

PACS number: **01.90. + g**

Physics news on the Internet (based on electronic preprints)

DOI: 10.1070/PU2003v046n10ABEH001619

1. Quantum interference of organic molecules

The quantum interference of organic molecules of biological origin has been observed for the first time at the Institute of Experimental Physics at the University of Vienna. The molecules of $C_{44}H_{30}N_4$ are plate-shaped and enter the composition of chlorophyll and haemoglobin. Molecular beams were produced by subliming solid substances in a vacuum chamber. At the heart of the experimental apparatus was the Talbot – Lau interferometer consisting of three phase lattices with a period of 1 μm: one lattice generated a coherent molecular beam, another served to produce diffraction and interference, and the third — part of the detector — was used to register the interference pattern. The experiment was repeated using a beam of organic (but not biological) molecules of $C_{60}F_{48}$, which appear as spherical layers of fluorine atoms surrounding a fullerene base. $C_{60}F_{48}$ molecules became the heaviest organic molecules to show quantum wave properties. Both $C_{44}H_{30}N_4$ and $C_{60}F_{48}$ molecules display distinctive interference patterns which cannot be explained by classical (non-quantum) effects. Earlier, in 1999, the quantum interference of C_{60} and C_{70} fullerene molecules was discovered for the first time by the same research group, led by A Zeilinger (see *Usp. Fiz. Nauk* **169** 1272 (1999) [*Phys. Usp.* **42** 1174 (1999)]).

Source: *Phys. Rev. Lett.* **91** 090408 (2003)
http://prl.aps.org

2. Gyroscopic effect in a Bose – Einstein condensate

The precession of a Bose Einstein condensate of rubidium atoms has been discovered by a team of researchers at Oxford University. By applying an evaporating cooling technique, an ellipsoidally-shaped Bose Einstein condensate was created in a magnetic trap. After the potential holding the atoms was put into rotation, the condensate produced a vortex filament and acquired a rotational moment equal to $\hbar$ per atom. Using an additional alternating magnetic field, the condensate was excited to vibrate in one of the planes, and this plane was then found to precess like an ordinary gyroscope. The rate of precession is equal to what the numerical solution of the Gross – Pitaevskiĭ equation yields.

Source: *Phys. Rev. Lett.* **91** 090403 (2003)
http://prl.aps.org

3. Giant molecules of He_2

J Leonard and colleagues in France have studied how molecules of the inert gas helium form. After a helium gas was cooled to ~ 10 μK in a magneto-optical trap, its atoms were transferred into the excited metastable state 2^3S_1. Subjected further to laser radiation with a frequency corresponding to the $2^3S_1 - 2^3P_0$ transition, the atoms were forced into the photoassociation process: absorbing a photon induces an electric dipole moment in an atom, allowing it to form coupled systems with other atoms. Because of their small binding energy, the resulting molecules measured 10 – 100 nm across, a record large size for two-atom molecules. The lifetime of the molecules was about 50 ns. The fast atoms into which the molecules decay exchange energy with other atoms thus heating the gas. Calorimetric measurements confirmed the formation of helium molecules and gave insight into how efficient this process was. It was found that about 1% of the atoms make a transition to the molecular state. It is interesting that in order to theoretically calculate the structure of a giant He_2 molecule, the speed of light should be considered finite for light propagation between the atoms.

Source: *Phys. Rev. Lett.* **91** 073203 (2003)
http://prl.aps.org

4. Cooling record

W Ketterle and colleagues at the Massachusetts Institute of Technology, using a new — gravito-magnetic — trap, cooled a Bose Einstein condensate of sodium atoms to a record-low temperature of 0.45 nK, which is six times lower than previous results. The cooling was carried out using the optical evaporation of the atoms combined with the trap expansion process, the latter causing the adiabatic cooling of the gas. The temperature of 0.45 nK was reached for about 30000 atoms in the trap. It is of interest to study the interaction of ultracold gases with surfaces; theory predicts atoms should experience quantum reflection from a surface.

Source: http://web.mit.edu/

5. X-ray flashes

Since 2001, X-ray flashes isotropically distributed over the celestial sphere and lasting tens to hundreds of seconds have been detected by the BeppoSAX X-ray space telescope. As compared with cosmic gamma ray bursts, X-ray flashes have lower photon energies (about 50 keV at peak brightness) and are 2 to 3 times less frequently detected. An assumption has been made that X-ray flashes are usual gamma ray bursts, but that they occurred at very large distances and have become less energetic due to cosmological expansion. New observations made with the Chandra space X-ray observatory and the radio telescope system VLT (the flares have an afterglow in the radio and the X-ray range) have made it possible to very accurately locate the sources of two X-ray flares, XRF 011030 and XRF 020427. With the help of the Hubble telescope, blue galaxies with intense star formation were found in these location regions at redshifts $z \sim 1$. Thus, the X-ray flares are not distant gamma-ray bursts but, similar to gamma-ray bursts, were probably generated by explosive processes in the final stages of the evolution of stars.

Source: http://arXiv.org/abs/astro-ph/0303514

Compiled by *Yu N Eroshenko*

Uspekhi Fizicheskikh Nauk **173** (10) 1130 (2003)
Translated by E G Strel'chenko