Another possibility is to exploit the stability of some molecular magnets. They can be plucked from the crystals in which they sit and placed elsewhere, such as on a surface, in a structure that couples two or more such qubits. The challenge would be to couple the qubits controllably while avoiding unwanted interactions. As an example of one step in that direction, a team led by Wolfgang Wernsdorfer of the Néel Institute in Grenoble, France, has coupled a single-molecule magnet with a carbon nanotube to study electrically driven nuclear-spin resonances.[5]

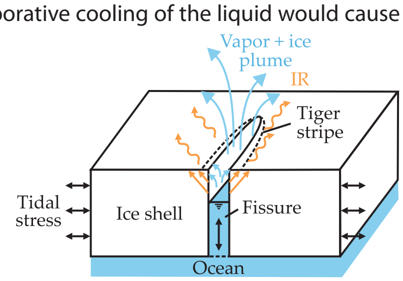
Andrea Morello of the University of New South Wales in Australia points out that, although molecular spins might currently be less developed than other platforms for quantum computing, they have nevertheless demonstrated a potential to serve as a testing ground for basic ideas and techniques relevant to quantum information. "The current surge of

PHYSICS UPDATE

These items, with supplementary material, first appeared at www.physicstoday.org.

TURBULENT DISSIPATION SUSTAINS ERUPTIONS ON ENCELADUS

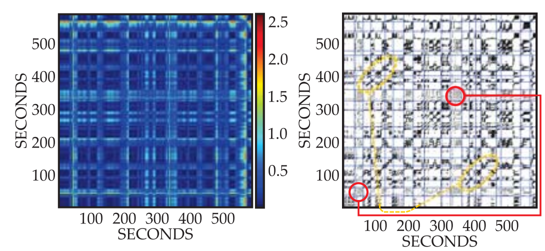
In July 2005 the *Cassini* spacecraft flew within 170 km of Saturn's moon Enceladus and discovered an icy landscape strewn with house-sized boulders and tectonic features. Among those features are so-called "tiger stripes," four fractures, each roughly 130 km long and flanked by a band of warm ice, that continuously spew plumes of ice, water vapor, and other gases into space. (See the article by John Spencer, PHYSICS TODAY, November 2011, page 38.) Edwin Kite (University of Chicago) and Allan Rubin (Princeton University) have produced a simple model that explains the local warmth and constant eruptions. Enceladus's surface is thought to be an ice shell roughly 35 km thick that floats on a salty liquid-water ocean. The researchers posit that the tiger stripes are open fissures a meter wide that run through the shell. As shown in the diagram, the ocean fills a fissure with water up to within a few kilometers of the moon's surface. Diurnal tides alternatingly narrow and widen each tiger stripe and force the water table to rise and fall. Tidal forces have long been known to drive the eruptions, but earlier researchers had expected that as the vapor ascends, evaporative cooling of the liquid would cause the fissures to freeze shut in less than a year. Kite and Rubin found that although the vertical water speed in the fissure is only about 1 m/s, the heat generated by the turbulent flow is enough to keep the slot unclogged. Reassuringly, their model accounts for the 5 GW IR signal *Cassini* measured around the tiger stripes and explains a previously puzzling time lag between the eruptions' peak flux and the tensile force that produces it. (E. S. Kite, A. Rubin, *Proc. Natl. Acad. Sci. USA*, in press, doi:10.1073/pnas.1520507113.)



—RMW

A NONLINEAR LOOK AT MUSIC

Nonlinear systems commonly come close to repeating themselves without being truly periodic. (See the article by Adilson Motter and David Campbell, PHYSICS TODAY, May 2013, page 27.) One tool for analyzing such behavior is the recurrence plot (RP), a two-dimensional graph that uses color or other means to quantify how similar a system is at any two times t_1 and t_2. But for long time series, patterns embodied in an RP invariably get lost or distorted. Music tracks, for example, are digitized typically at 44.1 kHz, so the waveform of even a five-minute piece comprises some 13 million points. In such a data set, features over short intervals reveal the tonality, whereas features over longer periods manifest structural elements. Miwa Fukino, Yoshito Hirata, and Kazuyuki Aihara of the University of Tokyo propose a novel way to capture both aspects: an RP of RPs. The researchers start by making RPs of overlapping short sections of a music track, then evaluate the similarity of the RPs. The figure on the left shows the RP of RPs for the first movement of Beethoven's Piano Sonata no. 23 (*Appassionata*); blue denotes the greatest similarity. Each short RP spanned a 4 s window offset from the previous one by 1 s. The banding indicates the recurrence of sections with different themes. Applying a similarity threshold for the large-scale RP accentuates that recurrence in the figure on the right. The diagonal traces circled in yellow, for example, show where a 40-bar stretch is repeated, albeit shifted by a major third, while the chorus circled in red repeats its motifs with increasing tempo. With the flexibility to define "closeness" in multiple ways, the technique is versatile, able to emphasize other features and analyze other types of data. (M. Fukino, Y. Hirata, K. Aihara, *Chaos* **26**, 023116, 2016.)



—RJF

A BIOLOGICALLY INSPIRED ARTIFICIAL EYE

Peters' elephantnose fish inhabits muddy, vegetation-covered rivers in west and central Africa. Although the fish relies on electrolocation to navigate and to find food, its weak eyes have evolved a distinctive sensitivity-enhancing mechanism. Between the eye's transparent inner retina, which receives light focused by the lens, and the photoreceptors, which convert light into neural impulses, lies a closely packed array of crystalline microcups. Because of their reflective inner surfaces, the microcups concentrate light onto the photoreceptors, thereby boosting sensitivity. Hewei Liu, Yinggang Huang, and Hongrui Jiang of the University of Wisconsin–Madison have designed and built a marble-sized artificial eye that uses a similar mechanism. The eye's 6-mm-diameter ball lens focuses light onto a 48×48 array of glass microcups that lines a retina made from a transparent polymer and coupled to a CMOS imager. The light enters a microcup through the 77-µm-diameter front aperture and continues to the 20 µm rear aperture either by passing straight down the 120 µm length of the