Science News

Pluto Demoted

Pluto was stripped of its status as a planet on 24 August 2006 when astronomers from around the world redefined it as a "dwarf planet", leaving just eight major planets in the solar system.

The status of Pluto as a planet came under a clout when in 1979 it temporarily moved closer to the sun than Neptune in the solar system. It may be recalled that Pluto moves in a highly elliptical orbit around the sun. Every 248 years the two planets, Neptune and Pluto, swap places and for about 20 years, which implies that Pluto becomes the eighth planet and Neptune the ninth in terms of their distance from the sun. This topsy-turvy situation was rectified on 11 Feb. 1999 when Pluto crossed Neptune's orbit and became the ninth planet once again.

But is Pluto really a planet? That's what astronomers have been discussing for last decade or so when some members of the International Astronomical Union (IAU) suggested that Pluto be given the status of a minor planet. Why? For one thing Pluto is very small. It is 6 times smaller than the Earth, and even smaller than seven of the solar system's moons (the Moon, Io, Europa, Ganymede, Callisto, Titan and Triton). Pluto's own moon, Charon, is larger in proportion to its planet than any other satellite in the solar system. Some astronomers consider the pair to be a double planet.

The other reason that questioned the status of Pluto has been its unusual elliptical orbit. It is the only planetary orbit which crosses that of another planet (Neptune), and it is tilted 17 degrees with respect to the plane of the solar system. Astronomers once thought that Pluto may have been a satellite of Neptune that was ejected to follow a tilted elliptical path around the sun. However, careful simulations of the orbits and dynamics of Pluto and Neptune indicate that this is not likely to be so.

Pluto's composition is unknown, but its density (about 2 g/cm^3) indicates that it is probably a mixture of rock and ice. All the other rocky planets — Mercury, Venus, Earth and Mars — are located in the inner solar system, close to the Sun. Except for Pluto; all of the outer planets — Jupiter, Saturn, Uranus and Neptune — are gaseous giants. Once again, Pluto is a misfit.

Despite its well-known peculiarities, Pluto's official status as a planet was never in jeopardy until 1992 when David Jewitt and J. Luu discovered a curious object called 1992 QB1. QB1 is a small icy body, similar in size to an asteroid, orbiting 1.5 times further from the sun than Neptune. QB1 was the first hint that there might be more than just Pluto in the distant reaches of the solar system. Since then nearly 100 objects like QB1 have been found. They are thought to be similar to Pluto in composition and, like Pluto, many orbit the sun in a 3:2 resonance with Neptune. This swarm of Pluto-like objects beyond Neptune is known as the Kuiper Belt, after Gerard Kuiper, who first proposed

that such a belt existed and served as a source of short period comets. Astronomers estimate that there are at least 35,000 Kuiper Belt objects greater than 100 km in diameter, which is several hundred times the number (and mass) of similar sized objects in the main asteroid belt.

So, is Pluto really a planet or is it more like a dormant comet, simply the largest known member of the Kuiper Belt? That's the question that astronomers have recently been debating.

Other than its relatively large size, Pluto is practically indistinguishable from the other Kuiper Belt Objects (KBOs) and short period comets. The main difference is Pluto's reflectivity, which is much higher than that of known KBOs. According to Dr David Jewitt, University of Hawaii, USA, Pluto has a higher albedo (60%) than envisaged for the other KBOs. Albedo, it may be recalled is the fraction of sunlight that is reflected back into the space from the surface of a planet or a moon. But this is an artifact of size - Pluto has enough mass and gravity to retain a tenuous atmosphere from which bright surface frosts may be deposited on the surface.

In a press release dated 3 February 1999 the International Astronomical Union stated that "No proposal to change the status of Pluto as the ninth planet in the solar system has been made by any Division, Commission or Working Group of the IAU responsible for solar system science. Lately, a substantial number of smaller objects have been discovered in the outer solar system, beyond Neptune, with orbits and possibly other properties similar to those of Pluto. It has been proposed to assign Pluto a number in a technical catalogue or list of such Trans-Neptunian Objects (TNOs) so that observations and computations concerning these objects can be conveniently collated. This process was explicitly designed to not to change Pluto's status as a planet". However, this view of IAU stands revised in the last week of August 2006.

After a heated debate among 2,500 scientists of the International Astronomical Union (IAU) that met in Prague in August, 2006, a majority voted in favour of the proposal to demote Pluto to a dwarf planet instead of a planet. This followed the adoption of a new definition for a celestial body to be classified as a planet of the solar system. According to the new definition of planets adopted by the IAU, a planet is an object that orbits the sun, forms itself into a sphere by its own gravitational field and has enough gravitational pull to clear its path ff space debris. The IAU definition also requires that a classical planet should be the sole occupant of its orbit. Unlike other eight planets of the solar system, the orbital path of the Pluto overlaps with other objects such as the planet Neptune and asteroids.

The IAU has, therefore, now classified Pluto as a dwarf planet and accordingly assigned it the asteroid number 134340, by which it will be referred from now onwards. With this decision it seems that not only the toys and models of the solar system would become instantly obsolete, but would also compel teachers and publishers to update textbooks and lessons used in

classrooms for decades. Discovered in 1930 by the American Clyde Tombaugh, the icy rock of Pluto has traditionally been considered the ninth planet, farthest from the sun in the solar system.

The definition of a planet, approved after a heated debate at the International Astronomical Union (IAU) meeting in Prague, drew a clear distinction between Pluto and the other eight planets. The need to define what a planet is was driven by technological advances enabling astronomers to look further into space and measure more precisely the size of celestial bodies. According to Richard Binzel, Professor of Planetary Sciences at The Massachusetts Institute of Technology and a member of the planet definition committee this is all about the advancement of science changing our thinking as we get more information. The significance of the decision is that new discoveries and new science have told us that there is something different about Pluto from the other eight planets and as science learns more information, we get new results and new considerations.

In fact, the decades-old debate on the definition of a planet received impetus when Brown discovered UB313 in 2003. Xena, as it is nicknamed, is larger than Pluto, instantly leading to a worldwide debate whether a new planet had been discovered. The scientists agreed that, to be called a planet, a celestial body must be in orbit around a star while not itself being a star. It must be large enough in mass for its own gravity to pull it into a nearly spherical shape and have cleared the neighborhood around its orbit. Pluto was disqualified because its oblong orbit overlaps Neptune's. Xena also does not make the grade of being a planet, and will also be known as a dwarf planet.

However, everybody does not seem to share with the views of the IAU about Pluto. Many members of IAU were amazed that the agreed-upon definition, the first time the IAU has tried to define scientifically what a planet is, comes in sharp contrast to the draft circulated amongst the delegates at the General Assembly. Alan Stern of the Southwest Research Institute in Boulder, Colorado, overseer of science investigations on NASA's New Horizons mission to Pluto, called the reclassification rash and illogical. He is confidant that people would continue to consider Pluto a planet regardless of the decision taken at IAU meeting. That document, which kept Pluto as a planet and would have added three others, touched off a revolt that grew daily. Some delegates appeared downright hostile to the notion. Michael Shara, Astrophysics Curator at the American Museum of Natural History in New York revealed that the Museum had received enormous numbers of telephone calls, many of which are on the verged on hate mail from second-graders — very angry children who said, 'what have you done?' This is the cutest, most Disney-esque of the planets. 'How could you possibly demote it'?

Tombaugh's 94-year-old widow Patricia thinks that the discoverer, like any good scientist, would have accepted the demotion as inevitable. In her opinion her husband Clyde would have said, 'Science is a progressive thing and if you're going to be a scientist and put your neck out, you're apt to have it bitten

upon. She added that a small amount of her husband's ashes were now on a spacecraft bound for Pluto.

The new definition creates a second category called "dwarf planets," as well as a third category for all other objects, except satellites, known as small solar system bodies. From now on, or at least for the time being, traditional planets will be restricted to eight: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune. Whether Pluto remains to be classified as a planet or a dwarf planet, the fact is that it is there deep in the solar system and to continue to revolve around the sun in its known orbit.

(*Source:* NASA website)

Pluto's Two Small Moons Christened Nix and Hydra

What seems to be an irony of fate that on 22 June 2006, just two months before being stripped of the status of a planet, the two small satellites of Pluto discovered in May 2005, were named Nix and Hydra by the International Astronomical Union (IAU), the internationally recognized authority for assigning designations to celestial bodies. In Greek mythology Nyx was the goddess of darkness and the night, a very appropriate name for a moon orbiting Pluto - the god of the underworld. To avoid confusion with the asteroid (3908) Nyx, the Egyptian spelling Nix was chosen. Hydra is the serpent with nine heads that guarded the underworld.

A team of researchers from Southwest Research Institute (SwRI) in Boulder, Colorado, the Johns Hopkins University Applied Physics Laboratory (APL) in Laurel, Md., the Space Telescope Science Institute in Baltimore and Lowell Observatory in Flagstaff, Ariz., used Hubble Space Telescope images to make the discovery in support of NASA's mission to Pluto and beyond the Kuiper Belt that has been named 'New Horizons'. Alan Stern, co-leader of the discovery team and the New Horizons principal investigator from SwRI expressing his pleasure on the decision of the IAU, optimistically commented that one is going to be hearing a lot more about Nix and Hydra in coming years as the astronomers are already applying for telescope time to study their orbits and physical properties. And when New Horizons flies by Pluto in the summer of 2015, each will be mapped in detail.

(*Source:* NASA News on line)

TAPP-3 Synchronized with the Grid

Unit-3 of the Tarapur Atomic Power Project (TAPP) was synchronized with the grid on 15 June 2006. The 540 MWe Unit-3 of the Tarapur Atomic Power Project (TAPP) attained criticality on 21 May 2006 that signified the start of self-sustaining nuclear fission chain reaction in the reactor core. Designed and built by the Nuclear Power Corporation TAPP-3 is the sixteenth nuclear power reactor in the country. With this the aggregate capacity of NPCIL will increase to 3900 MWe.

TAPP - 3 and 4 (the later has achieved criticality on March 6, 2005) comprise two Pressurised Heavy Water Reactor (PHWR) units of 540 MWe each. PHWRs use natural uranium as fuel and heavy water both as moderator and

coolant. The experience gained from TAPP – 3 and 4 is to be utilised for up rating the unit size to 700 MWe. Four such units of 700MWe each are proposed to be built, two units each at Rawatbhata in Rajasthan and Kakrapur in Gujarat.

(*Source:* Nuclear India)

Optical Atomic Clock

James C. Bergquist, Physicists at the National Institute of Standards and Technology (NIST), Boulder, Colorado, USA has claimed that his team of researchers has refined an innovative atomic clock, which would be more precise than the best of clocks designed during the last 50 years. The advancement according to researchers may indicate that the reign of cesium atomic clocks is coming to an end.

To track time, a cesium clock exploits the absorption of microwaves by a cloud of cesium atoms. In contrast, the NIST optical clock makes use of interactions between ultraviolet radiation and a single mercury ion. Ultraviolet electromagnetic waves oscillate about 100,000 times as fast as the cesium-cloud microwaves do and so provide a much finer means to measure a second.

The NIST researchers led by Bergquist having made further improvements have designed a clock that's about 10 times as precise as the world's cesium standard. According to NIST figures, the cesium standard would be off by no more than 1 second in 70 million years of continuous operation. The NIST advance could ultimately improve navigation and tele-communications systems, opines Jean-Jacques Zondy of France's National Metrology Institute in La Plaine Saint Denis. Beyond that, the achievement "raises the issue of changing the definition of time", he notes.

However, a redefinition of the second, now based on a specific property of cesium, may be decades away, according to Zondy. Scientists don't yet know whether some other atom will prove better than mercury in optical clocks. The record-low uncertainty of the NIST clock opens the door to ultraprecise tests of foundations of physics, including relativity and the steadiness of the so-called fundamental constants. According to Bergquist at least one such test is already well under way. In recent years, astrophysical data have indicated that the fine-structure constant called *alpha* has increased since the early universe. By comparing the behaviour of the new mercury clock and another NIST optical clock based on aluminum, the NIST team is seeking evidence that *alpha* may be changing today.

(*Source:* Science News online)

Titan's Lakes: Evidence of liquid on Saturn's largest moon

New radar images indicate that Saturn's giant moon Titan contains lakes of liquid hydrocarbons. The finding provides the first compelling evidence for bodies of liquid on the surface of any object besides Earth, say the researchers who analysed the images.

Located in Titan's north polar region, the lakes range in width from just under a kilometre to 32 km and extend up to 90 km. Titan's surface, at a frigid –180°C,

is much too cold for liquid water. According to Stephen Wall, Planetary Scientist of NASA's Jet Propulsion Laboratory in Pasadena, Calif, the lakes probably consist of methane, possibly mixed with ethane. The lakes are a source of the methane gas that accounts for 5 per cent of Titan's smoggy atmosphere, assert Wall and his colleagues. Over millions of years, sunlight breaks down atmospheric methane, and scientists have long sought a source that could replenish it. They've suspected that much of the moon might be covered with methane seas.

NASA's Cassini spacecraft, which began touring Saturn in the summer of 2004, dispelled that notion. But radar images taken by the craft on 22 July 2006 show a landscape that resembles lake-strewn Minnesota. If the lakes are indeed composed of methane, the hydrocarbon would cycle between Titan's surface and atmosphere just as water cycles on Earth. Researchers consider the discovery of the equivalent of a hydrological cycle on Titan quite significant as the finding adds yet another reason to study the moon as it may help scientists to unravel the mystery of frozen Earth prior to appearance of life on it.

Although Titan's hydrocarbon haze hides the moon's surface in visible light, radar penetrates the smog. Radar-dark regions, such as the ones just found by Cassini, can denote either a smooth, liquid surface or an accumulation of powder or sand that absorbs light. However, Wall interprets that several signs from Cassini paint a lakelike portrait. Not only are the dark areas shaped like lakes, but they also have channels leading out of them. A smooth, dry powder or sand couldn't sculpt channels. Furthermore, some of the lakelike areas show what appear to be multiple shorelines, as if the body of liquid has been receding. Millions of years ago, when methane was more plentiful, lakes might have covered much more of the moon, suggests Jonathan Lunine of the University of Arizona in Tucson, who collaborated with Wall.

Cassini would not provide radar images of areas near Titan's South Pole until 2008. But this October, the radar system will look at the north polar region of Titan from a different angle. If such observations over several years show changes with season or brightness changes that could be caused by waves, they'll strengthen the evidence that liquid methane currently resides on Titan, says McEwen.

(*Source:* Science News online)

New Technique Can Manipulate Light Beams

It may be surprising to observe a laser beam spreads when it is directed to the moon and returned by one of the mirrors, a few kilometers in diameter, left behind by the Apollo astronauts at the end of their trip. This spread is mostly due to atmospheric distortions, but it nonetheless poses problems to those who wish to keep laser beams from diverging or focusing to a point as light travels through a medium.

Now a team of physicists, mathematicians, and electrical engineers from the California Institute

of Technology and the University of Massachusetts at Amherst has come out a trick to keep light pulses from diverging or focusing. Using a multi-layer sandwich of glass plates alternating with air, the scientists have provided the first experimental demonstration of a procedure called "nonlinearity management". This technique wouldn't do anything for light traveling all the way to the moon, but could be useful in future generations of devices involving optical switching and optical information processing, for which precise control of laser pulses will be advantageous.

The researchers have demonstrated that a laser beam passing through multiple layers of glass and air can be made to last much longer than if it had passed through only one type of medium. This procedure exploits a phenomenon known as the "Kerr effect", which causes the refractive index of an individual material to change if the light energy is sufficiently intense. When light is propagated only through glass, one obtains a focused beam so intense that it generates a plasma in the medium by ionizing it. Using a multi-layer "Kerr sandwich" of light and air, however, keeps the plasma from being created because the different refractive indices of the media cause the light beam to diverge and converge several times.

However, the researchers say that the setup they have used is intended to demonstrate that nonlinearity management can be performed, and it is not by any means the final version of a practical apparatus.

(*Source:* Science Daily online)

Apple Juice Benefits Neurotransmitter that Affect Memory

'An apple a day keeps the doctor away' is perhaps one of the most familiar proverbs. Now a research study conducted by scientists at University of Massachusetts Lowell (UML) demonstrates that apple products can help boost brain function similar to medication. Apples and apple juice may be among the best foods that could be added to our diet especially for babies and senior citizens, according to researchers.

Research on animals at the University of Massachusetts Lowell (UML) indicates that apple juice consumption may actually increase the production in the brain of the essential neurotransmitter acetylcholine, resulting in improved memory. Neurotransmitters such as acetylcholine are chemicals released from nerve cells that transmit messages to other nerve cells. Such communication between nerve cells is vital for good health, not just in the brain, but throughout the body.

Thomas Shea, Director, UML Center for Cellular Neurobiology and Neurodegeneration Research anticipates that the day may come when foods like apples, apple juice and other apple products are recommended along with the most popular medicines for Alzheimer's disease. The role of acetylcholine in the brain is not a new area of research. Alzheimer's medication studies start with the premise that increasing the amount of acetylcholine

in the brain can help to slow mental decline in people with Alzheimer's disease. Testing a similar hypothesis, the UML research team found that having animals consume antioxidant-rich apple juice had a comparable and beneficial effect.

In this novel animal study at UML, adult (9-12 months) and old (2-2.5 years) mice, some specially bred to develop Alzheimer's-like symptoms, were fed three different diets (a standard diet, a nutrient-deficient diet, and a nutrient-deficient diet supplemented with apple components (in this case, apple juice concentrate was added to their drinking water). Among those fed with the apple juice-supplemented diet, the mice showed an increased production of acetylcholine in their brains. Also, after multiple assessments of memory and learning using traditional Y maze tests, researchers found that the mice who consumed the apple juice-supplemented diets performed significantly better on the maze tests.

The findings also suggest that the apple-supplemented diet was most helpful in the framework of an overall healthy diet. Shea concludes, "The findings of the present study show that consumption of antioxidant-rich foods such as apples and apple juice can help reduce problems associated with memory loss." According to Shea clinical study evaluating consumption of apple products on humans will begin in the near future.

(*Source:* Science Daily online)

Anti-obesity Vaccine Tested

In what may be the first published breakthrough of its kind in the global battle against obesity, scientists at The Scripps Research Institute have developed an anti-obesity vaccine that significantly slowed weight gain and reduced body fat in animal models.

In the new study, mature male rats immunized with specific types of the active vaccine ate normally yet gained less weight and had less body fat, indicating that the vaccine directly affects the body's metabolism and energy use. This finding may be especially important to stop what is commonly known as "yo-yo dieting", the cycle of repeated loss and regain of weight experienced by many dieters. The new vaccine, which is directed against the hormone ghrelin (pronounced "grell-in"), a naturally occurring hormone that helps regulate energy balance in the body, has shown the potential, in animal models at least, to put an end to that risky and often futile struggle.

Ghrelin, a gastric endocrine hormone produced primarily in the stomach, plays a physiological role in energy homeostasis, although the full extent of that role remains unknown. It was first identified in 1999 as a naturally occurring ligand—a molecule that binds to another to form a larger molecular complex—for a growth hormone secretagogue receptor. What is known is that ghrelin promotes weight gain and fat storage through its metabolic actions, decreasing the breakdown of stored fat for energy as well

as curbing energy expenditure itself. During periods of weight loss, such as dieting, the body produces high levels of ghrelin to slow down fat metabolism, encourage eating, and promote fat retention, changes which normally make it difficult to lose weight and keep it off. There is broad speculation that ghrelin evolved as a response to the feast or famine conditions of early humans. Those who were genetically predisposed to eat heartily and store fat efficiently during periods of plenty were more likely to survive the next round of scarcity and passed this trait onto the next generation. In recent years, however, that powerful genetic legacy has come in direct conflict with the dangerous phenomenon of overeating in the developed world

The findings of the research team may mark a turning point in the treatment of obesity by confirming the effectiveness of immunopharmacotherapy to combat this serious and growing global problem. Immunopharmacotherapy engages the immune system, specifically antibodies, to bind to selected targets, directing the body's own immune response against them. This approach is being tested in a number of other areas including drug addiction, especially addiction to cocaine and nicotine.

According to Kim Janda, Jr. Professor of Chemistry at Scripps Research, the study shows that the vaccine developed by the research team slows weight gain and decreases stored fat in rats. The research showed that even though food intake was unchanged in all testing groups, those who were given the most effective vaccines gained the least amount of weight. To have an impact on appetite and weight gain, the hormone, ghrelin, first has to move from the bloodstream into the brain – where, over long periods, it stimulates the retention of a level of stored energy as fat. The researchers claim that their study is the first of its kind to provide evidence proving that preventing ghrelin from reaching the central nervous system can produce a desired reduction in weight gain.

However, researchers caution that their study does not answer all the questions pertaining to obesity treatment once and for all. What the study confirms is that this looks like a serious workable solution to the problem. And while much more research is needed to understand the full therapeutic potential of immunopharmacotherapy in combating obesity, these initial results are extremely positive. Right now it appears that active vaccination against ghrelin is one avenue that can slow weight gain and fat build-up in the body.

A vaccine against ghrelin also is particularly compelling in terms of the well-documented problems of human dieting. When you diet, the body responds as if it was starving and produces ghrelin to slow down fat metabolism and stimulate eating, changes meant to help retain and regain body fat. As a result, many people end up regaining the weight they lost and more once they go off their diets. This vaccine may have the real potential to prevent or seriously reduce yo-yo dieting; the repetitive cycle of weight loss and gain, because it interferes with ghrelin's

ability to promote weight gain and fat accumulation.

(*Source:* Science Daily online)

X-rays Reveal Archimedes' Hidden Writings

Previously hidden writings of the ancient Greek mathematician Archimedes are being uncovered with powerful X-ray beams nearly 800 years after a Christian monk scrubbed off the text and wrote over it with prayers.

Researchers at Stanford University's Linear Accelerator Center in Menlo Park have been using X-rays to decipher a fragile 10th century manuscript that contains the only copies of some of Archimedes' most important works. The X-rays generated by a particle accelerator cause tiny amounts of iron left by the original ink to glow without harming the delicate goatskin parchment. According to William Noel, curator of manuscripts at Baltimore's Walters Art Museum, the investigation is providing new insights into one of the founding fathers of western science. It is perhaps the most difficult imaging challenge on any medieval document because the book is in such terrible condition. It takes about 12 hours to scan one page using an X-ray beam about the size of a human hair, and researchers expect to decipher up to 15 pages that resisted modern imaging techniques. After each new page is decoded, it is posted online for the public to see.

Archimedes, born in the 3rd century B.C., is considered as one of ancient Greece's greatest mathematicians, perhaps best known for discovering the principle of buoyancy while taking a bath. The 174-page manuscript, known as the Archimedes Palimpsest, contains the only copies of treatises on flotation, gravity and mathematics. Scholars believe a scribe copied them onto the goatskin parchment from the original Greek scrolls. Three centuries later, a monk scrubbed off the Archimedes text and used the parchment to write prayers at a time when the Greek mathematician's work was less appreciated. In the early 20th century, forgers tried to boost the manuscript's value by painting religious imagery on some of the pages.

Over the past eight years, researchers have used ultraviolet and infrared filters, as well as digital cameras and processing techniques, to reveal most of the buried text, but some pages were still unreadable. However, scientists are not optimistic to never recover all of it.

(*Source:* SciCentral)

Hydrogen Power System Unveiled

A system that produces hydrogen energy to provide backup lighting and warmth has been demonstrated at the Chewonki Foundation's environmental education center. The nonprofit foundation teamed up with the Portland-based Hydrogen Energy Center to develop the system that was touted as an example of the kind of cutting-edge technology that can reduce dependence on fossil fuels and help ease global warming.

It is well known that hydrogen represents a huge growth industry, and the researchers around the world are trying to develop reliable hydrogen based energy systems. The system unveiled at

Chewonki uses renewable power — from solar panels atop the center and purchases of "green" electricity — to produce hydrogen from water through a process known as electrolysis. New technology that produces the gas at high pressure eliminates the need for a costly compressor. Developers of the system claim that it is the first publicly accessible direct high-pressure hydrogen energy system as well as the first complete hydrogen energy system.

Because hydrogen is flammable, the electrolyzer and eight cylinders of the gas are stored in a wood and concrete shed. The gas is then taken by a pipe, where three fuel cells convert it into one kilowatt of electricity. That power will be available in the event of an outage to supply four days' worth of lighting, operation of the building's water pump and warmth for animals that include a turtle, an iguana and an alligator.

The project, which took more than two years to complete, was designed to demonstrate how hydrogen can be generated, stored and used to provide energy. While the hydrogen generator is educational in nature, researchers are confident that commercial applications for the technology are beginning to emerge.

(*Source:* Sciencenews online)

Dark Matter Spotted After Cosmic Crash

An intergalactic collision is providing astronomers with a giant payoff: the first direct evidence of the invisible material that theorists say holds galaxies together and accounts for most of the universe's mass. For nearly 70 years, cosmologists have agreed that theories of gravity account for observations in Earth's solar system but fail on a larger scale. For example, if those theories held throughout the universe, objects on the outskirts of the Milky Way would rotate more slowly than those toward the centre. But observations have revealed that it is not so.

Scientists have offered two competing explanations of this discrepancy. The first is that an invisible substance called dark matter accounts for 90 percent of the universe's mass and gravity. Although scientists don't know what dark matter consists of, they propose that it keeps each galaxy intact. However, there is another view that doesn't accept existence of dark matter and that traditional models of gravity simply need modification.

To search for dark matter, Douglas Clowe of the University of Arizona in Tucson and his colleagues used several telescopes and observatories to image an unusually energetic collision between two galaxies that occurred 100 million years ago. Normally, as galaxies travel through the universe, gravity keeps dark and ordinary matter close together, so the invisible substance can't be distinguished. During a galactic merger, however, hot gases from one galaxy bump into hot gases in the other and both galaxies are slowed by a force similar to wind resistance. But dark matter from one galaxy, in theory, passes right through another galaxy's dark matter. According to Clowe dark matter particles don't experience the same type of drag that slows down gas clouds. His team

used a technique called gravitational lensing to locate the main mass in the aftermath of the collision. If dark matter didn't exist, all the mass would have been lumped together with the gases. Instead, the researchers found most of the mass in clumps that appeared to have whizzed past the hot gases.

The method called gravitational lensing essentially involves observation and measurement of change in direction of light as it passes close to a massive objects in space. The gravity of a massive object, whether visible or invisible, changes the direction in which light travels. By observing and measuring this light, researchers can figure out the location and even size of the object, whether a star, galaxy, or cloud of gas, responsible for the bending. The researchers focused on a galaxy cluster called 1E0657-56 found that the gravity of something invisible and extremely massive had bent light coming from more-distant galaxies visible in the background. In fact, they detected two large, separate clumps. One of the clumps, the researchers say, is made of ordinary matter, consisting of hot gases. The other clump is made of dark matter. Normally, ordinary and dark matter would be together in the same clump.

But why would dark matter separate from ordinary matter? During the impact, the hot gases of one galactic cluster slowed down the hot gases of the other. In contrast, because dark matter from one galaxy passes right through another galaxy's dark matter, the dark matter wasn't slowed by the impact. So, they could detect the two types of matter as separate clouds.

Clowe's team argues that only a theory of gravity that includes dark matter can explain the separation. According to Maxim Markevitch of the Harvard-Smithsonian Center for Astrophysics in Cambridge, and a member of the research team their finding proves in a simple and direct way that dark matter exists. It puts to rest the remaining doubt that cosmologists have had until now. The matter separation caused by the collision is "mind-boggling," says cosmologist Michael Turner of the University of Chicago. However, he adds that the researchers can't rule out alternative theories, in part because the models from them are so inconsistent.

(*Source:* Science News online)

Extending Life of Lithium Batteries

Modern rechargeable batteries for electronic gadgets generally use lithium compounds as the positive electrode and have revolutionised the electronics industry. They can be made very compact but can still deliver the required voltage to run everything from cell phones to digital cameras and notebook computers. And, not forgetting those ubiquitous MP3 players. However, everyone using a laptop, digital camera or a MP3 player experiences the frustration due to battery discharge every now and then. As gadgetry becomes sophisticated so consumer demands on battery life have risen. Moreover, more powerful lithium batteries are beginning to be used in power tools and may soon be seen in electric vehicles, applications that are much more draining than those for which conventional lithium batteries are used.

A solid solution to the problem could come from chemists in the UK. They have devised a new and efficient way to improve battery power as well as make that precious charge last longer. According to Kuthanapillil Shaju and Peter Bruce of the University, St Andrews, Scotland, lithium batteries use so-called intercalation materials as their anode. These materials are composed of a solid network of lithium atoms together with other metals, such as cobalt, nickel, or manganese, meshed together with oxygen atoms. When one charges a lithium battery, the charging current pulls the positive lithium ions out of this network. When this battery is used, it discharges as these lithium ions migrate back into the electrode, pulling electrons as they go, and so generating a current.

The challenge is to make new electrode materials that deliver high power (fast discharge) and high energy storage. Shaju and Bruce hope that they could solve these problems by developing a new way of synthesizing a particular lithium intercalation compound ($Li(Co_{1/3} Ni_{1/3} Mn_{1/3})O_2$). As a bonus, they hope to be able to simplify the complicated manufacturing process.

The St Andrews team has devised a new synthetic approach to the compound that involves simply mixing the necessary precursor compounds - organic salts of the individual metals - with a solvent in a single step. This is in sharp contrast to the conventional multi-step process used for making the compound. Using this technique, they have been able to make highly uniform lithium oxide intercalation materials in which nickel, cobalt, and manganese ions are embedded at regular intervals in the solid, which also contains pores for the electrolyte. The highly porous nature of the new material is crucial to its electrical properties. The pores allow the electrolyte to make intimate contact with the electrode surface resulting in high rates of discharge and high energy storage. The St Andrews team has tested their new lithium electrode material by incorporating it into a prototype battery and found that it gives the battery far superior power and charge retention. Increasing the rate by 1000%, so that the battery can be discharged in just six minutes, reduces the discharge capacity by only 12%. The test results suggest that this approach to rechargeable batteries could be used to make even higher power batteries for vehicles and power tools. There is an added bonus in that replacing a proportion of the cobalt used in the traditional lithium-cobalt-oxide electrodes with manganese improves safety by reducing the risk of overheating.

Flying on Hydrogen

Georgia Institute of Technology researchers have conducted successful test flights of a hydrogen-powered unmanned aircraft believed to be the largest to fly on a proton exchange membrane (PEM) fuel cell using compressed hydrogen. The fuel-cell system that powered the 22-foot (6.6 metre) wingspan aircraft generates only 500 watts. According to Adam Broughton, a research engineer who is working on the project in Georgia Tech's Aerospace Systems Design Laboratory (ASDL) five

hundred watts is sufficient to light a bulb, but not for the propulsion system of an aircraft this size. In fact, 500 watts represents about 1/100th the power required by a hybrid car. The project jointly undertaken by ASDL and the Georgia Tech Research Institute (GTRI) has been led by David Parekh, Deputy Director, GTRI and the founder of Georgia Tech's Center for Innovative Fuel Cell and Battery Technologies.

Parekh wanted to develop a vehicle that would both advance fuel cell technology and galvanise industry interest. While the automotive industry has made strides with fuel cells, apart from spacecraft, little has been done to leverage fuel cell technology for aerospace applications. According to him a fuel cell aircraft is more compelling than just a lab demonstration or even a fuel cell system powering a house. It is also more demanding. With an airplane, you really push the limits for durability, robustness, power density and efficiency.

Fuel cells, which create an electrical current when they convert hydrogen and oxygen into water, are attractive as energy sources because of their high energy density. Higher energy density translates into longer endurance. Though fuel cells don't produce enough power for the propulsion systems of commercial passenger aircraft, they could power smaller, slower vehicles like unmanned aerial vehicles (UAVs) and provide a low cost alternative to satellites. Such UAVs could also track hurricanes, patrol borders and conduct general reconnaissance. Fuel cell powered UAVs would have several advantages over conventional UAVs, according to researchers. To begin with, fuel cells emit no pollution and unlike conventional UAVs, don't require separate generators to produce electricity for operating electronic components. Another plus, because fuel cells operate at near ambient temperatures, UAVs emit less of a heat signature and would be stealthier than conventionally powered UAVs.

Comet Swan

There's a new comet in the night sky, Comet Swan. It's a trifle too dim for naked-eye viewing, but it is an easy target for binoculars and small telescopes. Observers report a "spectacular" emerald-colored head and a long sinuous tail. All those interested in tracking the comet may visit http://spaceweather.com for sky maps and more information.

(Compiled and edited by R. Joshi)