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1. 'Phonon tunneling'

I Altfeder and his colleagues at the AFRL Laboratory (Ohio, USA) used inelastic electron tunneling spectroscopy to investigate the heat transfer effect from the tip of a scanning tunneling microscope (with a CO molecule attached to the tip apex) to an Au(111) film across the vacuum gap a few angstroms wide. The lock-in potential and second derivative of electric current between the tip and the film due to electron thermal emission were measured at three film temperatures: 90, 150, and 210 K, which made it possible to calculate the phonon concentration and temperature at the tip apex. It was found that the last tip atom equilibrates its temperature, which initially was 275 K, with that of the gold film surface, i.e., efficient heat transfer was taking place. This effect is explained in terms of the thermal energy transfer across the vacuum gap via electromagnetic interaction between the CO molecule and its electrical image. The image, i.e., the redistribution of surface electrons compensating for the electric fields in the bulk of the metal, oscillated synchronously with the thermal vibrations of the molecule itself, and excited phonons in the gold film. The efficiency of this mechanism of heat transfer under experimental conditions proved to be ten orders of magnitude higher than the efficiency of radiant heat transfer. The authors called the above effect the 'phonon tunneling effect', although it is not directly connected with the phenomenon of quantum tunneling.

Source: *Phys. Rev. Lett.* **105** 166101 (2010)
http://dx.doi.org/10.1103/PhysRevLett.105.166101

2. Rotation of graphene flakes in an ion trap

B E Kane (University of Maryland, USA) carried out an experiment in which he observed a record-fast rotation frequency of a macroscopic trapped object (graphene flake) caused by a circularly polarized light wave. Micron-sized charged specimens (multilayer flakes) were injected into a quadrupole ion trap using electrospray ionization (ionization by spraying in an electric field) technique and kept in a state of levitation in the potential of an oscillating electric field. Absorption of light transferred some angular momentum to the samples, and they started rotating at a frequency of about 1 MHz. The high strength of graphene protected the samples from destruction by centrifugal forces, while electrostatic repulsion kept the flakes of levitating graphene nearly flat. The rotation frequency was measured using an AC electric field: when the field went out of resonance, this caused the specimen to tilt with respect to the rotation axis, which affected the reflected light. The effect of levitation in the ion trap opens new possibilities for studying mechanical and electronic properties of graphene since in this case there is no need for a special substrate which would distort its electronic properties.

Source: http://arXiv.org/abs/1006.3774

3. Magnetic field of a light wave in a nanocavity

M Burresi [FOM Institute for Atomic and Molecular Physics (AMOLF), The Netherlands] and his colleagues have developed a new technique for recording the magnetic field of light in photonic crystal nanocavities. In a photonic crystal fabricated as a two-dimensional array of holes in a silicon membrane, a smooth area left with three holes unpunched served as a nanocavity. The beam of a semiconductor laser was sent into the cavity through a waveguide — a row of unpunched holes. A near-field aperture metal nanoprobe was placed at a distance of 20 nm from the membrane surface, i.e., in the near field of the light wave. If the metallic ringlike aperture of the probe was placed over the antinode of the magnetic field, a shift of resonance was observed towards shorter wavelengths. This blueshift is caused by inducing ring currents in the nanoprobe, which generate a magnetic field opposite the field of the light wave, and this reduces the effective size of the cavity and, hence, reduces the resonance wavelength. Up to now, only the effect of an electric component of electromagnetic waves on matter was observed at optical frequencies above several THz, but in this experiment the effect of the electric field is small because its node lies within the magnetic field antinode.

Source: *Phys. Rev. Lett.* **105** 123901 (2010)
http://dx.doi.org/10.1103/PhysRevLett.105.123901

4. Fractal dynamics of seismic microvibrations

Vladimir Shiltsev (Fermi National Accelerator Laboratory, Batavia, USA) presented new generalized results of studying seismic microvibrations. His analysis encompassed data gathered from 15 accelerator facilities including Tevatron, LEP, and other accelerators. Work of this type, covering results of micron-resolution measurements of the ground motions in large particle accelerators with hydrostatic and laser level meters, is conducted at accelerators because ground vibrations cause a shifting of focusing magnets and other elements of accelerators relative to one another. Without special corrective devices, this would seriously distort the beam trajectory — by 0.2–0.3 mm per day. After subtracting the periodic tidal oscillations and slow shifts due to seasonal variations of temperature, we are left with stochastic microvibrations from a large number of sources; not all of them have been identified. However, the averaged properties of this background obey a simple diffusion type relationship: namely, the mean square of the relative displacement dY of two points (ground elements) separated by a distance L and measurement time T is $\langle dY^2 \rangle \approx ATL$, where the site-dependent constant $A \sim 10^{-5\pm1}$ μm^2 s^{-1} m^{-1}; the mean

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relative displacement in the vertical plane exceeds that in the horizontal plane by approximately 20%. This empirical expression holds with good accuracy at a distance L from a few meters to several dozen kilometers, and time intervals T from minutes to several years. The dependence $\langle dY^2 \rangle \approx ATL$ was first proposed in early 1990s by V V Parkhomchuk (G I Budker Institute of Nuclear Physics, Novosibirsk) and his coworkers. According to Shiltsev's theoretical predictions, this dependence is a consequence of the fractal dynamics of the cascade of geological blocks over different scales. The results of such studies are important, in particular, for designing future linear accelerators.

Source: *Phys. Rev. Lett.* **104** 238501 (2010)
http://dx.doi.org/10.1103/PhysRevLett.104.238501

5. Origin of the Magellanic Stream

The Large and Small Magellanic Clouds — a closest known interacting pair of dwarf galaxies, satellites of the Milky Way — are trailed by a stream of neutral gaseous hydrogen (the Magellanic Stream). Its age is 1 to 2 billion years and it spans for at least 150° across the sky. It was assumed that this stream was produced as a result of 'stripping' of outer gas layers of the satellites by gravitational tidal forces of the Galaxy and/or through interaction between gas envelopes of the Galaxy and its satellites. The probable trajectory of motion of the Magellanic Clouds in the galactic halo has recently been clarified with the Hubble Space Telescope: satellite galaxies either approach the Galaxy for the first time, not having completed even a single revolution, or travel in a very elongated orbit with a period of more than 6 billion years. In both cases, the above mechanisms of stream formation have to be rejected. G Besla (Harvard-Smithsonian Center for Astrophysics, Cambridge, USA) and her colleagues developed an alternative theory. According to their formation mechanisms, the gas plume was pulled out the Small Magellanic Cloud by the tidal gravitational field of the Large Magellanic Cloud even before the infall onto the Galaxy. Then the gas plume stretched and the Magellanic Clouds moved a long distance away from each other. The fact that the satellites previously formed a binary coupled system is confirmed by the presence of a low-metallicity bridge of gas (referred to as the Magellanic Bridge) and a common gas envelope. Numerical simulation by G Besla et al. identified a configuration of mutual orbits of the Magellanic Clouds and the direction of their infall onto the Galaxy, which reproduce the observed astronomical picture with a good accuracy.

Source: http://arXiv.org/abs/1008.2210v1

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