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Physics news on the Internet (based on electronic preprints)

1. Nondestructive photon detection

While a conventional photodetector measures a photon by converting it into an electrical signal after an absorption event, nondestructive photon observations are not ruled out by the fundamental laws of quantum mechanics, and indeed a number of nondestructive techniques have been developed over the years. These, however, have been too difficult to execute until now. Researchers from France have recently been successful in performing a first nondestructive observation. In the experiment of G Nogues and coworkers, the photon was to be found between two mirrors in the cavity and an atom of rubidium passed through a cavity between two mirrors, and its wave function phase shift acquired in the presence of a photon can easily be detected. By sending additional rubidium atoms through the cavity, one can measure the photon repeatedly without destroying it. Although the photon was not destroyed as a particle, its quantum state was of course altered in accord with Heisenberg's uncertainty principle. The method may be used in quantum logic gate design, according to the authors.

Source: http://www.nature.com/

2. Unusual crystals

In normal diffraction experiments, X-ray radiation passing through an atomic crystal lattice forms a characteristic interference pattern after being scattered on the atoms. Austrian physicist A Zeilinger and his colleagues performed what may be called an inverse experiment by making a standing electromagnetic wave ('crystal lattice') to scatter an atomic beam. The standing wave was produced by reflecting a laser beam off a gold mirror, and the atomic beam was formed in a so-called 'atom laser'. Having passed the standing electromagnetic wave, atoms produced an interference pattern similar to that obtained on a crystal lattice. While experiments of this type were started by Zeilinger's group back in 1996, the most complete analog of Bragg diffraction has only recently been obtained.

Source: http://www.nature.com/

3. Superhigh precision measurement of light frequency

A technique for measuring the frequency of visible light to a precision of 3×10^{-17} (to compare with the 2×10^{-15} accuracy of the best atomic clocks based on measuring RF atomic transitions) has been developed at the Max Planck Institute for Quantum Optics using femtosecond laser pulses with a regular set of many frequency peaks forming their spectra. By comparing the laser emission, light signal, and reference wave frequencies, first the frequency difference between the signal studied and the reference wave, and then the signal frequency itself can be determined to a high accuracy. In this way, the atomic transition frequencies of caesium (D_1-line) were measured with 1000 times the accuracy of previous measurements. With this technique, it is hoped that a more effective optical version of atomic clocks can be developed and more accurate values for some of the fundamental physical constants will be obtained.

Source: *Physics News Update*, Number 434
http://www.hep.net/documents/newsletters/pnu/pnu.html#RECENT

4. Neutrino oscillation

New evidence for neutrino oscillation (mutual transformations of different types of neutrino) has been found in the K2K (KEK + Kamiokande) experiment in Japan. In this, a narrow neutrino beam was generated by the proton accelerator at the KEK laboratory located in Tsukuba City near Tokyo, whose muon and tau neutrino percentages were measured using a number of detectors, particularly a kiloton water Cherenkov detector, to record neutrino events. The neutrino beam then travelled 250 km away from KEK through the Earth and reached the underground Super-Kamiokande detector situated at the Kamioka Observatory, a steel 50,000-ton water reservoir with thousands of photomultipliers on its inside surface for detecting Cherenkov radiation. At this end, a greatly reduced number of muon neutrinos indicated that oscillation processes occur in the travelling beam. Evidence for neutrino oscillation was also found in the Super-Kamiokande experiments about a year ago, when neutrinos from cosmic ray collisions with the upper atmospheric layers were examined. The phenomenon of neutrino oscillation requires nonzero-mass neutrinos, and these are predicted by the most Grand Unification theories in which various interaction types (weak, electromagnetic, and strong) are unified. The neutrino oscillation discovery may help explain the deficit of solar neutrinos, and massive neutrinos may account for a large part of the dark matter (or hidden mass) in the Universe thus furthering our understanding of its large-scale structure.

Source: http://unisci.com/

5. Star birth

According to current views, stars are formed by the gravitational contraction of and subsequent thermonuclear reactions in dense dark clouds of interstellar molecular gas and dust. The details of these processes are not entirely clear, however, nor are the conditions for the formation of particular star types known. At present, while very old stars aged 12 billion years or more and also very young stars exist, the star formation process goes on so that in principle protostars at the very early evolution stages of cold cloud contraction may be present. This stage is normally difficult to

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see, however, because the dust component of the protostar material blots out the light of stars beyond them and so obscures the protostar interiors from observation. This difficulty has been overcome by E Lada and her colleagues at the University of Florida, who developed an elegant near-infrared technique for observing stars. Specifically, the object they studied was the dark globule Barnard 68 (B68), 500 light years from Earth and located against a background of dense stars whose infrared light penetrates the globule. Based on the change in the color of the background stars, the distribution of dust within the B68 globule was examined and some information on its inner structure obtained. It was found that B68 is currently at the very early contraction stage, and that it will take another 100,000 – 200,000 years or so for the contraction to complete. About 10 million years after the collapse, thermonuclear reactions will burn hydrogen and a new star will shine like the sun. About 4.5 billion years ago, our Sun must have undergone similar processes.

Source: http://unisci.com/

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