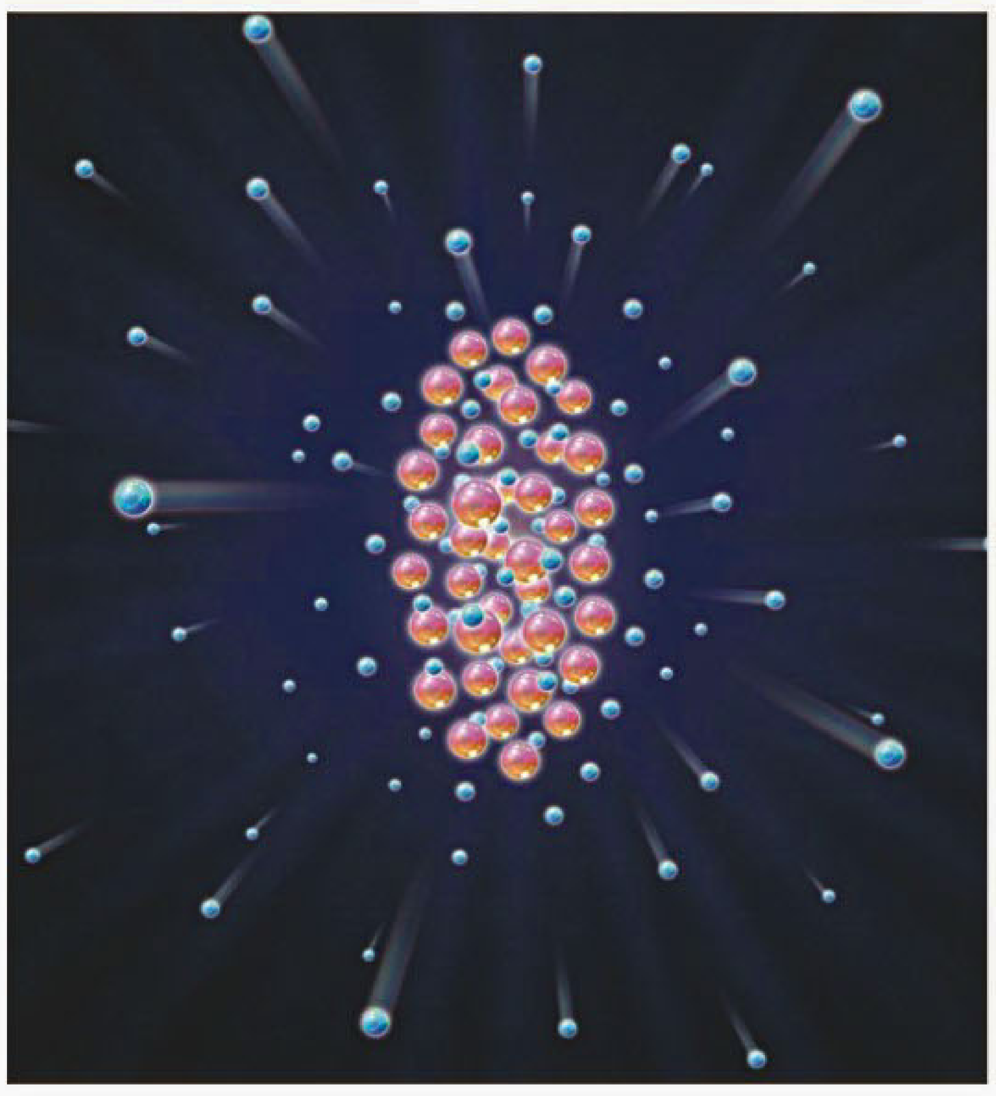
The Daily Star
# SCIENCE & LIFE
12
DHAKA TUESDAY MARCH 22, 2011, E-MAIL: science&life@thedailystar.net

# Icy gaze into Big Bang

SCIENTISTS of the Institute for Quantum Optics and Quantum Information (IQOQI) in Innsbruck, Austria, have reached a milestone in the exploration of quantum gas mixtures. In an international first, the research group led by Rudolf Grimm and Florian Schreck has succeeded in producing controlled strong interactions between two fermionic elements -- lithium-6 and potassium-40. This model system not only promises to provide new insights into solid-state physics but also shows intriguing analogies to the primordial substance right after the Big Bang.

According to theory, the whole universe consisted of quark-gluon plasma in the first split seconds after the Big Bang. On Earth this cosmic primordial "soup" can be observed in big particle accelerators when, for example, the nuclei of lead atoms are accelerated to nearly the speed of light and smashed into each other, which results in particle showers that are investigated with detectors. Now the group of quantum physicists led by Prof. Rudolf Grimm and PhD Florian Schreck from the Institute for Quantum Optics and Quantum Information (IQOQI) of the Austrian Academy of Sciences together with Italian and Australian researchers has for the first time achieved strong controlled interactions between clouds of lithium-6 and potassium-40 atoms. Hence, they have established a model system that behaves in a similar way as the quark-gluon plasma, whose energy scale has a twenty times higher order of magnitude.



**In an international first, the research group led by Rudolf Grimm and Florian Schreck has succeeded in producing controlled strong interactions between two fermionic elements - lithium-6 (blue) and potassium-40 (red).**

Hydrodynamic expansion

In 2008, the Innsbruck physicists found Feshbach resonances in an ultracold gas mixture consisting of lithium and potassium atoms, which they have used to modify quantum mechanical interactions between particles in a controlled way by applying a magnetic field. In the meantime, they have overcome all technical challenges and are now the first to also produce strong interactions between those particles. "The magnetic fields have to be adjusted precisely to one in 100000 and controlled accurately to achieve this result," explains Florian Schreck.

In the experiment the physicists prepare the ultracold gases of lithium-6 (Li) and potassium-40 (K) atoms in an optical trap and overlap them, with the smaller cloud of heavier K atoms residing in the centre of the Li cloud. After turning off the trap, the researchers observe the expansion of the quantum gases at different magnetic fields. "When the particles show a strong interaction, the gas clouds behave hydrodynamically," says Schreck. "An elliptical nucleus is formed in the centre of the particle cloud, where the potassium and lithium atoms interact. Moreover, the expansion velocity of the particles, which are different initially, become equal." According to theory, both phenomena suggest hydrodynamic behavior of the quantum gas mixture. "This behavior is the most striking phenomenon observed in quantum gases, when particles strongly interact," says Rudolf Grimm. "Therefore, this experiment opens up new research areas in the field of many-body physics."

New possibilities for exciting experiments

High energy physicists have made these two observations as well when producing quark-gluon plasmas in particle accelerators. The Innsbruck quantum gas experiment can be regarded as a model system to investigate cosmic phenomena that occurred immediately after the Big Bang. "In addition and above all, we can also use this system to address many questions of solid-state physics," says Rudolf Grimm, who is going to further explore the quantum gas mixture with his research group. "The big goal is to produce quantum condensates, such as Bose-Einstein condensates consisting of molecules made up of lithium and potassium atoms. This will tremendously increase our capabilities to realize novel states of matter."

The physicists have published their findings in the scientific journal Physical Review Letters. Their work is supported by the Austrian Science Fund (FWF) and the Special Research Area FoQuS, the European Science Foundation ESF within the framework of EuroQUAM, the Wittgenstein award granted by the FWF and the Austrian Ministry of Science.

Source: Science Daily.

WELLSIAN DREAM

## Atom smasher a time machine!

**A worker inside the LHC tunnel working on the large magnets that guide particles around the LHC loop**

In a 'long shot' theory, physicists propose that the world's largest atom smasher could be used as a time machine to send a special kind of matter backward in time.

The scientists outline a way to use the Large Hadron Collider (LHC), a 17-mile long (27-km) particle accelerator buried underground near Geneva, to send a hypothetical particle called the Higgs singlet to the past.

There are a lot of "ifs" to the conjecture, including the major question of whether or not the Higgs singlet even exists and could be created in the machine.

"Our theory is a long shot, but it doesn't violate anylaws of physics or experimental constraints," physicist Tom Weiler of Vanderbilt University said in a statement.

However, if the theory proves correct, the researchers say the method could be used to send messages to the past or the future.

Weiler and Vanderbilt graduate fellow Chui Man Ho describe their idea in a paper posted March 7 on the research website arXiv.org.

Elusive Higgs

The Higgs singlet is related to another theorized but not yet detected particle called the Higgs boson. This particle, and its related Higgs field, are thought to confer mass on all the other particles, and its discovery could help scientists answer the question, why do some particles have more mass than others?

The search for the Higgs boson was one of the main motivations for building the LHC in the first place. Since the atom smasher began regular operation last year, it has yet to find evidence of the Higgs boson, but the machine is still ramping up to its peak energies.

If the collider does succeed in producing a Higgs boson, some theories predict that it will create a Higgs singlet at the same time.

This particle may have a unique ability to jump out of the normal three dimensions of space and one dimension of time that we inhabit, and into a hidden dimension theorized to exist by some advanced physics models. By traveling through the hidden dimension, Higgs singlets could reenter our dimensions at a point forward or backward in time from when they exited.

Source: Live Science

CHIP MEETS NERVE

## Mind melds with machine

**Projections from nerve cells (orange in this color-enhanced image) seem to seek out and explore tiny semiconducting tubes**

Nerve cell tendrils readily thread their way through tiny semiconductor tubes, researchers find, forming a crisscrossed network like vines twining towards the sun. The discovery that offshoots from nascent mouse nerve cells explore the specially designed tubes could lead to tricks for studying nervous system diseases or testing the effects of potential drugs. Such a system may even bring researchers closer to brain-computer interfaces that seamlessly integrate artificial limbs or other prosthetic devices.

"This is quite innovative and interesting," says nanomaterials expert Nicholas Kotov of the University of Michigan in Ann Arbor. "There is a great need for interfaces between electronic and neuronal tissues."

To lay the groundwork for a nerve-electronic hybrid, graduate student Minrui Yu of the University of WisconsinMadison and his colleagues created tubes of layered silicon and germanium, materials that could insulate electric signals sent by a nerve cell. The tubes were various sizes and shapes and big enough for a nerve cell's extensions to crawl through but too small for the cell's main body to get inside.

When the team seeded areas outside the tubes with mouse nerve cells the cells went exploring, sending their threadlike projections into the tubes and even following the curves of helical tunnels, the researchers report in an upcoming *ACS Nano*.

Source: Science News

NUMBERS GAME

# How serious is Japan nuclear crisis?

AS it was almost bound to do at some point, Japan's nuclear safety agency has uprated its assessment of the Fukushima power station incident from a level four to a level five.

The level five rating applies specifically to the nuclear reactors in buildings 2 and 3 at Fukushima, rather than to the spent fuel cooling ponds that have lost water and where the stored fuel is heating up.

That implies that the regulators believe the main source of radioactivity coming from the plant has been the reactors.

Certainly, one of the the spikes in readings earlier in the week appeared to co-incide with damage to reactor number 2, believed to be a crack in the containment system - the symptoms being a sharp release of steam and an abrupt drop in pressure.

On Thursday and Friday, radiation levels around the plant appeared much more stable.

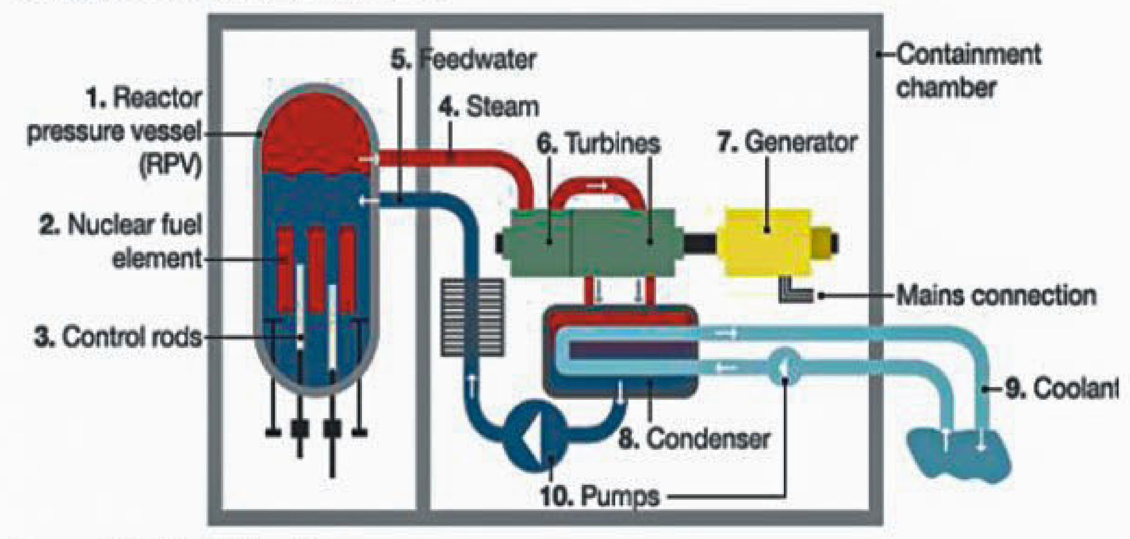
And although elevated readings have been noted in some locations 30km from Fukushima, there has been nothing outside the 30km protection zone that has appeared to pose a danger to health.

Despite this, a number of governments have advised their citizens to stay much further away - or in the case of the UK, to consider doing so.

However, when the UK's chief scientific adviser explained the reasoning to BBC News on Thursday, he was still painting a worst-case scenario that appeared some way short of apocalyptic.

"The worst-case scenario would see the ponds starting to emit serious amounts of radiation, with some of the reactors going into a meltdown phase," he said.

**Boiling Water Reactor system**




Source: RobbyBer/Wikimedia

"We put that together with [a possible scenario of] extremely unfavourable weather conditions - wind in the direction of Tokyo, for example.

"Even in that situation, the radiation that we believe could come into the Tokyo area is such that you could mitigate it with relatively straightforward measures, for example staying indoors and keeping the windows closed."

Fukushima now becomes the third level five incident in half a century of nuclear power.

The first was the Windscale reactor fire in the UK in 1957 - the second, the partial meltdown of a reactor at Three Mile Island in the US in 1979.

Richard Wakeford from the Dalton Nuclear Institute, a visiting professor in epidemiology at the University of Manchester, recently re-assessed the effect of radiation released at Windscale.

Using data and computer models, his scientific paper concluded that the release could have caused about 240 cases of cancer, half of them fatal.

However, inquiries into Three Mile Island concluded it probably caused no deaths.

That raises the question of why both are in the same INES category, given that Three Mile Island did not, in the end, have more than a local impact.

"The reason why Three Mile Island was rated a five is that there was major damage to the reactor core and there was potential for a widespread release of radioactive material - it didn't happen, but that potential is built into the event scale," said Professor Wakeford.

In terms of material released, he said: "Fukushima is somewhere between the two - clearly there have been releases, and you have a possible breach of the containment system - no-one really knows."

Source: BBC

VACUUM FEEDER

## Carnivores that suck up prey

CARNIVOROUS bladderworts trap prey with speed that would make a Bond villain shudder in gleeful envy.

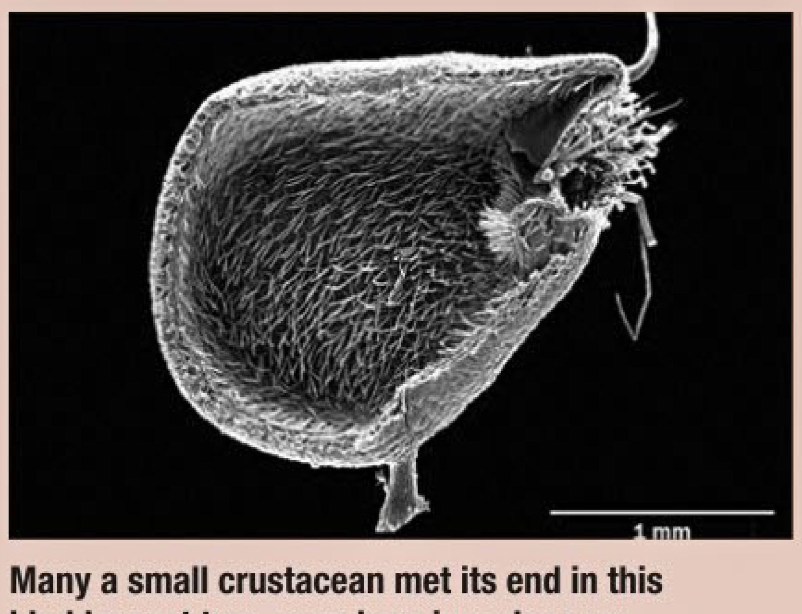
Using high-speed cameras, researchers have gotten the first good look at how these underwater plants spring their ambushes. Bladderworts sport trap doors that buckle in with a tiny nudge, creating a whirlpool that sucks in wee critters all in about half a millisecond. That's some of the fastest plant action on Earth, a French and German team reports online February 15 in the Proceedings of the Royal Society B.

Forget Venus flytraps. Bladderworts of the genus Utricularia are really cunning meat eaters. "Utricularia are the smallest of carnivorous plants and also, evidently, the most sophisticated," says Lubomír Adamec, a plant physiologist at the Academy of Sciences of the Czech Republic. These netlike veggies are dotted with tiny traps, often no wider than an ant is long.

Small or not, the traps are masterpieces of suction. Pumped nearly dry, the chambers set up a pressure difference between the plant's innards and the water outside. When swimmers brush up against a series of hairs along the trap door, the door bursts open and sucks water and crustaceans alike in.

Despite decades of interest in these nefarious plants, botanists couldn't say for sure how the traps worked. Bladderworts were just too quick for old-school cameras. But with fancy new high-speed cameras, biologists can get their close-ups, says Adamec.

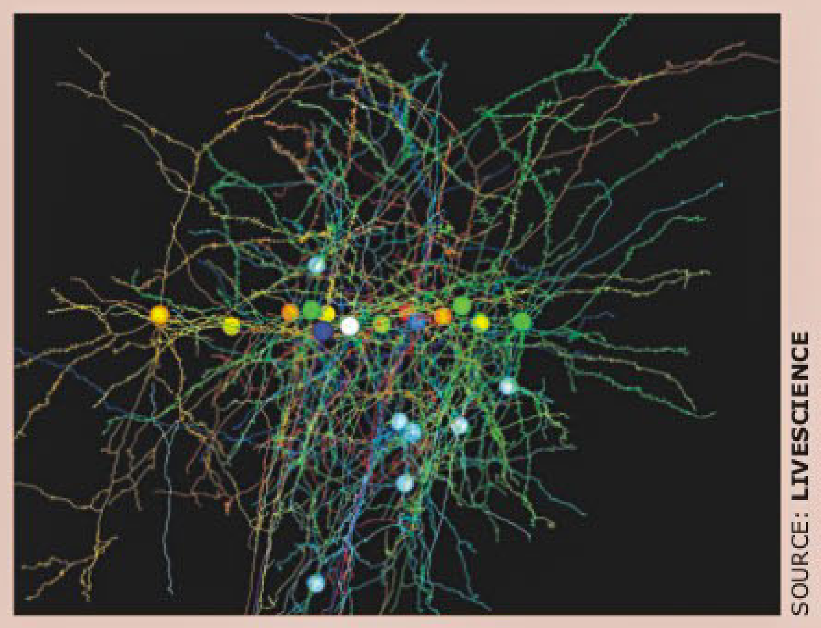
Source: Science News




**Many a small crustacean met its end in this bladderwort trap, seen here in a close-up**

WIRED & WEIRD

# A nerve cell in three-dimension




For the first time, scientists have reconstructed a three-dimensional circuit of connected cells in the brain's seat of consciousness. Their new approach, which involves the use of high-tech microscopes and a supercomputer, offers the unprecedented opportunity to unravel the complex wiring of the brain by navigating through the tangled and dense jungle of cells similar to the way Google crawls the Web.

The research, published by two separate teams in the March 10 issue of the journal Nature, demonstrates the possibility of tackling questions about brain function that traditional methods can't address. One study was led by neurobiologist Clay Reid of Harvard University, and the other was spearheaded by Winfried Denk at the Max Planck Institute for Medical Research in Heidelberg, Germany.

DID YOU KNOW?

## How can we foretell Earthquake?

China has suffered some terrible earthquakes, and it isn't surprising that China's scientists want to find ways of forecasting them. In 1975, they were successful. They cleared the city of Haicheng two hours before a devastating quake and saved the city's population. Earthquake forecasting is, however, still inexact; the Chinese have failed to predict several earthquakes since 1975, but they have advanced the science of earthquake prediction.