PHYSICS UPDATE

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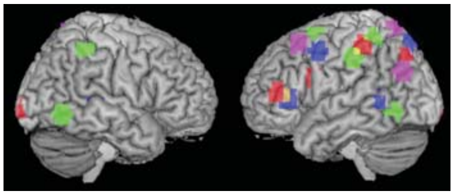
SOUNDING OUT THE QIN

The Chinese zither, the qin, is ancient in origin. Construction of the instrument became standardized in the Tang dynasty (618–907 CE), a thousand years after it was celebrated in poems compiled by Confucius. A qin's body consists of a 1.2-meter-long hollow box made from two pieces of lacquer-covered wood. To play a qin, the musician lays the instrument on a special table and plucks or strums its seven strings, which run the length of the box. All the strings are tuned in the bass register. When played unstopped, the qin sounds deeply sonorous, like the low strings of a cello or a guitar. Higher notes sound more like a banjo. Despite its long prominence in Chinese culture, the qin has not been subjected to acoustical study—until now. Chris Waltham, Yang Lan, and Evert Koster of the University of British Columbia obtained five qin and suspended each of them in an anechoic chamber. Using accelerometers, microphones, and other devices, the researchers determined the vibrational modes of the instruments' wooden shells and internal cavities. They also measured the frequency dependence of the radiated sound. Although the acoustical properties differed from instrument to instrument, a consistent picture emerged.

Low-frequency notes arise from the bending modes of the frame, whereas high-frequency notes arise from cavity modes. In follow-up experiments, Waltham, Lan, and Koster plan to examine how the two types of modes interact. (C. Waltham, Y. Lan, E. Koster, *J. Acoust. Soc. Am.* **139**, 1592, 2016.) —CD

REPURPOSING AN ANCIENT BRAIN FOR MODERN PHYSICS

Functional MRI (fMRI) detects the seconds-long rushes of oxygenated blood to areas of the brain that are engaged with whatever the subject is thinking or doing at the time. The technique is being increasingly used to develop semantic models—how the concept of, say, an object that we see or an emotion that we feel is represented neurally in the brain. Robert Mason and Marcel Just at Carnegie Mellon University now extend those studies to physics concepts. Momentum, entropy, magnetic field, and other abstract concepts are qualitatively different from concrete nouns, action verbs, and numbers, and aren't what the brain was built for. The researchers' study focused on nine right-handed participants, all upperclassmen or graduate students in physics or engineering. The individuals first were asked to list two or three properties to describe each of 30 physics terms; "velocity" properties, for example, might include "vector" and "motion." Next came the scans, during which the terms were displayed in random order multiple times, and the participants actively thought about each in turn. Afterward, the participants were asked to split the terms into four to six groups and give each category a name. When Mason and Just correlated the fMRI maps, both for the same individual and for different individuals, they found consistent neural signatures that could be described by five factors. One was trivial: the length of the word.

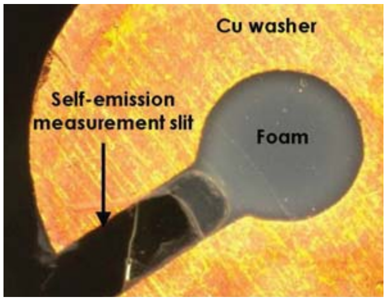


But aided by the participants' categorizations and property descriptions, the researchers could assign semantic physics interpretations to the other factors: causal motion (pink regions in the figure) registered strongly for terms such as "gravity" and "torque"; periodicity (green), for "sound waves" and "diffraction"; mathematical representation (red), for "acceleration" and "heat transfer"; and energy flow (blue), for "heat transfer" and "electric field." Moreover, the activated regions variously fall within parts of the brain known to process relevant fundamental aspects such as visualization and rhythm. (R. A. Mason, M. A. Just, *Psychol. Sci.*, in press, http://dx.doi.org/10.1177/0956797616641941.) —RJF

FOAM MITIGATES KEY OBSTACLE IN QUEST FOR LASER FUSION

The goal of inertial confinement fusion is to swiftly heat and compress small capsules of hydrogen fuel with a powerful laser. Ideally, the implosion is spherically symmetric: Hydrogen fuses into helium and emits alpha particles, which slam into more hydrogen and trigger a sustained fusion reaction. In practice, however, Rayleigh–Taylor instabilities subvert spherical symmetry. Barely perceptible bumps on the capsules or variations in laser intensity get magnified as the fuel implodes and create fractures through which the hot, dense plasma needed to drive the reaction escapes.

Now an international team of physicists using the OMEGA laser at the University of Rochester in New York has reduced Rayleigh–Taylor instabilities with the help of extremely low-density foam. The researchers spread the foam over a thin sheet of foil (see image below), which served as the target in place of a fuel capsule. Once struck by six 500-joule beams, the foam vaporized instantaneously into a plasma, which smoothed out imperfections in the laser beams before the light reached the foil.



The researchers found that a 500 μm layer of 7 mg/cm^3 foam reduced the imprint of laser imperfections by a factor of two. The next step is to envelop a round capsule with the foam in an attempt to achieve perfectly spherical compression.

The technique will probably have limited use at the site of the world's most powerful laser, Lawrence Livermore National Laboratory's National Ignition Facility. Most NIF energy trials involve illuminating a small cylinder called a hohlraum, which emits x rays that squash the fuel inside. But directly zapping the fuel has become a hot area of research, particularly after NIF failed to reach its goal of achieving ignition—generating more energy than that of the laser—by 2012 (see PHYSICS TODAY, February 2015, page 24). (B. Delorme et al., *Phys. Plasmas* **23**, 042701, 2016.) —AG