

Physics news on the Internet (based on electronic preprints)

1. An atom laser

A rudimentary atom laser has been developed at the Massachusetts Institute of Technology (MTI) for the first time ever. In contrast to the conventional laser whose output beam consists of a coherent light wave, the output beam of its atom counterpart consists of a single coherent atom wave. The heart of the new device is a Bose-Einstein condensate of sodium atoms. Initially, all condensate atoms are held in a magnetic trap and have a spin of the same direction. When an external alternating electromagnetic field is applied, the spin of some atoms changes direction, these atoms escape from the trap and fall downward under the action of the gravitational field of the Earth. The falling beam of atoms thus produced owes its coherence to that of the original atoms of the Bose-Einstein condensate. The beam atoms constitute a single quantum wave. To demonstrate the coherence explicitly, W Ketterle and his colleagues at MTI investigated the interference of two beams. In their experiments they unambiguously observed an interference pattern usually occurring when two de Broigle waves at a wavelength of 30 μm interfere.

The researchers see many ways for their atom laser to be improved. The experiments were carried out in a vacuum unit. The beam length was not greater than a few millimeters because of the interaction with the residual air molecules. In a higher vacuum, however, it would be possible, at least in principle, to produce longer beams able to propagate not only downward but in other directions as well. The new laser can generate only short pulses, but the scientists plan to produce continuous atom beams in the future. The atom laser can probably serve as the basis for new scientific devices of high precision, such as an atomic clock. It can also find many uses in fine technologies to produce molecular nanostructures.

Source: http:aip.org/physnews/special.htm

2. A multicolor laser

A solid-state laser has been designed at Los Alamos National Laboratory, USA, which can be made, through a simple change of frequency, produce light of four visible colors: red, orange, green, and blue. The generation of a blue beam is certainly an achievement, because this color is difficult to generate efficiently and reliably from solid materials. The crystal of the new laser is fabricated from zirconium-fluoride-based glass doped with two kinds of impurities. The various colors of light result from transitions of the impurity ions to different lower-energy states.

Source: http:/www.lanl.gov/projects/PA/
Releases/97-003.html

Uspekhi Fizicheskikh Nauk **167** (3) 286 – 286 (1997)
Translated by B V Kuznetsov; edited by S D Danilov

3. A single-electron transistor

Researchers at the University of Minnesota have devised an ultra-tiny transistor that stores a single electron to represent one bit of information. The transistor is fabricated from silicon and operates at room temperature. Because in the new transistor one bit of information is stored in one electron, it switches between states in a sharp, stepwise manner. In binary code, the absence of a stored electron would mean '0', and its presence, '1'. In the conventional transistor, it takes thousands of electrons to store 1 bit of information, the transition between the states is extended by an amount equal to the storage time, and is accompanied by statistical noise. On top of its high speed of operation, the new transistor is one-hundredth to one-thousandth the size of the conventional one. The remarkable qualities of the new transistor open up broad prospects for its use in microelectronics and computers.

Source: http://unisci.com/

4. The age of the stars and the age of the Universe

Until quite recently, the age of the oldest stars in the Universe was thought to be about 15 billion years. At the same time, cosmological methods estimated the Universe itself to be three to five billion years younger. The latter figure was obtained within the framework of the standard cosmological model with a plane space and $\Lambda = 0$, and the estimate owed its uncertainty to the insufficient accuracy in determining the Hubble constant. There is, thus, an obvious discrepancy between the age of the stars and the age of the Universe. This discrepancy will be possibly removed by the observational data gathered by the Hipparcos satellite launched by the European Space Agency in 1989. The satellite is removed from the Earth to a distance about equal to the diameter of the Earth's orbit. Simultaneous observations from the Earth and Hipparcos provide an equivalent of stereovision and offer a way to accurately determine distances to stars. It has been found that the distances to some Cepheids (a special class of variable stars) are 10% greater than was previously assumed. Adopted as 'standard candles', these Cepheids let astronomers to construct a cosmic distance scale, and to determine the Hubble constant and the age of the Universe. According to new data, the age of the Universe is 13 billion years. Because of the inaccurate distance scale, the stars were assigned overestimated brightnesses. By the theory of stellar evolution, the age of stars depends on their absolute brightness. The recalibrated age of the oldest stars is 11 billion years and checks with the age of the Universe.

Source: http:/science-mag.aaas.org/science
Science Online

Compiled by *Yu Eroshenko*