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Trees break at a nearly constant wind speed

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PHYSICS UPDATE

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ENIGMATIC COSMIC SOURCE PUMPS OUT MULTIPLE RADIO BURSTS

In 2007 Duncan Lorimer and colleagues scoured archival data from a 2000–01 survey of the Magellanic Clouds and discovered an energetic radio pulse of less than 5 ms duration. Since that discovery, about 20 more so-called fast radio bursts (FRBs) have been reported. One of them, identified in 2014, has now been shown to have a property that sets it apart from all its brethren: It bursts repeatedly. Laura Spitler of the Max Planck Institute for Radio Astronomy and company spotted the source, named FRB121102 (because its first burst was on 2 November 2012), in data taken with the Arecibo Observatory's William E. Gordon Telescope, pictured here. In May and June 2015, the Gordon telescope pointed to the location of FRB121102 for follow-up observations. Spitler and colleagues discovered 10 additional bursts, whose separations ranged from 23 s to 572 s.

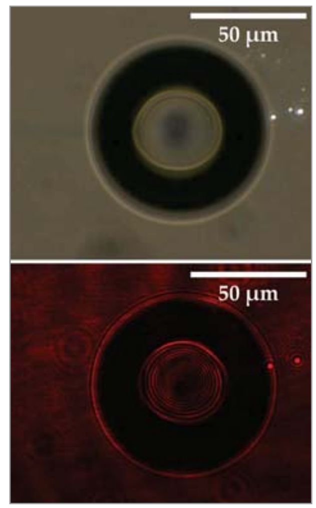
Astronomers are puzzling over the nature of FRB emitters. Before the Spitler and company finding, FRBs appeared to be one-time occurrences whose proposed causes have included the merging of neutron stars and the collapse of a neutron star to a black hole. But those cataclysms are incompatible with a repeating source such as FRB121102. Instead, the researchers suggest, the repeating bursts could be rare, energetic pulses from an extragalactic neutron star. Possibly, many or all FRBs are repeaters whose multiple pulses have escaped detection. Or the lesson of FRB121102 may be that FRBs come in at least two types, as do now-familiar gamma-ray bursts and supernovae. (L. G. Spitler et al., *Nature* **531**, 202, 2016. Photo courtesy of the NAIC–Arecibo Observatory, a facility of NSF.) —SKB

SKYRMIONS GO FOR A RIDE

Some physicists have high hopes that tiny vortices of magnetization called magnetic skyrmions will change the way we store data on computers. But there aren't many materials that support those swirls of magnetism, and the ones that do require cryogenic temperatures. Now a research team led by Geoffrey Beach of MIT and Mathias Kläui of the University of Mainz in Germany has created and manipulated room-temperature skyrmions at the interface between metallic thin films. Using a technique for fabricating read and write heads for hard drives, the scientists sandwiched a thin sheet of cobalt or cobalt-iron-boron between two layers of nonmagnetic material, such as platinum or tantalum. Then they applied magnetic field pulses that caused the magnetic moments of interfacial atoms to twist and form skyrmions that were about 100 nm in diameter. The physicists next built a nanosized track and used pulses of current to push and pull the magnetic swirls at speeds exceeding 100 m/s. The track demonstration is significant because it is modeled after the workings of a proposed data storage device called racetrack memory. Physicists envision skyrmions as robust data carriers—the state of a bit would be determined by the presence or absence of a skyrmion—that are smaller and could be manipulated far more quickly than the magnetic domains in traditional hard drives. The next step toward that goal is generating skyrmions that don't require a bulky or energy-sapping external magnet to maintain stability. (S. Woo et al., *Nat. Mater.*, in press, doi:10.1038/nmat4593.) —AG

BOILING WATER ONE BUBBLE AT A TIME

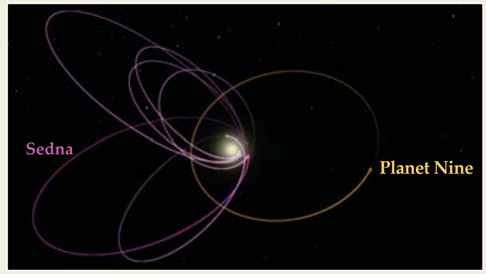
The first step in boiling water is the formation of bubbles at the bottom of the pan. Those bubbles grow and leave the heated surface within a few milliseconds, which makes it difficult to study their formation in real time. Now Shalabh Maroo of Syracuse University and his colleagues have found a way to make the bubbles stick around longer. They took a container filled with room-temperature water and used a focused laser beam to locally heat a spot at the bottom of the container. A vapor bubble that forms on the spot can be held in place for hours by setting the laser power so that evaporation at the bubble's base is balanced by condensation at its cooler parts. Thanks to that stability, the researchers could study at leisure how bubbles on a heated surface behave in different situations, including presence or absence of dissolved air, the use of hydrophilic or hydrophobic surface material, and increases in laser power. The figure shows a bubble, viewed from below, on a silicon dioxide surface in degassed water; the set-up is illuminated with light from a halogen lamp (upper) and a helium–neon laser (lower). Interference fringes revealed a thin liquid microlayer at the bubble's base. In water with dissolved air, the bubbles steadily grew larger even at constant laser power due to the continuous release of air into the bubbles. Maroo and his colleagues measured the air release rate and thus the liquid evaporation rate in the microlayer. The results should help researchers better understand the dynamics of bubble growth during boiling. (A. Zou et al., *Sci. Rep.* **6**, 20240, 2016.) —SC



TREES BREAK AT A NEARLY CONSTANT WIND SPEED

What's the maximum load a piece of wood can sustain before breaking? The question has a star-studded history, with contributions from Leonardo da Vinci, Galileo Galilei, the Bernoulli family, and Leonhard Euler, among others. The topic is one of practical importance, with applications in shipbuilding and curve fitting as well as in architecture and engineering. Christophe Clanet and colleagues at École Polytechnique in Palaiseau, France, and ESPCI Paris Tech have now looked at its implications for the ability of live trees to withstand wind. Examining data from the storm Klaus that hit southwest Europe in 2009, the team observed significant overlap between the areas of strongest wind and the areas of most broken trees. Where local wind speeds topped roughly 42 m/s, fewer than half the trees survived, whether soft-

A GIANT PLANET IN THE KUIPER BELT



Before they were discovered, Neptune and Pluto were conjectured to explain discrepancies between planetary orbits and Newtonian expectations. Now a pair of astronomers from Caltech, theorist Konstantin Batygin and observer Michael Brown, have proposed that our solar system includes a new planet. But Planet Nine, as they call it, doesn't explain small orbital perturbations; instead it accounts for unlikely similarities in the orbits of six objects, among them the minor planet Sedna, located far away in the Kuiper Belt. The figure shows those orbits in purple; the length of Sedna's semimajor axis is about 500 AU (Earth–Sun radii); Pluto's is 40 AU. For all six, the semimajor axis points in about the same direction, and all six orbits are inclined by 30° or so with respect to Earth's orbit. Having calculated that the likelihood of such a coincidence is 0.007%, Batygin and Brown explored the possibility of a gravitational mechanism to shepherd the Kuiper Belt objects into their similar paths. Analytical calculations and *N*-body simulations established that Planet Nine could plausibly account for the similarities, provided it is at least 10 times as massive as Earth and orbits in the plane of the six objects along the trajectory illustrated in yellow. Surprisingly, the theoretical work also implied that some Kuiper Belt denizens have orbits nearly perpendicular to Earth's. Five such bodies have been spotted. The Caltech model is silent as to where the putative Planet Nine currently lies on its 10-millennium journey around the Sun. If it's not too close to its aphelion, telescopes should have already spotted it, and it might be in old, overlooked data. At aphelion, the biggest telescopes on Earth could still spot it. (K. Batygin, M. E. Brown, *Astronom. J.* **151**, 22, 2016.) —SKB

wood pines or hardwood oaks. To explore that connection, the researchers took quite different samples—meter-long beech rods and centimeters-long pencil leads—held them horizontally from one end, and added weight to the other end until they broke. They found that the critical radius of curvature at which the rods broke was independent of length and scaled with the $3/2$ power of the diameter. That's consistent with having stress-concentrating defects whose typical sizes scale with the rod diameter. Back outside, the wind's bending force is distributed over a tree's length and width. Indeed, one would expect tall, skinny trees to break more readily than short, thick ones. But trees tend not to be both tall and thin simultaneously; rather, they top out at about $1/4$ of their self-buckling height. Incorporating that allometric relationship, the researchers obtained a formula for the critical wind speed that depends only weakly on tree size. Further accounting for wind gusts yields a value for that critical wind speed suggestively close to what was actually observed. (E. Virot et al., *Phys. Rev. E* **93**, 023001, 2016.) —RJF

TOWARD A SOLAR-POWERED LASER

To most people, the phrase "solar energy" conjures up images of photovoltaic panels or solar thermal collectors. But one long-explored application is the solar-pumped laser, which offers the promise of greater efficiencies both in generating coherent radiation and in converting the Sun's energy into usable forms. Research on such devices dates back 50 years. Solar irradiation can average several hundred watts per square meter at Earth's surface, yet early prototypes never produced even 0.1 watt per square meter of sunlight-collecting mirror. One path toward higher efficiencies lies in appropriating a wider swath of the solar spectrum. Doping a common laser material, neodymium-doped yttrium aluminum garnet (Nd:YAG), with chromium ions has shown promise. Shermakhamat Payziyev and Khikmat Makhmudov of the Uzbekistan Academy of Sciences now report on a refinement to further improve performance: shifting the spectral-harnessing responsibilities to a separate region that couples to the laser's active region. In the pair's model, a mirror focuses sunlight into the Nd:YAG active region, which has been further doped with cerium ions and which primarily absorbs in the yellow and red. Photons of other colors travel down to an end cap containing Cr-doped gadolinium scandium gallium garnet (Cr:GSGG), which primarily absorbs in the blue-violet and orange regions of the solar spectrum and reemits in the red; a mirror reflects the emitted red photons back into the Nd:YAG. The Cr:GSGG therefore effectively serves as a frequency converter that channels much more of the solar energy into the laser. In their simulation the researchers found up to 32% of the incident sunlight going into the laser light. The pair notes that even higher outputs should be possible by separately optimizing the regions' operating temperatures. (S. Payziyev, K. Makhmudov, *J. Renew. Sust. Ener.* **8**, 015902, 2016.) —RJF

A GENTLY AERATED BED OF GLASS BEADS SORTS OBJECTS BY DENSITY

When air is injected at a high enough rate into the bottom of a container filled with powder, the powder bed can go from a solid-like state to a fluid-like one. Objects dropped onto the so-called fluidized bed sink or float depending on their density. The phenomenon finds use in industrial-scale separators like the one pictured here, which sorts plastics for recycling. Now Jun Oshitani of Okayama University in Japan, Derek Chan of the University of Melbourne in Australia, and their colleagues have found that the same job can be done with lower air flow rates that don't fully fluidize the powder and require less energy. The researchers dropped 3-cm-diameter hollow plastic spheres filled with varying amounts of iron or lead onto a gently aerated bed of 0.25-mm-diameter glass beads. Unexpectedly, for sphere densities between 1 and 1.3 times that of the bed, the less dense the sphere was, the deeper it sank into the bed. Further, the final depth of a sphere could be controlled by changing the air flow rate. The researchers conjecture that when the sphere density is close to that of the bed, rising air can lift the sphere slightly. The void that forms below the sphere allows air flow to increase and locally fluidize the bed near the sphere. But because they monitored the sinking spheres with a counterweight connected to the sphere by a line through a pulley, the researchers aren't certain what's happening inside the opaque bed. To find out, they plan to turn to MRI, high-speed x-ray imaging, or other more sophisticated tools. (J. Oshitani et al., *Phys. Rev. Lett.* **116**, 068001, 2016.) —SC PT