Physics News Update

The AIP Bulletin of Physics News

Number 697, August 19, 2004 by Phil Schewe and Ben Stein

Newly Created Antihydrogen Atoms

Newly created antihydrogen atoms have been caught speeding for the first time. Owing to the vast preponderance of ordinary matter over antimatter in the visible universe, and the propensity of any antimatter around to annihilate hastily with any conventional particulate matter in the vicinity, the only place anti-atoms exist on Earth for more than a microsecond is in a chambered vault at the CERN Antiproton Decelerator (AD) lab in Geneva. There, antiprotons created artificially in high-energy proton collisions and anti-electrons (positrons) from a radioactive source are cooled and brought together in a bratwurst-sized vessel filled with electrodes at various voltages. By careful husbandry (first of all, the antiprotons have to be slowed by a factor of 10 billion, from an energy of 5 MeV to .3 meV) anti-hydrogen (or H-bar) atoms are made from antiprotons and positrons.

Although the anti-h's haven't yet been definitely fixed in space or produced in their lowest quantum state (which is what you need to do laser spectroscopy), there are still other studies that can be made on these very rare atoms as they mill about. (For some previous CERN anti-H results see Update 605 and Update 611.) One thing that can be done is to measure the speeds of the anti-atoms by seeing how many of them emerge from a region of oscillating electric fields without being ionized. The ATRAP collaboration, one of the CERN H-bar groups, has done exactly this. They have determined that the anti-atoms are moving with an average energy of 200 meV, which corresponds to a velocity only about 20 times that of the thermal speed of an equivalent sample of atoms kept at a temperature of 4.2 K. This is still too warm for the purpose of holding the anti-atoms in a trap, but the researchers suspect that their current crop of anti-atoms contains some with much lower velocities and that there will be a way to cull an ever colder allotment in the future now that there is a speedometer for antihydrogen atoms. (Gabrielse et al., Physical Review Letters, 13 August; gabrielse@physics.harvard.edu, 33-450-28-38-95.)

Why are Seacoasts Fractal?

In a famous paper written decades ago, Benoit Mandelbrot asked how long the coastline of Britain really was. The answer depends on what kind of meter stick you use. The closer one looks at any scale of a rocky coast map, from well above the 100 kilometer level to the kilometer level, and so on to the meter level, the more indented and lengthy the "coastline" becomes. Not only that, but the coast's underlying geometry seems be fractal, meaning that it is extremely fractured and also self-similar: the shape looks, in a statistical sense, the same at all levels of magnification.

Now, scientists in France have inquired into the physical processes that actually could carve out a fractal coast. Their simulation of a rocky coast evolution depends on an iteration of erosion action. First, waves are allowed to erode the weak points in a smooth shoreline. This makes the shore irregularly indented and longer. This erosion exposes new weak points, but at the same time mitigates the force of the sea by increasing the wave damping. These steps are then repeated over and over. The resultant coast is fractal, with an effective dimension of 4/3.

According to Bernard Sapoval and A. Baldassarri of the Ecole Polytechnique (Palaiseau, France) and their colleague A. Gabrielli of the "Enrico Fermi" Center (Rome), this new study provides the first suggestion of how a fractal shoreline comes about. (Sapoval et al., Physical Review Letters, upcoming; bernard.sapoval@polytechnique.fr, 33-169334172.)

Nanotube Dynamos

Two scientists in India have produced a tiny voltage in a small electrical circuit by blowing gas across a mat of carbon nanotubes and doped semiconductors. This result arises from two physical effects.

First, in the Bernoulli effect, gas rushing past a surface produces pressure differences along streamlines, which in turn can produce a temperature gradient along a material sample.

Second, in the Seebeck effect, a temperature gradient (the far ends of the material being at different temperatures) can generate a voltage difference across the sample.

In the experiment of Professor Ajay.K. Sood and his graduate student Shankar Ghosh at the Indian Institute of Science (Bangalore) gas is blown over a mat of carbon nanotubes as well as doped silicon and germanium. With a small sliver of germanium as a sample, a voltage difference of 650 micro-volts was generated. The power flow amounted to 43 nano-watts.

This doesn't sound like much power, and the researchers have not yet determined whether the effect could be scaled up (a no-moving-parts carbon nanotube/doped-semiconductor generator of electricity), but one definite near-term application would be in a new type of gas flow velocity sensor for research in problems of turbulence or aerodynamics.

Compressed air was used to produce the tiny amount of electricity, but even human breath blown at the inclined sample produced a measurable result of several micro-volts. (Sood and Ghosh, Physical Review Letters, 20 August 2004; asood@physics.iisc.ernet.in, shankar@physics.iisc.ernet.in.)

Back to Physics News Update