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Physics news on the Internet (based on electronic preprints)

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1. Possible observation of the Higgs boson

The ATLAS and CMS Collaborations (CERN) have presented the refined LHC data supporting the discovery of a particle whose properties correspond to predictions for the Higgs boson. The Higgs boson constitutes a quantum of the Higgs field which imparts mass to particles in the process of the spontaneous breaking of gauge symmetry. The detection of the Higgs boson would bring to completion the experimental confirmation of the Standard Model of elementary particles, in which only the Higgs boson remained unconfirmed among all the theoretically predicted particles. The confidence level of the discovery of the new short-lived particle-boson — which may indeed prove to be the missing Higgs boson — is about 5σ at the mass of 125–126 GeV/c^2; the data in various decay channels are in good agreement between themselves. Even though the confidence level of confirmation is sufficient for announcing a discovery, it cannot be excluded that, as new data is stored and processed, some correction may become necessary.

Source: http://press.web.cern.ch/press/PressReleases/Releases2012/PR17.12E.html

2. M-modification of carbon

An experiment conducted by Y Wang (Yale University, USA) and his colleagues has confirmed that cold compression at room temperature transforms graphite into crystalline M-carbon modification, whose existence was predicted in 2006. This transition is due to the destruction of π bonds between atoms and the formation of new σ bonds. The work employed X-ray diffraction technique and Raman spectroscopy. Such structural changes in carbon in the course of cold compression had been observed previously, but it was impossible to establish which specific modification of carbon had been emerged. Theoretical calculations predicted about a dozen possible outcomes. The structural transition in the new experiment occurred at 19.2 GPa, and the relaxation to the new state lasted for several hours. According to the totality of the data obtained, the compression created M-carbon, while all other suggested modifications are ruled out. In contrast to diamond, the synthesis of M-carbon requires compression only: heating is not needed; notice that the hardness of the M-carbon thus obtained compares well with that of diamond.

Source: *Scientific Reports* **2** 520 (2012) http://dx.doi.org/10.1038/srep00520

3. Giant spin Seebeck effect

The phenomenon known as the spin Seebeck effect [discovered in 2008 by researchers from Tohoku University (Japan)] consists in the presence of a temperature gradient causing spin current. Previously, this effect was observed only in materials with magnetic ordering (ferromagnets, semiconductors, and insulators). In the new experiment, C M Jaworski (Ohio State University) and his colleagues observed a spin Seebeck effect of very large magnitude in a nonmagnetic material. The measurements were performed at temperatures from 2–20 K in a 3-T magnetic field on a semiconducting InSb specimen doped with tellurium atoms. The Seebeck effect in InSb is three orders of magnitude (8 mV K^-1) greater than in other known materials; hence, it was given the name 'giant spin Seebeck effect'. The authors of the experiment believe that the effect is so large because electron–phonon interactions enhance the spin–orbit interaction between electrons. The observed effect may lead to the creation of efficient thermoelectric generators.

Source: *Nature* **487** 210 (2012) http://dx.doi.org/10.1038/naturell221

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4. Superconducting parametric amplifier

Precision measurements require good amplifiers of electric signals. Alas, transistor amplifiers, even cryogenic ones, are characterized by significant intrinsic noise, while the dynamic range and bandwidth of those parametric amplifiers designed to date have been too narrow. Researchers at the California Institute of Technology and NASA Jet Propulsion Laboratory constructed a new superconductor-based parametric amplifier in which all these shortcomings have been largely eliminated. Amplification is produced in a nonlinear kinetic inductor in the superconducting transmission line. This nonlinearity arises as current approaches the critical value, as predicted in both the Ginzburg–Landau and the BCS theories. The amplifier design is based on a superconducting 0.8-m long NbTiN helix through which a mixture of the pump signal and the signal to be amplified is passed. Nonlinearity produces an additional phase shift, which results in parametric amplification. The gain in the frequency range from 8–14 GHz reaches 20 dB, while the noise level measures only 3.4 photons, which is close to the quantum limit due to zero point fluctuations. The operating frequencies of amplifiers built using this concept may in the future reach ~ 1 THz. The amplifier was designed primarily to boost very weak signals in radio astronomy, but may find applications in quantum mechanics experiments owing to its ultimately low noise.

Source: *Nature Physics* **8** 623 (2012). http://dx.doi.org/10.1038/nphys2356

5. Dark galaxies

Direct observations of small dark galaxies for redshifts $z > 2$ have been carried out for the first time using the 8.2-meter VLT telescope of the European Southern Observatory in Chile. Their masses are $\sim 10^9 M_\odot$ and they mostly consist of dark matter and gas with a small number of stars. In the past, only indirect evidence of their existence was detected in absorption lines in the spectra of quasars. New observations using the VLT recorded fluorescent Ly_α-gas emission in twelve such galaxies. The emission is caused by the radiation from the quasar HE 0109-3518 at redshift $z = 2.4$. The quasar illuminates nearby galaxies and the gas contained in them re-emits the incident light in the fluorescence process. To isolate this weak signal against the noisy background, a frequency filter with a narrow transmission band was used. The rate of star formation in these galaxies is about 100 times slower than in typical galaxies of the same era.

Source: http://arXiv.org/abs/1204.5753

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