researchers cut the semiconductor into bar- and coin-shaped samples and en polished them. They used the bar-shaped samples for electrical transport measurements and the coin-shaped samples for thermal conductivity measurements.

The scientists found that the crystalline semiconducting material exhibited ultralow thermal conductivities in the temperature range 300 to 550 kelvin. Using spectroscopic analysis, they detected soft vibrations of disordered silver and copper ions propagating in the crystalline semiconductor; this phenomenon is known as phonon transport and it contributes to the observed low thermal conductivity. In addition, the electronic states of the rigid sulphur sublattice caused the electronic charge transport in the semiconductor.

The researchers say that such decoupling of electronic and phonon transports leads to a unique combination of temperature-dependent conduction switching and ultralow thermal conductivity in the semiconducting material near room temperature. They say that such temperature-dependent changes of the conduction properties open up the possibility of making a new class of temperature-controlled diode or transistor devices based on a single compound.

The authors of this work are from: *New Chemistry Unit and Theoretical Sciences Unit, Jawaharlal Nehru Centre for Advanced Scientific Research, Jakkur, Bangalore and Variable Energy Cyclotron Centre, Bidhannagar, Kolkata, India.*

Reproduced from Nature India

<http://www.natureasia.com/en/nindia/article/10.1038/nindia.2014.129>

Guin, S. N. et al. Temperature dependent reversible p–n–p type conduction switching with colossal change in thermopower of semiconducting AgCuS. J. Am. Chem. Soc. 136, 12712–12720 (2014)

Stable, biocompatible graphene from bio-ionic liquids

Researchers have developed a technique to form biocompatible, few-layered graphene oxide sheets from bio-ionic liquids — ionic liquids derived from biomolecules. When dispersed in water, these ionic liquids reduce and stabilize graphene oxide sheets. Such sheets are potentially useful for fabricating energy-storage devices, biomedical devices and heat-resistant composite materials for the automobile and aircraft industries.

Graphene oxide is usually reduced using hydrazine, which is toxic. This chemical contaminates the graphene oxide, making it unsuitable for use in biomedical applications such as tissue engineering. The researchers developed a method for making biocompatible graphene oxide from non-toxic chemicals that involves synthesizing ionic liquids from choline and fatty acids. They prepared four ionic liquids with different counter anions: choline hydroxide, choline bicarbonate, choline formate and choline caproate.

To modify separately synthesized samples of graphene oxide, the researchers added these ionic liquids to aqueous solutions containing dispersed graphene oxide. On adding the ionic liquids, the colour of the dispersed graphene oxide changed from brownish to blackish, indicating modification of graphene oxide. These ionic liquids also converted many-layered graphene oxide sheets into few-layered sheets.

By performing absorption measurements, the researchers confirmed that the ionic liquids modified the graphene oxide sheets through reduction. The graphene oxide sheets modified by the ionic liquids exhibited low absorption to ultraviolet and visible light, suggesting that the graphene oxide sheets had been reduced. Choline hydroxide and choline bicarbonate were found to reduce graphene oxide sheets more efficiently than choline formate and choline caproate.

The ionic liquids stabilized graphene oxide sheets dispersed in water for up to one year through the formation of nanoscale sheets of graphene oxide. “This long-term stability of the graphene oxide sheets is promising for the large-scale production of non-toxic graphene,” says Kamallesh Prasad, a senior author of the study.

Reproduced from Nature India

<http://www.natureasia.com/en/hindia/article/10.1038/nindia.2014.124>

Sharma, M. et al. Studies on the affect of bio-ionic liquid structures on the spontaneous reduction and dispersion stability of graphene oxide in aqueous media. *RSC Adv.* 4, 42197–42201 (2014)

Physics

Flocking behaviour of the non-living

Non-living things can also organise themselves and move in a group if rendered motile, just like formations of flying birds, according to new research on small metal beads and rods¹. The insight might lead to possible new method for cellular matter transportation in the human body.

Researchers at the Indian Institute of Science (IISc), Bangalore and TIFR Center for Interdisciplinary Sciences, Hyderabad dispersed millimetre-sized tapered brass rods among spherical aluminum beads on a gently vibrating surface. They were interested in studying the collective behaviour of such moving rods. They found that the motile rods dragged the beads along, and neighbouring rods reoriented themselves to move in a circle.

The researchers call this phenomenon a ‘flocking transition’ where the rods go into a state of spontaneous alignment“. We were expecting the rods to show cooperative behaviour as seen in living objects”, says Ajay Sood, one of the authors. The study shows that particles far apart can influence self-organisation as opposed to the conventional thinking that they just follow their nearest neighbours.

The researchers claim that their work demonstrates for the first time the ‘formation of a true flock in a collection of dry grains’. The discovery that a small concentration of motile particles can transport a large non-motile cargo might have wide applications in biological systems as well as industry, they say.

Reproduced from Nature India

<http://www.natureasia.com/en/nindia/article/10.1038/nindia.2014.133>

Kumar, N. et al. Flocking at a distance in active granular matter. Nat. Comm. (2014) doi: 10.1038/ncomms5688

Tabletop experiment corrects long-standing optics error

A tabletop physics experiment is all set to redefine some basic concepts of quantum physics long overlooked by our physics textbooks.

The experiment proposed by a team of Indian physicists shows a way to correct a long-standing error that creeps into conventional optical experiments probing the quirky world of elementary particles.

One of the cornerstones of quantum theory is the fact that particles can also behave as waves. In conventional optics experiments, beams of photons passing through two slits on a screen generate waves that spread out and interfere with each other. This interference creates a pattern forming an image on a detector screen.

The physicists now claim that an error occurs at this point since the widely used double-slit experiment calculates results only by considering the photons that take straight paths while passing through the slits and leaves out photons that are thought to follow curvy paths. Computing the curvy paths of photons, the physicists have found that they could have significant effects on the results of such experiments, thereby providing a way to control experimental errors.

“We arrived at theoretical results that aim to find the correction to the commonly used naive application in conventional slit-based interference experiments,” says Urbasi Sinha, one of the physicists from Raman Research Institute, Bangalore. If successfully performed, the

proposed tabletop experiment will be able to quantify this correction which may even lead to rewriting textbooks, Sinha told *Nature India*.

Sinha adds that the results of their study will have applications in interferometer-based quantum computing and analysis of observational radio astronomy data related to the early universe.

Physicist Richard Feynman has long predicted that elementary particles such as electrons can take all possible paths while passing through double slits. However, physicists have neglected the contribution of looped (curvy) paths of elementary particles such as electrons and photons to experimental results in slit-based experiments.

In physics, nearly straight paths (green in picture) of photons through slits are known as classical paths; whereas looped paths (purple in picture) are known as non-classical paths. To quantify the contribution of photons taking looped paths, the researchers devised a computer model of triple-slit experiment which could be performed on a table. Their model considered all possible paths of photons passing through triple slits on their way from a source to a detector.

In order to analyse the effect of non-classical paths in interference experiments, the researchers considered the effect of such paths on an experimentally measurable parameter denoted by the Greek symbol kappa. They found that the non-classical paths (each photon passing through two slits) of photons contributed to non-zero values of kappa. "What would have been expected to be zero considering only straight line paths now turns out to be measurably non-zero having taken the non-classical ones into account," says researcher Aninda Sinha from the Indian Institute of Science, Bangalore.

In addition, the researchers found that kappa is very strongly dependent on certain experimental parameters. They claim that keeping all other experimental parameters fixed, kappa increases with an increase in wavelength. The researchers predict that it is possible to find reasonably high value of kappa for a microwave beam passing through wide slits with wider inter-slit distance. Such an experiment could be performed in a radio astronomy lab, they say.

Reproduced from Nature India

<http://www.natureasia.com/en/nindia/article/10.1038/nindia.2014.132>

Sawant, R. et al. Non-classical paths in interference experiments. *Phys. Rev. Lett.* 113, 120406 (2014)

Space

Neutron stars display bizarre gravitational effects

By analysing observational data using analytical models, researchers have gained new insights into how strong gravitational fields drag space–time inside distant fast-rotating neutron stars¹. These insights will be useful for understanding how gravity affects the magnetic field distribution of neutron stars.

The general theory of relativity predicts that massive rotating neutron stars will drag space–time around themselves. This phenomenon is known as the frame-dragging effect. Previous studies had measured the values of the frame-dragging effect for slowly rotating neutron stars, but those values are not useful for understanding the frame-dragging effect in rapidly rotating neutron stars.

To obtain insights into the frame-dragging effect in rapidly rotating neutron stars, the researchers calculated the values of the frame-dragging effect for three distant fast-rotating neutron stars by developing analytical models to analyse observational data.

The researchers found that the frame-dragging value peaked at the centre of the stars and that the value decreased near the equator and poles on the star surfaces. The rotational speed of the star does not influence these values. The researchers performed detailed theoretical calculations and found that the values of the frame-dragging effect tend to be negligible inside neutron stars even in the presence of a very strong gravitational field.

This is very eccentric behaviour of the frame-dragging effect. Previous studies predicted that the values of the frame-dragging effect varied inversely with distance for massive rotating celestial bodies such as neutron stars, but the findings of this study refute that idea. The researchers say that their results provide exact values for the frame-dragging effect both inside and outside rotating neutron stars, including at their centres.

Reproduced from Nature India

<http://www.natureasia.com/en/nindia/article/10.1038/nindia.2014.130>

Chakraborty, C. et al. Dragging of inertial frames inside the rotating neutron stars. Astrophys. J. 790, 2 (2014)

Looking for habitable planets beyond solar system

By analysing observational data, researchers have gleaned new insights into the best places to search for habitable extrasolar planets (known as exoplanets) orbiting Sun-like stars in the Milky Way¹. These insights can inform future space missions designed to search for exoplanets that may potentially harbour life.

The habitable zone of a star is defined as the region around the star in which liquid water can exist on the surface of a rocky planet. The existence of water may allow carbon-based, photosynthetic life forms, similar to those on Earth, to evolve. These life forms could modify the planet's atmosphere to an extent that it could be detected from Earth.

To identify exoplanets in the habitable zones of stars, the researchers analysed planets and planet candidates discovered by NASA's Kepler space telescope, the Observatoire de Paris in France and the High Accuracy Radial Velocity Planet Searcher at the European Southern Observatory in Chile. They considered habitable exoplanets orbiting F, G and K stars (G stars are similar in size to the Sun, whereas F and K stars are bigger and smaller than the Sun, respectively), as the lifetimes of such stars generally exceed two billion years — long enough for life to evolve on orbiting planets.

The researchers detected the highest occurrence of exoplanets in the habitable zones around G stars; F stars showed 9.5% lower occurrence of exoplanets in their habitable zones

than G stars, while K stars had the lowest occurrence of exoplanets in their habitable zones. The researchers also found that the occurrence of exoplanets in the habitable zone increased with the increasing star lifetime.

“The findings of this study will be useful for space missions dedicated to the detection of habitable exoplanets,” says Anirban Pathak, a senior author of the study.

The authors of this work are from: *Jaypee Institute of Information Technology, Noida, India, Palacky University, Olomouc and Regional Centre for Special Optics and Optoelectronics Systems – TOPTEC, Turnov, Czech Republic*

Reproduced from Nature India

<http://www.natureasia.com/en/nindia/article/10.1038/nindia.2014.123>

Pintr, P. et al. Relative stellar occurrence of exoplanets in habitable zones of the main sequence F, G, K stars. Planet. Space. Sci. 99, 1–6 (2014)

Opinion

This section will occasionally carry the guest editorial from Current Science. Eminent scientists from India are invited to provide their insights on a topic of their choice. You can access Current science at <http://www.currentscience.ac.in>

Who are 'people of genius'?

Popular press, often even science administrators, keep asking the questions why has not India produced Ramans, Ramanujans and Boses since independence. Those people (and Einsteins of the West) would rise to excellence irrespective of the system. They are not product of the system. They just happen. That is why those are rare and whenever they happen, they become demi gods. Such phenomena in any human society are inexplicable and their number cannot be used as a measure of success of any science enterprise. Except the likes of above, scientists need system support to excel. Most Nobel laureates of post-second world war give credit to the university where they had early education and to the ambiance in their working place, which enabled them to carry out excellent work. How do we know which university/ institute is the good place to get educated and/or to work? Various ranking systems are being used (promoted?) these days as measures of quality. QS World University Rankings®, TIME Higher Education Ranking, Shanghai Ranking, etc. are all trying to tell us how good an organization's average is. If the averages were higher, the people at the top would reach greater heights of scientific excellence. Again, both popular press and science administrators keep asking the question why isn't any university/ institute in India as good as MIT or Caltech? Is that really so? What about IITs/agriculture universities for undergraduate education or JNU, HCU, etc. for postgraduate education or IARI, IISc, TIFR, CSIR Labs, etc. as work places to carry out high-quality research? Such organizations have led the transformation of a complex country of very diverse 1.2 billion people in less than two human generations using only peaceful democratic tools. Reasons for this puzzle may lie in what the abovementioned ranking systems measure (for example, publications in top-rated science journals, internationalization, etc.) and what they do not (for example, national/local impact of teaching and learning).

Of course, no doubt that when it comes to research in basic science or technology transferred to industry, we are no way near world's best. How do we reach the list of world's top 100 of such research organizations? In 1945, James Bryant Conant, then President of Harvard University said, 'There is only one proved method of assisting the advancement of pure science – that of picking men of genius, backing them heavily, and leaving them to direct themselves. Except that *men of genius* should be read as *people of genius*, this is an all time relevant statement. A large number of excellent scientists under one roof would become such a formidable force that no bureaucracy would be able to slow them down, rather they transform the administration as an enabling force. Then the question is where do we find 'people of genius'? As large majority of any population is born with similar levels of curiosity, creativity and learning abilities, it is the education that makes them genius for the job they are hired for. Therefore, if average quality of research in India is not good, we should blame our education system. Then how is that we have made tremendous progress in agriculture, engineering, space, medicine? We have witnessed accelerated transformation of India in the past 20 years. Seeding for this change happened immediately after independence, when we set up excellent engineering schools, agriculture/medical colleges and universities. They produced people of genius who scripted not just Indian growth story, but triggered global transformation. But for these geniuses working in India and overseas (some may call it as brain drain, but the dynamics of the world of science and technology and the global economy call it brain gain), we would not have seen FDI flowing to India since 1990s or India becoming the 3rd or the 4th largest economy in the world. If the world's best universities and industries have recognized graduates from India as 'people of genius', our professional education system must have got its curriculum right. If IITs had not introduced Computer Science degree even before Bill Gates of USA knew anything about computers, the Indian growth story would not have been what it is today. I would go a step further and

say that the world would not have seen the kind of economic growth that we are witnessing today. While our professional education system has met with intended goals in the recent past, our general education has somehow failed. Still, there is so much of resistance to change our general education system. We are crying for change in our politics, the way government functions, the attitude of men towards women, the attitude of haves towards have-nots, etc., but we resist changes to our curriculum that round our education system and thereby, put a break to all positive changes in the society.

Some may claim that it is not that we resist changes to our curriculum, we do not have a consensus on what should be the new curriculum. After all, we are argumentative Indians! Hopefully, one day we will overcome apprehensions in our mind on the perceived negative impact of changing the curriculum and visualize guaranteed benefits for the future. Here are few things what we should keep in mind, if and when we decide to make sweeping changes to our education system.

1. Evolutionary biology tells us that genetic diversity in a species is relatively more important than the size of the population for its survival in a continuously changing environment. As it would be difficult to predict the needs of the future, our education has to be broad based such that variety of skill sets would be available in the population. A country of 1.2 billion people that would soon achieve 30% GER (means 18 million more students coming to tertiary education), a country with multiple languages and cultural diversity, cannot depend on a uniform curriculum. Otherwise, even while we continue to send indigenous rockets to the Mars, we would depend on knowledge developed elsewhere to keep our lands green. Diversity in curriculum also helps to take full advantage of our, much talked about, demographic dividend and would meet the needs of the skilled human resources of the world (in today's political system we may call them immigrants, but they are the same explorers of the migrating humanity of earlier millennia).
2. Tertiary education in India is largely provided by private educational organizations (nearly 60% of all enrolment is in private colleges/universities²). By making education a not-for-profit activity and keeping them under the tight control of local universities, we have halted bold changes to the curriculum that could have happened in some of these organizations. While it is important to be vigilant and prevent exploitation of innocent public, too much governance is only an impediment to the positive change that would naturally emerge in a large demand–supply chain.
3. We have come a long way in shedding our prejudices against FDI. Attracting FDI is not just about attracting financial investments, it is about adopting best management practices of the world. We now accept FDI even in defence and insurance as routine policy decisions. But, we resist FDI in developing good educational organizations. Allow foreign universities to set up their campuses and let them bring another dimension to our education system. It will only expand the diversity in the skill sets of the population. Not allowing foreign universities has not stopped aspiring young Indians to explore and be exploited in faraway places. At least, we can keep a vigilant eye on foreign universities on Indian soil and protect gullible people!
4. When it comes to reforms in education or setting up new universities/institutes, we should be aware that any benefit of these initiatives would be realized only in generation-timescale (20–30 years). Best example, IITs that were set up in 1950s and 1960s helped to change Indian economy and thereby the society in 1990–2010. We should, therefore, resolve to provide uninterrupted long-term support to educational organizations.
5. We need to enthuse both teachers and students to work towards building excellent centres of science education and garner public support for the same. For this, we should make science education a movement of people. India is uniquely placed in this context.

We are argumentative people, because (at least, let us assume that) rational thinking is part of our culture! This strength should be exploited and make the society science-literate. DST's INSPIRE is an excellent programme in this direction, which should be further expanded to involve all school/college teachers and students in taking up small projects on water, energy, earth and epidemic diseases. The programme should be designed such a way that teachers and students learn fundamental concepts of science while doing these projects and at the same time generate large-scale data. One example, as part of International Year of Chemistry, a large number of students and teachers all over the world were involved in developing a pH-map of the earth. Such mission-projects are educational for the general public and at the same time, generate data for R&D. People participation in science programmes may also lead to increase in the number of sentences in the election manifesto of all political parties. Such positive feedback loop is much needed to ensure continual support to ever evolving education programmes.

Reproduced from Current Science

<http://www.currentscience.ac.in/Volumes/107/05/0731.pdf>

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For more about him please visit <http://www.iiserpune.ac.in/~ls.shashidhara/>

Forthcoming events in India

International conference on Technical textiles and Nonwovens

New Delhi, 6-8 Nov 2014

<http://www.textileconferenceiitd.com/2014/>

5th International Conference on Stem Cells and Cancer (ICSCC-2014): Proliferation, Differentiation and Apoptosis

New Delhi, 8-10 November 2014

<http://www.icscc.in/>

6th Asian Thermal Spray Conference (ATSC – 2014)

Hyderabad, 24-26 November 2014

<http://atsc2014.in/>

CII Knowledge Expo

New Delhi, 20 – 22 November 2014

<http://ciiknowledgexpo.in/>

The Expo encompasses the following conferences: 2nd GITA Platform; 14th CII-NID Design Summit; 4th Global University-Industry Congress; 6th Intellectual Property Summit and the 4th Innovation and Entrepreneur Summit

International Conference on Genome Architecture and Cell Fate Regulation

Hyderabad, 1 – 4 December 2014

<http://www.genomearchitecture.in/conference/home/>

36th International Conference of the Linguistic Society of India

Thiruvanthapuram, 1 – 4 December 2014

<http://www.lsi.org.in/lsi.img/ICOLSI-1.pdf>

IEG-IFPRI International Conference: Innovation in Indian Agriculture: Ways Forward

New Delhi, 4 – 5 December 2014

http://www.iegindia.org/events%5Ccallforpapers_innovagri.htm

Recent Advances in Operator Theory and Operator Algebras

Bangalore, 9 -19 December 2014

<http://www.isibang.ac.in/~jay/OTOA2014/OTOA14.html>

International Conference on "A decade after the Indian Ocean Tsunami - Status and Experiences"

Puducherry, 10 – 13 December 2014

<http://www.iotsunami2014.org/home.html>

5th International Fluid Mechanics and Fluid Power (FMFP) Conference

Kanpur, 12-14 December 2014

<http://www.iitk.ac.in/fmfp14/index.html>

12th international conference on fiber optics and photonics

Kharagpur, 13-16 December 2014

<http://www.photonics2014.in/index.html>

EMBO Conference: Upstream and downstream of Hox genes

Hyderabad, 14–17 December 2014

<http://events.embo.org/coming-soon/index.php?EventID=w14-34>

30th International PLEA Conference: SUSTAINABLE HABITAT FOR DEVELOPING SOCIETIES Choosing the way forward

Ahmedabad, 16-18 December 2014

<http://www.plea2014.in/>

102nd Indian Science Congress

Mumbai, 3-7 January 2015

Focal theme - Science & Technology for Human Development

5th International Conference on Research into Design

Bangalore, 7 – 9 January 2015

<http://cpdm.iisc.ernet.in/icord15/>

International Conference on Applications of Fractals and Wavelets

Coimbatore, 10 – 11 January 2015

<http://www.amrita.edu/icafw2015/index.php>

3rd International Conference on Design Creativity

Bangalore, 12 – 14 January 2015

<http://www.cpdm.iisc.ernet.in/icdc2014/#/overview.php>

2nd International Conference on Perception and Machine Intelligence

Kolkata, 15 – 16 January 2015

<http://www.cdackolkata.in/permin15/> (website not operational at this time)

International conference on Evidence Informed Practice-An approach to health care reforms

Manipal, 24 – 25 January 2015

<http://conference.manipal.edu/eip2015/>

11th International Conference on Distributed Computing and Internet Technologies

Bhubaneswar, 5 – 8 February 2015

<http://www.icdcit.ac.in/>

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