

PACS number: **01.90.+g**

Physics news on the Internet (based on electronic preprints)

DOI: 10.1070/PU2001v044n06ABEH000864

1. Collisions of ultra-relativistic gold ions

The main objective of the experiments on the collision of heavy ultra-relativistic ions at CERN (Switzerland) and Brookhaven National Laboratory (USA) is to create quark-gluon plasma. This state of matter is expected to appear at energy densities of order 2.5 GeV fm^{-3}, when a phase transition from nucleon matter to quark-gluon plasma (i.e. the deconfinement of quarks) must occur. Some evidence for quark-gluon plasma was seen in collision experiments on lead ions at CERN in 2000. Now Brookhaven physicists have performed similar experiments on gold ions, in which energies ten times higher than those at CERN were achieved. Whether Pb + Pb and Au + Au collisions succeeded in compressing matter into quark-gluon plasma, however, remains an open question, but some unexpected results have been obtained. It is known that in nuclear collisions, apart from their disintegration products — i.e. lighter particles and neutrons — a lot of other particles appear, which form a dense and hot fireball and blast away from the collision point. In the Brookhaven Au + Au experiment, the particle production rate was much higher than expected, and the particle production stage in the fireball was much shorter that predicted theoretically. The observation that the particle production stage shortens with increasing energy also disagrees with calculations.

Source: http://unisci.com/stories/20012/0501012.htm

2. Superconductivity mechanism in MgB_2

W Pickett and J An of the University of California have discussed the mechanism of superconductivity in MgB_2, an intermetallic compound in which this property was discovered in early 2001 (see *Usp. Fiz. Nauk* **171** 306 (2001) [*Phys. Usp.* **44** 330 (2001)]). Since a crystal of magnesium diboride consists of alternating layers of magnesium and boron atoms, one would assume that the structure of chemical bonds in MgB_2 differs from that in usual metals. Computer simulations showed, however, that the chemical bonds in this material effectively behave as purely metallic, implying that superconductivity in MgB_2 should be described by the Bardeen – Cooper – Schrieffer theory.

Source: *Phys. Rev. Lett.* **86** 4366 (2001)
http://prl.aps.org

3. Anisotropy of the microwave background radiation

The anisotropy of the microwave background radiation has been measured in the multipole range $l = 100-900$ using the new radiointerferometer DASI at the South Pole. The acoustic (Sakharov) peaks at $l \simeq 200$ and $l \simeq 559$ known from previous experiments were detected, and a third peak at $l \simeq 800$ was observed for the first time. These observations confirm the theory that cosmological density perturbations originate from quantum fluctuations at the inflation stage and impose strong constraints on alternative models, e.g., the model with topological defects.

Source: http://xxx.lanl.gov/abs/astro-ph/0104489

4. A rotating black hole

Researchers using the X-ray space telescope known as Rossi X-ray Timing Explorer (RXTE) have found signs of angular momentum in the object GRO J16550-40, believed to be a black hole of 5.5 – 7.9 times the mass of the Sun. The black hole is located about 10,000 light-years from Earth and forms a binary star system together with a normal star. Matter flows from the star into the black hole and falls into it from the accretion disk interiors, emitting X-ray radiation in so doing. It is also observed that the black hole ejects two jets of particles, similar to but much smaller in scale than jets from quasars. The spectrum of the x-ray radiation emitted features quasi-periodic oscillations with a frequency of 450 Hz, interpreted as being due to the periodic motion of plasma in the innermost stable orbit around the black hole. For a black hole mass exceeding 5.5 solar masses, a 450-Hz orbit may only exist if the black hole has an appreciable spin. Thus, RXTE data provide the first direct evidence for the existence of rotating (or Kerr) black holes.

Source: http://xxx.lanl.gov/abs/astro-ph/0104487

5. Elasticity of the RNA molecule

Researchers in the Berkeley Lab's Physical Biosciences Division have succeeded in measuring the mechanical properties of individual molecules of ribonucleic acid. They attached the two ends of a molecule to microscopic plastic beads and used a laser beam and a piezoelectric device to control (and monitor) their respective motions. This enabled the researchers to fold, unfold, and stretch the molecule as well as to measure the mechanical stresses that developed and the energy that was spent in the process. The relaxation of the molecule to its original state after its was bent was also studied. RNA is a biopolymer molecule whose various types are involved in transmitting hereditary information via the protein synthesis process. Usual methods, for example, the melting of a large sample of a biopolymer, yield only the averaged characteristics of a molecule — neglecting the fact that there are a variety of ways in which each molecule can be deformed. The Berkeley experiments have shown that the mechanical properties of individual RNA molecules have a large spread around their average values, the specific amount of the spread depending on the type of the deformation involved.

Source: *Science* **292** 733 (2001);
http://www.sciencemag.org

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Uspekhi Fizicheskikh Nauk **171** (6) 648 (2001)
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