 

PACS number: **01.90. + g**

# Physics news on the Internet (based on electronic preprints)

DOI: 10.3367/UFNe.0181.201102b.0150

## 1. Asymmetry in $t\bar{t}$ pairs

The CDF Collaboration at the Tevatron Accelerator of the Fermi National Accelerator Laboratory (Batavia) measured the spatial asymmetry of the inclusive forward–backward production of quark–antiquark $t\bar{t}$ pairs in $p\bar{p}$ collisions. This asymmetry arises because the positive charge of the proton repels the t quark and attracts the $\bar{t}$ quark, with the result that the t quark and the jets of particles it produces are ejected with higher probability in the direction of motion of $p$. So far, a sample of 1260 events have been analyzed in which at least one of the t or $\bar{t}$ quarks has undergone a semilepton decay of the $t \to l\nu b$ type, while the second quark decayed through the hadron channel $t \to q\bar{q}'b$. In the rest frame of the $t\bar{t}$ pair, the asymmetry depends on pseudorapidity $\eta$ and invariant mass $M_{t\bar{t}}$. For $M_{t\bar{t}} > 450$ GeV$/c^2$, the measured asymmetry comprised $48 \pm 11\%$, while taking into account the first correction in the Standard Model gives $8 \pm 1\%$, i.e., the statistical significance of the difference is $3.4\sigma$, and the asymmetry agrees with the predicted value at smaller $M_{t\bar{t}}$. These measurements are important for testing theoretical predictions and searching for new effects, such as exotic heavy resonances which, according to some hypotheses, may contribute to asymmetry.

Source: http://arXiv.Org/abs/l 101.0034vl

## 2. Trions in carbon nanotubes

Researchers at Kyoto University (Japan) R Matsunaga, K Matsuda, and Y Kanemitsu have for the first time produced and observed trion quasiparticles in hole-doped carbon nanotubes. Trions (also known as charged excitons) constitute three-particle bound states consisting of one electron and two holes (electron vacancies). Trions have been observed at room temperature by optically exciting p-doped nanotubes and recording their absorption spectra and photoluminescence. The energy of the spectral peaks corresponding to trions appears far below than that of bright excitons by 0.1–0.2 eV. The considerable difference between peak energies may be caused by strong electron–hole exchange interaction in carbon nanotubes. Trions had been observed earlier in several other systems. The distinguishing feature of trions is that they carry a charge and therefore can be controlled by electric fields; consequently, this property may in the future make them useful for nanotube-based spintronic devices.

Source: *Phys. Rev. Lett.* **106** 037404 (2011)
http://dx.doi.org/10.1103/PhysRevLett.106.037404

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DOI: 10.3367/UFNr.0181.201102b.0150
Translated by V I Kisin

## 3. Symmetry of the Möbius strip in metamaterials

A group of researchers at the University of California led by X Zhang developed a metamaterial whose electromagnetic properties manifest the topological $C_3$ symmetry of the Möbius strip, which has no analogs in natural materials. The metamaterial was produced using standard electron-beam lithography techniques. It constitutes an array of meta-atoms forming trimers composed of metallic segments. The number of 'Möbius twists' corresponds to the number of sign changes in the interaction between a meta-atom and its neighbors under 360° rotation, which is determined by a segment configuration. The spectrum of radiation transmitted through the metamaterial was studied using infrared spectrometry. The topological nature of the obtained resonances (i.e., dips in the spectrum) is confirmed by the fact that the resonant frequencies predominantly depend only on the number of 'twists' and are less sensitive to other characteristics of meta-atoms.

Source: *Phys. Rev. Lett.* **105** 235501 (2010)
http://dx.doi.org/10.1103/PhysRevLett.105.235501

## 4. Friction on a superconductor

M Kisiel and his colleagues studied the contribution of electronic and phononic excitations to the effect of non-contact friction between a micromechanical probe (cantilever) and superconducting film at temperatures close to $T_c$. The researchers examined the effect of friction on cantilever vibrations in a vacuum at a distance of approximately 0.5 nm from the niobium film. As the film cooled to below $T_c$, the friction coefficient decreased by a factor of about three. This is an indication that electronic friction dominates in the metallic state, and that phononic friction begins to dominate after the transition to the superconducting state, because electrons form Cooper pairs and thus cease to take part in friction. The relation between the friction coefficient and distance to the film and between the friction coefficient and the potential difference between specimens as observed in the experiment are in good agreement with the theoretical curve.

Source: *Nature Materials* **10** 119 (2011)
http://dx.doi.org/10.1038/nmat2936

## 5. Results of Planck telescope observations

Observational data obtained by the European Space Agency's Planck satellite since mid-2009 have been presented. The space telescope was placed at the Lagrange point L2 at a distance of 1.5 million km from Earth. It is an array of 74 detectors operating at frequencies from 25 to 1000 GHz, i.e., at the boundary between the IR and radio bands. The spectrum of perturbations of the microwave radiation was measured in the IR band for multipoles $l = 200 - 2000$. The statistical characteristics of anisotropy are identical at frequencies from at least 217 to 857 GHz. A catalog of compact and unresolved objects was also compiled; it includes thousands of relatively cold individual sources. The population of remote galaxies was analyzed, in which intense star formation is proceeding at a rate exceeding the current star formation rate in our Galaxy by a factor of 100 to 1000. The observation of these galaxies in other bands meets with difficulties because their emission is absorbed by dust clouds. In order to record the microwave background and individual objects it is of paramount importance to carefully filter out the diffuse background radiation emitted in the Galaxy in collisions of atoms and photons with interstellar dust; consequently, this dust also became one of the main subjects of study. According to the data of the Planck telescope, dust particles in gas–dust clouds rapidly revolve due to collisions with atoms of gases and UV photons; their rotation generates anomalous microwave radiation in the range of $\sim 10 - 60$ GHz. Cold gas–dust clumps in the Galaxy at a temperature of 7–17 K and mass of $(1 - 10^5) M_\odot$ were studied. These clumps are distributed in the shape of filaments associated with molecular clouds; with time, new stars will start forming in many of them. Considerable success was achieved in studying galaxy formation by following the Sunyaev–Zeldovich effect. The Sunyaev–Zeldovich signal was measured for 169 clusters, of which 20 were identified for the first time. Power formula dependence was confirmed for the Sunyaev–Zeldovich effect as a function of richness (the number of galaxies) of clusters. The Planck data were compared with the observation of clusters in the X-ray band from the XMM-Newton X-ray observatory and good agreement was found with theoretical predictions based on dynamic models of clusters. The Planck and XMM-Newton telescopes discovered a supecluster of galaxies at redshift $z = 0.45$ — a rather unexpected result.

Sources: http://arXiv.org/abs/1101.2022
http://www.esa.int/SPECIALS/Planck/SEMK4D3SNIG_0.html

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