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Physics news on the Internet (based on electronic preprints)

1. Quantum computer

A new promising approach to creation of a quantum logical element (an original constituent of quantum computers-to-be) has been developed by researchers at MIT and at Delft University of Technology. As an improvement over small electromagnetic cavities and photon-involved nuclear-magnetic resonance on molecules proposed previously, their idea is to use microscopic superconducting loops as quantum memory cells. Because electric current in such loops obeys the laws of quantum mechanics, two opposite directions of the current may represent not only the 'zero' and 'one' states but also their superpositions, with a consequence that the so-called 'qubits' of information are realized. The major advantages, the researchers claim, are that present-day technologies allow large systems of superconducting loops to be easily fabricated and that the possibility is raised to couple such cells using additional loops. For a quantum computer to be practical, it must have at least 80 memory cells. Individual cells can be controlled by magnetic microwave pulses, and to read out the information they stored, superconducting magnetometers can be used. Importantly, a way to make memory cells to perform coherently is yet to be found.

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

2. One-electron cyclotron

According to quantum mechanics, an electron in a uniform magnetic field occupies discrete energy levels known as Landau levels. S Peil and G Gabrielse, of Harvard University, have become the first physicists to perform such an experiment on a single electron. By combining the Penning trap with specially arranged electrical and magnetic fields, the electron was made to rotate perpendicular to and drift along the magnetic field, the energy of the rotational motion being discrete according to theory. To prevent the electron from chaotically jumping between the energy levels, it was cooled to 80 mK, 50 times less than previously achieved for any isolated elementary particle. The experimental device is in fact the quantum limit of the conventional cyclotron — a 'quantum cyclotron.' Applying an oscillating electrical field parallel to the magnetic field, it was found that level-to-level transitions of the electron in the magnetic field corresponded to changes in the electron's rotation frequencies.

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

3. Temperature of atomic nuclei

Although temperature presents a statistical quantity and as such is normally defined for systems containing enormously large numbers of particles, Norwegian researchers have originated a method with which the temperature of atomic nuclei including a relatively small number of protons and neutrons can be determined. The atomic nucleus is in a sense a drop of liquid with nucleons moving chaotically inside, and information about the internal state of a nucleus can be obtained from the spectrum of gamma emission produced by nuclear collisions. For the Dy nucleus (the atomic number 66) with its 162 nucleons, the temperature determined in this way was 6×10^9 K.

Source: *Physics News Update*, Number 443
http://www.hep.net/documents/newsletters/pnu/pnu.html#RECENT

4. Stars near the SN 1987A supernova

Astronomers using the Hubble Space Telescope have studied the characteristics and spatial distribution of stars within 30 pc of SN 1987A, a supernova which exploded in 1987 in the Large Magellanic Cloud and is situated 51.4 kpc from the Earth. The knowledge of the stellar population around a supernova is crucial for the understanding of how the pre-explosion star and its environment evolved. It is found that in the region explored both young (with ages between 1 and 150 Myrs) and a much older (more than 10 Gyrs) stars are present and that the star formation rate has increased severalfold in the last 8 Gyrs. The spatial distribution of stars in the vicinities of the supernova displayed those peculiarities that deserve attention. Interestingly, stars having nearly the same age but strongly different masses are distributed differently in space. In particular, an increased concentration of massive stars is observed in the supernova's immediate vicinity. This lack of mass/space correlation in distributions of stars of a coeval generation is confirmed by statistical methods and implies that stars differing in mass were formed to a large extent independently and by different mechanisms. As to the initial mass function, this is an area-averaged characteristic and thus a superposition of a large number of contributions from stars of different generations.

Source: http://xxx.lanl.gov/abs/astro-ph/9908188

5. New ISO data

Both astronomical observations and theoretical predictions suggest that every existing galaxy might have undergone a number of mergers with other galaxies during its lifetime. A characteristic feature of such merged galaxies are huge irregular ejects due to tidal forces and the presence of double nuclei. A number of intriguing discoveries concerning luminous merging galaxies close to the Earth have been made with the Infrared Space Observatory (ISO). While two nuclei of the Arp299 galaxy appear inconspicuous at optical wavelengths due to strong dust absorption, they produce about 90% of the entire galaxy's IR luminosity. The matter in one of the nuclei shows some indication of rotation as a whole. Spectral studies imply that the powerful IR emission is

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associated with the intensive star formation occurring in the nuclei, presumably due to the galaxy merging. In the double galaxy Antennae formed by merging of two spiral galaxies, very compact areas of extranuclear starburst are found which give up to 15% of the overall galaxy's 15 μm mid-IR output but are optically invisible. Another noteworthy finding is a giant elliptic radio galaxy in symbiosis with a spiral galaxy which was absorbed by the former during their collision. The massive elliptic galaxy has an active nucleus which produces relativistic ejects. All the indications are that the bar (central cross piece) of the spiral galaxy serves as a bridge by means of which gas comes to the active nucleus of the elliptic galaxy to power a supermassive black hole there — a process in which large amounts of energy are released.

Source: http://xxx.lanl.gov/abs/astro-ph/9908188

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