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1. Rare channel of single t-quark production

The CDF and DZero Collaborations (Fermi National Accelerator Laboratory, USA) have identified events of s-channel production of a single (but not free) t-quark in $p\bar{p}$ collisions. These t-quarks are most often produced in $t\bar{t}$ pairs in strong interactions, while rare events of single t-quark production in the s-channel are due to weak interactions, when two of the quarks entering into the composition of the colliding p and $\bar{p}$ transform into a W-boson, which then decays into t- and $\bar{b}$-quarks. The data gathered from 2001 to 2011 give 40 such events. With the precision currently attained, the measured single t-quark production cross section in the s-channel equals $1.36^{+0.37}_{-0.32}$ pb, which agrees with the cross section 1.05 ± 0.05 pb calculated within the Standard Model. In the 1960s (before quark confinement was revealed), Ya B Zeldovich and his colleagues analyzed various astrophysical and physico-chemical aspects of the hypothesis of free quark existence; see *Sov. Phys. Usp.* **8** 702 (1966); *Usp. Fiz. Nauk* **87** 113 (1965).

Sources: http://arXiv.org/abs/1402.3756
http://www.fnal.gov/pub/presspass/press_releases/2014/Top-Quark-Puzzle-20140224.html

2. Neutrino oscillations in terrestrial matter

Data on the influence of terrestrial matter on neutrino (ν) oscillations by the Mikheyev–Smirnov–Wolfenstein mechanism were first obtained using the Super-Kamiokande neutrino observatory (Japan). The ν oscillations, i.e., the transformation of one type of ν to another, are due to the difference in their flavor and mass states. The oscillations of noninteracting ν may be caused by a time-dependent change in the phase difference of states. These are called vacuum oscillations. But ν_e oscillations can be amplified resonantly in interaction with charged particles in a substance (the Mikheyev–Smirnov–Wolfenstein effect). Approximately half of the ν_e produced in nuclear reactions in the Sun reach Earth, and the rest of the ν_e transform on the way into ν_μ and ν_τ. Part of these ν_μ and ν_τ oscillate back to ν_e when passing through the depths of Earth at night, which was just recorded by the Super-Kamiokande detector at a confidence level of 2.7σ. According to the data accumulated over 18 years of observations, the detector registered at night by 3.2 ± 1.1 (stat) ± 0.5 (syst)% more ν_e than in the daytime. In other experiments, including those with atmospheric ν, the influence of terrestrial matter on neutrino oscillations has not yet been distinguished.

Source: *Phys. Rev. Lett.* **112** 091805 (2014)
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3. Possible registration of relic gravitational waves

Data on the influence of relic gravitational waves on the microwave background radiation anisotropy were first obtained with the BICEP2 (Background Imaging of Cosmic Extragalactic Polarization) radio telescope at the South Pole in Antarctica. An array of 512 superconducting detectors was operated for three seasons in 2010–2012 to observe a celestial area of 380 sq deg at a frequency of 150 GHz. Gravitational waves have not yet been registered straightforwardly, but BICEP2 revealed their indirect influence on relic radiation polarization. This influence showed up in the epoch of recombination when the Universe's age was 380 thousand years. In the range of multipoles with $l = 30 - 150$, BICEP2 registered at a confidence level of 5.9σ an excess of B-mode polarization which could not be caused by the effect of gravitational lensing or by other sources, but is most likely due to gravitational waves. The ratio of the tensor perturbation mode to the scalar one was determined to be $r = 0.20^{+0.07}_{-0.05}$, which somewhat exceeds the upper limit obtained earlier with other telescopes. The existence of relic gravitational waves was predicted by the inflation model of the early Universe based on the idea of its rapid exponential expansion in very early cosmological epochs. Gravitational waves are generated at the inflation stage simultaneously with curvature disturbances from quantum fluctuations. The discovery of relic gravitational waves is a serious argument in favor of the inflation theory, but independent confirmations will make the results more reliable.

Source: http://arXiv.org/abs/1403.3985

4. Cobalt from supernova outburst

Researchers of the RAS Institute of Space Research (Moscow) and the Max Plank Institute for Astrophysics (Germany) E M Churazov, R A Sunyaev, and S A Grebnev, and their colleagues from other countries have carried out observations on the gamma spectrometer SPI mounted aboard the orbital observatory INTEGRAL and registered (at 847 keV) the spectral line of the decay of radioactive ^{56}Co nuclei produced upon the explosion of type Ia supernova SN 2014J in galaxy M82. Cobalt lines have already been registered upon explosions of collapsing supernovae (for example, supernova SN 1987A), but this line for type Ia supernovae has been observed for the first time. Type Ia supernovae are generally thought to originate from thermonuclear explosions of stars — white dwarfs in close binary systems during gas flow from a companion star onto a white dwarf or upon the coalescence of two white dwarfs. The exploration of SN 2014J using INTEGRAL was undertaken 46–63 days after the outburst. The observational data confirmed the expectations of scientists that the photon yield from radioactive ^{56}Co decay must begin at precisely this time interval. An estimate was obtained showing that ^{56}Ni in the amount of about 70% of the solar mass was synthesized in the explosion, and then ^{56}Ni nuclei decayed into ^{56}Co. Observation of the cobalt decay line is important for refinement of the supernova models and studying nucleosynthesis processes in the Universe.

Source: http://www.astronomerstelegram.org/?read = 5992
http://press.cosmos.ru/vpervye-zaregistrirovan-sintez-kobalta-56-pri-vspyshke-sverhnovoy-tipa-ia

5. Galactic tendrils in voids

Examining the correlation of galaxies in the GAMA (Galaxy and Mass Assembly) survey, M Alpaslan (University of St. Andreas, Great Britain and the University of Western Australia) and his colleagues discovered in voids a new type of large-scale structures, namely, tendrils consisting of several galaxies. Earlier, only lone galaxies were observed in voids, i.e., in regions with a lowered concentration of galaxies between superclusters. The tendrils of galaxies originate at a filament and terminate at another filament or in empty space in a void. They contain up to six galaxies and are of about 14 kpc long. The tendrils discovered are fairly numerous, and their constituent galaxies may contain up to a quarter of the entire stellar baryon matter. The tendrils differ morphologically from the filaments (giant structures containing galaxies and galactic clusters) in that they possess a much lower mean density. The presence of plane and elongated structures in the distribution of galaxies was predicted in the theoretical work of Ya B Zeldovich and his colleagues and have been, on the whole, confirmed by astronomical observations. The galactic tendrils discovered represent a new, previously unknown type of large-scale structures.

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