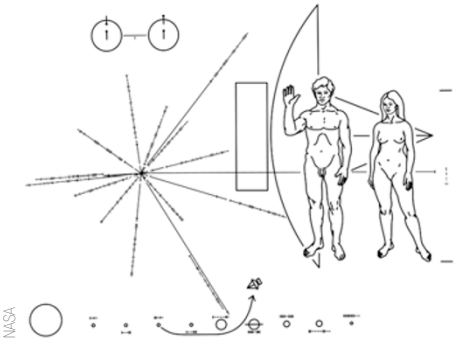
Pioneer possibility



Phys. Rev. D **76,** 042005 (2007)
The 'Pioneer anomaly' is still there. Thirty-five years after the launch of the spacecraft, and billions of miles later, the strange deceleration of both Pioneer 10 and Pioneer 11 remains unaccounted for. The explanation may yet prove mundane — gas leaks or thermal effects, perhaps — but the possibility of new physics has not been ruled out.

A gravitational source in the outer Solar System has been debated: some consider that our relatively poor knowledge of the orbits of the outer planets (Uranus, Neptune and Pluto) allows the possibility of such a source, which influences the Pioneers; others do not. Kjell Tangen now wonders about the impact of non-geodesic motion — an outer-Solar-System gravitational source, or long-range deviations in the gravitational field, could make sense if the Pioneers' flights are not geodesic, as usually assumed.

As the detailed re-analysis of the Pioneer data continues, the debate rolls on. Meanwhile, the Pioneers, each bearing a 'message' (pictured) from Earth, travel ever onwards.

Flipping conduction

Phys. Rev. Lett. **99,** 094503 (2007)
Common sense suggests that when insulating particles are added to a poorly conducting liquid, the conductivity of the suspension should decrease — owing to the obstacle that the particles present to the free movement of ions. Indeed, the reliability of impedance-based techniques used in the analysis of a variety of complex materials, from soil to human tissue, depends on this assumption. Yet, according to a study by Nicolas Pannacci and colleagues, common sense could be wrong.

At sufficiently high fields, the collision of mobile ions with particles can cause the particles to become electrically polarized, with positive charges accumulating on one side and negative charges on the other. Given the correct material conditions, this accumulation can cause the particles to spontaneously rotate — a phenome non known as Quincke rotation — providing a more efficient basis for transporting charges from one place to another than by unencumbered diffusion alone, increasing the conductivity to greater than that of the pure liquid.

Heat harvest

Appl. Phys. Lett. **91,** 093508 (2007)
Advances in the energy efficiency of low-power electronic devices suggest the possibility that these devices could be powered by heat alone. The most common systems for doing so are based on thermoelectric materials, which generate a voltage in response to a temperature gradient by the so-called Seebeck effect. To work effectively, however, these devices require large gradients, and even then they do not get close to the thermodynamic limit for the maximum power that can be generated from a given heat flow.

Motoki Ujihara and colleagues propose a device that takes a radically different approach. Their device uses a soft magnet, wedged between two leaf springs, that expands and contracts dramatically as it undergoes a second order phase transition, which causes it to move back and forth between hot and cold reservoirs. The authors suggest that by converting the mechanical energy produced to electricity using conventional piezoelectric materials, they should be able to harvest heat with a performance similar to commercial thermoelectrics.

What a molecule

Nature **449,** 195–197 (2007)
Name a molecule made from four particles of the same mass. The answer, 'di-positronium' (Ps_2). In his 1946 paper "Polyelectrons", John Wheeler speculated about the possibility of combining two Ps atoms — each consisting of an electron and a positron — but only now have such molecules been produced, a feat reported by David Cassidy and Allen Mills.

Cassidy and Mills start with trapped positrons, which they implant in a porous silica film; about 10% of the positrons capture an electron to form Ps. The Ps atoms then diffuse through the film and, during their 60-ns lifetime, they visit some 10,000 pores, giving a 10% probability that two Ps atoms meet. When they do so, the silica walls act as the required third body (for momentum conservation) for a Ps_2 molecule to form.

The authors have produced about 100,000 Ps_2 molecules in their experiments. Using more intense positron sources, they hope to achieve the Ps densities at which Bose–Einstein condensation is predicted

Fluctuations of cosmic proportions

Astrophys. J. **667,** L1–L4 (2007)
Above the Earth's atmosphere, space plays host to much gamma-ray traffic. The many sources of high-energy photons both within our galaxy and beyond complicate attempts to determine the origin of the uniform cosmic gamma-ray background that has been known since the 1970s. Viable sources include photons from the cosmic microwave background that have been accelerated through collisions (inverse Compton scattering) with cosmic-ray electrons — themselves accelerated within structure shocks around galaxy clusters; and blazars, which are energetic active galactic nuclei that have supermassive black holes as engines. To further complicate matters, blazars are highly variable and, despite being compact, are hard to resolve because they are so distant.

To discriminate between the two gamma-ray sources, Francesco Miniati and co-workers model fluctuations in their angular intensity. The calculated power spectra show different levels of fluctuations that should resolved by the Large Area Telescope on board the space telescope GLAST, due to launch in 2008. Moreover, observations using GLAST (pictured during assembly) will help distinguish galactic from extragalactic gamma-rays and perhaps detect new gamma-ray sources.