Emissions turn into fuel

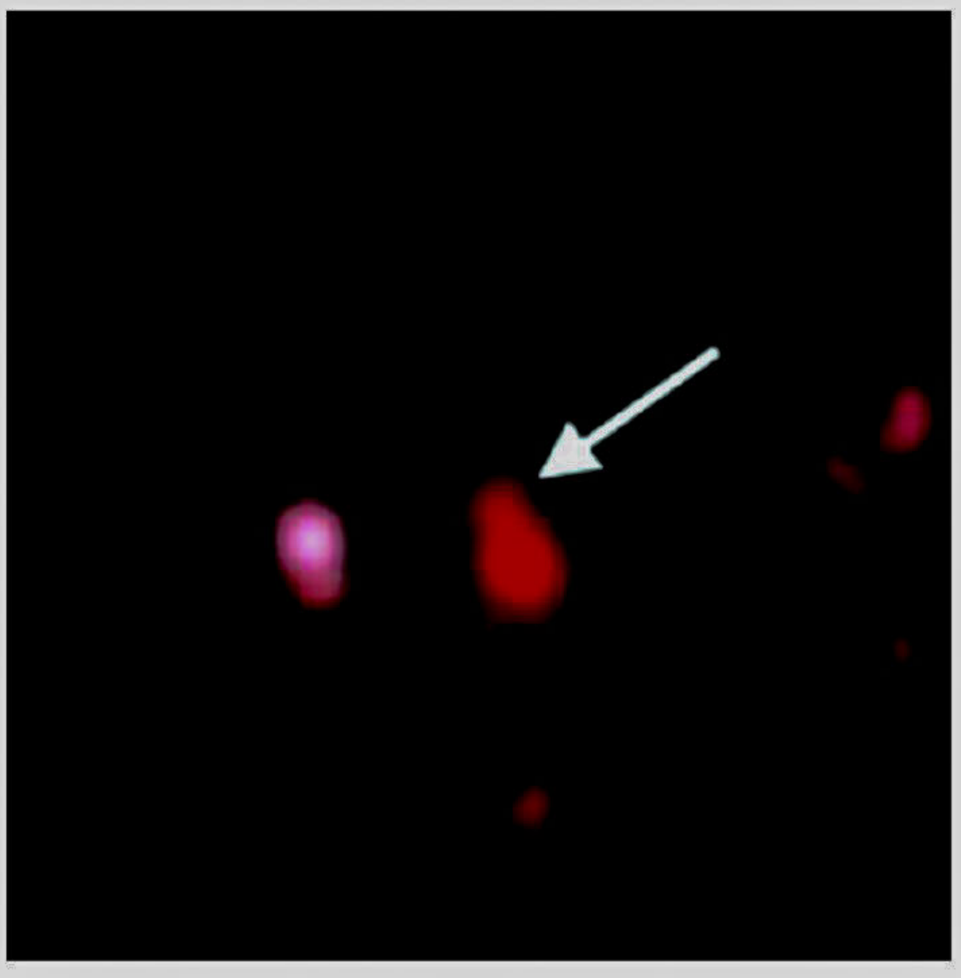
AN Illinois research team has succeeded in overcoming one major obstacle to a promising technology that simultaneously reduces atmospheric carbon dioxide and produces fuel.

University of Illinois chemical and biological engineering professor Paul Kenis and his research group joined forces with researchers at Dioxide Materials, a startup company, to produce a catalyst that improves artificial photosynthesis. The company, in the university Research Park, was founded by retired chemical engineering professor Richard Masel. The team reported their results in the journal Science.

Artificial photosynthesis is the process of converting carbon dioxide gas into useful carbon-based chemicals, most notably fuel or other compounds usually derived from petroleum, as an alternative to extracting them from biomass.

In plants, photosynthesis uses solar energy to convert carbon dioxide (CO2) and water to sugars and other hydrocarbons. Biofuels are refined from sugars extracted from crops such as corn. However, in artificial photosynthesis, an electrochemical cell uses energy from a solar collector or a wind turbine to convert CO2 to simple carbon fuels such as formic acid or methanol, which are further refined to make ethanol and other fuels.

"The key advantage is that there is no competition with the food supply," said Masel, a co-principal investigator of the paper and CEO of Dioxide Materials, "and it is a lot cheaper to transmit electricity than it is to ship biomass to a refinery."



However, one big hurdle has kept artificial photosynthesis from vaulting into the mainstream: The first step to making fuel, turning carbon dioxide into carbon monoxide, is too energy intensive. It requires so much electricity to drive this first reaction that more energy is used to produce the fuel than can be stored in the fuel.

The Illinois group used a novel approach involving an ionic liquid to catalyze the reaction, greatly reducing the energy required to drive the process. The ionic liquids stabilize the intermediates in the reaction so that less electricity is needed to complete the conversion.

The researchers used an electrochemical cell as a flow reactor, separating the gaseous CO2 input and oxygen output from the liquid electrolyte catalyst with gas-diffusion electrodes. The cell design allowed the researchers to fine-tune the composition of the electrolyte stream to improve reaction kinetics, including adding ionic liquids as a co-catalyst.

"It lowers the overpotential for CO2 reduction tremendously," said Kenis, who is also a professor of mechanical science and engineering and affiliated with the Beckman Institute for Advanced Science and Technology. "Therefore, a much lower potential has to be applied. Applying a much lower potential corresponds to consuming less energy to drive the process."

Next, the researchers hope to tackle the problem of throughput. To make their technology useful for commercial applications, they need to speed up the reaction and maximize conversion.

"More work is needed, but this research brings us a significant step closer to reducing our dependence on fossil fuels while simultaneously reducing CO2 emissions that are linked to unwanted climate change," Kenis said.

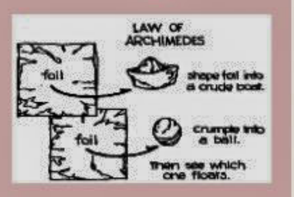
Graduate students Brian Rosen, Michael Thorson, Wei Zhu and Devin Whipple and postdoctoral researcher Amin Salehi-Khojin were co-authors of the paper. The U.S. Department of Energy supported this work.

SOURCE: **SCIENCE DAILY**

KNOW-WHY VS KNOW-HOW

The creative urge

DR. ALI ASGAR



ARCHIMEDES, Galileo, Newton, Faraday, Bohr, Heisenberg, Einstein, Landau, Fermi, Feynman are known as physicists and Leibnitz, Gauss, Minkowski, Hilbert, Neumann are recognized more as mathematicians than physicists. Inspite of their great contributions to physics, rather indirectly, the letter group contributed through the development of mathematical formalism.

Another distinction is made between physics and technology where the first is concerned with the 'know-why' inspired by the creative urge and pure curiosity and the second is the search for know-how guided by innovative skill to fulfill the practical necessities of life. These two activities were quite independent of each other in their initial undeveloped stages.

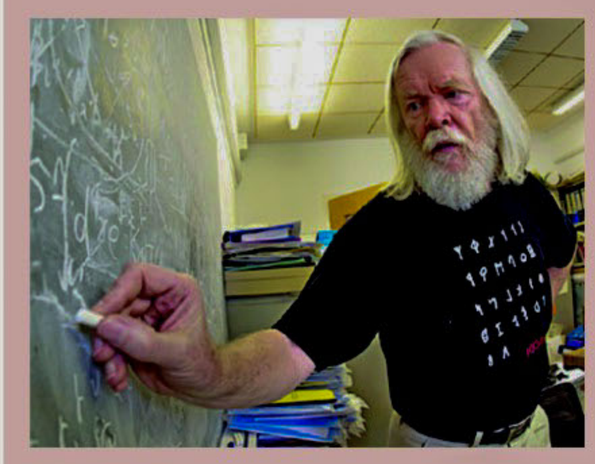
Physics also in its mechanistic and primitive stage of classical age was district from humanistic subjects and social sciences, because physics was considered objective and quantitative knowledge of inanimate nature while most of humanistic subjects like philosophy, literature and social sciences were considered as subjective and qualitative and as such arbitrary. Thus before modern physics with its two great pillars namely the theory of relativity and quantum mechanics evolved, there were much unexplored and impenetrable territories of knowledge constituting the boundaries between physics and other disciplines.

The revolutionary changes brought about by the physicists in the last hundred years through their discovery of new tools, both theoretical and experimental, to explore the territories separating physics from other disciplines have created new challenges, and new possibilities of unification. The boundaries set by size, energy, choice of subject area or methodology used to define the domain of physics are now all crossed or tunnel. The physicists have solved the puzzle of Hydrogen molecule, mapped the depth of the proton, redesigned the atomic nucleus, explored the centres of stars, the double helix of the genetic material and the alpha helix of the protein. Physics is now stretching into the infinitely small, infinitely large and infinitely complex.

The writer is President, Bangladesh Physical Society.

ELUSIVE HIGGS

Secret of mass



Petter Higgs

A major breakthrough in particle physics came in the 1970s when physicists realized that there are very close ties between two of the four fundamental forces namely, the weak force and the electromagnetic force. The two forces can be described within the same theory, which forms the basis of the Standard Model. This 'unification' implies that electricity, magnetism, light and some types of radioactivity are all manifestations of a single underlying force called, unsurprisingly, the electroweak force. But in order for this unification to work mathematically, it requires that the force-carrying particles have no mass. We know from experiments that this is not true, so physicists Peter Higgs, Robert Brout and François Englert came up with a solution to solve this conundrum.

They suggested that all particles had no mass just after the Big Bang. As the Universe cooled and the temperature fell below a critical value, an invisible force field called the 'Higgs field' was formed together with the associated 'Higgs boson'. The field prevails throughout the cosmos: any particles that interact with it are given a mass via the Higgs boson. The more they interact, the heavier they become, whereas particles that never interact are left with no mass at all.

This idea provided a satisfactory solution and fitted well with established theories and phenomena. The problem is that no one has ever observed the Higgs boson in an experiment to confirm the theory. Finding this particle would give an insight into why particles have certain mass, and help to develop subsequent physics. The technical problem is that we do not know the mass of the Higgs boson itself, which makes it more difficult to identify. Physicists have to look for it by systematically searching a range of mass within which it is predicted to exist. The yet unexplored range is accessible using the Large Hadron Collider, which will determine the existence of the Higgs boson. If it turns out that we cannot find it, this will leave the field wide open for physicists to develop a completely new theory to explain the origin of particle mass.

SOURCE: **CERN**

STRANGE THING

The theory of everything

OBAIDUR RAHMAN

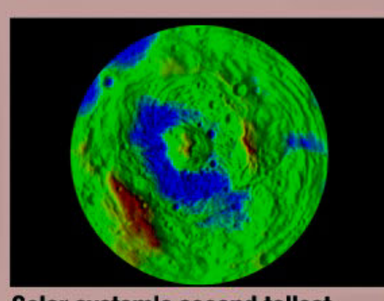
IN non-technical terms, M-theory presents an idea about the basic substance of the universe. M-theory was developed in 1995 by physicist Edward Witten. It is actually the unifying theory of superstrings. And superstring theory states that particles, previously thought of as tiny balls of energy, are in fact minute wiggling strings. It must be mentioned here that scientists are still trying to decipher the M-theory however so far, there are just only few leads. For example, physicists still are not sure whether M-theory exists as a single formation or only as a network. But they do ponder, however, over the possibility that perhaps this is the theory that Einstein thought to be "The theory of everything" concerning this and the other Universes.

But perhaps the most appealing factor concerning M-theory is that it has 11 space-time dimensions, not 10, as previously thought. The M-theory states that, space-time has ten space dimensions and one time dimension and firmly advances the idea that 7 of the dimensions are curled up so small that we don't even notice them which leaves us with the illusion that, there exist only 3 dimensions, the ones that we are familiar with today. Also according to M-theory, in this 11th dimension, a string could acquire enough energy to expand infinitely into what scientists refer as floating membrane. In physics, membrane is a two-dimensional entity assumed as a fundamental constituent of matter in superstring theories of particle physics. It is understood that our Universe exists on a floating membrane, along with infinite parallel Universes on their own membranes. From this foundation, it was further discovered that (mathematically) gravity might "leak" into our membrane from another nearby membrane, accounting for its relatively weak force in comparison to the other forces. Experts believe, perhaps it is here that lays the connectivity that M-theory talks about which allowed this idea to succeed in unifying all forces in the universe with one, elegant theory, the M-theory. But nobody's still sure as further research is in order in this regard. Aside from this, with additional study, M-theory also provided another crucial bit of information regarding how the phenomena of Big Bang might have occurred at the first place. And the answer is with two membranes colliding. And also according to this very theory, there lies about 10500 different Universes, each with its own set of laws! But only few would allow beings like us to exist.

M-theory, being a fundamental theory of physics that is a strong candidate for the theory of everything, is in actuality in a very preliminary stage. Already it has been up for intense assessment for lacking predictive power or being un-testable. But experts still believe that M-theory is the most general super-symmetric (a subtle kind of symmetry that cannot be associated with a transformation of ordinary space) theory of gravity. And for this very reason, according to Prof. Stephen Hawking, M-theory is the only candidate for a complete theory of the Universe.

Vesta's pride

Miniplanet sports megapeak



Solar system's second tallest mountain hides out on Vesta.

NANTES, France Vesta might be a planetary runt, but it holds bragging rights to one of the solar system's highest peaks.

Rising 20 kilometers from the floor of an enormous impact basin in the asteroid's south pole, Vesta's massif is taller than Hawaii's Mauna Kea Earth's highest mountain when measured from the bottom of the ocean. Vesta's peak is still smaller than the solar system's reigning giant, a Martian volcano called Olympus Mons. But then, Vesta is only 530 kilometers in diameter to Mars's 6,800 kilometers. Scientists haven't named the protrusion yet, but the crater is named Rheasilvia, after the mythological mother of the twins who founded Rome.

Chris Russell, principal investigator of NASA's Dawn mission, says he now considers Vesta the smallest terrestrial planet in the solar system. "Like Earth, Mars, Venus and Mercury, Vesta has an ancient basaltic crust, lava flows going across the surface, and it also has a large iron core," he says. "It has tectonic features, like on Earth: rift valleys, ridges, cliffs, hills and a giant mountain."

These and other new results from the Dawn spacecraft, which has been circling Vesta since mid-July, were presented October 3 during a joint meeting of the American Astronomical Society's Division of Planetary Sciences and the European Planetary Science Congress.

SOURCE: **SCIENCE NEWS**

PRE-HISTORY ON WALL

'Sistine Chapel' of Caves

SOURCE: **LIVESCIENCE**

The artwork already has suffered from exposure to the public, and the cave has been closed to tourists since 2002, when light-loving microorganisms were found living on the paintings. [See the Altamira cave paintings]

In August 2010, Spain's Ministry of Culture announced plans to reopen the cave, pending decisions by a panel of experts about how many visitors would be allowed inside each year. But according to the Spanish researchers, reopening could be a death knell for the art.

A history of degradation

The drawings were first discovered in 1879 by the 9-year-old daughter of an amateur archaeologist, Marcelino Sanz de Sautuola. It would take more than two decades for the scientific community to accept the Paleolithic art as genuine, but by 1955, the cave was receiving around 50,000 visitors each year, according to the National Museum of Altamira. In 1973, some 174,000 people tramped through to see the paintings.

DID YOU KNOW?

What happened to Dodo?

The dodo has been extinct since the mid-to-late 17th century. It is commonly used as thearchetype of an extinct species because its extinction occurred during recorded human history and was directly attributable to human activity.

The dodo (Raphus cucullatus) was a flightless bird endemic to the Indian Ocean island ofMauritius. Related to pigeons and doves, it stood about a meter (3.3 feet) tall, weighing about 20 kilograms (44 lb), living on fruit, and nesting on the ground. The dodo was known by the name "walghvogel" ("wallow bird" or "loathsome bird," in reference to its taste), first used in the journal of vice-admiral Wybrand van Warwijck, who visited the island in 1598. The bird was also referred to as "dronte" by the Dutch, a name which is still used in some language.