

## **Particle Study Sheds Light on Earth's Crust**

Physicists at an underground observatory in Japan have for the first time detected and analysed antineutrinos - elusive particles 500,000 times smaller than an electron - created by radioactive fires deep within the Earth.

The observation sheds new light on the complicated processes that generate heat below the Earth's crust and generate the movement of tectonic plates.

The findings are "a landmark result (that) ... will allow better estimation of the abundance and distributions of radioactive elements in the earth," wrote University of Maryland geologist William G. McDonough in an editorial accompanying the report in *Nature*.

An 85-member team led by physicists Giorgio Gratta at Stanford and Atsuto Suzuki at Japan's Tohoku University snared the tiny subatomic particles with the help of the Kamland observatory, which is essentially a giant vat of baby oil, benzene and fluorescent material that flashes when an antineutrino pass through it.

The detector is buried in a cavern underneath a mountain in Kamioka, Japan to reduce "pollution" from nuclear reactors, which also can generate antineutrinos. Physicists were able to distinguish between the two tiny particles because antineutrinos from nuclear reactors have a different energy spectrum.

"What may be most revolutionary is the alternative it provides to traditional probing methods, which simply bore down from the surface - a very costly technique that can trigger earthquakes," said Stanford Geophysicist Professor Norman Sleep. The deepest borehole drilled to date is about 7.4 miles deep, reaching to 1/500 of the Earth's radius.

The new technique "promises to give geologists and seismologists better data to predict volcanoes, earthquakes and other volatile Earth dynamics," Sleep said.

Gratta said the Kamland results, particularly the ratios of thorium to uranium it discovered, "support earlier theories about the nature of matter in the Earth's crust, core and lower mantle."

The team concluded that about 16.2 million antineutrinos per square centimetre per second are streaming out of the interior. They calculated that radioactive decay producing that level of radiation is likely generating about 24 terawatts of heat continuously.

That is about the same amount of heat as is generated by chemical reactions and phase changes, such as crystallization of liquids, and heat left over from the Earth's formation.

“Antineutrinos reveal just some basic chemistry about the inner Earth. But when you know nothing, knowing a little can make a big difference,” Gratta said.

*Source: Indian Express, July 31, 2005*

## **CMRI Develops Flyash based Mine Support**

CMRI has developed a flyash based mine support as a suitable substitute for timber prop. Other constituents of this prop are a resin and a fibre which have been used as binding material and reinforcing material, respectively. It is expected to be highly useful for the mining industry as this prop is light in weight, cost effective and bears good compressive as well as tensile strength. Moreover, it would fulfil the long cherished need for a suitable substitute for the timber prop which is becoming prohibitively expensive day by day due to its increasing scarcity. The reason behind its short supply is the restrictions imposed for cutting trees to avoid escalating environmental degradation as a consequence of burgeoning denudation of forests. This development is the outcome of a comprehensive research work conducted by CMRI under an S&T project entitled ‘Development of Flyash based Roof Support Suitable for Underground Coal Mines’ sponsored by the Ministry of Coal, Government of India. Investigations were carried out taking into account flyash samples collected from various thermal power stations. From the analysis of the results, Talcher flyash emerged as the most suitable for making prop. It contains maximum CaO (1.82%), very little combustible material (2.5%) and good percentage of SiO<sub>2</sub> (56.63%). Its bulk density is the lowest (0.74). Due to presence of good amount of calcium oxide, this flyash is pozzolanic in character and contributes much to the smoothness of the mixture with other ingredients required for making a prop. While less content of the combustible material reduces the fire risk of the prop, low bulk density makes it light in weight. Good percentage of silica ensures good compressive and tensile strengths. It was followed by the second phase of the investigation which aimed at finding out a suitable binding material. A suitable resin was selected for its low viscosity, high ignition point temperature and low density. With a view to finding out an appropriate reinforcing material, the physical and thermal behaviours of a number of natural as well as synthetic fibres were examined. Finally, a number of props of different sizes were made from the composite mixture of Talcher flyash and selected resin as well as fibre and tested rigorously. The average failure load and crippling stress were observed to be 14223 kg and 181.19 kg/cm<sup>2</sup>, respectively for props of 2.5 m length and 13512 kg and 172.13 kg/cm<sup>2</sup>, respectively for props of 3m length. The behaviours of the props in actual field conditions were investigated by installing them at New Pit and Horladih coal mines. No physical and mechanical changes were observed in the insitu mine environment during a period of two months of experimentations. The props were found to withstand the load of 8 tonnes. The newly developed prop is cheap in cost also. According to a conservative estimate, cost of one prop of 3 m length and 10cm diameter comes in the vicinity of Rs. 790 only. It may be added here that at present about 75 million tonnes of flyash is produced annually in India and if its production continues even at the present rate, it would create serious environmental problems unless it is suitably utilised. If the CMRI know-how of this prop is commercially exploited, it would open up a new avenue for waste utilisation and thereby go a long way in off-

loading the flyash dumps resulting into lesser chances of air and water contamination due to flyash. The area of the land blocked by flyash will also reduce considerably.

*Source: CMRI Newsletter, Vol.14, No.3, July-Sept. 2004*

## **Breakthrough in Solar Photovoltaics**

The Holy Grail of researchers in the field of solar photovoltaic (SPV) electricity is to generate it at a lower cost than that of grid electricity. The goal now seems to be within reach. A Palo Alto (California) start-up, named Nanosolar Inc., founded in 2002, claims that it has developed a commercial scale technology that can deliver solar electricity at US \$ 0.05 per kWh. The breakthrough has come by the application of nanotechnology to create components via molecular self-assembly, including quantum dots (10nm large nanoparticles) as well as nanotemplates with structural order extending through all three dimensions. In addition, Nanosolar has demonstrated that the three dimensionally engineered nanotemplates can be conformally coated or solidly filled with semiconductor paint to create ultra-thin solar cells with layers that are yet another factor 100x thinner than conventional thin film amorphous silicon solar cells. This allows a 10x larger surface area of these structures to be used to achieve a 10x increase in efficiency for such thin layers, thus making it possible to use even less material for similarly efficient cells. Conventional inorganic semiconductors tend to require intricate processing to ensure large grains of crystallinity (in the extreme case: monocrystallinity) so that charges can travel hundreds of nanometres without getting trapped and lost (at internal crystal boundaries). The 3D nanocomposite architecture of the ultra-thin-absorber cells makes possible absorption of a substantial fraction of the incoming sunlight despite the ultrathin layers since the charges need to be transported only several nanometres without much opportunity for a loss. This means the requirements on the semiconductor material can be relaxed and low cost materials such as inorganic semiconductors of the IIb/VIa and Ib/IIIa/VIa families as well as solution coatable organic semiconductors can be used. According to the CEO, Martin Roscheisen, the conversion efficiency (percentage of incident light energy converted to electrical energy) of the Nanosolar SPV cell is above 12 per cent for its first product prototypes. He claims that the Nanosolar SPV cell costs only \$ 0.36 per peak watt. The semiconductor paint can be applied to a flexible substrate, such as a polymer sheet, through a simple web printing process, to create an array of ultra-thin solar cells. Nanosolar has developed proprietary substrate technology that keeps the substrate cost within a smaller fraction of the overall product cost than any other state-of-the-art thin-film solar cell technology. The company has also developed a powerful new way of interconnecting individual solar cells into larger modules and large-area sheets and allows high-throughput module assembly at high yield. The flagship product, Nanosolar SolarPly, is a 4.30m x 3.05m solar electricity module delivering 774W per cm<sup>2</sup> at 110V. The company is now offering solar panels at below \$1 per peak watt. The Nanosolar team, headed by CEO Martin Roscheisen, has some top-notch Indian technologists assisting it. Among them are Dr. Siva Sivaram (ex-Intel) and Dr. A. Prabhakar, former Director, of the US National Institute of Standards and Technology.

*Source: The Hindu, Feb. 3, 2005*

## Tenth Planet Discovered

Astronomers announced that they had found a lump of rock and ice that was larger than Pluto and the farthest known object in the solar system. The discovery will probably rekindle debate over the definition of “planet” and whether Pluto still merits the designation.

The new object – as yet unnamed, but temporarily known as 2003 UB313 – is now 9 billion miles away from the Sun, or 97 times as far away as Earth and about three times Pluto’s current distance from the Sun. Its 560-year elliptical orbit brings it as close as 3.3 billion miles. Pluto’s orbit ranges from 2.7 billion miles to 4.6 billion.

The astronomers do not have an exact size for the new planet, but its brightness and distance tell them that it is larger than Pluto, the smallest of the nine known planets.

“It is guaranteed bigger than Pluto,” said Michael E. Brown, a professor of planetary astronomy at the California Institute of Technology and a member of the team that made the discovery. “Even if it were 100 percent reflective, it would be larger than Pluto. It can’t be more than 100 percent reflective.”

The discovery was made on Jan. 8 at Palomar Observatory in California. Dr. Brown and the other members of the team – Chadwick A. Trujillo of the Gemini Observatory in Hawaii and David L. Rabinowitz of Yale University – then found that they had, unknowingly, taken images of the planet, using the observatory’s 48-inch telescope, as far back as 2003.

Last year, the same team announced the discovery of a distant body they named Sedna, which, until the latest discovery, had held the title of farthest known object in the solar system. But Sedna, smaller than Pluto, is on a far stranger, 10,500-year orbit that takes it as far out as 84 billion miles.

Dr. Brown said they had a name they have proposed for the planet, but did not want to disclose it until it had been formally approved by the International Astronomical Union. “We have a name we really like, and we want it to stick,” he said.

Informally, the astronomers have been calling it Xena after the television series about a Greek warrior princess, which was popular when the astronomers began their systematic sweep of the sky in 2000. “Because we always wanted to name something Xena,” Dr. Brown said.

The astronomers were not able to see 2003 UB313 using NASA’s Spitzer Space Telescope, looking for infrared heat emitted by its minus-405 degree surface. That means the planet is less than 1,800 miles in diameter.

What is most surprising is that the orbit of the planet is sharply skewed to most of the rest of the solar system. The orbits of most planets lie close to the same plane as Earth's, known as the ecliptic plane.

The orbit of 2003 UB313 is tilted by 44 degrees. "That blows my mind," said Harold Levison of the Southwest Research Institute in Boulder, Colo., who was not involved in the discovery. "Getting something up that high is very hard."

The object is also the third brightest in the Kuiper Belt, a ring of icy bodies that circles beyond Neptune. The new planet could have been easily discovered much sooner if anyone had looked at that part of the sky.

It's because no one looks that far off the ecliptic," Dr. Brown said. "No one expects to have an inclination that high."

Another group of astronomers led by Jose-Luis Ortiz at the Sierra Nevada Observatory in Spain announced that they had found a large Kuiper Belt object, designated 2003 EL61, that they thought could be Pluto-size or larger. Dr. Brown's group had been observing the same body, but had not announced it, and their observations had already pinpointed a moon circling 2003 EL61, which constrained the size of the body to 30 percent the mass of Pluto and about 70 percent the diameter.

On his Web site, Dr. Brown wrote that the Spanish group deserved credit, saying his group had gambled that no one else would find the planet. "We were wrong!" he said.

Dr. Brown had still hoped to hold back announcements of 2003 UB313 and another large Kuiper Belt object, 2005 FY9, until October, but his hand was tipped by Brian G. Marsden, Director of the International Astronomical Union's Minor Planet Centre in Cambridge, Mass., who urged him to make the announcement as soon as possible.

Dr. Marsden said that it was possible by looking on the Internet at the logs of one of the telescopes Dr. Brown's team had been using to find out where they had been pointed. He had, he said, reason to think someone had done that, "presumably" in preparation for their own observations.

"I was shocked to find this kind of information was available on the Web," Dr. Marsden said.

*Source: New York Times and Hindustan Times dated 31.7.2005*

## **String Theory**

String Theory provides a unified description of the fundamental particles and forces in nature, including gravity. This quantum gravity theory is at present the best hope for concrete computable answers to fundamental questions, such as the underlying symmetries in nature, the quantum behaviour of black holes, the existence and breaking

of super symmetry, and the quantum treatment of singularities. It might also shed light on larger issues, such as the nature of quantum mechanics and space & time. In String Theory, all forces and particles emerge in an elegant geometrical way, realizing Einstein's dream of building everything from the geometry of space-time.

According to this theory, the world is rather like a ball of string than a pointillist painting. This is because the basic building block of nature in this scheme are not the tiny particles but unimaginable small loops and snippets of string-like entities existing in a ten-dimensional universe. One of the plus point of the theory is its promise of sanctifying the marriage of the ultra-small world of quantum physics to the macro world of Einstein's theory of relativity, which operates at very large cosmic scales.

Andrew Strominger, the celebrated Harvard physicist, says the String Theory group at the Tata Institute of Fundamental Research in Mumbai has the "highest intellectual output per dollar of any such group in the world". In recent years, India has emerged as one of the world's hottest places for doing research in String Theory.

David Gross, winner of the last year's Nobel Prize for Physics is also ebullient on India, which he says is "certainly not a Third World Country as far as science goes in any way today". Apart from string Theory, in areas, like astrophysics, condensed matter physics and high energy physics, the country is ahead of a lot of very highly advanced European countries, he adds.

*Source: Indian Geological Congress, Bulletin, Vol.1, No.1, 2005*

## **Biofuel: Jatropha**

The use of bio-fuel will increase manifold. Biofuel plant-farming, harvesting, extraction and esterification process will provide large employment and bring down crude oil imports. *Jatropha curcas* is one of the bio-fuel plants that grows well on dry land with little water. It has a 50-year life. Fruiting takes place from 6 months to three years and the plant yields up to 5 tonnes per hectare of oil-seeds that can produce two tonnes of bio-diesel. Bio-diesel plants grown in 11 million hectares can yield revenue of approximately Rs. 20,000 crore/year and employment to over 11 million people for its various processes. Use of bio-diesel is CO<sub>2</sub> – emission free.

This oil can also be used in soap and candle industries. Its by-product glycerin can be used in the pharma industry. De-oiled cake is raw material for composting and the plantation is good for honey production.

Jatropha saplings can be multiplied through tissue culture. Presently, an indigenously designed bio-fuel plant for 250 liters per day is in operation. Larger plants and other commercial outlets will have to be planned.

*Source: Indian Geological Congress, Bulletin, Vol.1, No.1, 2005*

## Has Taipei 101 caused quakes?

Standing 508 metres high, the Taipei 101 is the world's tallest building. And at 700,000 tonnes, it must be among the heaviest. The sheer size of the Taiwan sky-scraper has raised unexpected concerns. Taipei 101 is thought to have triggered two recent earthquakes because of the stress that it exerts on the ground beneath it.

According to the geologist Cheng Horng Lin, from the National Taiwan Normal University, the stress from the skyscraper may have reopened an ancient earthquake fault. And it is not just skyscrapers that are a problem. Dams and underground waste dumps may also cause rumblings if they become too large.

Before the construction of Taipei 101, the Taipei basin was a very stable area with no active earthquake faults at the surface. It only had micro-earthquakes (less than magnitude 2) happening about once a year.

However, once Taipei 101 started to rise from the ground, things changed. "The number of earthquakes increased to around two micro-earthquakes per year during the construction period (1997 to 2003).

"Since the construction finished there have been two larger earthquakes (magnitude 3.8 and 3.2) directly beneath Taipei 101, which were big enough to feel," says Dr. Lin.

Other experts are unconvinced. "A building will change the stress on the ground under the building, but this probably won't reach down to around 10 km, the level where the earthquakes occurred," says John Vidale, an earthquake expert.

*Source: Guardian News Service, Hindustan Times dated 3.12.05*

## The Top Ten Suspension Bridges in the World

The main load of the bridge is supported by the primary load bearing cable suspended between towers. From this cable vertical suspender cables are attached to the deck on which the road is built. This design enables long distances to be spanned. (Figures represent span/deck length in metres)

1. Messina, Italy, 3300/3666 incomplete (2011)
2. Kitan Straight, Japan, 2500 incomplete
3. Qiongzhou Haixia, China, 2500 incomplete
4. Akashi Kaikyo, Japan, 1991/3911 (1998)
5. Izmit Bay, Turkey, 1668 (2002)
6. Dongfang, China, 1650 incomplete
7. Store Baelt (Great Belt East), Denmark, 1624/6800 (1997)
8. Runyang (Zhenjian Yangzhou), China, 1490 incomplete (2005)
9. Ging Long D a Qiao, China, 1418 incomplete (2007)
10. Humber, England, 1410 (1981)

*Source: Hindustan Times, July 8, 2005*

## The Top ten Countries by Railway Network

1. United States 227,736 km
2. Russia 222,293 km
3. China 87,157 km
4. India 71,898 km
5. Australia 63,230 km
6. Canada 54,439 km
7. Germany 48,683 km
8. Argentina 46,142 km
9. France 34,091 km
10. Brazil 29,519 km

Source: Nationmaster.com

## IITs Ranked Third Best

The IITs (Indian Institute of Technology) have been ranked the third best technology universities in the world for 2005, according to the prestigious *Times Higher Education Supplement* (THES).

The highly respected publication said: “Our peer review of the world’s top technology universities shows that in 2004, the high praise for the Indian Institutes of Technology was no fluke.

“Up to third position in 2005 from fourth place last year, the IITs are a source of Indian national pride as well as innovation and wealth”. Among science universities, the IITs have been ranked 36<sup>th</sup> in the world.

This praise of the IITs comes along with glowing tribute for India, which the study says is “head and shoulders above the competition in global sourcing”.

## Indians send home record \$21.7 billion

International migration can generate substantial gains for migrants and their families, as well as their origin and destination countries, if policies to better manage transfer of remittances are pursued, says the World Bank Global Economic Prospects (GEP) report for 2006. The report, which forecasts that South Asia will be receiving some \$32 billion in remittances this year, says that with recorded inflows of \$21.7 billion in 2004, India received the most in terms of remittances.

Remittances recorded worldwide in 2005 are estimated to exceed \$232 billion. Of this, developing countries are expected to receive \$167 billion, more than twice the level of

development aid from all sources, the report said. South Asia will receive a 67 percent increase from 2001.

*Source: Hindustan Times, Nov. 18, 2005*

## **Major Steel Investments of Rs. 180,000 Crore in India**

### **Jharkahnd State**

<b><i>Company</i></b>	<b><i>Planned investment</i></b>	<b><i>Capacity (pa)</i></b>
Jindal Steel	Rs. 12,000 crore	5 mt
Tata Steel	Rs. 53,000 crore	17 mt
Mittal Steel	Rs. 40,000 crore	12 mt

### **Orissa State**

Jindal Steel	Rs. 13,000 crore	6 mt
Essar Steel	Rs. 10,700 crore	4 mt
Posco	Rs. 52,000 crore	12 mt

*\*(1crore = 10 million)*

*Source: Indian Express dated 16.10.2005-12-21*

## **Valley of Flowers in World Heritage**

International Union for Conservation of Nature (IUCN) and UNESCO has named the Valley of Flowers as a World heritage site. Located in Chamoli district, Uttaranchal, India, it houses over 500 species of rare wild flowers.

Spread over 87 square kilometres, it is the second national park in the state to have been named as a World heritage site after the Nanda Devi National Park located in proximity.

The valley that attracts thousands of ecologists, environmentalists, zoologists, trekkers, tourists and pilgrims from all over the world is known to local residents as the Bhyundar Ghati.

Legend in the Ramayana states that Hanuman collected Sanjeevani herb to revive Lakshman when he was wounded during the battle with Ravana.

The area got the fame after noted English botanist Frank S. Smith spent years here doing research. He gave the region its present name in his book brought out in 1937.

Nilgiris Mountain Railways has also been given the status of a World Heritage site. It'll now get annual funds from Unesco.

*Source: Hindustan Times, July 17, 2005*

## ***PIONEERS***

*This issue of the Journal is dedicated to the following pioneers who have been constant source of inspiration.*

- Let me not pray to be sheltered from dangers, but to be fearless in facing them.

***- Rabindranath Tagore***

- Success usually comes to those who are too busy to be looking for it.

***- Henry David Thoreau***

- Every great and commanding moment in the annals of the world, is the triumph of some enthusiasm.

***- Ralph Waldo Emerson***

- Where there is love there is life.

***- Mahatma Gandhi***

- Keep away from people who try to belittle your ambitions. Small people always do that, but the really great make you feel that you, too, can become great.

***- Mark Twain***

- Spend some time alone everyday. Remember that silence is sometimes the best answer. Share your knowledge. It's a way to achieve immortality.

***- Tenzin Gyasto, The Dalai Lama***

- If you find that you have made a mistake, then you must not be afraid of admitting the fact and amending your ways.

***- Confucius***

- Many of life's failures are people who did not realize how close they were to success when they gave up.

***- Thomas Edison***

- Great works are performed, not by strength, but by perseverance.

***-Samuel Johnson***

<b><i>BLISSFUL THOUGHTS</i></b>
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- Hope: The only definition of life.

*- Acharya Mohaprajyana*

- The wealth acquired with a knowledge of the proper means and without foul practices will yield virtue and happiness.

*- Thirukkural*

- Laughter is the closest thing to the grace of God.

*- Karl Barth*

- Everything that slows us down and forces patience, everything that sets us back into the slow circles of nature, is a help. Gardening is an instrument of grace.

*- May Sarton*

- Beauty in things exists in the mind which contemplates them.

*- David Hume*

- Change your thoughts and you change your world.

*- Norman Vincent Peale*

- The soul is not where it lives but where it loves.

*- Thomas Fuller*

- What a wonderful life I've had. I only wish I had realized it sooner.

*- Collette*

- Deeds which make you sad and repentant are liked better by the Lord than the good deed which turns you vain and conceited.

*- Nahjul Balagha*

- Look at yourself in the mirror of introspection. That is the way you can become flawless in the spiritual mirror of your soul.

*- Paramahansa Yogananda*