

Physics news on the Internet (based on electronic preprints)

1. Supernovae at cosmological distances

Preliminary results based on discoveries of the most distant supernovae (exploding stars) ever observed were presented at the American Astronomical Society meeting on January 16, 1996. The observations were carried out using largest telescopes around the world and were coordinated by the Berkeley National Laboratory (California, USA). The discoveries were made as a part of more general project (Supernova Cosmology Project) headed by Saul Perlmutter. The goal of the project is to measure so-called Universe's deceleration parameter whose value characterises the change in the rate of cosmological expansion, or, in other words, the temporal course of the Hubble constant. According to the Einstein equations, the deceleration parameter is equal to the half of the ratio of the matter density in the Universe to the critical density, thus on the value of this parameter depends the way the Universe will end — will it continue to expand forever or the expansion will be followed by contraction at a particular time.

All 18 supernovae were discovered by their brilliant light: during an explosion a supernova is brighter than the entire galaxy of milliard stars where it was born. Supernovae were found in galaxies separated from the Earth by distances up to 7 milliard of light years. Most of supernovae were classified as being 'type 1a'. Such supernovae are remarkable in that their peak brightness is known. By using them as standard candles one can calculate their distance which, together with measurements of redshifts in supernova spectra will provide the deceleration parameter.

By now the information on the first seven supernovae has been processed. A preliminary conclusion is drawn that the rate of the Universe's expansion decreases with time. For the first time in the history of cosmology the determination of the deceleration parameter will become possible after discovering approximately 50 supernovae of type $1a$. As the investigations are planned to be continued over next few years, the accuracy of the results will improve continuously.

The measurements were carried out with the help of the technique developed at the Berkeley Lab. An ultrasensitive electronic camera attached to a telescope is used to photograph thousands of distant galaxies at the time of a new moon. The second set of photographs of the same galaxies is obtained just before the next new moon. With the help of a computer the photographs are compared and appearance of new supernovae is revealed. Such experiments have only recently become possible owing to advances in computers, light-detectors, and the Internet which joins together the world largest telescopes and research centres.

Source: Lynn Yarris, http://www.lbl.gov/Science-Articles/Research-News.html

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Translated by S D Danilov

2. Anti-hydrogen

Particles of antimatter were artificially produced in laboratory experiments decades ago; antiprotons, for example, were first synthesised in 1950s. Positrons were discovered in cosmic rays in 1932. But only in September 1995 CERN scientists for the first time succeeded in synthesising atoms of anti-hydrogen from antiprotons and positrons.

11 atoms of anti-hydrogen were synthesised after three weeks of experiments at the CERN Low Energy Antiproton Ring by passing antiprotons through a xenon gas jet. Moving in the Coulomb field of xenon nuclei, small part of antiprotons convert a part of their energies into electron-positron pairs. The positrons whose velocities are close to those of antiprotons could join antiprotons thus creating atoms of anti-hydrogen. In the experiments the anti-atoms were not captured by any traps and after short periods of time they annihilated with surrounding ordinary matter. The techniques needed to accumulate and store antimatter now are under intensive development at CERN. It is planned to create electric and magnetic bottles in which anti-atoms will be stored and thoroughly analysed by spectroscopic and other methods.

It is necessary to verify whether the antimatter atoms obey the same physical laws as the atoms of ordinary matter. In particular, one should like to know whether they behave in the same manner under gravity and are CPT-invariant. Violation of the CPT-symmetry would imply that there exist some unknown properties of fields which are beyond the framework of the standard theory.

Source: CERN Press Release, http://www.cern.ch/Press

Composed by *Yu N Eroshenko*