DNA tells quantum states apart

DO the principles of quantum mechanics apply to biological systems? Until now, says Prof. Ron Naaman of the Institute's Chemical Physics Department (Faculty of Chemistry), both biologists and physicists have considered quantum systems and biological molecules to be like apples and oranges. But research he conducted together with scientists in Germany, which appeared recently in Science, shows that a biological molecule -- DNA -- can discern between quantum states known as spin.

Quantum phenomena, it is generally agreed, take place in extremely tiny systems -- single atoms, for instance, or very small molecules. To investigate them, scientists must usually cool their material down to temperatures approaching absolute zero. Once such a system exceeds a certain size or temperature, its quantum properties collapse, and "every day" classical physics takes over. Naaman: "Biological molecules are quite large, and they work at temperatures that are much warmer than the temperatures at which most quantum physics experiments are conducted. One would expect that the quantum phenomenon of spin, which exists in two opposing states, would be scrambled in these molecules -- and thus irrelevant to their function."

New research shows that a biological molecule -- DNA -- can discern between quantum states known as spin

But biological molecules have another property: they are chiral. In other words, they exist in either "left-" or "right-handed" forms that can't be superimposed on one another. Double-stranded DNA molecules are doubly chiral -- both in the arrangement of the individual strands and in the direction of the helices' twist. Naaman knew from previous studies that some chiral molecules can interact in different ways with the two different spins. Together with Prof. Zeev Vager of the Particle Physics and Astrophysics Department, research student Tal Markus, and Prof. Helmut Zacharias and his research team at the University of Münster, Germany, he set out to discover whether DNA might show some spin-selective properties.

The researchers fabricated self-assembling, single layers of DNA attached to a gold substrate. They then exposed the DNA to mixed groups of electrons with both directions of spin. Indeed, the team's results surpassed expectations: The biological molecules reacted strongly with the electrons carrying one of those spins, and hardly at all with the others. The longer the molecule, the more efficient it was at choosing electrons with the desired spin, while single strands and damaged bits of DNA did not exhibit this property. These findings imply that the ability to pick and choose electrons with a particular spin stems from the chiral nature of the DNA molecule, which somehow "sets the preference" for the spin of electrons moving through it.

In fact, says Naaman, DNA turns out to be a superb "spin filter," and the team's findings could have relevance for both biomedical research and the field of spintronics. If further studies, for instance, bear out the finding that DNA only sustains damage from spins pointing in one direction, then exposure might be reduced and medical devices designed accordingly. On the other hand, DNA and other biological molecules could become a central feature of new types of spintronic devices, which will work on particle spin rather than electric charge, as they do today

Source: Science Daily

FROM HEART OF DARKNESS

Black hole jets in HD

JUMBO JETCombined X-ray, microwave and visible-light data reveal jets emanating from the central black hole of Centaurus

ASTRONOMERS have produced the sharpest images ever of twin jets racing outward from the vicinity of a galaxy's central black hole.

Using the combined power of nine radio telescopes arrayed across the Southern Hemisphere, the images reveal features just 15 light-days across in the heart of the nearby galaxy Centaurus A, 12 million light-years away. At its core, the galaxy contains a black hole as massive as 55 million suns.

The new images home in on a region around the black hole less than 4.2 light-years across smaller than the distance between the sun and its nearest star, says Roopesh Ojha of NASA's Goddard Space Flight Center in Greenbelt, Md. Ojha and his colleagues describe their findings in the June Astronomy & Astrophysics.

To obtain the high-resolution radio images, the team combined data from an array of radio telescopes with resolution equivalent to a single superdish about 80 percent of Earth's diameter.

The images reveal for the first time just how close to a black hole a jet can form, a constraint that must now be incorporated into models of how such jets are generated, Ojha says.

The jets are thought to arise as matter approaches and falls onto the black hole, fueling the beast and radiating energy in the process. But the exact details are unknown, Ojha notes.

Source: Science News

BUDDING SCIENTISTS

Chitosan as preservative

Visitors watching demo of the science project: "Chitosan as preservative and fertiliser" at a science fair

STAR SCIENCE DESK

A team of students from Rajuk Uttara Model College under the guidance of their teacher carried out experiment on Chitosan to see if it can be used as a low cost, environment-friendly preservative and fertilizer. Their initial attempt proved to be a success.

Chitosan is a derivative of Chitin, a nitrogenous polysaccharide related chemically to cellulose. It is a principal constituent of the outer covering of crustaceans like shrimps, crabs, mollusks, etc. Chitosan is produced commercially through deacetylation of Chitin.

Motivated by a desire to free the fish, fruit and vegetables we consume everyday from harmful chemicals used as preservatives by traders, Rafiqul Islam, along with his year mate Tasneem Ferdous, tried to find a safer alternative. Their research project styled "Chitosan as preservative and fertilizer" drew a lot of attention and appreciation at last year's science fairs held in their own college as well as at BAF Shaheen College. Prof. Dr Narul Abser from chemistry Dept of JU and two other professors from physics and biology Dept of DU adjudged their project as the best one. Bangladesh University of engineering technology (BUET) teachers adjudicated at the BAF Shaheen College science fair.

TRAPPED FOR LONGER

Corralled antimatter atoms

SCIENTISTS have succeeded in trapping atoms of anti-hydrogen for more than 15 minutes.The feat is a big improvement on efforts reported last year that could corral this mirror of normal hydrogen for just fractions of a second at best.

The researchers tell Nature Physics journal that they can now probe the properties of antimatter in detail.

This will help them understand why the Universe is composed of normal matter rather than its opposite.

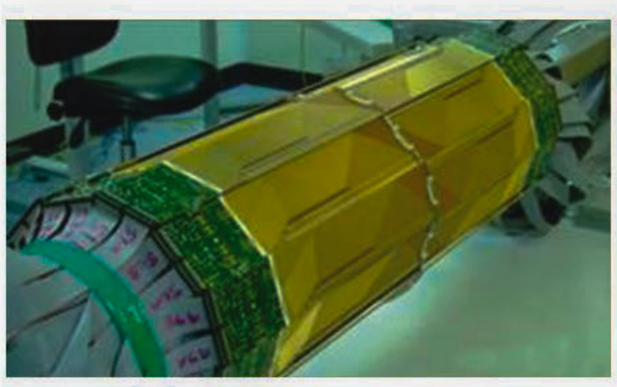
The laws of physics appear to make no distinction between the two and equal amounts should have been created at the Big Bang.

"We have improved the efficiency of trapping compared with what we published last November," said Jeffrey Hangst, who works on the Alpha collaboration at the Cern particle physics laboratory in Switzerland.

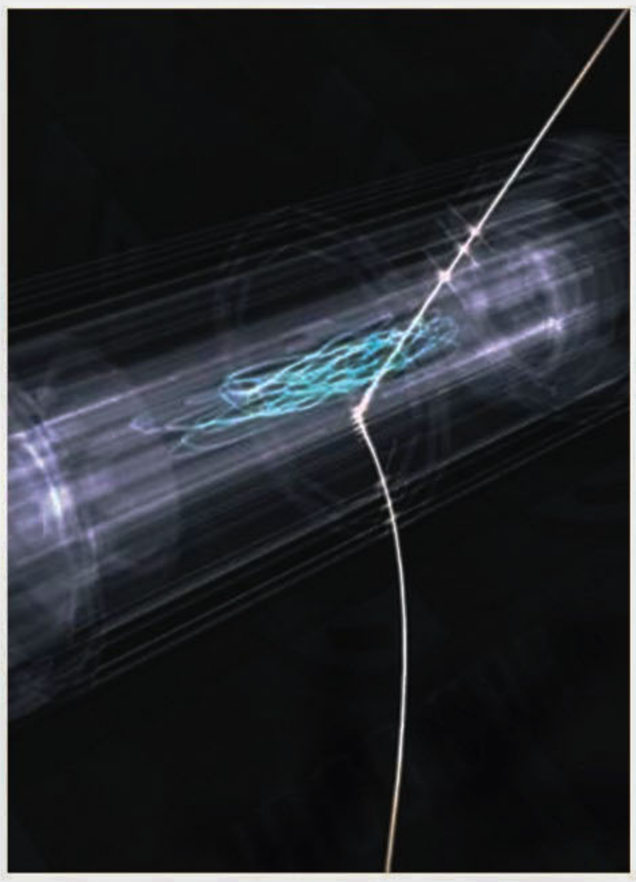
"In order to make these studies, it surely helps to have more atoms and we've made an improvement of about a factor of five. We announced 38 trapped atoms [last year]; we've now studied about 300 which have been held for varying amounts of time."

In normal matter, a hydrogen atom comprises an electron bound to a proton. In the anti-form, the mirror of an electron - a positron - is bound to an antiproton. Together, these two particles make a neutral anti-atom.

Particle physics labs such as Cern can make antimatter particles routinely but until now they have had great difficulty in retaining this material because it will instantly annihilate on contact with conventional containers made of normal matter.



The team uses an ultra-cold magnetic trap



An artist's conception of an anit-hydrogen atom being released from the trap after 1,000 seconds

The Alpha collaboration, however, has developed a frigid, evacuated, "magnetic bottle" that allows its scientists to enclose anti-hydrogen particles and draw out the time before they are destroyed. Initially this was a mere two-tenths of a second but the team says it has increased this period more than 5,000-fold.

Source: BBC

HUB-AND-SPOKE

Revealing information flow

POLITICAL thrillers that portray a "web of corruption" get it all wrong, at least according to an analysis of e-mails between Enron employees. The flow of the famously corrupt corporation's electronic missives suggests that dirty dealings tend to transpire through a sparse, wheel-and-spoke network rather than a highly connected web.

Employees who were engaged in both legitimate and shady projects at the company conveyed information much differently when their dealings were illicit, organizational theorist Brandy Aven of Carnegie Mellon University in Pittsburgh reported June 1 at an MIT workshop on social networks. The distinction is visible in the network of e-mails among employees, which takes the shape of a wheel with a central hub and isolated spokes when content is corrupt, rather than a highly connected net of exchanges.

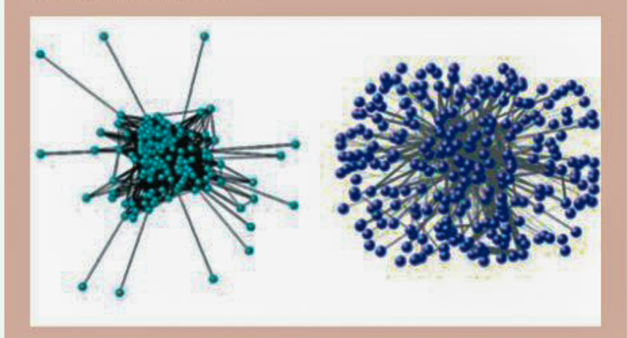
While today Enron is associated with corporate fraud, for years the energy and commodities company was a Wall Street darling.Fortune magazine named Enron America's most innovative company for six consecutive years ending in 2000. But by the next year, the U.S. Securities and Exchange Commission was investigating the firm's dealings.

"They were not only innovative technologically and administratively, but also in their accounting practices," said Aven.

Aven's analysis compared communications regarding three legitimate innovative projects and three corrupt ones that went by the names JEDI, Chewco and Talon. Communications regarding the shady deals took on a wheel-and-spoke shape, a setup that maximizes secrecy and control. A small, relatively informed clique occupies the hub at the center, communicating with protruding spokes that don't share ties with each other. The hub gets information from the spokes, which in their isolation are less likely to whistle-blow and can be played off each other.

That the sneaky behavior employed to cover the corrupt "innovations" at Enron might have been revealed just by diagramming who is e-mailing whom suggests that the structures of social networks might be a good diagnostic tool. Probing the shapes of social networks might help investigators identify electronic dens of intrigue, such as people communicating within a terrorist network, said Aven.

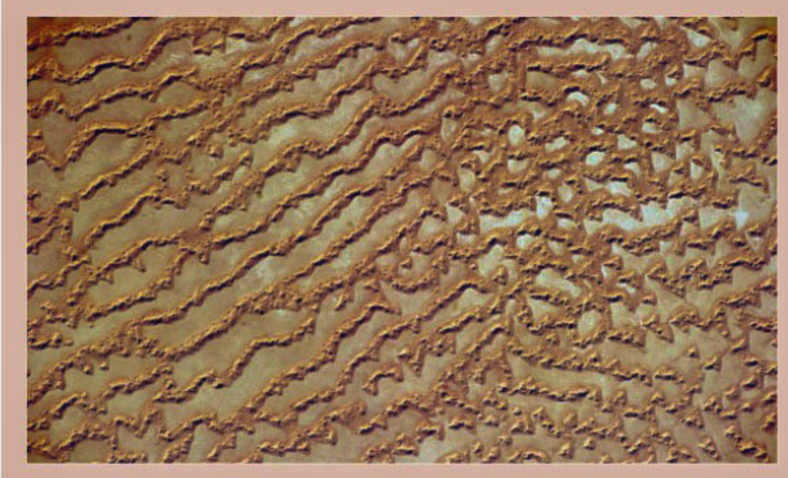
Source: Science News



Widely shared e-mails (right), sparse network of illicit project (left)

IMAGE FROM SPACE

Sand dunes in Oman



Source: Live Science

The image, taken by astronauts, is of crescent-shaped sand dunes alternating with salt flats called sabkhas.

The setup, in Oman, has lots of names, according to NASA . It is known as the Ar Rub' al Khali, or the Empty quarter. It's also referred to as a sand sea.

The dunes are oriented at right angles to northwesterly trade winds, called the Shamal winds, that originate in Iraq.

The image was taken May 16, 2011 by astronauts aboard the International Space Station.

DID YOU KNOW?

What is a SoLoMo?

SoLoMos are mobile phone applications that combine social networking and location data. SoLoMo is a combination of the words social, location or local, and mobile. These applications concentrate on local areas making geo-local engagement possible.