

PACS number: **01.90.+g**

Physics news on the Internet (based on electronic preprints)

1. Low Speed Atom Scattering

The scattering of atoms at low relative speed is of interest in that it highlights the quantum properties of the atoms. Because of the typically large velocity spread of cooled atoms, until recently no experiment with ultracold atoms has allowed accurate knowledge of the atomic pre-collision speeds. This problem was overcome in a recent Yale University experiment in which the interaction of two clouds of caesium atoms, first cooled to 1 K and then tossed up to a height of several centimeters, was studied near the top of their trajectories. The relative atomic speeds were found from the time delay of the clouds in reaching the top, a laser technique being employed to measure the speeds before and after collision. When at the top of the trajectory, the atoms interact for a fairly long time and, importantly, without external influences unavoidable in magnetic or laser traps. The interference of s- and p- waves was observed and the relative energy at which s-waves cancel and the atomic clouds pass through one another unscattered was found. Application to the construction of superhigh precision atomic clocks is suggested.

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

2. Relativistic nonlinear optics

An experiment carried out at Michigan University has demonstrated for the first time that the magnetic field of light does affect the motion of the electron the light is scattered upon. In the classical theory of Thomson scattering, only the electric field of light affects the motion of a charge. The magnetic field may be neglected if the velocity obtained by the charge is much less than the speed of light — the usual situation experimentally. In the M-U experiment, however, the laser light used was strong enough to make the charge, the electron, vibrate with relativistic velocities in the field of light. A superhigh-power laser beam acting on a beam of helium atoms ionized the atoms and was scattered by free electrons and ions. It was found that the real cross section differs from its Thomson value and that the scattered frequency depends on the angle. The implication is that electrons move along a very complicated path due to the combined forces of the electric and magnetic fields. With this experiment, a new field of research, 'relativistic nonlinear optics,' seems to have been opened.

Source: http://www.nature.com

3. Diffraction properties of ortho- and para-hydrogen

Hydrogen molecules differ in quantum symmetry properties and in the types of allowed rotation states depending on whether a molecule's two protons have their spins aligned (ortho-hydrogen) or oppositely directed (para-hydrogen). Under normal conditions, the common view was that the states of the nuclei have little or no effect on the way the atoms interact with one another: in chemical reactions, for example, only outer atomic shells are of importance. However, ortho- and para-hydrogen molecules should interact differently with a crystal surface, according to Geert-Yan Kroes of Leiden University, Netherlands. J P Toennis and his colleagues at The Max Planck Institute in Germany were able to confirm this prediction experimentally by studying the diffraction of para- and ortho-hydrogen beams at the surface of a LiF crystal. The difference in the diffraction patterns of the two beams was explained by the difference in the number of quantum states involved in the interaction of hydrogen molecules with the electrical fields of surface atoms. The effect may be useful in probing the electric field structures of surfaces.

Source: http://ojps.aip.org/prlo/top.html

4. Background radiation fluctuations

New data on the angular fluctuations of the background radiation temperature were obtained using a radio telescope at the Amundsen-Scott Antarctic South Pole Station. The background radiation, whose discovery in 1965 confirmed the so-called hot universe model, is highly anisotropic and possesses a Planck-type spectrum at about 3 K. Small spatial fluctuations in the radiation temperature are believed to have formed near the hydrogen recombination time after the Big Bang and are now carrying information on processes that took place at that stage. Theoretically, the average fluctuation should depend periodically on the angle: an effect, which was predicted by A D Sakharov and subsequently studied in detail by Silk, Zel'dovich, and Syunyaev. The periodic dependence results from the interaction of adiabatic density-of-matter fluctuations with sound wave radiation. Owing to the South Pole location of the telescope, one and the same portion of the sky was observed and statistically significant results obtained in spite of the Earth's rotation. The radiation intensity decreases with decreasing angular scale amounts, in the researchers' view, to the observation of the first 'acoustic peak' of the predicted oscillation. The particular position of the peak depends on the parameters of the cosmological model used. Observations suggest that the total density of matter in the universe (including the hidden mass, baryon matter, and possibly the Λ term) is close to the critical density and that the spatial geometry of the universe in this case is very nearly Euclidean, in consistency with the inflation model of the early universe.

Source: http://unisci.com

5. NGC 5907 Galaxy

In 1994, the observation of a faint stellar halo around the spiral galaxy NGC 5907, 39 million light years away, revealed a halo brightness profile very nearly coincident with the density profile of the dark matter halo as obtained from the galaxy rotation curve. This is unusual because for most galaxies brightness falls off much faster away from the center. Also, spectral analysis showed that the halo stars are metal-rich compared with other spiral galaxies. Recent Hubble observations revealed yet another unexpected result, namely, that the galaxy halo has much fewer massive bright stars than expected for normal galaxies of the same brightness. This implies that the glow of the halo is overwhelmingly dominated by dwarf stars invisible to the telescope. Thus far, no good explanation is available to account for such a strong disproportion between bright and faint stars.

Source: http://www.berkeley.edu

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