

PACS number: **01.90. + g**

Physics news on the Internet (based on electronic preprints)

1. Superfluidity of Bose-Einstein condensate

In the past few years a Bose degenerate gas (Bose-Einstein condensate) of some alkali metals and hydrogen atoms has been produced. Such a condensate forms at low temperatures — when the average distance between atoms becomes comparable to their de Broglie wavelength — and its atoms are all in the same quantum state, implying that the condensate is superfluid. To demonstrate this superfluidity directly, two experiments, one at NIST and the other at MIT, were performed. The NIST team observed quantized superfluidity vortices in a condensate of rubidium atoms. These latter, originally residing in two different states of spin, were subject to the combined action of microwave radiation and laser light with the result that some of them reversed their spin and so became involved in vortex motion, each vortex containing one unit of angular momentum. In the MIT experiment, a laser beam punched a hole in a sample of Bose-Einstein condensate and then scanned it along the sample, the moving hole being equivalent to a moving body. Characteristically for the superfluid state, a critical velocity (of 2 mm/sec) was found below which no energy dissipation was observed.

Source: Physics News Update, Number 449
http://www.hep.net/documents/newsletters/pnu/pnu.html#RECENT

2. Quantum properties of fullerene

Louis de Broglie's particle-wave duality is one of the foundation stones of quantum mechanics, and by now not only individual elementary particles but also atoms and even small atomic clusters have been observed to possess wave properties. Recently the wave properties of the fullerene C_{60} and C_{70} molecules were demonstrated by the Austrian physicist A Zeilinger and his colleagues, who were able to create interference patterns using beams of these molecules. It has been a matter of debate since the early days of quantum mechanics, to what extent its wave concepts are applicable to macroscopic objects (in particular, Schrödinger's well-known thought experiment with a cat is a good illustration). C_{70} is the biggest object thus far to reveal wave properties, and it is unlikely that such objects as, say, viruses, ever will.

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

3. The passage of light through holes

While elementary theory maintains that light cannot pass through a hole less than the light wavelength across, in 1998 a French research group led by T Ebbesen showed this to be possible for certain wavelengths if a metal plate perforated with small holes is illuminated with the light. This effect was explained in terms of plasmons, i.e. vibrations of electrons on the metal surface, and now computer simulations by J Pendry of the University of London and his Spanish colleagues have confirmed this hypothesis. The simulations show that the incident light excites plasmon modes on the metal surface, which then carry energy to the opposite side of the plate where this energy is reconverted to light. So what passes through the plate is in fact the energy stored in light rather than light itself. The calculations agree favorably with experiment even though, for the sake of simplicity, narrow slits were taken to model real holes. Owing to the resonance properties of the plasmons, the light transmission coefficient should depend on the thickness of the plate according to the researchers.

Source: http://www.nature.com

4. Unusual star

The variable star η Carina located 10,000 light years from Earth is one of the most interesting objects in our Galaxy. It is 150 times as massive and 4 million times as bright as the Sun, and its bipolar ejections indicate the existence of an intense magnetic field in the star. Although the nebula surrounding the star looks like a supernova remnant, the explosion that created it did not, for some unknown reason, lead to the destruction of the star and to its transformation into a black hole or a neutron star. It is believed that the nebula acts like a natural UV laser analogous to a microwave maser. Using the Chandra X-ray Observatory, new features, namely an outer gaseous ring, a hot inner core, and a hot central source with a supermassive star within were discovered in the nebula's structure, which are 2 light years, 3 light months, and less than one light month in diameter, respectively and were presumably formed by shock waves due to the star's explosions.

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

Compiled by *Yu N Eroshenko*

Uspekhi Fizicheskikh Nauk **169** (11) 1272 (1999)
Translated by E G Strel'chenko