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1. Structure of Λ(1405)-resonance

The Λ(1405)-resonance particle, which was considered to occupy the lower excited state of the Λ-baryon with a quark composition of uds, was discovered in 1961. To date, its structure has remained disputable, because the mass of this particle is less than expected in the three-quark model. In the 1960s, R Dalitz and colleagues speculated that Lambda (1405) actually constitutes not a three-quark particle but a 'subatomic molecule' consisting of the bound state of a meson (K^- or $\bar{K}^0$) and a nucleon (a proton or a neutron). The hypothesis of Dalitz and his colleagues has been neither proved nor disproved, but the belief in its validity has increased with time. J M M Hall (University of Adelaide, Australia) and coworkers have carried out new supercomputer *ab initio* calculations by the 'lattice QCD' method and obtained for the first time the electromagnetic form factors of Λ(1405) rather accurately. The heavy s-quark was found not to contribute to the magnetic moment of Λ(1405). This is only possible if the s-quark resides inside a spin-zero meson forming a bound system with a nucleon. The simulation of the Λ(1405) mass in the molecular model also shows better agreement with the experiment. However, a comprehensive validation of the molecular Λ(1405) structure needs further investigation.

Source: *Phys. Rev. Lett.* **114** 132002 (2015)
http://arXiv.org/abs/1411.3402

2. Quantum entanglement of almost 3000 atoms

Researchers from Serbia and the USA have generated quantum entanglement in a large atomic ensemble of about 3000 atoms via their interaction with a single photon. R McConnell and colleagues placed ultracold ^{87}Rb atomic gas into an optical cavity, transmitted weak laser radiation through the cavity, and measured the output photon polarization. The turn of a polarization vector through 90° relative to the original direction corresponded to the transition of almost all the atoms to an entangled state upon their interaction with a single photon. Nearly 94% of 3100 atoms in the cavity were brought into an entangled state, which is a record for systems comprising a large atomic ensemble. The experiment was carried out many times, and the characteristics of escaping photons were used to reconstruct the Wigner function for atoms in the cavity, characterizing their probability distribution. In a certain region, the Wigner function was negative, which was indicative of a nonclassical system. The distribution also displayed a non-Gaussian character, which testified to entanglement in the directions of atomic spins. Large quantum-entangled ensembles of atoms can find applications in high-accuracy atomic clocks and in making precision measurements.

Source: *Nature* **519** 439 (2015)
http://dx.doi.org/10.1038/nature14293

3. Water ice between graphene sheets

The structure of water ice locked in a narrow spacing (three-water-molecules thick) between two graphene sheets was investigated in an experiment guided by I V Grigorieva and A K Geim (University of Manchester, Great Britain). Owing to the fact that mutual attraction of graphene sheets by van der Waals forces builds up a pressure of ~ 1 GPa between them, water already freezes under these conditions at room temperature. The ice structure was examined by a high-resolution transition electron microscope. The ice turned out to have a square crystal structure with a lattice constant (the distance between oxygen atoms) of 2.83 Å, in contrast to the hexagonal structure of conventional ice. No co-orientation of the crystal directions of ice and carbon was then revealed. It is possible that square-lattice ice should also appear in natural conditions inside the microcapillaries of some hydrophobic rocks.

Source: *Nature* **519** 443 (2015)
http://dx.doi.org/10.1038/nature14295

4. Propagation of shock perturbation in granular medium

R P Behringer (Duke University, Durham, NC, USA) and his colleagues have applied the photoelasticity method to study the force propagation effect in a granular medium. As distinct from elastic media where weak perturbations propagate as linear waves, in a granular medium considerable nonlinearity is observed, even upon a weak impact. A substance changing its optical properties under deformation was powdered between two transparent plexiglas plates, which allowed observing the propagation of mechanical stress in the medium. The speed and spatial structure of the perturbation running through the medium after the impact by a down-falling intruder was measured with a high-speed photography. The character of perturbation propagation turned out to depend on the dimensionless parameter $M = t_c v_0/d$, where v_0 is the velocity of the falling intruder at impact, d is the diameter of particles of the medium, and t_c is the characteristic collision time between pairs of grains. For $M \ll 1$, the force perturbation propagates in the medium along solitary chains of particles; because of the loose contact of particles, especially in the upper part of the vessel, the forces are transported along separate lines only. If $M \geqslant 0.6$, the chains are densely located, and a well-pronounced collective front of perturbation propagation is observed.

Source: *Phys. Rev. Lett.* **114** 144502 (2015)
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5. Gravitational lensing of relic radiation

Gravitational lensing of microwave background radiation onto dark matter haloes has been revealed for the first time by the radio telescope Atacama Cosmology Telescope (Chile) on the scale of masses of galactic groups and clusters of galaxies ranging $\sim 10^{13} - 10^{14} M_{\odot}$. These objects provide large density perturbations and are already at the nonlinear stage of their evolution. The gravitational lensing of relic radiation had already been observed earlier by other telescopes, but only on scales of tens and hundreds of megaparsecs (galactic superclusters). A map of relic radiation fluctuations measured by Atacama Cosmology Telescope and calibrated by the Planck telescope data was compared with the distribution of 12,000 galaxies from the SDSS-III/BOSS optical survey, and the lensing effect was revealed at a 3.2σ significance level. Observation of gravitational lensing of relic radiation opens up prospects of the study of dark matter distribution on the scale of galactic groups and clusters.

Source: *Phys. Rev. Lett.* **114** 151302 (2015)
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