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Electron beam reveals lower speed for magnetic switching

Researchers at the Stanford Synchrotron Radiation Laboratory (SSRL) have found that the ultimate speed of magnetic switching is at least 1000 times slower than previously expected – a result that has implications for future hard-disk computer-drive technologies.

“Smaller and faster” are the standard goals in computing, and magnetic recording is no exception. However, a physical speed limit has always been expected – a threshold above which the magnetic domains defining the “1”s and “0”s become unstable. In “precessional switching” these logical bits are recorded when the magnetic field associated with the “write” pulse current reaches a certain value. At the SSRL the linac’s electron beam creates some of the world’s briefest magnetic pulses, only 2 ps long, which have been used to investigate whether switching remains stable with such short pulses and, hence, at fast recording times.

The team fired up to seven electron bunches

in a row through samples of magnetic recording media. They expected to see dark and light concentric rings around the focus point of the beam, corresponding to grains magnetized in the two possible directions. Instead, the pictures showed all shades of grey, indicating that some grains had switched while others had not. With the help of theoretical physicist Alexander Kashuba of the Landau Institute for Theoretical Physics in Moscow, the team realized their data bore the signature of a chaotic system.

The pulse length of 2 ps suggests a speed limit of about 1 bit per picosecond, or 10^{12} bits per second, some 500 times faster than in modern computers (Tudosa *et al.* 2004). The challenge now is to understand why the maximum speed limit seems to be at least 1000 times lower than expected.

Further reading

I Tudosa *et al.* 2004 *Nature* **428** 831.

Positrons show new kind of chemistry

A long-standing puzzle in positron physics has been why positrons sometimes seem to annihilate faster in matter than naive calculations would predict. Now Cliff Surko at the University of San Diego has found that the increase in annihilation cross-section for very-low-energy positrons may be linked to their forming bound states with neutral atoms – and the consequence could be a whole new kind of chemistry.

In 1997 calculations by Jim Mitroy and Gregory Ryzhikh of what is now Charles Darwin

University in Australia had already predicted a bound state of neutral lithium and a positron. Other calculations suggest that the fact the Pauli principle is avoided for systems of an electron and a positron might make hydrogen–antihydrogen molecules lower in energy than hydrogen–hydrogen ones. Of course, none of these exotic molecules exist for long before the positrons annihilate, but the effect could make significant contributions to the low-energy positron annihilation rate in space.

Further reading

G Ryzhikh and J Mitroy 1997 *Phys. Rev. Lett.* **79** 4124.

E Samuel Reich 2004 *New Sci.* **182** 2444 p34.

The physics of cacti

Physics, as every physicist knows, is what ultimately determines the forms that living things take. Patrick Shipman and Alan Newell of the University of Arizona in Tucson have shown that some simple hypotheses about stresses in a growing cactus can lead to the spiral structures seen in plants such as cacti,

sunflowers and in pine cones. The main observation centres on minimization of strain energy by triplets of almost periodic deformations, which lead to the natural-looking plant shapes and even the Fibonacci numbers (1,2,3,5,8,...) you can count on the spirals of a pineapple.

Further reading

P Shipman and A Newell 2004 *Phys. Rev. Lett.* **92** 168102.

Spacecraft takes off for relativity tests

The long-awaited launch of Gravity Probe B, a satellite designed to provide two new tests of general relativity, took place on 20 April. Carrying four ultra-precise gyroscopes, the satellite should provide the first direct measurements of the geodetic effect and the frame-dragging effect. The geodetic effect is a change in the direction of the spin axis that occurs as the gyroscope follows the curvature of space–time near any massive object. The frame-dragging, or Lense–Thirring effect, first predicted in 1918, is caused by the Earth’s rotation effectively pulling space–time along with it as it turns.



The flight dewar for the Gravity Probe B satellite will maintain the experiment with its four ultra-precise gyroscopes at an operating temperature of 1.8 K.

During its mission, Gravity Probe B will monitor any drift in the gyroscopes’ spin axes alignment in relation to a guide star. The size of the frame-dragging effect is miniscule. In a polar orbit of 640 km, it should make the spin axis change by just over 40 milliarcseconds in one year; in the same time period, the geodetic effect will produce a relatively huge change of more than 6600 milliarcseconds. Gravity Probe B will measure the minute frame-dragging effect to a precision of 1% or better and the geodetic effect to one part in 10 000.

Further reading

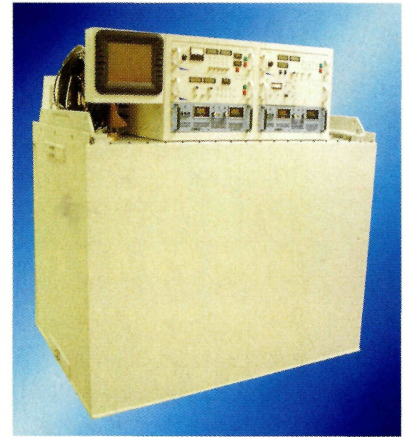
www.gravityprobeb.com.

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