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1. Decay of the D_s meson

The CLEO Collaboration (Cornell University) reported observations for the first time of the decay of a charmed meson (with a c-quark in its composition) into a baryon–antibaryon final state. D_s mesons were created in the reaction $e^+e^- \to D_s^{*-}\bar{D}_s^+$ when electron and positron beams collided at a center-of-mass energy of about 4170 MeV. The CLEO-c detector recorded meson decays into protons and antineutrons: $D_s^+ \to p\bar{n}$. The branching fraction of this process was measured, amounting to $(1.30 \pm 0.36) \times 10^{-3}$. All in all, 13 decays were recorded. Among the known three charm mesons, only D_s possesses a mass sufficiently large for decaying into a pair of nucleons. The decay proceeds through the annihilation channel and involves a virtual W^+ boson. The results of the experiment are important for testing complicated theoretical models describing decays of charmed mesons.

Sources: *Phys. Rev. Lett.* **100** 181802 (2008)
http://dx.doi.org/10.1103/PhysRevLett.100.181802

2. Quantum Hall effect without an external magnetic field

The quantum Hall effect has only been observed previously in atomically thin semiconductor films placed in a strong external magnetic field at temperatures close to absolute zero. C Kane and his colleagues at the University of Pennsylvania made a theoretical prediction that this effect may arise in certain materials without an external magnetic field, provided electrons are in certain states of motion and polarization, experiencing strong spin – orbit interaction. The moving electron gas therewith creates its own internal magnetic field responsible for the quantum Hall effect. A group of researchers at Princeton University led by Z Hasan observed for the first time the quantum Hall effect in a bulk crystalline bismuth – antimony compound, $Bi_{0.9}Sb_{0.1}$, without any external magnetic field being applied. The scattering of ultrashort X-ray pulses on faces of the crystal was studied using a high-energy accelerator-based technique termed synchrotron photoelectron spectroscopy. The characteristics of scattering allowed an exploration of charge distribution in the crystal. This distribution is found to have the form typical of the quantum Hall effect.

Source: *Nature* **452** 970 (2008)
http://dx.doi.org/10.1038/nature06843

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3. Radiation transmission through subwavelength holes

In 1950, C J Bouwkamp, a Dutch researcher who worked at Philips, developed a theory describing how electromagnetic waves pass through holes with subwavelength diameter. Bouwkamp predicted the distribution of charge and electric field induced in matter in the vicinity of the hole. Since then, numerous experiments have studied the transmission of light waves through small holes in metal plates, but there has been no direct testing of Bouwkamp's theoretical model. The first to measure the distribution of an electric field intensity near a hole were A Adam and P Planken (Delft University of Technology, the Netherlands) and their colleagues from South Korea and Germany. Radio waves of frequency 10^{12} Hz were sent through holes in a gold plate. Radiation went through holes even when their diameters were a mere 1/50 the light wavelength. The gold plate was placed on the surface of a GaP crystal. The measurement technique was based on the fact that the microwave radiation induced charges and an electric field in the gold plate and these in turn induced changes in the optical refractive index of the GaP crystal in the proximity of the hole. These very small changes were recorded by means of a laser beam. Laser pulses were synchronized with the radio wave source and served to determine the dynamic pattern of charge and electric field intensity distributions on the metal surface close to the hole with a spatial resolution of less than one wavelength and a temporal resolution of better than one period of oscillations of the microwave radiation. The results of measurements confirm the theoretical predictions of C J Bouwkamp. The approach used in this experiment may find practical applications in microscopy utilizing electromagnetic waves of the teraherz range.

Source: *Optics Express* **16** 7407 (2008)
http://dx.doi.org/10.1364/. 16.007407

4. Memristor

S Williams and his colleagues of Hewlett-Packard Labs in Palo Alto, California have created a new type of passive elements of electric circuits, which change their electric resistance depending on the amount of charge passed through. The concept of this instrument, given the name memristor (Memory Resistor), was suggested by L Chua (University of California, Berkeley) in 1971. The electric properties of the memristor resemble the hysteresis phenomenon; similar behavior of resistance was earlier observed in current – voltage characteristics of microelectronic devices based on thin films. S Williams and his colleagues built the memristor out of two parts of titanium dioxide — a semiconductor — in contact with each other, one of which was doped with impurity atoms. An electric field causes the impurities to drift, producing a typical hysteresis effect of memristance. Memristors may find applications alongside ordinary electronic components as, for instance, electronic switches and memory cells.

Source: *Nature* **453** 80 (2008)
http://dx.doi.org/10.1038/nature06932

5. Intergalactic gas

The totality of available observational data (including the measurements of microwave background anisotropy) and their theoretical interpretation have established quite reliably that baryons make up approximately 4.5% of the mass of matter in the Universe. However, we see only about half of this amount as stars, gas clouds in galaxies, and hot gas in galactic clusters. It is most likely that the missing baryons reside in the intergalactic gas. Detailed computer simulation has shown that gravitation must force nonbaryon dark matter (hidden mass), galaxies, and intergalactic gas to gather into filament-like structures, and that huge galactic clusters must be located in regions where filaments intersect one another. The gas temperature is predicted to be about $10^5 - 10^7$ K. Filament-like distribution of matter is indeed revealed by the distribution of galaxies and weak gravitational lensing, but no data have been obtained until recently on the presence of baryonic gas in such filaments. The reason was its very low density and, consequently, very weak emission intensity. Favorable conditions for recording X-ray emission may arise when a filament is oriented close to the direction of the line of sight and its apparent surface brightness is correspondingly relatively high. This situation is realized for the filament of matter connecting two galactic clusters Abell 222 and Abell 223, having a red shift $z = 0.21$. Weak X-ray emission from the region between the clusters was already detected earlier by the ROSAT telescope. New detailed observations by the X-ray space telescope XMM-Newton confirm these data and point to the presence of weakly luminous gas in the filament. The gas density and temperature correspond to theoretically expected values. Evidence has thus been obtained that the missing baryons may indeed reside in the intergalactic medium.

Source: http://arxiv.org/abs/0803.2525

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