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Physics news on the Internet (based on electronic preprints)

1. A continuous 'atomic' laser beam

The simplest 'atomic' laser was first constructed at MIT in 1997. Unlike its optical counterpart emitting coherent light beams, the 'atomic' laser produces coherent atomic beams, using a Bose-Einstein condensate (BEC) of atoms for the purpose. While until recently only very short atomic pulses were achievable in this way, a continuous 100-ms beam of Rb atoms is now reported by researchers at the Max Planck Institute for Quantum Optics in Germany. In contrast to the broad front propagation of ordinary laser light, the atomic beam they produced was about a nanometer in diameter, i. e. thousands of times narrower than the optical focus, owing to the minimum noise conditions that a specially designed magnetic trap secured for the BEC formation process. Subject to an alternating electromagnetic field of a special configuration, the Rb atoms escaped the trap and then fell under the influence of gravity, the coherence of this falling atomic beam following that of the original BEC atoms. In alternative NIST experiments, an atomic laser has been created in which the atomic beam can escape not just downwards but in any direction, the choice being controlled by two optical laser beams applied to a sodium atom BEC. The NIST atomic beam was not a continuous one, however, but rather a quasi-continuous succession of nearly overlapping pulses. A continuous atomic laser may be useful in high-precision measuring devices and in high-tech molecular nanostructure production processes.

Source: *Physics News Update*, Number 422
http://www.hep.net/documents/newsletters/pnu/pnu.html#RECENT

2. The de Broglie wavelength of a packet of light

In 1994, Jacobson and Yamamoto of Stanford University predicted that the de Broglie wavelength of a wave packet comprising several photons should be shorter than that of any individual photon, the decrease in the wavelength being inversely proportional to the number of photons. For example, a 1000 photon wave packet of green light was expected to have an X-ray de Broglie wavelength. A Brazilian team lead by S de Pádua has for the first time verified this prediction for a two-photon case. In the experiment conducted by the team, coherent photon pairs were produced by splitting a photon in an optically nonlinear crystal, after which the interference of the two-photon wave packets as well as the interference of either photon in a pair were individually observed and the wavelengths involved were measured. Consistent with the theoretical prediction, a reduction of the de Broglie wavelength of a wave packet to half that of each individual photon was observed.

Source: http://publish.aps.org/FOCUS/

3. Remote galaxy

Researchers using the Hubble Space Telescope have seen the remotest galaxy ever detected, and one probably still at the early stages of its formation. The light that now comes to Earth was emitted by the galaxy when the Universe was only a few hundreds of millions years old, i.e. just 5% of its present age. The distance to the galaxy was determined from the spectral red shift due to the expansion of the Universe. For the galaxy observed, the parameter z of the red shift turned out to be 6.68. While there is a huge amount of excess ultraviolet light in the galaxy's emission, the large red shift causes the UV radiation to displace to the optical region. The UV emission is probably due to the fact that light from young hot stars is scattered on gas clouds present in the galaxy but not incorporated into star material.

Source: http://www.nature.com
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4. Gamma-ray burst from a galaxy core

Hubble observations of the optical source identified with the cosmic gamma-ray burst GRB 970508 have been repeated to reveal that, since the last observation in August 1998, the source brightness has faded to the point that no emission from it can now be distinguished. At the same time, the new Hubble images reveal the presence of an elliptical galaxy which was earlier obscured by the bright light from the optical source. Importantly, the optical source is only 70 ps or less from the galaxy's center and must therefore take part in its core processes. The nature of gamma-ray bursts is still a matter of debate. According to earlier optical data, they arise in galaxies with a high rate of star formation which may, in the present case, occur in the galaxy's core. Alternatively, the activity of the core may explain the phenomenon.

Source: http://xxx.lanl.gov/abs/astro-ph/9903236

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