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Physics news on the Internet (based on electronic preprints)

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1. Quark – gluon plasma

In recent years, lead-ion and gold-ion collision experiments at CERN (Switzerland) and Brookhaven National Laboratory (USA) have provided evidence for the existence of quark – gluon plasma, a hot dense soup of individual quarks and gluons with one hundred times the density of an ordinary nuclear matter. Now Brookhaven physicists have provided further confirmation of creating a highly unusual plasma environment. What they did was to discover the jet quenching phenomenon that had been predicted theoretically. In high energy nuclear collisions, the ejection of a pair of quarks usually gives rise to two particle jets in their wakes. In the Brookhaven's RHIC experiments, only one jet was occasionally observed in head-to-head collisions of gold nuclei. A likely explanation is that the second jet traveling in the direction of the collision region is getting absorbed by quark – gluon plasma. The absorption occurs when a quark – antiquark pair emerges near the surface of a nucleus and one of the quarks flies through the central collision region. As a control experiment, collisions between a beam of gold nuclei and that of deuterons were studied. In this case, quark – gluon plasma is not created, and the particle jets come in pairs flying in opposite directions.

Source: http://www.bnl.gov/bnlweb/pubaf/pr/2003/bnlpr061103.htm

2. Orthopositronium lifetime

Positronium, the system of an electron and a positron orbiting around each other, is unstable and has an annihilation lifetime of about 142 ns. For parapositronium (a positronium variety with the electron and positron spins oppositely directed), the measured lifetime is in excellent agreement with theory. For orthopositronium (spins of the two particles point in the same direction), however, the experimental and QED-calculated values have differed by over 0.1%, giving rise to a number of exotic explanations beyond the Standard Model of elementary particles. Now R Vallery and his colleagues at the University of Michigan have used a new technique to make the most accurate measurement yet of the orthopositronium lifetime. Orthopositronium 'atoms' were created by firing a low-energy positron beam into a micron-thick nanoporous silica film. To detect the gamma rays produced by annihilation reactions, a scintillation detector was used. The measured lifetime was found to be within 0.014% of the predicted value. In previous experiments, the authors believe, there was a systematic error due to the fact that many of the orthopositronium 'atoms' annihilate on the cavity walls of the detector.

Source: *Phys. Rev. Lett.* **90** 203402 (2003),
http://prl.aps.org

3. Magnetic anisotropy energy

A team of physicists from Switzerland, Italy, France, and Germany have measured the largest magnetic anisotropy energy known so far. The measurement was made on a layer of cobalt atoms deposited on a platinum substrate. The layer was grown by the molecular-beam epitaxy technique. The researchers placed the material in a magnetic field of 7 T and then measured the magnetization of Co atoms along and perpendicular to the field. The magnetic anisotropy energy was calculated to be 9.3 ± 1.6 meV per cobalt atom, which is about 200 times larger than that of cobalt atoms in a bulk crystal and several times larger than maximum values for other materials.

Source: *Science* **300** 1130 (2003); www.sciencemag.org

4. Pure spin current

Two groups of researchers, one at the University of Iowa (USA) and the other at the University of Marburg (Germany) have independently generated a directed electron spin current without an accompanying charge current. In both experiments, a semiconductor material was illuminated by two differently polarized laser beams, with photons in one of them twice as energetic as in the other. The radiation promoted electrons into the conduction band and produced two counterpropagating electron flows with oppositely directed spins. Due to the quantum interference of one- and two-photon absorption, the charge flows exactly cancelled one another, whereas the spin flows added. The latter is due to the fact that, as far as the spin transfer is concerned, the motion of a specific spin state in one direction is equivalent to the motion of an opposite spin state in the opposite direction.

Source: *Phys. Rev. Lett.* **90** 136603 (2003),
Phys. Rev. Lett. **90** 216601 (2003),
http://prl.aps.org

5. Magnetic field of an isolated neutron star

A group of astronomers from Italy and France has measured the magnetic field of an isolated neutron star, one which is not a member of a multiple stellar system. Isolated neutron stars are amenable to observation in the radio and X-ray wavelengths. Among the isolated neutron stars known, only the object 1E1207.4-5209 reveals spectral absorption features in addition to the X-ray thermal continuum. The most precise spectroscopic observations of the neutron star 1E1207.4-5209 were made using the Chandra/XMM-Newton. Absorption features were observed at energies of 0.7, 1.4, and 2.1 keV, and some evidence for spectral features at 2.8 keV was found. The most likely interpretation of these features is the electron cyclotron resonance scattering of X-ray radiation. The corresponding magnetic field strength should be about 8×10^{10} G, which is 50 to 100 times less than indirectly estimated from the neutron star's spindown rate. The cyclotron interpretation is supported by periodic variations in the features, presumably due to the star rotation and because the cyclotron resonance scattering cross section depends on the angle between the magnetic field and the photon momentum.

Source: http://arXiv.org/abs/astro-ph/0306189

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