Ciliberto, PHYSICS TODAY, September 2015, page 30.) In the electron example, if all spin measurements must be made along the *x*- or *z*-axis, each measurement dissipates a minimum amount of heat roughly equal to Boltzmann's constant times the temperature. Cabello and colleagues show, however, that if an experimenter is free to make spin measurements anywhere in the *xz*-plane, the heat generated per measurement is unbounded—obviously, an unphysical result.

Heat need not be produced in a hidden-variables theory if a system could store unlimited information. Such is the case, for example, for David Bohm's version of quantum mechanics, in which a continuous pilot wave serves as the information repository. And in formulations of quantum mechanics without hidden variables, such as in the Copenhagen interpretation, heat is not generated because there is no deterministic register to update. (A. Cabello et al., *Phys. Rev. A* **94**, 052127, 2016.) —SKB

THE SPACE WEATHER ON THE CLOSEST EARTH-LIKE EXOPLANET

In August 2016 hints were confirmed that an Earth-like planet orbits the Sun's nearest stellar neighbor, the red dwarf Proxima Centauri. The discovery excited astronomers. Proxima Centauri is close enough that the exoplanet, Proxima Centauri b, will be directly visible to the next generation of space telescopes and to the giant ground-based telescopes currently under construction. (The accompanying artist's impression depicts Proxima Centauri as seen from the exoplanet surface.) Furthermore, the exoplanet's orbit lies within the star's habitable zone—that is, the volume of space within which a planetary surface can sustain liquid water given enough atmospheric pressure. Does the exoplanet have a thick atmosphere? To begin to address that question, Cecilia Garraffo of the Harvard–Smithsonian Center for Astrophysics and her colleagues modeled the hot wind of charged particles that emanates from Proxima Centauri. Because the precise values of the star's magnetic field and the exoplanet's orbital inclination and eccentricity are unknown, the researchers ran their magnetohydrodynamic model eight times with different sets of parameters. According to the model, Proxima Centauri's wind is roughly as

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strong as the Sun's, even though the red dwarf is smaller and dimmer. But because of Proxima Centauri's low luminosity, its habitable zone lies much closer to the star than the Sun's does. For all eight scenarios, the wind that buffets Proxima Centauri b is approximately 1000 times more powerful than solar wind is at Earth's orbit. Even though the exoplanet likely has a magnetic field, whatever atmosphere the exoplanet was endowed with was likely blown away long ago. (C. Garraffo, J. J. Drake, O. Cohen, *Astrophys. J. Lett.* **833**, L4, 2016.) —CD

PITCH SHARPENING IN WOODWINDS

Today's concert woodwinds feature as many as two dozen tone holes and a bevy of levers, called keys, that put the full chromatic scale over multiple octaves at a player's fingertips. Yet even on keyless instruments, like the recorder, bagpipe chanter, and the Japanese shakuhachi, a player can use so-called cross-fingering to fill in the chromatic gaps: Covering one or more tone holes below the first open hole usually lowers, or flattens, the pitch by a semitone. But in what's known as an intonation anomaly or pitch sharpening, cross-fingering can, in some circumstances, raise the pitch.

The flute is often presented as an example for understanding wave resonances: The open hole closest to the player's mouth sets the effective length, which in turn determines the resonant frequencies and thus the notes produced. Although the actual pitch details aren't quite that simple, the behavior is for the most part well understood and amenable to numerical calculation. Yet pitch sharpening has gotten little attention. Now Seiji Adachi at the Fraunhofer Institute for Building Physics in Stuttgart, Germany, offers an explanation of the effect by modeling a minimal system—a flute with one open tone hole—as a system of coupled oscillators. Closed tone holes below the open hole essentially create a downstream pipe of adjustable length. The upper and lower flute sections will have their own resonant frequencies, but since the sections interact, the resonances shift—some higher, some lower.

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Moreover, some of the coupled modes are more easily excited than others. By extending his model to include an additional resonant mode in the upper bore, Adachi could quantitatively account for both pitch flattening and pitch sharpening in an actual recorder. (S. Adachi, *Acoust. Sci. Tech.* **38**, 14, 2017.) —RJF PT