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1. Quantum Zeno effect

The role of the observer is one of the most discussed questions in quantum mechanics. A physical system cannot be observed without being affected by the observer — say, by photons he uses to illuminate the system. The prevailing view so far has been that quantum processes slow down as a result (the 'quantum Zeno effect'), and in particular the decay of a quantum state (e.g., the spontaneous decay of an atom from one state to another of lower energy) proceeds at a lower rate when being measured. Indeed if the measurements are continuous, the system will not decay at all according to this view. But now, by revising the theory of the Zeno effect, two Israeli scientists, G Kurizki and A Kofman, have shown that in most cases the reverse is actually true, i.e., that observations accelerate rather than slow down decays processes ('anti-Zeno effect'). Although this theory has not yet been tested experimentally, the researchers foresee no problems of principle in doing this.

Source: *Nature* **405** 546 (2000)
http://www.nature.com/

2. Optical frequency measurement

J L Hall of the Max Planck Institute in Garching, Germany, and his colleagues, have developed a new technique for the superhigh-precision measuring of optical frequencies. The researchers employed 12-fs laser pulses with a repetition rate of 100 MHz as a reference signal, using an atomic clock to stabilize the time interval between the pulses. By generating about 4×10^6 harmonics in a nonlinear optical medium, millions of spectral lines spaced at every 100 MHz in frequency were produced, the origin of this 'scale' being gauged by neodymium laser with a well-known emission frequency. By comparing the position of a spectral line of the emission under study with the position of reference signal harmonics, the frequency of the line can be determined to within about 100 MHz (relative error of 10^{-11}). With its fairly simple construction, the device can potentially find wide application in physics experiments.

Source: *Phys. Rev. Let.* **84** 5102 (2000)
http://publish.aps.org/FOCUS/

3. Metallic deuterium

Physicists at Livermore have found evidence that deuterium D_2 (heavy hydrogen) becomes metallic at a pressure of 50 GPa and a temperature of 8000 K, i.e., under conditions similar to those in Jupiter's interior. Metallic hydrogen H_2 was produced at Livermore in 1996. In the new experiment, a working medium heated by a powerful laser pushed a plunger thus launching a shock wave in a sample of liquid deuterium. As the pressure increased, both the compressibility and reflectance of deuterium increased, the former increase indicating the destruction of D_2 molecules and the latter, the onset of metallic properties. The transition to the conducting state was continuous, so that at any one time deuterium was a mixture of molecules, atoms, ions, and free electrons. The continuous metallization transition suggests that there is no distinct boundary inside Jupiter between the metal core and the outer molecular layers.

Source: *Phys. Rev. Let.* **84** 5564 (2000);
Physics News Update, Number 488
http://www.hep.net/documents/newsletters/pnu/pnu.html#RECENT

4. Jets from galactic cores

Pictures of a jet produced by a radio galaxy have been captured by NASA's Chandra X-ray Observatory. Observed to emerge from numerous active galaxies throughout the universe, jets such as this originate in galactic cores and, thin and narrow, extend to a distance of hundreds and thousands light years — to end up with a gigantic cloud of gas ('radio blade'). Jets and blades are synchrotron-emitting radio sources and are also seen in visible light. According to theoretical models, jets form inside the accretion disk surrounding a supermassive black hole in the galaxy's core, and are collimated and confined primarily by magnetic fields, the jet formation region being not bigger than the solar system. New Chandra observations have shown that the radio blade of the galaxy in question is very bright at X-ray wavelengths. The brightness and spectrum of this glow are different from those expected from current theoretical models. Some theoreticians speculate that a shock wave is produced in the head of the jet, at the front of which electrons and possibly protons are accelerated to relativistic speeds and then lose their energy in the form of X-rays.

Source: http://www.nasa.gov

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