KMVPHY-SPECTRUM

WE LEAD OTHERS FOLLOW

A PHYSICS NEWS LINE

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Science means constantly walking a tightrope between blind faith and curiosity; between expertise and creativity; betwee bias and openness; between experience and epiphany; between ambition and passion; and between arrogance and conviction - in short, between an old today and a new tomorrow. **Heinrich Rohrer**

Visionary Physicist

THEORETICAL PLASMA PHYSICIST IN THE IMMEDIATE POST-INDEPENDENCE period: DR. BIMLA BUTI

Bimla Buti (born 1933) is an Indian physicist and specializes in the field of plasma physics. She was the first Indian woman Physicist Fellow of Indian National Science Academy(INSA). In 1994, she was awarded INSA-Vainu Bappu Award. After earning BSc (Hons) and MSc from Delhi University, Buti studied at the Department of Physics, University of Chicago, where she was privileged to work with Nobel Laureate Prof. S. Chandrasekhar and obtained her PhD in Plasma Physics in 1962. Her sister's husband, tried hard to persuade her to study medicine, but she did like physics, probably because of my interest in applied mathematics.

The training provided by Dr. Chandrasekhar had an indelible effect on her professional life and helps in strengthening the self-reliance, the confidence to face all kinds of situations and the courage not to bow to unjust pressure. She always spoke her mind fearlessly and for this she had to suffer professionally. But she has no regrets. On her return from USA, she worked at Delhi University as a Post Doc for two years, but decided to go back to USA to work as Resident Research Associate of the National Academy of Sciences at Goddard Space Flight Center (NASA). There she was associated with the Theoretical Division headed by a brilliant plasma physicist T. G. Northrop. She also worked at the Indian Institute of Technology, Delhi as a Senior Scientific Officer (1968-70). Vikram Sarabhai, the then Director, Physical Research Laboratory (PRL), invited her to join PRL, where she worked from 1970 to 1993 as Associate Professor, Professor, Senior Professor and Dean of Faculty. At PRL, Buti initiated the experimental Plasma Physics programme. This group grew and eventually moved out of PRL and formed a new institute, now known as Institute of Plasma Research under Department of Atomic Energy. She was the Director of Plasma Physics at the International Centre for Theoretical Physics, Trieste, Italy during 1985-2003. Besides visiting NASA Centers, she worked at the University of California, Los Angeles, from 1986 to 1987 and publishing a large number of research papers and has edited four books. She trained a number of students and has worked at different NASA centers, namely, Goddard Space Flight Centre, MD; Ames Research Centre, CA and Jet Propulsion Laboratory (JPL), Pasadena, CA. She was the first Indian woman Fellow of TWAS and the first Indian woman Physicist Fellow of INSA. Professor Buti received the Vikram Sarabhai Award for Planetary Sciences (1977), Jawaharlal Nehru Birth Centenary Lectureship Award (1993), Professional Achievement Citation Award of University of Chicago, USA (1996) and US Medal for Fundamental Contributions in the Physics of Nonlinear Waves and Chaos (2010).

Science News Section

Physicists Observe Quantum Behavior in Liquid Vibrations

For the first time, Yale lab of physics and applied physics professor Jack Harris, along with colleagues at the Kastler Brossel Laboratory in France; have directly observed quantum behavior in the vibrations of a liquid body. A study about the research appears in the journal Physical Review Letters. This new experiment opens a potentially rich area of further study into the way quantum principles work on liquid bodies. Harris and his team discovered that they could detect the sound wave's quantum properties: its zero-point motion, which is the quantum motion that exists even when the temperature is lowered to absolute zero; and its quantum "back-action," which is the effect of a detector on the measurement itself.

Dying stars called collapsars may forge much of the universe's gold

Heavy elements such as gold, platinum and uranium might be formed in collapsars — rapidly spinning, massive stars that collapse into black holes as their outer layers explode in a rare type of supernova. "Black holes in these extreme environments are fussy eaters," says astrophysicist Brian Metzger of Columbia University, a coauthor of the study. They can gulp down only so much matter at a time, and what they don't swallow blows off in a wind that is rich in neutrons computer simulations reveal. Astronomers have long puzzled over the origins of the heaviest elements in the universe as an extreme environment densely packed with neutrons is required. That's where a chain of reactions known as the r-process can occur, in which atomic nuclei rapidly absorb neutrons and undergo radioactive decay to create new elements. Scientists had suspected that when two dead stars known as neutron stars collide, the r-process could occur in material churned up by the merger. These dense dead stars can take a long time to coalesce. But heavy elements have been found in ancient stars that formed early in the universe's history. It's not clear whether a neutron star merger could happen fast enough to explain the elements' presence in those early stars.

TRIP TO SCIENCE CITY, KAPURTHALA AND IUAC, NEW DELHI

About 30 science students accompanied with 3 teachers visited Pushpa Gujral Science City, Kapurthala to enhance their knowledge about the various innovative demonstrations of Science concepts. Students visited to various educational galleries consist of Earthquake Simulator, Flight simulator, Dome theatre, 3-D show & Climate change theatre etc. They watched models on aircraft & satellites, space shuttles in Space & Aviation Gallery. Students visited to Energy education & Awareness Park where there were various demonstrations uses of various forms of non- conventional energy sources such as Solar energy, wind energy, bio energy & nuclear energy. A Second Group of about 22 students of B.Sc. & M.Sc. (Physics) accompanied with four teachers visited Inter University Accelerator Centre, Delhi to enhance their knowledge about the Accelerators and their utilizations in the advancement of science. Students attended a seminar which was related to various accelerators such as 15 UD Pelletron Accelerator, 50kV Tabletop accelerator and ExpEYES Experiments for young Engineers and scientists). Then students visited various labs, where they were explained that how an accelerator works. The basic objective of IUAC is to provide front ranking accelerator based research facilities to create possibilities for internationally competitive research within the university system.

THE FATHER OF FIBER OPTICS: NARINDER SINGH KAPANY

First, it was Jagadish Chandra Bose at the turn of the century, who was the first to demonstrate wireless signaling in 1895. Later, he even created a radio wave receiver called the 'coherer' from iron and mercury. Then came Satyendranath Bose, whose paper got published in Zeitschrift der Physik in 1924, and the famous Bose-Einstein statistics theory came into picture. Moving on, G N Ramachandran deserved a Nobel for his work on triple helical structure of collagen. E C George Sudarshan produced pioneering contributions to Quantum Optics and coherence, but his work was ignored, and Roy Glauber was awarded the Physics Nobel in 2005 for the same work.

And in 2009 the one half of the Nobel Prize for Physics has been awarded to Charles K Kao 'for groundbreaking achievements concerning the transmission of light in fibers for optical communication.'

What the Academy omitted to note was that Moga, Punjab-born Narinder Singh Kapany, widely acknowledged as the Father of Fiber Optics had far the stronger claim. Charles Kao in a 1996 paper put forward the idea of using glass fibers for communication using light; he tirelessly evangelized it and fully deserves a share of the Prize.

The Indian American scientist has over 100 patents and has received many awards, including the "Fiat Lux Award" from the U.C. Santa Cruz Foundation in 2008. He has published over 100 scientific papers and four books on optoelectronics and entrepreneurship.

A graduate of the Agra University in India, he completed advanced studies in optics at the Imperial College of Science and Technology, London, and received his doctorate from the University of London in 1955. It was during his PhD at the Imperial College in 1954 when he first managed to transmit images over a bundle of optic fibers. Before he finished his course in the Imperial College, he received a scholarship from the Royal Society to pursue further research in fiber optics. His career has spanned science, entrepreneurship and management, academia, publishing, lecturing and farming, his bio notes. His personal interests include philanthropy, art collecting, and sculpting. He has endowed a chair of Sikh Studies the University of California, Santa Barbara and a chair each in Opto-Electronics & Entrepreneurship at UC Santa Cruz.

Kapany tirelessly developed applications of fiber optics for endoscopy during the fifties and later coined the term Fiber Optics in an article in Scientific American in 1960. Kao studied the problem carefully and worked out a proposal for long-distance communications through glass fibers.

Narinder Singh Kapany narrated in one of his interviews, "When I was a high school student at Dehradun in the beautiful foothills of the Himalayas, it occurred to me that light need not travel in a straight line, that it could be bent. I carried the idea to college. Actually it was not an idea but the statement of a problem. When I worked in the ordnance factory in Dehradun after my graduation, I tried using right-angled prisms to bend light. However, when I went to London to study at the Imperial College and started working on my thesis, my advisor, Dr Hopkins, suggested that I try glass cylinders instead of prisms. Initially, my primary interest was to use them in medical instruments for looking inside the human body. The broad potential of optic fibers did not dawn on me till 1955."

Kapany was confronted with another problem. A naked glass fiber did not guide the light well. Several people then suggested the idea of cladding the fibre. Cladding, when made of glass of a lower refractive index than the core, reduced leakages and also prevented damage to the core. Finally, Kapany was successful; he and Hopkins published the results in 1954 in the British journal Nature.' Recognizing the nature of his work, Harold Hopkins encouraged him to do a PhD in optics, but his heart was still set on coming back to India after completing his PhD in 1955 and setting up his own venture. In fact, India's first Prime Minister Jawaharlal Nehru, a tremendous votary modern science, wanted Kapany to work for the Indian government as a Scientific Advisor to the Ministry of Defence.

However, a meeting with an American professor at a science conference in Italy (1954), where he presented the very first publication on fiber optics, altered the course of his life, and eventually, he joined the University of Rochester as a faculty member. "One year led to another which led to a job which immediately got me into entrepreneurship and instead of starting a company in India, I ended up starting my first company in this area in Palo Alto (Silicon Valley).

He has received many awards including 'The Excellence 2000 Award' from the USA Pan-Asian American Chamber of Commerce in 1998. He is a Fellow of numerous scientific societies including the British Royal Academy of Engineering, the Optical Society of America, and the American Association for the Advancement of Science. Kapany has endowed a chair of Sikh Studies at U.C. Santa Barbara and a chair each in optoelectronics and entrepreneurship at U.C. Santa Cruz. His personal interests include philanthropy, art collecting, and sculpting.

Kapany's "Dynotic Sculptures" have been exhibited at the Exploratorium in San Francisco and other museums.

Asia Society's Northern California Honored Narinder Singh Kapany with Asia Game Changers awards. It is because of his groundbreaking work that the people around the globe can reap the benefits of high-speed communication and medical procedures such as endoscopy and laser surgeries.

When the Nobel Committee awarded the 2009 Prize to Kao, many in the scientific community were perplexed that Kapany was overlooked for the award. In fact, the Nobel Committee had even acknowledged Kapany's work in a detailed publication. The man himself, however, wasn't too perturbed by this oversight and expressed his sentiments as "What can you say about this? It is known that Professor Kao started work in this field many years after me. He faced competition too. I don't think there should be any controversy about it. It is up to the Swedish Academy to decide. They have used whatever criteria they wanted to use." he said. His contributions, however, have been recognised by the Massachusetts Institute of Technology (MIT), which acknowledges him as the inventor of fiber optics.

KMVPHY-SPECTRUM

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PHYSICS WORKSHOP BY SHIKSHA RATTAN DR. JASWINDER SINGH

PG Department of Physics organized an experimental workshop cum interaction by Shiksha Rattan Dr. Jaswinder Singh. His "Lab on Wheels", the mobile car laboratory is becoming a fascination for students around the state. He is a National Awardee by the Department of Science and Technology, Govt. of India and honorable President of India.

Dr. Singh demonstrated and simplified the complex Mathematics and Physics concepts with easy and interesting experiments. He laid emphasis on practical knowledge so that we can easily frame our goal. He demonstrated the concept of charge using a charged balloon, paper bits and Teflon tape. He explained the concept of open and closed circuit, Archimedes principle, Boyle's Law, formation of waves, image formation and inversion. He also showcased handmade fire alarm, digital electroscope, solar fan, solar charger and rocket launcher based on Newton's third law. He ended with the words that weak men wait for the opportunities but intelligent men create them.

LAB EXPOSURE INTERNSHIP PROGRAMME AT NIT JALANDHAR

15 days Internship programme was conducted in NIT, Jalandhar from 26 December 2018- 9 January 2019. The programme was guided by Prof. Dr. B.S Kaith, NITJ. Two students Amanjot Kaur of B.Sc (NON – MEDICAL) and Pahul Padam of M.Sc Chemistry from Kanya Maha Vidyalaya, Jalandhar has attended the programe. The Topics that were discussed in the programme was "Prepartion of Hydrogel and its characteristics". This programme is very knoweledgeable for students . This programme indeed turned out to be valuable and fruitful for both the aspiring students.

NATIONAL GRADUATE PHYSICS EXAM (NGPE)

National Graduate Examination was conducted on 20 January 2019 in KMV College in which all the graduated students participated. Total 84 students enrolled in this exam. The participation, purely voluntary, offers an opportunity to measure one's standing against a national standard. A number of scholarships (subject to a maximum of 5) have been instituted to encourage students to take-up physics as a career. Those who seek admission in M.Sc. (physics) after NGPE, are eligible for these scholarships.

FIZ-VIZ QUIZ WAS ORGANIZED ON JANUARY 29, 2019

P.G Department of Physics conducted a Fiz-Vis Quiz i.e. Physics visual Quiz,dated 24 January 2019 in which graduate and post graduate students participated. The main aim of the event was to clear the concepts of students in an interesting manner. There were four teams with three participants each: - Focus Vector, Energy and Inertia. The quiz was divided into four rounds. There was also a visual round in which some videos were shown to the teams and they had to tell the phenomena behind that experiment. Some questions were also asked from the audience to make this quiz more interesting.

MS. AMANJOT KAUR PRESENTED A RESEARCH PAPER IN 22ND PUNJAB SCIENCE CONGRESS

This year Punjab Science congress was organized in DAVIET Jalandhar. Ms. Amanjot Kaur of B.Sc (N.M) 1st year along with Ms. Pahul Padam (M.Sc Zoology 1st year) have participated in the congress and presented a research paper on the topic "Biomedical applications of Hydrogels". Dr. Neetu Chopra has also accompanied the students to introduce the students to the scenario of the congress and explain the motives of such events in the development of science. Madam Principal honored the students for their achievements.

SCIBRATION WAS ORGANISED

A collaborative venture of the Science Faculty, Scibration, an inter College competition was organized on February 28, 2019. the events included in the endeavor were Fancy Dress Competition, Poster Making, Rangoli Making, Choreography. Eight Colleges from all over the Punjab participated in various events organized to make the venture a success. The overall trophy was grabbed by Khalsa college for women, civil lines, Ludhiana, whereas the first runner up trophy was won by Kanya Maha Vidyalaya, Jalandhar.

FIVE DAYS LECTURE SERIES BY PROF. C.K. JAYASANKAR

PG Department of Physics organized five days lecture series. The resource person was Prof. C.K. Jayasankar from S.V. University, Tirupati. He started his lecture series atomic spectra, in which he discussed about structure of atoms and the origin of atomic spectra. He explained the causes of fine and hyperfine structures to the students. On the second day he started his lectures with the formation of molecules and the types of spectroscopy associated with the molecules. He also explained different types of lasers and phenomena behind them. Further, he discussed Q-switching. Third day he enlightened the students about the relation between science and nature by giving examples of floating leaf. He also elaborated with the concept of photoluminescence to the students. Fourth day of the series started with a talk on Raman Spectroscopy. He also discussed stokes and anti stokes lines and the quantum theory explaining the origin of Raman Spectroscopy. Last day he concluded his talks by discussing the coupling schemes in atoms and asking the queries of the students about the various topics covered during these days

TWO DAYS NATIONAL SYMPOSIUM ON ON NANOSTRUCTURED MATERIALS : STRUCTURE, PROPERTIES AND APPLICATIONS WAS ORGANIZED

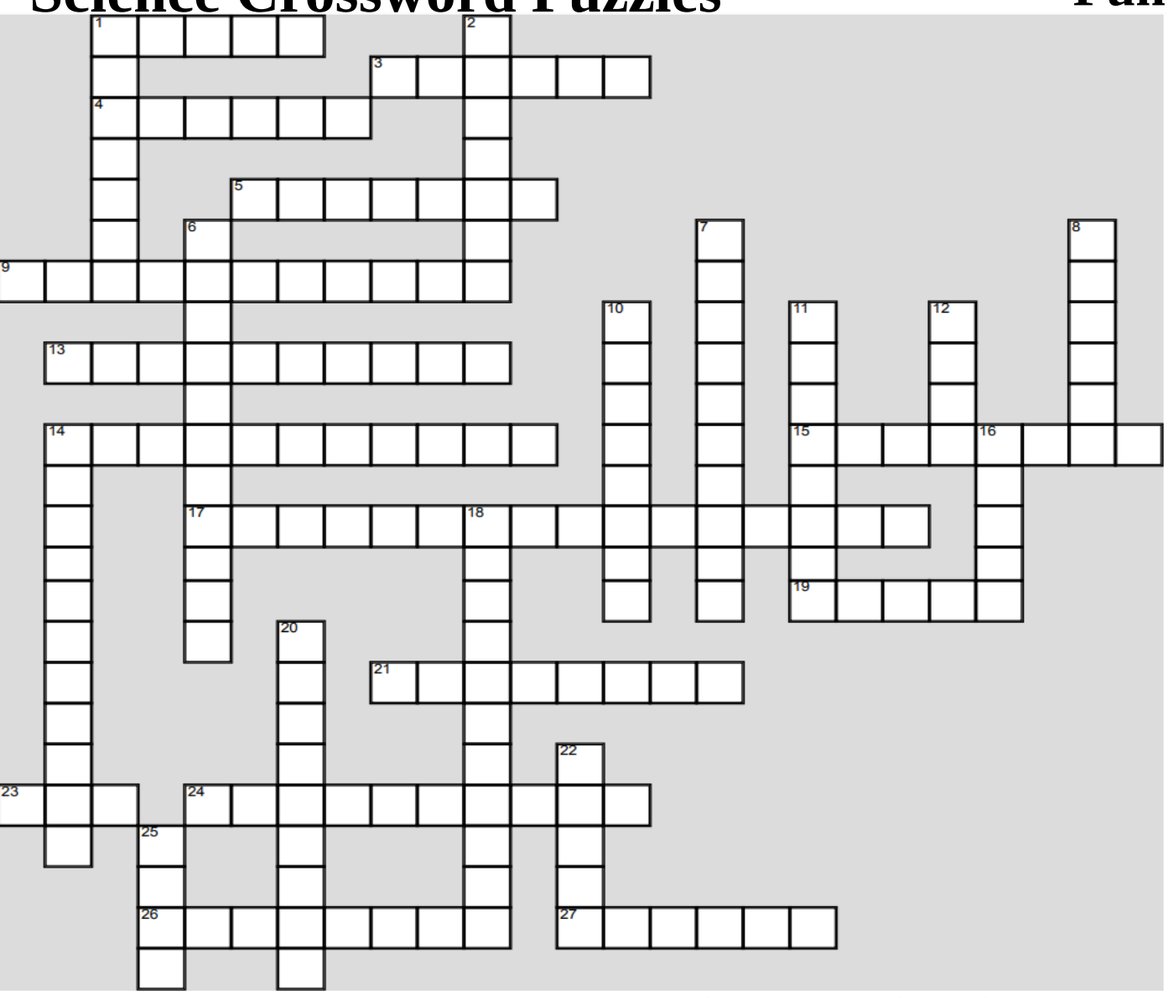
P.G. Department of Physics organized National symposium on "Nanostructured Materials: Structure, Properties and Applications" between February 22-23, 2019. The two day symposium was generously supported by four agencies i.e. Materials Research Society of India (MRSI), Bangalore, Department of Atomic Energy (DAE), Mumbai, Council of Scientific & Industrial Research (CSIR) New Delhi and Gujarat Borosil Ltd. New Delhi. The symposium commenced with the inaugural ceremony by invoking the Blessings of Almighty and the inaugural address by the principal Dr. Atima Sharma. She stressed that the area of nano materials is perhaps one of the fastest growing areas of materials science. It aims at tailoring materials with desired functionalities for applications in emerging technologies. She welcomed all the resource persons and delegates.

The keynote address was by Prof. Dr. Govind Prasad Kothiyal. He addressed audience about the Quest for New Materials. In his talk, he highlighted the applications of glass/glass-ceramics related to optical fibres, window panes/ architectural materials and optical components. Mrs. Parminder Kaur, Convenor, NSNM-19 acknowledged the presence of all amenities and other participants and highlighted the importance of nano materials in the present era of materials science. She thanked four premier national bodies for their major role in conducting such in depth symposium to promote scientific temper and education in our country. The other invited speakers of the symposium were Dr. Hitesh Sharma (IKG PTU, Amritsar), Dr. Ramandeep Singh Johal (IISER, Mohali), Dr. Ravi Kumar (NIT, Hamirpur), Dr. O.P Pandey (Thapar institute of Engineering and Technology), Dr.Sevi Murugavel, and Dr. Atul Khanna (GNDU, Amritsar).

EDUCATIONAL TRIP TO CSIO, CHANDIGARH

100 students of B.Sc Non medical, Electronics Sem VI, M.Sc Sem IV visited CSIO, Chandigarh on the occasion of National Science Day. Central Scientific Instruments Organisation (CSIO) is a National Laboratory dedicated to Research, Design and Development of Scientific and Industrial instruments. It is one of the constituent laboratories of the Council of Scientific and Industrial Research (CSIR), India, an industrial research and development organisation of the country. . Incentives for trip were provided by DBT for those students who chose scientific research as their career. It was a trip to the place where science, fun & learning are inseparable. Students have visited various Labs (Fibre Optics Lab, Opto Chemistry Lab and Motion Sensor Lab) with the 6 teachers. They were imparted knowledge about the working of these equipments and their applications.

Science Crossword Puzzles



Across

1 Newtons ___ Law of Motion: Objects at rest tend to stay at rest
3 Measure of the pull of gravity actin on the mass of an object
4 One of the three states of matter
5 The ___ of air is the weight of a given volume of air
9 Absolute pressure includes this along with gauge pressure in its final reading
13 What weighs less than air?
14 The force a rotating object exerts outward away from the center of rotation
15 This is the force that acts on a unit of area.
17 The amount of water vapor actually present in the atmosphere.
19 Newtons ___ Law of Motion: For every action there is an opposite and equal reaction
21 Force is Area times _____
23 One of the three states of matter
24 The transfer of physical heat by direct contact
26 _____ humidity is the ratio of the amount of vapor actually present in the atmosphere to the amount that could be present
27 If the pressure of a confined gas is doubled, the pressure will do what

Down

1 The point about which a lever rotates
2 Energy in motion
6 Ratio of the span to the chord of the airfoil
7 The transfer of heat by means of moment of a heated gas of liquid.
8 Anything which occupies space and has weight
10 The boiling point of a given liquid varies with _____
11 The point where humid air is cooled to become saturated
12 The measure of the quantity of matter in an object
14 The force a rotating object exerts inward from the center of rotation
16 One of the three states of matter
18 The speed of sound varies with a change in this
20 Energy at rest
22 Force times distance divided by time
25 Force times Distance

Story time

Down and Out

Ogby regained consciousness slowly, vaguely aware that the water around her was cold. Too cold. Ice was already beginning to form in the upper corners of the ship.

She almost drifted back to sleep, almost content to die to this way. Then her curiosity got the better of her. Even before unstrapping herself, she noted that gravity was pulling her to the bottom of the cabin with just as much force as ever. Perhaps the zero gravity moment had only been a dream. The pain, however, was real. Wincing as she moved her bruised body, she stepped over to check the controls. The batteries still had some power left, and the heaters were nearly on full. So why was the water so cold? She maxed out the heaters and moved over to the window. The outside view was so strange that it took her a long time to parse it into something she could understand. The ship apparently lay on the underside of a giant, bright, icy plain; she had probably crashed into it from below. The ship must be buoyant here, she realized, as if she was inside a giant air pocket.

Her mind reeled with questions. Had she penetrated the ice, broken through to the center of the ocean? Why was there no water here? Why was it so bright? What was this place? Closer to the ship, she saw that the icy plain was scarred, rippled in a circular pattern. And into the center of the ripples snaked a black line, coiling around itself until it disappeared into the ice.

The cable!

Her mind started to piece together a story. Something had sucked her down through the ice. Her ship had come flying through, launched down into the air pocket, stretching the cable tight. The cabin had jolted as the cable had snapped. Then the ship had reversed direction, and crashed upwards into the ice. But why? None of this made any sense to her. Still, that cable… that was her link to a world that made sense. If she could reconnect it to the ship, she could call for help. There might even be enough slack to reach. But the only way to do it was to go outside, and the only way to go outside was to open the hatch, spilling out most of her water. She'd never survive long enough to be rescued.

Still, the ice in the cabin was continuing to spread — if she didn't act soon she'd be frozen solid, and no one would ever know what had become of her. Making a run for the cable would surely be better than that.

Steeling her resolve, she began to hyper funnelate, readying her system for what lay ahead. She knew that the area outside must be very cold — the evidence was quickly crystallizing all around her — so she spent a few moments hunting for something to wear on her feet. But the only free objects were the plastic seat-cover slabs. She grabbed three of them with three feet, hoping they'd provide enough insulation. Ice had already started to form on the hatch, but she broke it free with the plastic slabs and started turning the primary release wheel with her two free feet. One turn, two turns…

Without warning the door flew outward, pulling Ogby with it. Water spurted out around her, erupting into a frenzied boil. Panicked, she clung to the wheel, feeling the water rush past her as it left the ship.

She had been wrong about the temperature. If the water was hot enough to boil, she would be roasted alive in seconds.

But even as the water frothed around her, she noticed that it was quickly freezing onto the surface of the icy plain. Could it be cold after all? Her body was becoming uncomfortable, first aching all over, and now flaring with pain. Then she noticed that her air bladders were inflating on their own accord, and she had to clench them tightly to keep them under control. Gravity wasn't infinite here, she suddenly realized. But the pressure was very low — maybe even zero. Zero pressure meant infinite volume, and her own bladders were struggling to obey that particular law of physics. Ogby recalled the evacuated chambers from the airlabs, and quickly guessed that she

had just entered an enormous vacuum. The water from the ship had now emptied completely. A quick glance inside told her that everything else had frozen solid. There would be no reserve to breathe later.

Fun Times with Physics

INAUGURATION OF INNOVATION HUB

P.G. Department of Physics established an Innovation hub, which was inaugurated by Madam Principal, Dr. Atima Sharma. Innovation hub is an independent place of Learning, inspiration, motivation, recreation, imagination and thinking. In order to enhance the creativity and skill in Education of Basic Physics, some experiments like circular pendulum, anharmonic oscillator, Transmission line, Black hole, Air cannon, Doppler Effect, rotational Motion, Motion in inclined plane, energy transfer in spring etc, were demonstrated to make it easier for the students to understand the concepts of Physics in a practical way. Further, students showcased and explained their handmade.

And if she was in a vacuum, she knew there wasn't much time. She had to get to that cable quickly, before her body could no longer contain the pressure inside of her.

It wasn't far to the cable, only about thirty lengths. And now that she was out of water, the weak gravity pulled her upwards, directly toward the ice. She glanced in the other direction…

The view below nearly made her faint. Directly beneath her, visible now that she was out of the ship, sat an enormous brilliant sphere, banded with swirling colors as if it were chroming to her in another language. A smaller yellow sphere floated on top of it, casting a shadow on the large sphere's misty surface. The large sphere also had a second shadow, although Ogby couldn't tell what was casting it. There must be an even brighter light source somewhere else....

Distractions, she told herself. She had to concentrate on the cable if she was to survive. Still, those spheres looked so far away that her vertigo was starting to kick in.

With a flash of insight she decided to try the reorientation trick she used in the factory. *That's not down*, she told herself, still staring at the spheres. *That'sup. The ice is down*.

She positioned her legs accordingly, touched the three plastic slabs to the ice, and let go of the wheel. In a moment she was trotting across the surface towards the free end of the cable. *Yes!* she mentally cheered herself on, imagining the world turned upside down.

I'm running on the ice, on top of the ice, on the outside …

Outside. Even as she approached the cable she knew it was true. She wasn't inside the ocean at all. The light source casting those shadows wasn't visible, so it had to be on the other side of the ice. The second shadow might even be her entire world!

She picked up the cable, her mind so busy that she barely appreciated the connector was still intact. If she was Outside, then her entire worldview must be wrong. What she considered "up" was actually toward the center of her world; Roov's excavations

through the rock could only break through to the other side of the ocean. Th e Cities were on the *outer* edge of the ocean, and the Rygors spent their lives with their feet pointed outwards and their heads pointed to the center. Yes, the ocean was a spherical shell, but it wasn't curved in the way that everyone had assumed.

Ogby was almost back to the ship now, her body ablaze with pain. The plastic slabs were already freezing in her grip, but she wouldn't let them go.

She pulled more of the slack in her direction, shifting the cable connector in her grip, and at that moment her second foot exploded.

Agony flooded through her nervous system. Her airbladder was broken, in tatters, and she watched numbly as her juices quickly oozed out of the wound. Some corner of her mind knew that this was the end, this was where her internal pressure would equalize with the vacuum of this alien space.

She had been so close…

But she wasn't dead yet. Ignoring the pain, she clenched the fingers on her second foot, applying pressure to the wound as best she could. She felt her second leg shudder, but the oozing slowed to a halt.

Somehow she reached the ship, plugged in the cable, climbed through the hatch. Her first foot did all the work, locking it shut behind her and moving over to the buoyancy controls.

Ogby needed pressure fast, and the tanks of compressed air were her only hope. Normally the air was released into the flexible buoyancy chamber, not the main cabin, but a few flipped levers rerouted the valves. Even as she felt her life slipping out of her second leg, her soning receptors began to pick up the unique noise of hissing air.

She rested for a moment as the pressure built up, feeling the pain in her foot subside. There was ice in the bottom of the cabin, but she knew she would never breathe again. All she had left to accomplish in this life was to communicate her findings down below. Wincing with the eff ort, she pressed her receptors directly over the speaker.

The device was designed to sone through water, not air, but her body seemed to work as a decent medium. Immediately she heard the faint words:

"orange, green, blue, yellow, speak, orange, green, blue, yellow. Please speak."

They were calling her, spelling out the colors of her name as best they could via sound.

She soned a reply, expecting it to hurt more than it did. Compared to the rest of her injuries, the sensation of soning through air felt almost pleasant. Their response came quickly. "received, received, where you? whirlpool here."

A whirlpool? The explosion in the hole had triggered a whirlpool! It all made sense to her now; whirlpools were simply the sucking of water from the high-pressure ocean, through the ice, to the zero-pressure of Outside. She began to explain the situation to whomever was listening. It would have been a difficult explanation even if she could chrome, let alone using the paltry soning vocabulary, but somehow she managed to convey the basic story: she had discovered Outside. She told them that for the next expedition, they should bring pressure suits, heaters, thermal shielding, light filters, cameras and recording equipment. She told them to watch the colored spheres and figure out what they could tell the Rygors about the rest of the universe. It was only at the very end that she realized she had been soning with Boro for the entire conversation. She couldn't hear any emotion in his electronic voice, but somehow it still came through when he said goodbye. Ogby somehow found the strength to sone one last sentence. "WE MEET WHEN YOU COME OUTSIDE."

Leaning back on the remnants of her frozen water, Ogby's gaze through the window fell upon the large sphere that she had just discovered, far below. *Was the sphere chroming to her?* she dimly wondered. *Telling her all the secrets of the universe?* She tried to focus, but the last shreds of her attention could only note the sphere's most prominent feature, gazing back at her. When Ogby's consciousness finally slipped away, her final mental image was of that great, red spot.

Ken Wharton

Science Crossword Puzzles

Across

2.Velocity 6. Unbalanced Forces 7. Acceleration 9. Pull 10. Gravity 11. Force

Down

1. Balanced Forces 3. Push 4. Friction 5. Momentum 8. Motion

Balloon in car

when the car accelerates, the air around gets drawn to the back of the car, which makes the helium balloon go forward.

Soap Box Derby

it is unquestionably less stable than a four wheeler, especially when it goes fast, so it is not advised to use it for racing. But if you wish to move slow the three wheeler is more economic