Physics – Uspekhi **52** (9) 975 – 976 (2009)

PACS number: **01.90. + g**

Physics news on the Internet (based on electronic preprints)

DOI: 10.3367/UFNe.0179.200909f.1002

1. Large parity violation effect in ytterbium atoms

Parity violation (the invariance of the properties of systems related to mirror reflections) was first detected in 1957 in the asymmetry of the ejection of electrons from decaying cobalt-60 atoms in a strong magnetic field. Until recently, the record magnitude of this effect was observed in caesium atoms. D Budker and colleagues at the University of California, Berkeley and the Lawrence Berkeley National Laboratory (USA) measured the degree of parity violation in ^{174}Yb atoms, which proved to be approximately 100 times stronger than in caesium atoms. Transitions were observed between atomic ytterbium $6s^2\ ^1S_0 \to 5d6s\ ^3D_1$ levels, which corresponded to the wavelength of the absorbed photons equal to 408 nm. These transitions are forbidden by selection rules; in other words, they occur with very low probability. Transitions to upper energy levels in a beam of ytterbium atoms were excited by laser pulses in crossed electric and magnetic fields. The excitation rate of these transitions in atoms was measured by observing the fluorescent emission from spontaneous transitions of atoms to lower energy levels. The rate of atomic transitions in the left-handed field configuration was higher than in the case of right-handed configuration. Parity violation arises as a result of the mixing of levels of different parity due to the weak interaction in the external electric field. So far, the accuracy achieved in the experiment has only been 14%, but it has proved sufficient for detecting the record-high parity violation in ^{174}Yb. Future experimental examinations of parity violation in various isotopes of nuclei and in transitions between hyperfine-splitted levels could provide new data on the distribution of neutrons in nuclei and perhaps could help in finding effects that go beyond the Standard Model of elementary particles; they will also lead to measurements of the anapole moment of nuclei [see *Usp. Fiz. Nauk* **167** 1213 (1997) (*Phys. Usp.* **40** 1161 (1997))].

Source: *Phys. Rev. Lett.* **103** 071601 (2009)
http://dx.doi.org/10.1103/PhysRevLett.103.071601

2. Growth mechanism of carbon nanotubes

Researchers at Université de Lyon (France) and Rice University (USA) discovered that as new atoms join a carbon nanotube in the course of its growth, the nanotube often rotates axially. This mechanism of nanotube growth was predicted in a theoretical paper by B Yakobson. A field emission microscope (FEM) was used to directly observe nanotubes in the process of catalyzed growth, with an FEM tip moving along the growth zone of the nanotube. The image of the nanotube was projected onto a phosphorus-covered screen and the processes taking place were video-recorded. In one of the experiments, a nanotube made 180 rotations around its axis during 11-min growth. Another interesting result was the observation that the nanotube revolved stepwise, not smoothly, doing one complete turn in approximately 24 discrete steps. Atoms joined the rotating nanotube in pairs, forming a helical structure. The unique mechanical and electronic properties of carbon nanotubes hold great promise for the future in designing new superstrong materials and elements of microelectronics. Clarifying the mechanism of nanotube growth may help control this process in industrial-scale production.

Source: *Nano Lett.* **9** 2961 (2009)
http://dx.doi.org/10.1021/nl901380u

Uspekhi Fizicheskikh Nauk **179** (9) 1002 (2009)
DOI: 10.3367/UFNr.0179.200909f.1002
Translated by V I Kisin

3. Transparent aluminium

J Wark (Oxford University, Great Britain) and coworkers observed a transition in aluminium to a phase that is transparent to XUV radiation in response to irradiation by laser pulses. Aluminium foil was exposed to pulses from the world's most powerful soft X-ray laser, FLASH, operating in Hamburg. The radiation flux density for 92-eV photons over a small area of the foil reached 10^{16} W cm^{-2}. The light of the laser produced single ionization of practically all the aluminium atoms by knocking electrons out of the L shells, without destroying the crystal structure; this kept the specimen transparent to UV photons for 40 fs.

Source: *Nature Physics* Published online 26 July 2009,
http://dx.doi.org/10.1038/nphysl341

4. Nanolaser went over the diffraction limit

M T Hill (Technical University of Eindhoven, The Netherlands) and his colleagues in the Netherlands together with the researchers at Arizona State University (USA) designed a microscopic laser whose lateral dimensions are below the diffraction limit of the radiation it emits. The device consists of alternating semiconducting InP/InGaAs/InP structures of a square cross section, 90 to 350 nm thick, bounded on both sides by insulating SiN layers 20 nm in thickness; the entire structure is coated with an outer layer of silver. Epitaxy, electron-beam lithography, dry etching and various material deposition techniques were used to create the laser. Electric current was passed through special contacts connected to the semiconductor, and electrons and holes were injected into the structure. The layered structure forms a waveguide through which gap plasmon modes can propagate, undergoing reflections from silver layers at waveguide edges — as light does in a Fabry–Perot interferometer. The device can generate laser radiation with a wavelength of about 1500 nm, while being less than a quarter of a wavelength thick. The diffraction limit is overcome both because the wavelength in an insulator is shorter than that in vacuum and because photons are transformed into surface plasmons in metal layers. The generation of laser light was recorded even at room temperature, despite the fact that the device is more efficient if it is cooled considerably. Nanolasers may find applications in, for example, computers to transfer signals between components of microelectronic circuits, thus greatly speeding up their work.

Source: *Optics Express* **17** 11107 (2009)
http://dx.doi.org/10.1364/. 17.011107

5. Massive compact galaxy in early Universe

P van Dokkum (Yale University, USA) and his colleagues from an international team of astronomers measured with the 8-meter Gemini South telescope in Chile the dispersion of stellar velocities in the 1255-0 galaxy. The galaxy was observed at redshift $z = 2.186$, i.e., in the epoch when the age of the Universe was a mere 3 billion years. However, with the mass of the galaxy $\sim 10^{11} M_{\odot}$, stars in it move with a velocity dispersion of 510^{+165}_{-95} km s^{-1}, which is approximately 2.5 times greater than the velocity dispersion in typical present-day galaxies. The size of galaxy 1255-0 is, however, six times smaller than that of present-day elliptical galaxies of the same mass. It is not clear so far what mechanism formed such dense galaxies and what their evolution path was. It is conceivable that in the time since such galaxies were formed, they merged with other surrounding galaxies and acted as seeds of the very dense central regions of today's giant galaxies. It is also possible that central supermassive black holes formed very early in such galaxies.

Source: *Nature* **460** 717 (2009)
http://dx.doi.org/10.1038/nature08220

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