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Physics news on the Internet (based on electronic preprints)

1. Two-dimensional Bose – Einstein condensate

In the last few years, the Bose – Einstein condensates of atoms of hydrogen and some alkaline metals have been obtained, which form due to particles gathering together in the zero-momentum zero-energy state at low temperatures. Scientists from the University of Turku (Finland) and the Kurchatov Institute (Russia) produced for the first time a two-dimensional BEC of hydrogen atoms. After placing hydrogen on the surface of liquid helium-4 at 0.12 – 0.2 K, a strong magnetic field was applied which aligned the proton and electron spins of the hydrogen atoms and increased the density of hydrogen atoms enough to form a condensate. No model of the two-dimensional BEC is yet available.

Source: *Physics News Update*, Number 415
http://www.hep.net/documents/newsletters/pnu/pnu.html#RECENT

2. Speed of light in a medium

While the speed of light in a medium is less than in vacuum, a large speed reduction is problematic because of the increase in absorption which generally accompanies a significant increase in the refraction index. Using a new technique developed by a Harvard University team led by L V Hau, laser light is slowed down to 17 m s^{-1} (about 20×10^6 times less than in vacuum) when passed through a Bose – Einstein condensate of sodium atoms at a temperature of a few nK; the resulting induced transparency effect greatly reduces the level of absorption. It is found that the transparency of the medium varies very strongly with the ray intensity — a nonlinear effect which can perhaps be used in opto-electronic components and wavelength conversion devices.

Source: http://www.nature.com/

3. M87 galaxy

From the core of a giant elliptic galaxy M87 at the centre of the Virgo cluster 50 million light-years away, jets of particles extending for hundreds thousand light-years are spewed out at relativistic speeds. It is believed that the jets form near a supermassive (3×10^9 solar masses) black hole at the galaxy's core and are powered by the gravitational energy of the matter falling onto the hole. The most powerful radio source in the Virgo cluster, M87 is known to emit x-rays from its extended halo. The x-ray emission from M87 and the central galaxies of other clusters is usually explained by the cooling flows model, in which the intergalactic gas in the cluster cools down and falls inward onto a galaxy. However, recent radio images made using the VLA telescope demand the revision of old concepts. Observations at a wavelength of 90 cm have revealed structures about 100,000 light-years across (10 times larger than previously possible with the same telescope) as well as radio-emitting bubble-like lobes, about 200,000 light-years across, located in the x-ray-emitting region. Along the jets from the galaxy's center, huge amounts of the energy exceeding energy lost in the x-ray emissionare emitted. Thus, the energy of the infalling matter is counterbalanced by that flowing outward along the jets. It is thought that the x-ray emission has its origin not in the cooling flows toward the galaxy but rather in the 'heating' flows outward.

Source: http://www.nrao.edu/

4. Optical emission from a gamma ray burst

Gamma ray bursts, which last only a few seconds and are distributed isotropically over the sky, have kept their origin a mystery 30 years after their discovery. A BATSE instrument onboard the Compton Observatory detects one gamma ray burst on average every day. Since the optical emission from a gamma ray burst was first detected early in 1997, a number of similar images, sometimes of remote galaxies, have been obtained. The observation of optical emission from the gamma ray burst catalogued as GRB 990123 appears to be a breakthrough in the field. While earlier observations showed optical sources in the fading stage, in the present case the brightening stage was also seen. An important feature of the optical spectrum is the absorption line corresponding to a redshift $z \approx 1.61$. GRB 990123 is one of the brightest gamma ray bursts ever seen. Assuming an isotropic emission process, the total energy emission exceeds the rest energy of the Sun. Such energy is obviously unachievable in the very popular cosmological models in which a gamma ray burst results from a collision of neutron stars in a binary system in a remote galaxy. This model remains valid only for a highly collimated emission. So far no evidence had been found for the gravitational lensing of a gamma ray burst by any galaxy along the line of sight. The Hubble and Keck images show that the optical source is located within a galaxy to which the observed absorption line presumably belongs. The distance between the optical source and the assumed center of the galaxy is several kiloparsecs implying that the burst has nothing to do with galaxy core processes.

Source: http://xxx.lanl.gov/abs/astro-ph/9902182

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