SCIENCE NEWS

Scientists Use Quantum Mechanics to Show that Glass should Melt Near Absolute Zero

Quantum mechanics, developed in the 1920s, has had an enormous impact in explaining how matter works. The elementary particles that make up different forms of matter — such as electrons, protons, neutrons and photons — are well understood within the model quantum physics provides. Even now, some 90 years later, new scientific principles in quantum physics are being described. The most recent gives the world a glimpse into the seemingly impossible.

Professor Eran Rabani of Tel Aviv University's School of Chemistry and his colleagues at Columbia University have discovered a new quantum mechanical effect with glass-forming liquids. They've determined that it's possible to melt glass — not by heating it, but by cooling it to a temperature near absolute zero.

This new basic science research, to be published in Nature Physics, has limited practical application so far, says Professor Rabani. But knowing why materials behave as they do paves the way for breakthroughs of the future. "The interesting story here," says Professor Rabani, "is that by quantum effect, we can melt glass by cooling it. Normally, we melt glasses with heat."

Turning the thermometer upside-down

Classical physics allowed researchers to be certain about the qualities of physical objects. But at the atomic/molecular level, as a result of the duality principle which describes small objects as waves, it's impossible to determine exact molecular position and speed at any given moment — a fact known as the "Heisenberg Principle." Based on this principle, Professor Rabani and his colleagues were able to demonstrate their surprising natural phenomenon with glass.

Many different materials on earth, like the silica used in windows, can become a glass — at least in theory — if they are cooled fast enough. But the new research by Professor Rabani and his colleagues demonstrates that under very special conditions, a few degrees above absolute zero (459.67° Fahrenheit), a glass might melt.

It all has to do with how molecules in materials are ordered, Professor Rabani explains. At some point in the cooling phase, a material can become glass and then liquid if the right conditions exist.

"We hope that future laboratory experiments will prove our predictions," he says, looking forward to this new basic science paving the way for continued research.

Classical glass

The research was inspired by Nobel Prize winner Philip W. Anderson, who wrote that the understanding of classical glasses was one of the biggest unsolved problems in condensed matter physics. After the challenge was presented, research teams around the world rose to it.

Until now, structural quantum glasses had never been explored, i.e., what happens when you mix the unique properties in glass and add quantum effects. Professor Rabani was challenged to ask, "if we looked at the quantum level, would we still see the hallmarks of a classical glass"?

What the researchers unearthed is a new and unique hallmark, showing that quantum glasses have a unique signature. Many materials he says can form a glass if they are cooled fast enough. Even though their theory is not practical for daily use: few individuals own freezers that dip down nearly 500 degrees below zero.

Professor Rabani is currently on sabbatical at the University of California, Berkeley, as a Miller visiting professor.

(Source: Science Daily Online)

Poor Work ability may Predict Faster Deterioration of Health

Poor work ability in midlife may be associated with an accelerated deterioration of health and functioning in old age, states a study published in Canadian Medical Association Journal (CMAJ).

In a 28-year follow-up population-based study, Finnish researchers studied middle-aged white-collar and blue-collar employees to see if a person's work ability in midlife might predict their risk of death or disability.

In 1981, a total of 5971 employees aged 44-58 reported on their perceived work ability as part of a longitudinal study hosted by the Finnish Institute of Occupational Health. By 2009, altogether 1918 persons had died and the ability to perform daily activities was assessed among 2879 respondents.

"We found that work ability in midlife predicted decline in health and functioning among men and women during the 28-year follow-up even after adjustments for health and lifestyle factors," writes Dr Mikaela von Bonsdorff, Gerontology Research Centre, University of Jyväskylä, Finland with coauthors. "The risks showed similar gradients among blue- and white-collar employees, but the risk of death was generally higher among blue-collar employees."

The authors conclude that, "perceived work ability in midlife correlates with mortality among blue-collar and white-collar employees, and work ability in midlife predicts disability in old age. It is plausible that a person's capacity to perform activities in relation to the demands posed by their age-appropriate role in society tracks through decades. The current work ability of middle-aged employees could, therefore, be considered as an early predictor of functioning in old age."

(Source: Science Daily Online)

Learning Causes Structural Changes in Affected Neurons

When a laboratory rat learns how to reach for and grab a food pellet — a pretty complex and unnatural act for a rodent — the acquired knowledge significantly alters the structure of the specific brain cells involved, which sprout a whopping, of 22 per cent more dendritic spines connecting them to other motor neurons.

The finding, published in the journal proceedings of the National Academy of Sciences by Mark H. Tuszynski, M.D. Ph.D. Professor of Neurosciences and Colleagues at the University of California, San Diego School of Medicine, underscores the brain's remarkable ability to physically change as it learns (not just in rats, but presumably in humans too), but also reveals that the effect is surprisingly restricted to the network of neurons actually involved in the learning.

"I think it's fair to say that in the past it was generally believed that a whole cortical region would change when learning occurred in that region, that a large group of neurons would show a fairly modest change in overall structure," said Tuszynski, who is also director of the Centre, for Neural Repair at the UC San Diego and a neurologist at the Veterans Affairs San Diego Health System.

"Our findings show that this is not the case. Instead, a very small number of neurons specifically activated by learning show an expansion of structure that's both surprisingly extensive — there is a dramatic increase in the size and complexity of the affected neurons — and yet highly restricted to a small subset of cells. And all of this structural plasticity is occurring in the context of normal learning which highlights just how changeable the adult brain is as a part of its normal biology."

Tuszynski said the new work improves science's basic understanding of how the brain learns. "This tells us that learning may be mediated by relatively few cells, but these few cells exhibit a substantial or extensive change in structure." Notably, the impacted cells in the rat study were not clustered together, but widely distributed over the motor cortex of the rat brain, suggesting that learned behaviours create expansive networks of distant cells.

Whether these new connections and changes are permanent, is the subject of continuing research. For a rat, reaching for and grasping food is a learned behaviour that takes time and repetition to master, not unlike a person learning to ride a bike or play the piano. If the behaviour isn't regularly practised, it becomes rusty, though it may be later resumed and remembered.

"This seems to be a 'hard-wired' form of memory," said Tuszynski. We were curious whether we could find evidence of hard-wiring as part of learning in animal brains. We designed this study and our original hypothesis seems to be confirmed.

"Whether this physically represents the formation of long-term memory is hard to say" Tuszynski said, explaining that the data are correlative. "The rats learn, and we know that the learning is mediated by the small set of cells we studied. We know that adjacent cells in the cortex, which are not required to learn the new task, do not show the structural change. So presumably the structural change is occurring only in the learning neurons, and the learning would likely not occur without the structural change."

He added that in order to determine whether the structural change is necessary for the learning to occur, scientists would need to block the expansion in spines and then observe a failure to learn. "Yet the inference is quite strong that structural change is necessary for the learning to occur."

Tuszynski said it remains to be seen how the brain changes in other types of learning, such as language-based knowledge or arithmetic-type learning.

"Types of memory that require much repetition for learning — and that don't fade away easily — likely use this modification of (dendritic) structure to accomplish the learning," he said. "Other forms of memory that are not so hard to establish — and which fade more rapidly — may not involve such extensive structural changes. These are concepts that will be pursued in future studies."

Coauthors of the study are Ling Wang, James M. Conner and Jessica Rickert, all in the Department of Neurosciences, UC San Diego.

The research was supported by National Institutes of Health Grant AG10435 and by Dr Miriam and Sheldon G. Adelson Medical Research Foundation.

(Source: Science Daily Online)

Possible Path to Create Next Generation Computer Chips

University of Maryland researchers have made a breakthrough in the use of visible light for making tiny integrated circuits. Though their advance is probably at least a decade from commercial use, they say it could one day make it possible for companies like Intel to continue their decades long tread of making ever smaller, faster and cheaper computer chips.

For some 50 years, the integrated circuits, or chips, that are at the heart of computers, smart phones, and other high-tech devices have been created through a technique known as photolithography, in which each computer chip is built-up in layers.

In photolithography, each layer of a conductive material (metal, treated silicon, etc., is deposited on a chip and coated with a chemical that hardens when exposed to light. Light shining through a kind of stencil know as a mask projects, a detailed pattern onto the photoresist, which hardens where it's exposed. Then, the unhardened areas of photoresist and underlying metal are etched away with a chemical. Finally, the remaining photoresist is etched away using a different chemical treatment, leaving an underlying layer of metal with the same shape as the mask.

However, fitting more and more circuits on each chip has meant making smaller and smaller circuits. In fact, features of circuits in today's computer chips are significantly smaller than the wavelength of visible light. As a result, manufacturers have gone to using shorter and shorter wavelengths of light (radiation), or even charged particles, to enable them to make these circuits.

University of Maryland chemistry Professor John Fourkas and his research group recently introduced a technique called RAPID lithography that makes it possible to use visible light to attain lithographic resolution comparable to (and potentially even better than) that obtained with shorter wave length radiation.

"Our RAPID technique could offer substantial savings in cost and ease of production," Fourkas said. "Visible light is far less expensive to generate, propagate and manipulate than shorter wavelength forms of electromagnetic radiation, such as vacuum ultraviolet or X-rays. And using visible light would not require the use of the high vacuum conditions needed for current short wavelength technologies."

The key to RAPID is the use of a special "photoinitiator" that can be excited, or turned on, by one laser beam and deactivated by another. In new work just published online by Nature Chemistry, Fourkas and his group report three broad classes of common dye molecules that can be used for RAPID lithography.

In earlier work, Fourkas and his team used a beam of ultrafast pulses for the excitation step and a continuous laser for deactivation. However, they say that in some of their newly reported materials, deactivation is so efficient that the ultrafast pulses of the excitation beam also deactivate molecules. This phenomenon leads to the surprising result that higher exposures can lead to smaller features, leading to what the researchers call a proportional velocity (PROVE) dependence.

"PROVE behaviour is a simple way to identify photoinitiators that can be deactivated efficiently," says Fourkas, "which is an important step towards being able to use RAPID in an industrial setting."

By combining a PROVE photoinitiator with a photoinitiator that has a conventional exposure dependence, Fourkas and co-workers were also able to demonstrate a photoresist for which the resolution was independent of the exposure over a broad range of exposure times.

"Imagine a photographic film that always gives the right exposure no matter what shutter speed is used," says Fourkas. "You could take perfect pictures every time. By the same token, these new photoresists are extremely fault-tolerant, allowing us to create the exact lithographic pattern we want time after time."

According to Fourkas, he and his team have more research to do before thinking about trying to commercialise their new RAPID technology. "Right now we're using the technique for point-by-point lithography. We need to get it to the stage where we can operate on an entire silicon wafer, which will require more advances in chemistry, materials and optics. If we can make these advances — and we're working hard on it — then we will think about commercialisation."

Another factor in time to application, he explained, is that his team's approach is not a R & D direction that chip manufacturers had been looking at before now. As a result, commercial use of the RAPID approach is probably at least ten years down the road, he said.

Multiphoton photoresists giving nanoscale resolution that is inversely dependent on exposure time was authored by Michael P. Stocker, Linjie Li, Ravael R. Gattass and John T. Fourkas.

The authors acknowledge the support of the Maryland NanoCenter and its NispLab. The NispLab is supported in part by the National Science Foundation (NSF) as a Materials Research Science and Engineering Center (MRSEC) Shared Experimental Facility. This work was supported in part by the UMD-NSF-MRSEC.

(Source: Science Daily Online)

Gestures Provide a Helping Hand in Problem Solving

Talking with your hands can trigger mental images that help to solve complex problems related to spatial visualisation, an important skill for both students and professionals, according to new research published by the American Psychological Association.

Spatial visualisation is the ability to mentally rotate or move an object to a different position or view. An air traffic controller uses spatial visualisation to mentally track planes in the air-based only on a two-dimensional radar screen. An interior decorator needs spatial visualisation to picture how a living room will look with a sofa in different positions without actually moving the sofa.

"Hand gestures are spontaneous and don't need to be taught, but they can improve spatial visualisation," said psychologist Mingyuan Chu, Ph.D., who conducted the research with psychologist Sotaro Kita, Ph.D., at the University of Birmingham in England. "From Galileo and Einstein to daVinci and Picasso, influential scientific discoveries and artistic masterpieces might never have been achieved without extraordinary spatial visualisation skills."

The research findings appear in the February issue of the Journal of Experimental Psychology: General. Three studies examined the relationship between hand gestures and spatial visualisation using various mental rotation tests:

- In the first experiment, 132 students at the University of Birmingham were tested individually. Using a hidden camera, researchers recorded the number of hand gestures and found that spontaneous gestures increased as the problems became more difficult.
- A second experiment divided 66 students into three groups. One group was encouraged to use gestures, the second was given no instructions, and the third had to sit on their hands to prevent any gestures. The gesture-encouraged group performed significantly better on the tests than the other groups and also fared better on later tests where all of the participants had to sit on their hands, showing that the benefits of gestures may become internalised.

In a final experiment with 32 students, a gesture-encouraged group performed better on several tests, which demonstrated that gestures may help solve a range of spatial visualisation problems.

Hand gestures may improve spatial visualisation by helping a person keep track of an object in the mind as it is rotated to a new position. Since our hands are used so much in daily life to manipulate objects, gestures may also provide additional feedback and visual cues by simulating how an object would move if the hand were holding it, said Chu, who now works as a research fellow at the Max Planck Institute for Psycholinguistics in The Netherlands.

Spatial visualisation is important in many scientific fields, including mathematics, physics and engineering. It also helps in any occupation that requires the use of images or diagrams. The research should have practical implications for education, according to Chu and Kita.

Students in a physics class could be encouraged to use hand gestures to help and understand invisible forces such as magnetic fields. Art students could talk with their hands in a still-life class to picture a bowl of fruit or a nude model from a different angle to create a more vivid painting that creates the illusion of three dimensions on a flat canvas.

(Source: Science Daily Online)

New Transistors: An Alternative to Silicon and better than Graphene

Smaller and more energy-efficient electronic chips could be made by using molybdenite. In an article appearing online on 30 January in the journal Nature Nanotechnology, EPFL's Laboratory of Nanoscale Electronics and Structures (LANES) publishes a study showing that this material has distinct advantages over traditional silicon or graphene for use in electronics applications.

A discovery made at EPFL could play an important role in electronics, allowing us to make transistors that are smaller and more energy-efficient. Research carried out in the Laboratory of Nanoscale Electronics and Structures (LANES) has revealed that molybdenite, or MoS_2, is a very effective semiconductor. This mineral, which is abundant in nature, is often used as an element in steel alloys or as an additive in lubricants. But it had not yet been extensively studied for use in electronics.

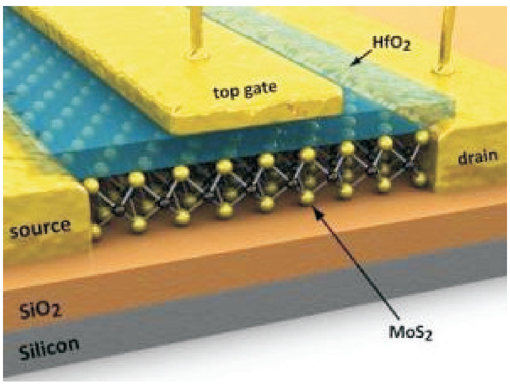
100,000 times less energy

"It's a two-dimensional material, very thin and easy to use in nanotechnology. It has real potential in the fabrication of very small transistors, Light-Emitting Diodes (LEDs) and solar cells," says EPFL Professor Andras Kis, whose LANES colleagues M. Radisavljevic, Professor Radenovic et M. Brivio worked with him on the study. He compares its advantages with two other materials: silicon, currently the primary component used in electronic and computer chips, and graphene, whose discovery in 2004 earned University of Manchester physicists André Geim and Konstantin Novoselov the 2010 Nobel Prize in Physics.

One of molybdenite's advantages is that it is less voluminous than silicon, which is a three-dimensional material. "In a 0.65-nanometre-thick sheet of MoS_2, the electrons can move around as easily as in a 2-nanometre-thick sheet of silicon," explains Kis. "But it's not currently possible to fabricate a sheet of silicon as thin as a monolayer sheet of MoS_2." Another advantage of molybdenite is that it can be used to make transistors that consume 100,000 times less energy in standby state than traditional silicon transistors. A semiconductor with a "gap" must be used to turn a transistor on and off, and molybdenite's 1.8 electron-volt gap is ideal for this purpose.

Better than graphene

In solid-state physics, band theory is a way of representing the energy of electrons in a given material. In semiconductors, electron-free spaces exist between these bands, the so-called "band gaps." If the gap is not too small or too large, certain electrons can hop across the gap. It thus offers a greater level of control over the electrical behaviour of the material, which can be turned on and off easily.



This is a digital model showing how molybdenite can be integrated into a transistor. (Credit: EPFL)

The existence of this gap in molybdenite also gives it an advantage over graphene. Considered today by many scientists as the electronic material of the future, the "semi-metal" graphene doesn't have a gap, and it is very difficult to artificially reproduce one in the material.

(Source: Science Daily Online)

A Clearer Picture of how Rivers and Deltas Develop

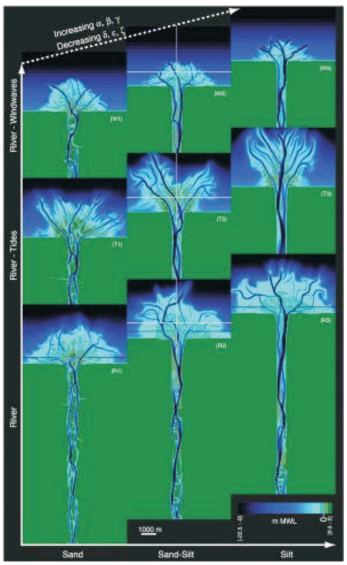
By adding information about the subsoil to an existing sedimentation and erosion model, researchers at Delft University of Technology (TU Delft, The Netherlands) have obtained a clearer picture of how rivers and deltas develop over time. A better understanding of the interaction between the subsoil and flow processes in a river-delta system can play a key role not only in civil engineering (delta management), but also in geology (especially in the work of reservoir geologists).
Nathanaël Geleynse et al. recently published in the journals Geophysical Research Letters and Earth and Planetary Science Letters.

Model

Many factors are involved in how a river behaves and the creation of a river delta. Firstly, of course, there is the river itself. What kind of material does it transport to the delta? Does this material consist of small particles (clay) or larger particles (sand)? But other important factors include the extent of the tidal differences at the coast and the height of the waves whipped-up by the wind. In this study, researchers at TU Delft are working together with Deltares and making use of the institute's computer models (Delft3D software). These models already take a large number of variables into account. Geleynse *et al* have now supplemented them with information on the subsoil. It transpires that this variable also exerts a significant influence on how the river behaves and the closely related process of delta formation.

Room for the River

The extra dimension that Geleynse *et al.* have added to the model is important to delta management, among other things. If — as the Delta Commission recommends — we should be creating "Room for the River," it is important to know what a river will do with that space. Nathanaël Geleynse explains: "Existing data do not enable us to give readymade answers to specific management questions ... nature is not so easily tamed ... but they do offer plausible explanations for the patterns and shapes we see on the surface. The flow system carries the signature of the subsoil, something we were relatively unaware of until now. Our model provides ample scope for further development and for studying various scenarios in the current structure."



Mapped results from the model for various types of sediment in the subsoil and for various types of water movement, for a given point in time. (Credit: Image courtesy of Delft University of Technology)

Geological information

River management is all about short-term and possible future scenarios. But the model developed by Geleynse *et al.* also offers greater insight into how a river/delta has developed over thousands of years. What might the subsoil have looked like and — a key factor for the oil industry — where might you expect to find oil reserves and what might their geometrical characteristics be? In combination with data from a limited number of core samples and other local measurements, the model can give a more detailed picture of the area in question than was possible until now. The link between the creation of the delta and the structure of the delta subsoil is also of interest to engineers who wish to build there. Hundreds of millions of people across the globe live in deltas and these urban deltas are only expected to grow in the decades to come.

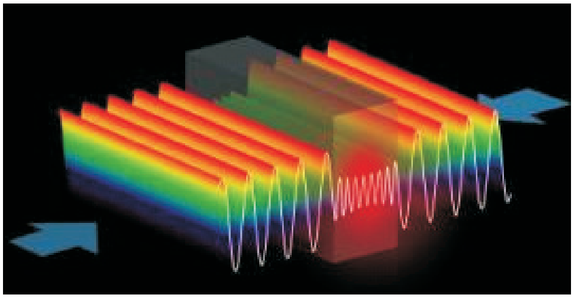
(Source: Science Daily Online)

World's First Anti-Laser Built

More than 50 years after the invention of the laser, scientists at Yale University have built the world's first anti-laser, in which incoming beams of light interfere with one another in such a way as to perfectly cancel each other out. The discovery could pave the way for a number of novel technologies with applications in everything from optical computing to radiology.

Conventional lasers, which were first invented in 1960, use a so-called "gain medium," usually a semiconductor like gallium arsenide, to produce a focussed beam of coherent light — light waves with the same frequency and amplitude that are in step with one another.

Last summer, Yale physicist A. Douglas Stone and his team published a study explaining the theory behind an anti-laser, demonstrating that such a device could be built using silicon, the most common semiconductor material. But it wasn't until now, after joining forces with the experimental group of his colleague Hui Cao, that the team actually built a functioning anti-laser, which they call a coherent perfect absorber (CPA).



In the anti-laser, incoming light waves are trapped in a cavity where they bounce back-and-forth until they are eventually absorbed. Their energy is dissipated as heat (Credit: Yidong Chong/Yale University)

The team, whose results appear in the 18 February issue of the journal *Science*, focussed two laser beams with a specific frequency into a cavity containing a silicon wafer that acted as a "loss medium." The wafer aligned the light waves in such a way that they became perfectly trapped, bouncing back-and-forth indefinitely until they were eventually absorbed and transformed into heat.

Stone believes that CPAs could one day be used as optical switches, detectors and other components in the next generation of computers, called optical computers, which will be powered by light in addition to electrons. Another application might be in radiology, where Stone said the principle of the CPA could be employed to target electromagnetic radiation to a small region within normally opaque human tissue, either for therapeutic or imaging purposes.

Theoretically, the CPA should be able to absorb 99.999 per cent of the incoming light. Due to experimental limitations, the team's current CPA absorbs 99.4 per cent. "But the CPA we built is just a proof of concept," Stone said. "I'm confident we will start to approach the theoretical limit as we build more sophisticated CPAs." Similarly, the team's first CPA is about one centimetre across at the moment, but Stone said that computer simulations have shown how to build one as small as six microns (about one-twentieth the width of an average human hair).

The team that built the CPA, led by Cao and another Yale physicist, Wenjie Wan, demonstrated the effect for near-infrared radiation, which is slightly "redder" than the eye can see and which is the frequency of light that the device naturally absorbs when ordinary silicon is used. But the team expects that, with some tinkering of the cavity and loss medium in future versions, the CPA will be able to absorb visible light as well as the specific infrared frequencies used in fiber optic communications.

It was while explaining the complex physics behind lasers to a visiting professor that Stone first came up with the idea of an anti-laser. When he suggested his colleague to think about a laser working in reverse in order to help him understand how a conventional laser works. Stone began contemplating whether it was possible to actually build a laser that would work backwards, absorbing light at specific frequencies rather than emitting it.

"It went from being a useful thought experiment to having me wondering whether you could really do that," Stone said. "After some research, we found that several physicists had hinted at the concept in books and scientific papers, but no one had ever developed the idea."

(Source: Science Daily Online)

The Green Machine: Algae Clean Wastewater, Convert to Biodiesel

Let algae do the dirty work

Researchers at Rochester Institute of Technology are developing biodiesel from microalgae grown in wastewater. The project is doubly "green" because algae consume nitrates and phosphates and reduce bacteria and toxins in the water. The end result is clean wastewater and stock for a promising biofuel.

The purified wastewater can be channeled back into receiving bodies of water at treatment plants, while the biodiesel can fuel buses, construction vehicles and farm equipment. Algae could replace diesel's telltale black puffs of exhaust with cleaner emissions low in the sulfur and particulates that accompany fossil fuels.

Algae have a lot of advantages. They are cheaper and faster to grow than corn, which requires nutrient-rich soil, fertiliser and insecticide. Factor in the fuel used to harvest and transport corn and ethanol starts to look complicated.

In contrast, algae are much simpler organisms. They use photosynthesis to convert sunlight into energy. They need only water — ponds or tanks to grow in — sunlight and carbon dioxide.

"Algae — as a renewable feedstock — grow a lot quicker than crops of corn or soyabeans," says Eric Lannan, who is working on his master's degree in mechanical engineering at RIT. "We can start a new batch of algae about every seven days. It's a more continuous source that could offset 50 per cent of our total gas use for equipment that uses diesel."

Cold weather is an issue for biodiesel fuels

"The one big drawback is that biodiesel does freeze at a higher temperature," says Jeff Lodge, associate professor of biological sciences at RIT. "It doesn't matter what kind of diesel fuel you have, if it gets too cold, the engine will not start. It gels up. It's possible to blend various types of biodiesel — algae derived with soyabeans or some other type — to generate a biodiesel with a more favourable pour point that flows easily."

Lannan's graduate research in biofuels led him to Lodge's biology lab. With the help of chemistry major Emily Young, they isolated and extracted valuable fats or lipids, algae produce and yielded tiny amounts of a golden-coloured biodiesel. They are growing the alga strain Scenedesmus, a single-cell organism, using wastewater from the Frank E. Van Lare Wastewater Treatment Plant in Irondequoit, N.Y.

"It's key to what we're doing here," Lodge says. "Algae will take out all the ammonia — 99 per cent — 88 per cent of the nitrate and 11 per cent of the phosphate from the wastewater — all those nutrients you worry about dumping into the receiving water. In three to five days, pathogens are gone. We've got data to show that the coliform counts are dramatically reduced below the level that's allowed to go out into Lake Ontario."

Assemblyman Joseph Morelle, whose district includes Irondequoit, applauds RIT's initiative. "Innovations developed at great academic institutions such as RIT will be key to solving many of the challenges we face, from revitalising the upstate economy to the creation of clean, renewable energy sources for the future. Professor Lodge and Eric Lannan's research bridges the gap between cost efficiency and environmental conservation and is a perfect example of how old problems can yield to new and creative solutions."

Lodge and Lannan ramped up their algae production from 30 gallons of wastewater in a lab at RIT to 100 gallons in a 4-foot-by-7-foot long tank at Environmental Energy Technologies, an RIT spinoff. Lannan's graduate thesis advisor Ali Ogut, Professor of Mechanical Engineering, is the company's president and CTO. In the spring, the researchers will build a mobile greenhouse at the Irondequoit Wastewater Treatment Plant and scale up production to as much as 1,000 gallons of wastewater.

Northern Biodiesel, located in Wayne County, will purify the lipids from the algae and convert them into biodiesel for the RIT researchers.

(Source: Science Daily Online)

'Periodic Table of Shapes' to Give a New Dimension to Mathematics

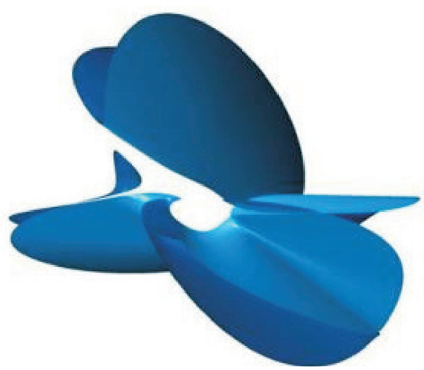
Mathematicians are creating their own version of the periodic table that will provide a vast directory of all the possible shapes in the universe across three, four and five dimensions, linking shapes together in the same way as the periodic table links groups of chemical elements.

The three-year project should provide a resource that mathematicians, physicists and other scientists can use for calculations and research in a range of areas, including computer vision, number theory and theoretical physics.

The researchers from Imperial College, London and institutions in Australia, Japan and Russia, are aiming to identify all the shapes across three, four and five dimensions that cannot be divided into other shapes.

As these building block shapes are revealed, the mathematicians will work out the equations that describe each shape and through this, they expect to develop a better understanding of the shapes' geometric properties and how different shapes are related to one another.

The work is funded by the Engineering and Physical Sciences Research Council, the Leverhulme Trust, the Royal Society and the European Research Council.



Sample shape: this one shows a slice of the cubic threefold (Credit: Imperial College, London)

Project leader, Professor Alessio Corti, from the Department of Mathematics at Imperial College, London, explained, "The periodic table is one of the most important tools in chemistry. It lists the atoms from which everything else is made, and explains their chemical properties. Our work aims to do the same thing for three, four and five-dimensional shapes — to create a directory that lists all the geometric building blocks and breaks down each one's properties using relatively simple equations. We think we may find vast numbers of these shapes, so you probably won't be able to stick our table on your wall, but we expect it to be a very useful tool."

The scientists will be analysing shapes that involve dimensions that cannot be seen in a conventional sense in the physical world. In addition to the three dimensions of length, width and depth found in a three-dimensional shape, the scientists will explore shapes that involve other dimensions, e.g. the space-time described by Einstein's Theory of Relativity has four dimensions — the three spatial dimensions, plus time. String theorists believe that the universe is made up of many additional hidden dimensions that cannot be seen.

Professor Corti's colleague on the project, Dr Tom Coates, has created a computer modelling programme that should enable the researchers to pinpoint the basic building blocks for these multi-dimensional shapes from a pool of hundreds of millions of shapes. The researchers will be using this programme to identify shapes that can be defined by algebraic equations and that cannot be divided any further. They do not yet know how many such shapes there might be. The researchers calculate that there are around 500 million shapes that can be defined algebraically in four dimensions and they anticipate that they will find a few thousand building blocks from which all these shapes are made.

Dr Coates, from the Department of Mathematics at Imperial College, London, added, "Most people are familiar with the idea of three-dimensional shapes, but for those who don't work in our field, it might be hard to get your head around the idea of shapes in four and five-dimensions. However, understanding these kinds of shapes is really important for lots of aspects of science. If you are working in robotics, you might need to work out the equation for a five dimensional shape in order to figure out how to instruct a robot to look at an object and then move its arm to pick that object up. If you are a physicist, you might need to analyse the shapes of hidden dimensions in the universe in order to understand how sub-atomic particles work. We think the work that we're doing in our new project will ultimately help our colleagues in many different branches of science.

"In our project we are looking for the basic building blocks of shapes. You can think of these basic building blocks as 'atoms', and think of larger shapes as 'molecules.' The next challenge is to understand how properties of the larger shapes depend on the 'atoms' that they are made from. In other words, we want to build a theory of chemistry for shapes," added Dr Coates.

Dr Coates has recently won a prestigious Philip Leverhulme Prize worth £ 70,000 from the Leverhulme Trust, providing some of the funding for this project. Philip Leverhulme prizes are awarded to outstanding scholars under the age of 36 who have made a substantial contribution to their particular field of study, recognised at an international level, and where the expectation is that their greatest achievement is yet to come.

(Source: Science Daily Online)

Nanotechnology may Lead to New Treatment of Liver Cancer

Nanotechnology may open a new door on the treatment of liver cancer, according to a team of Penn State College of Medicine researchers. They used molecular-sized bubbles filled with chemotherapy drugs to prevent cell growth and initiate cell death in test tubes and mice.

Researchers evaluated the use of molecular-sized bubbles filled with C6-ceramide, called cerasomes, as an anticancer agent. Ceramide is a lipid molecule naturally present in the cell's plasma membrane and controls cell functions, including cell aging or senescence.

Hepatocellular carcinoma is the fifth most common cancer in the world and is highly aggressive. The chance of surviving five years is less than five per cent, and treatment is typically chemotherapy and surgical management including transplantation.

"The beauty of ceramide is that, it is non-toxic to normal cells, putting them to sleep, while selectively killing cancer cells," said Mark Kester, Ph.D., G. Thomas Passananti, Professor of Pharmacology.

Cerasomes, developed at Penn State College of Medicine, can target cancer cells very specifically and accurately, rather than affecting a larger area that includes healthy cells. The problem with ceramide is that as a lipid, it cannot be delivered effectively as a drug. To solve this limitation, the researchers use nanotechnology, creating the tiny cerasome, to turn the insoluble lipid into a soluble treatment.

"Cerasomes were designed as a therapeutic alternative to common chemotherapeutics," said Kester. "These have been shown to be toxic to cancer cells and not to normal cells, and have already been shown to effectively treat cellular and animal models of breast cancer and melanoma. Cerasomes have also been shown to be essentially free of toxic side-effects normally associated with anticancer agents."

In the test tube and animal models of liver cancer, cerasomes, but not a placebo, selectively induced cell death in the cancer cells.

In mice with liver cancer, cerasomes blocked tumor vascularisation, the forming of blood vessels needed for growth and nutrition. Studies show that lack of nutrition causes cells to create more ceramide and leads to cell death.

"It is plausible that preventing liver tumor vascularisation with cerasome treatment could induce widespread apoptosis, a genetically programme series of events that leads to cell death in tumors," Kester said. "The efficacy of our cerasomes in the treatment of diverse cancers lends significant therapeutic promise as it translates from bench to bedside."

The researchers published their work in the journal *Gut*. A Penn State Dean's Feasibility Grant, Pennsylvania tobacco settlement funds, and the National Institutes of Health supported this work.

In an earlier study published in the journal *Blood*, researchers observed that cerasome use led to complete remission in aggressive, large granular lymphocytic leukemia in rats. In addition, the protein survivin, which prevents cell death, is heavily produced in NK-leukemia cells, but not in normal cells. Cerasome decreased expression of survivin and may lead to a therapeutic approach for fatal leukemia.

Other researchers are Hephzibah Rani S. Tagaram, M.D., Diego Avella, M.D, Eric. T. Kimchi, M.D., Kevin F. Stavely O'Carroll, M.D., Department of Surgery; Nicole A. DiVittore, Brian M. Barth, Ph.D., and James M. Kaiser, Department of Pharmacology; Yixing Jiang, M.D., Ph.D., Department of Medicine; and Harriet C. Isom, Ph.D., Department of Microbiology and Immunology.

(Source: Science Daily Online)

The more Secure you Feel, the less you Value your Stuff

People who feel more secure in receiving love and acceptance from others place less monetary value on their possessions, according to new research from the University of New Hampshire.

The research was conducted by Edward Lemay, Assistant Professor of Psychology at UNH, and colleagues at Yale University. The research is published in the *Journal of Experimental Social Psychology*.

Lemay and his colleagues found that people who had heightened feelings of interpersonal security — a sense of being loved and accepted by others — placed a lower monetary value on their possession than people who did not.

In their experiments, the researchers measured how much people valued specific items, such as a blanket and a pen. In some instances, people who did not feel secure placed a value on an item that was five times greater than the value placed on the same item by more secure people.

"People value possessions, in part, because they afford a sense of protection, insurance and comfort," Lemay says. "But what we found was that if people already have a feeling of being loved and accepted by others, which also can provide a sense of protection, insurance and comfort, those possessions decrease in value."

The researchers theorise that the study results could be used to help people with hoarding disorders.

"These findings seem particularly relevant to understanding why people may hang onto goods that are no longer useful. They may also be relevant to understand why family members often fight over items from estates that they feel are rightfully theirs and to which they are already attached. Inherited items may be especially valued because the associated death threatens a person's sense of personal security," Lemay says.

The research was conducted by Lemay; Margaret Clark, Aaron Greenberg, Emily Hill and David Roosth, all from Yale University and Elizabeth Clark-Polner from Université de Genève, Switzerland.

(Source: Science Daily Online)