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1. Evidence for the tau neutrino

According to the standard model of particle physics, for each lepton (electron, muon, or τ lepton) there is a corresponding neutrino (ν_e, ν_μ, and ν_τ, respectively). However, unlike for ν_e and ν_μ, no direct evidence had been found for the existence of ν_τ until recently. Such evidence has now been found for the first time at the Fermilab accelerator by bombarding a tungsten target with a beam of 800-GeV protons. This yielded a multitude of particles, some of which then decayed into τ and ν_τ. The beam of generated particles passed through a thick layer of shielding material and was subjected to a strong magnetic field, with the result that all the particles except the neutrino were separated out. As the next step, the interaction of the neutrino with emulsion layers was studied. The presence of a ν_τ in the beam is characteristically indicated by the creation of a τ lepton, which quickly decays into other particles. Of the 10^{14} τ neutrinos that passed through the emulsion over the length of the experiment, an estimated one hundred or so interacted with the emulsion material. Although there has been virtually no doubt among physicists about the existence of ν_τ, its direct detection is another important confirmation of the standard model.

Source: http://fn872.fnal.gov/

2. Measurement of nanometer distances

Since its discovery in 1958, the Mössbauer effect has been widely used in solid state research. Now another interesting application of this effect — to the precise measurement of nanometre distances — has been proposed by Yu V Shvydko and his colleagues at the University of Hamburg, whose basic idea is to compare the distance to be measured with the wavelength of the Mössbauer radiation from iron. This radiation has a well-defined frequency and is easy to produce in the laboratory, and its wavelength — and this is the point of the Hamburg team's work — can be very accurately measured using powerful X-ray beams. The electron synchrotron at DESY and the Argonne accelerator were used as the X-ray sources. The three reference points necessary for wavelength measurements were obtained by scattering X-ray beams from a silicon crystal, giving an accuracy of 1.9×10^{-7} for the Mössbauer wavelength. A further order-of-magnitude improvement in accuracy is currently planned by the team, which will enable fundamental physical constants to be measured using this technique.

Source: http://publish.aps.org/FOCUS/
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3. Crystal nucleation

A picture of how individual molecules — specifically, large organic ones — arrange themselves into a crystal has been obtained for the first time at the University of Alabama. Contrary to expectation, it was found that, rather than assuming compact shapes, crystals start as thin film structures, with the next molecular layer forming only after several tens of molecules get together in the lower layer. The reason for this is not clear because energetically, three-dimensional structures would be expected to form first. To observe the behaviour of the molecules, a new technique using an atomic force microscope was developed. The finding has important implications, among other fields, for atmospheric studies, where the mechanism of ice crystal formation is of crucial importance.

Source: http://unisci.com/

4. Two-dimensional turbulence

Small-scale vortices in a turbulent liquid flow coalesce into increasingly larger-scale ones — eventually to become observable. This 'reverse-cascade effect' is well-known in hydrodynamics, but until now nobody has been able to tell whether the energy of the vortices is dissipated to the fluid's internal friction (viscosity) or goes to its surroundings. To answer this, University of Pittsburgh researchers devised an experiment which enabled not only large-scale but also intermediate-scale vortex dynamics to be explored. The turbulence to be studied was created in a salt-based soap film, which was subject to an electric and a magnetic field, and into which microscopic mushroom spores were added to make turbulent flows visible. It was found that the energy transfer to the surrounding air is very nearly equal to and often greater than the energy dissipated to viscosity.

Source: *Physics News Update*, Number 496
http://www.hep.net./documents/newsletters/pnu/pnu.html#RECENT

5. Pulsar ages

Pulsars are rapidly spinning magnetic neutron stars, seen to pulsate periodically by an observer on Earth. Since the radiated energy is supplied by the star's rotation, the rate of rotation is steadily decreasing. In the simplest model, using the observed pulsar period P and the rate of slowing $\dot{P}$, the pulsar's age is found to be $\tau = P/2\dot{P}$ — the so-called 'dynamic' estimate which has been used for the last thirty years in the area. Now, however, Very Large Array (VLA) radio telescope images of the pulsar B1757-24 cast doubt on this value. The pulsar is observed near a shell of debris from the supernova explosion believed to have created it. Due to the lack of symmetry in supernova explosions, neutron stars usually are given large recoil velocities. By measuring the change in position of the pulsar over a seven-year period, the astronomers found its speed to be about 350 miles per second, suggesting the pulsar must have been moving for 40,000 years or more from the supernova explosion to arrive at its current position. The pulsar's dynamic age, on the other hand, is only 17,000 years. This is too large a discrepancy to explain by current theories of pulsar radiation. A hypothesis has been suggested, however, that the pulsar was not created by the supernova explosion at all and just happened to be there by chance.

Source: http://www.nrao.edu

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