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Physics news on the Internet (based on electronic preprints)

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1. Strange meson

The SELEX collaboration at Fermilab has discovered a new elementary particle $D^+_{sJ}(2632)$ consisting of an s-quark and a c-antiquark. The meson with a mass of 2632 MeV/c^2 was produced in proton – antiproton collisions at the Tevatron collider and identified from the products of its decay which proceeds through two (D^0K^+ and $D^+_s\eta$) production channels. The particle has an unexpected property in that, although its lifetime before it decays is three times shorter than the theoretical value, its decay rate to η mesons is six times higher than predicted by calculations — implying that some aspects of the complex dynamics of strong interaction may be being left out of account. To clarify the cause of this discrepancy, further experimental and theoretical research is needed. An international collaboration that includes Russian physicists from the Institute for High Energy Physics (Protvino), the Institute of Experimental and Theoretical Physics (Moscow), and the Petersburg Nuclear Physics Institute carried out the experiment.

Source: http://arXiv.org/abs/hep-ex/0406045

2. Observing the spin of a single electron

A magnetic resonance force microscope (MRFM) capable of detecting the spin of a single electron has been constructed at the IBM Almaden Research Center. Basically, the MRFM consists of a thin micrometer-scale silicon cantilever on whose tip a submicron ferromagnet is placed. An alternating magnetic field causes the cantilever to oscillate mechanically. The sample under study was brought to a distance of about 50 μm from the cantilever. The spin magnetic moment of an unpaired electron in the sample exerted a perturbing force (of about 10^{-18} N) on the cantilever, leading to a shift in the cantilever's oscillation frequency. The researchers used a laser interferometer to detect the oscillations. To enhance the effect, the system was brought to resonance by making the Larmor frequency of the electron under study equal to that of the cantilever's natural frequency. Whereas with previous MRFM microscopes only ensembles of many electrons could be studied, the new microscope has enough sensitivity to detect single-electron spins.

Source: http://arXiv.org/abs/quant-ph/0312139

3. Five-photon quantum correlation

Five photons were put into the so-called entangled state at the University of Science and Technology of China in Hefei for the first time. Although the entanglement of four particles had been demonstrated successfully earlier, it is only starting from five particles that the universal quantum error-correction algorithm necessary for quantum computing can be implemented. To put five photons into the entangled state, a complicated experimental technique was developed, which involves the nonlinear transformations of a laser beam passing through several crystals. The experiment was carried out by first separately entangling two photon pairs and then adding the fifth photon and putting all the photons together into a unified entangled quantum state.

Source: *Nature* **430** 54 (2004); www.nature.com

4. Focusing of sound in a phononic crystal

The term phononic crystals refers to composite materials that can cut out certain frequencies from the spectrum of a sound signal passing through them. This property is explained by the interference of the sound wave. J Page of the University of Manitoba, Canada and his colleagues have created a phononic crystal which has a negative index of refraction for ultrasound frequencies and is capable of focusing a sound wave. The new phononic crystal is a 3D array of 0.8-mm-diameter tungsten carbide beads immersed in water. At a certain frequency of the sound, the diverging wave emitted by a small source on one side of the crystal is refocused on the other side of it. A negative index of refraction had already been observed in photonic crystals which operate on electromagnetic waves.

Source: *Phys. Rev. Lett.* **93** 024301 (2004); http://prl.aps.org

5. Polarized particles in a cyclotron

D Pritchard and his colleagues at MIT established that molecular ions possessing an electric dipole moment have a somewhat different cyclotron revolution frequency than unpolarized ions. The frequency shift is due to the fact that the ends of a dipole have different cyclotron frequencies. For the CO^+ ion, for example, the relative frequency shift amounts to 1/109. Previous cyclotron studies had neglected this effect. The effect may prove useful for measuring dipole moments, for determining the quantum states of molecules, and possibly also for testing CPT-symmetry and searching for an electric dipole moment in the electron.

Source: *Nature* **430** 58 (2004); www.nature.com

6. Focusing laser radiation

A new laser radiation intensity record, namely 0.85×10^{22} W cm^{-2}, has been set by scientists from the Center for Ultrafast Optical Sciences at the University of Michigan. This intensity was achieved by focusing the beam from the titanium: sapphire laser (HERCULES) to a spot about 0.8 μm in size. The authors used adaptive optics for correcting wave-front distortion in the process. Before being focused down by a parabolic mirror, the beam reflected off another, deformable mirror, thereby improving the wave packet shape.

Source: http://physicsweb.org

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