physics update

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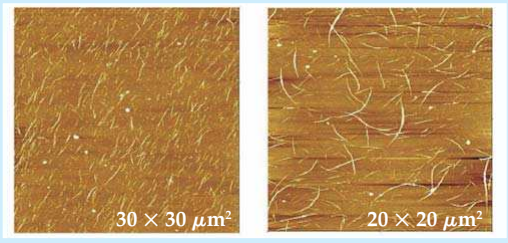
General relativity tested anew. The double pulsar system PSR J0737−3039A/B is unlike anything else observed in our galaxy. The binary's two members, called A and B for short, are radio pulsars that orbit in their mutual strong gravitational field. As a pair of cosmic clocks, the double pulsar offers unique opportunities to test general relativity and competing gravitational theories in the strong-field regime. In the latest of those tests, graduate student René Breton of McGill University and an international team determined the precession of B's spin axis around the binary system's total angular momentum. To do that, they measured the radio flux from A as it was periodically eclipsed by B. The data fit a model that included, among other parameters, the direction of B's spin axis and the opacity of the plasma surrounding B, where A's radio emission is absorbed. The deduced precession rate, about 5° per year with an uncertainty of about 13%, is consistent with the prediction of general relativity. Moreover, the precession rate can be related to a strong-field spin–orbit coupling not just for general relativity but for any Lagrangian-based theory of gravity whose action is unchanged by Lorentz boosts, rotations, and translations. Thus the new double-pulsar measurements determine a parameter that presents a test for generic alternatives to general relativity. (R. P. Breton et al., *Science* **321**, 104, 2008.) —SKB

Segregating nanotubes. Single-walled carbon nanotubes (SWNTs) are contending to augment or replace silicon as the semiconducting layer of the ever-shrinking field-effect transistor. However, SWNT synthesis produces a mixture of semiconducting and metallic nanotubes; the metallic ones cause transistors to short. Separation techniques, such as burning off or electrically shocking the metallic encroachers, are often multistep, unscalable processes. In a new technique, Zhenan Bao's group at Stanford University in collaboration with researchers at the Samsung Advanced Institute of Technology in South Korea, attach amine-terminated silane molecules to a silicon wafer's silicon dioxide surface layer. Then thin-film transistors



are made in a single step by spin-coating an SWNT solution onto the prepared wafer: Semiconducting nanotubes bind to the amine groups (left image), and metallic ones spin off. In a separate experiment, metallic nanotubes were shown to bind selectively with phenyl-terminated silane molecules on the SiO_2 dielectric surface (right image). Measurements between the source and drain of amine-modified SWNT transistors revealed high current flow when on and a leakage current in the pico-amp range. Atomic force microscopy also confirmed that spin-coating conditions can be tuned to control film density and nanotube alignment. The next move for the researchers is to pattern a complete microcircuit by positioning amine and phenyl groups on flexible or rigid substrates to form semiconducting transistor networks connected by metallic nanotube wires. (M. C. LeMieux et al., *Science* **321**, 101, 2008.)—JNAM

Nonexponential nuclear decay. Yuri Litvinov and coworkers at the GSI heavy-ion research institute in Darmstadt, Germany, have attracted much interest and puzzlement with their recent observation of sinusoidal modulation in the decay of two heavy nuclear species. The group produced single-electron ions of praseodymium-140 and promethium-142 and observed their decays over several minutes as the ions circled inside GSI's ion-storage ring. Recording K-capture decays, in which the lone remaining atomic electron is ingested and a neutrino spat out, the experimenters found that, for both ^{140}Pr and ^{142}Pm, the expected exponential decay curves exhibit seven-second modulations with amplitudes of 20%. Exponential decay is the hallmark of a system that doesn't know how old it is. But Eugene Wigner and Victor Weisskopf pointed out long ago that unstable quantum systems could exhibit departures from exponential decay at very early and late times. Litvinov and company tentatively attribute their observed oscillations to interference between two different neutrino mass eigenstates. If true, such relatively inexpensive nuclear-physics experiments could greatly ease a high-priority task in particle physics: determining the masses and mixing angles of the three distinct neutrino states. Theorist Harry Lipkin supports the GSI group's interpretation. He points out that the seven-second period is of the right order of magnitude for what's already known of the tiny neutrino-mass splitting. But an increasing number of theorists argue that the neutrino-interference explanation is not only wrong in detail; they claim it violates fundamental tenets of quantum mechanics. Theory aside, Paul Vetter and colleagues at Lawrence Berkeley National Laboratory report that they have failed to reproduce Litvinov's result. But the LBNL experiment was done with neutral atoms in a solid matrix, which, says Litvinov, complicates the simple two-body decay kinematics that renders the delicate effect visible. (Y. A. Litvinov et al., *Phys. Lett. B* **664**, 162, 2008; H. J. Lipkin, http://arxiv.org/abs/0801.1465; P. A. Vetter et al., http://arxiv.org/abs/0807.0649.) —BMS

Atomic tug of war. When an atom collides with a molecule, the two can recoil off each other like billiard balls. But, as Stuart Greaves (University of Bristol, UK) and colleagues Richard Zare (Stanford University) and Eckart Wrede (Durham University, UK) have discovered, the atom and molecule can also pull on each other. The researchers examined collisions of atomic hydrogen with molecular deuterium (a favorite system for testing the most intricate predictions of quantum chemistry), focusing on collisions in which the D_2 molecule emerged intact but with three additional quanta of vibrational energy. The expectation was that such vibrational excitation requires a head-on collision, from which the products are backscattered. However, Greaves and colleagues found that in many of the collisions they looked at, the atom and molecule were forward scattered. Simulations of the curious collisions revealed that the D_2 bond is lengthened, not compressed, under the influence of the H atom. The atom and molecule undergo what is essentially a frustrated chemical reaction: Instead of forming HD + D, they recross the reaction barrier back to H + D_2. It seems that a transitory chemical bond forms between the H atom and one of the D atoms, which tugs on the D–D bond and sets it vibrating before the H atom continues on its way. (S. J. Greaves et al., *Nature* **454**, 88, 2008.) —JLM ■