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Physics news on the Internet (based on electronic preprints)

1. Phase transitions in superconductors

According to Ehrenfest's phase transition classification scheme, at the first-order transition materials change their state in a sudden jump, releasing (or absorbing) an amount of heat in doing so. In second-order transitions, while the state of a material changes in a continuous way, the thermodynamic derivatives, e.g., specific heat, may experience jumps: these are transitions many metals and alloys go through when becoming superconducting. If the specific heat remains unaffected, the transition is said to be third or higher order. The first observation of such a transition was reported by D Hall and R G Goodrich who detected no specific heat change at the superconducting transition when studying the temperature dependence of the critical (superconductivity destroying) magnetic fields in $Ba_{0.6}K_{0.4}BiO_3$. Together with P Kumar, D Hall and R G Goodrich were able to develop a phase transition theory which agrees quite well the experimental data. Along with $Ba_{0.6}K_{0.4}BiO_3$, other superconductors of similar structure will hopefully provide a full understanding of the nature of higher-order transitions.

Source: http://xxx.itep.ru/abs/cond-mat/9904288
Phys. Rev. Lett. **82** 4532 (1999)

2. New transuranic elements

Elements 116 and 118 have been obtained for the first time at Berkeley Lab's Cyclotron by bombarding targets of lead with a krypton ion beam of about 450-MeV. Within less than a millisecond after its formation, the element 118 nucleus emits an α particle to become an isotope of element 116 with mass number 289. Element 116 is in turn radioactive and α decays into element 114, after which a chain of successive decays follows until element 106 forms. During 11 days of experiments, three such decay chains were observed and hence 3 atoms of element 118 emerged. Although transuranic elements are unstable and decay very quickly into other elements, an 'island of stability' — i.e., a region of relatively long half-decay times — is predicted for elements with about 114 protons and 173 neutrons in their nuclei [1]. Decay time measurements along the decay chain confirmed the stability island prediction. The work was initiated by Polish theorists who demonstrated the production of superheavy elements to be in principle possible with the experimental facilities available.

Source: http://www.lbl.gov/

[1] For more details see September issue of *Phys. Usp.* **166** 943 (1996); *Nature* **397** 289 (1999); and *Phys. World* **12** (2) 7 (1999); **12** (3) 19 (1999).

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3. Dispersion of light in vacuum

The speed of light is frequency independent to within a factor of 6×10^{-21}, B Schaefer of Yale University has established based on gamma-ray burst spectra. Frequency dependence would imply that light waves of different frequency reach the Earth at different times, which they do not. The previous most accurate estimate, derived from the spectrum of the Crab pulsar, was 5×10^{-17}. The speed of light would be frequency dependent if, for example, the photon mass were nonzero as some theories suggest. B Schaefer's result now puts an upper limit of $m_\gamma < 10^{-44}$ g on this mass.

Source: *Physics News Update*, Number 432
http://www.hep.net/documents/newsletters/pnu/pnu.html#RECENT; *Phys. Rev. Lett.* **82** 4964 (1999)

4. Hubble's constant

The Hubble Space Telescope project to determine the universe's rate of expansion has been completed. In the 18 faraway galaxies studied in the course of the project, nearly 800 Cepheid variable stars were discovered which, due to their luminosity being stable to pulse period changes, are good 'standard candles' for distance determination purposes. Knowing the distance to and the redshift of a galaxy yields the universe's expansion rate, i. e., Hubble's constant, whose value was found to be 70 km s^{-1} Mpc^{-1} to within 10%. If the universe has a critical density, this value implies the universe's age to be $t_0 = 12 \times 10^9$ years. For the open model, it may be somewhat older, as will also be the case for a nonzero Λ term.

Source: http://www.nasa.gov/

5. Unusual radiation

A new kind of radiation has been found in metal-foil electro-explosion experiments in water at the REKOM division of the RSC 'Kurchatov Institute', whose photoemulsion and film tracks differ from those of all radiations known and which exhibits strong magnetic properties reminiscent of P Dirac's monopole. The radiation is accompanied by another — transitional — radiation at the water-foil interface and is deflected along the lines of force when in a strong magnetic field. Remarkably, this new radiation is also emitted by the water through which an electromagnetic pulse has been passed, implying that the pulse-generated radiation is due to a non-acceleration mechanism, and enabling the magnetic charge and the radiation energy to be determined.

Source: http://www.geocities/ResearchTriangl/Lab/9241/monopole.htm

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