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1. Half-life of ^{60}Fe nuclei

A Wallner (Australian National University) and his colleagues have taken a new measurement of the half-life of neutron-excess ^{60}Fe nuclei. The results of the two previous measurements of this quantity differ by about two times, presumably because of inaccuracies in the determination of the initial number of ^{60}Fe nuclei in the samples. The ^{60}Fe isotope for the new measurements was obtained at the Paul Scherrer Institute (Switzerland). Then, γ-emission upon the decay of daughter ^{60}Co nuclei in $^{60}\mathrm{Fe} \to {}^{60}\mathrm{Co} \to {}^{60}\mathrm{Ni}$ chains was registered over four years at the Vienna University of Technology. The amount of ^{60}Co in a sample increases with time, and the half-life of ^{60}Fe nuclei was evaluated by retrieving the increase happened in the γ-radiation flux. The initial ^{60}Fe isotope fraction relative to the number of ^{55}Fe nuclei in the same sample was measured by the accelerator mass-spectroscopy technique, which diminished systematic inaccuracies. The measured half-life is close to the result of one of the two preceding experiments, and the improved value allowing for all the data available makes up $(2.60 \pm 0.05) \times 10^6$ years. In Nature, the ^{60}Fe isotope accrues in massive star cores and is synthesized in supernova outbursts and under irradiation of meteorites (before they fall to Earth) by cosmic rays. This isotope of cosmic origin is present in sedimentary rock at the sea bottom. With the help of the improved half-life value, the chemical evolution of galactic and solar-system matter could be investigated in more detail and the contribution from each of the sources ascertained.

Source: *Phys. Rev. Lett.* **114** 041101 (2015)
http://dx.doi.org/10.1103/PhysRevLett.114.041101

2. Analogue of the Möbius strip in optical radiation polarization

P Banzer (Max Planck Institute for the Science of Light, Germany) and his colleagues have become the first to generate in experiment a light field in which the polarization vector is twisted like a Möbius strip. The existence of a light field with a topologically complicated polarization was predicted theoretically by I Freund (Bar-Ilan University, Israel) in 2005. Such a field was obtained using so-called q-plates, i.e., devices built around liquid crystals modifying the polarization of light in a space-variant fashion. On passing through a q-plate, the light acquired orbital angular momentum, and a light field emerged at the output with circular polarization at the center of the beam cross section and linear polarization with a varying direction of polarization vector at the periphery. After beam focusing by a microscope objective, the longitudinal polarization component occurred outside the focal plane, and a 3D polarization distribution appeared in the form of a Möbius strip with three or five half-turns. This field structure was revealed from light scattering by a gold nanoparticle moving in the microscope focal plane (the 3D nanotomography of optical vector fields). Light fields with a Möbius polarization structure can find applications in the creation of unique micro- and nanodevices and in the production of new types of metamaterials.

Source: *Science* **347** 964 (2015)
http://dx.doi.org/10.1126/science.1260635

3. Magnetic field generation due to Weibel instability

An experiment has been performed by C M Huntington et al. at the University of Rochester (USA) on the Omega Laser Facility demonstrating magnetic field generation in collisionless oppositely directed plasma streams as a result of developing filamentation instability (Weibel instability). Oppositely directed plasma streams were produced by high-power laser heating and evaporation of the substance of two plastic discs. The observations were carried out using an intense proton flux created in nuclear fusion reactions upon laser heating and implosion of a $\mathrm{D}-{}^3\mathrm{He}$-filled container. This proton beam directly imaged the area of mutual penetration of plasma counter streams, and the magnetic field distribution was detected from the declination of proton trajectories. This distribution manifested a clearly pronounced filamentation corresponding to the development of Weibel instability with exponential field strengthening, as well as additional magnetic fields occurring by the Biermann battery mechanism upon disc evaporation. Weibel instability resulted in a convergence of several percent of plasma stream energy into magnetic field energy, even in the absence of seed fields. Analogous magnetic field generation processes can take place in shock waves from supernovae or from sources of cosmic gamma-ray bursts.

Source: *Nature Physics* **11** 173 (2015)
http://dx.doi.org/10.1038/nphys3178

4. Gamma-ray halo around Andromeda Nebula

Gas halos existing around galaxies are observed by X-ray gas emission and some other effects. In particular, the gas halo around galaxy M31 — the closest large spiral galaxy — was registered by the characteristic features in the UV spectrum of quasars in the line of sight and by the distortion of the relic radiation spectrum passing through the M31 halo. If sufficiently strong magnetic fields surround the galaxies, then extended galactic cosmic-ray (fast charged-particle) halos confined by the magnetic field must also exist. And in the interaction of galactic cosmic rays with rarefied gas, gamma rays must be generated in the halo. M S Pshirkov (SAI MSU, INR RAS, and Pushchino Radio Astronomy Observatory Astro Space Center of Lebedev Physical Institute), V V Vasiliev (Max Planck Institute for Astronomy), and K A Postnov (Sternberg Astronomical Institute

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MSU) have become the first to perform the search for such a gamma-ray halo around galaxy M31 on the basis of cosmic gamma-ray Fermi LAT data collected over 5.5 years. Extended gamma-ray emission field with a total luminosity of $(8.4 \pm 4.6) \times 10^{38}$ erg s^{-1} and the spectral index $\Gamma = 1.52 \pm 0.21$ was revealed in the energy range of 0.3–100 GeV within 3° (40 kpc) from the center of M31 at a 4.4σ confidence level. The existence of a gamma-ray halo proves that 10–100 nG must extend around the M31 galaxy up to distances of about 40 kpc.

Source: http://arXiv.org/abs/1501.03460

5. Relic gravitational waves

A possible detection by the BICEP2 telescope of a contribution to polarization of relic radiation from gravitational waves generated at the cosmological inflation stage was reported in 2014. However, cosmic dust clouds could account for a similar polarization pattern. A new joint analysis of the data performed by the BICEP2/Keck Array and Planck Collaborations has shown that the excess polarization signal revealed in 2014 can actually be exhaustively explained through the photon scattering by dust. BICEP2 performed observations at a frequency of 150 GHz, while Planck scanned the same sky area at a frequency of 353 GHz, at which the whole polarization signal is due to dust. The clear correlation of signals at different frequencies indicated that the BICEP2 signal must result from the same dust, and the restriction was imposed on the tensor-to-scalar mode ratio $r < 0.12$ at a confidence level of 95%. Therefore, the report on the discovery of the primary B mode of polarization and relic gravitational waves was untimely. More exact cosmic dust data are needed for their detection against the background.

Source: *Nature*, http://dx.doi.org/10.1038/nature.2015.16830
http://arXiv.org/abs/1502.00612

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