tion. But stellar winds don't release enough energy to account for more than a small fraction of CRs. It's estimated that fully 10% of the kinetic energy released in SN explosions ends up in CRs.

The only surprise, says Knödlseder, is that the γ luminosity tracks the star formation so well. "It implies a mean diffusion length [L_d] of only about 400 light-years from where the CR was created to where it collides and makes pions." Indirect evidence from the Milky Way disk's diffuse γ emission suggests a significantly longer L_d.

Because CR collisions with even the densest interstellar gas are few and far between, L_d depends much more on the twists of local magnetic fields than on gas density. In fact, many hadronic CRs manage to leak out of their natal galaxies without ever making a pion. "So we have to imagine that the magnetic-fields near 30 Doradus are particularly intricate," says Knödlseder, "or rethink the evidence from the Milky Way's disk."

To the extent that hadronic CRs don't escape before making pions, a galaxy's γ luminosity becomes a calorimetric measure of its CR energy. The γ observations indicate that starburst cores of M82 and NGC 253 have CR energy densities a hundred times that at the Milky Way's center. "That difference reflects a similar disparity in supernova rates," says theorist Massimo Persic (National Institute for Astrophysics, Trieste, Italy). "The correlation suggests that supernova remnants in very different environments share a common, perhaps universal, efficiency for accelerating cosmic rays."

Bertram Schwarzschild

References

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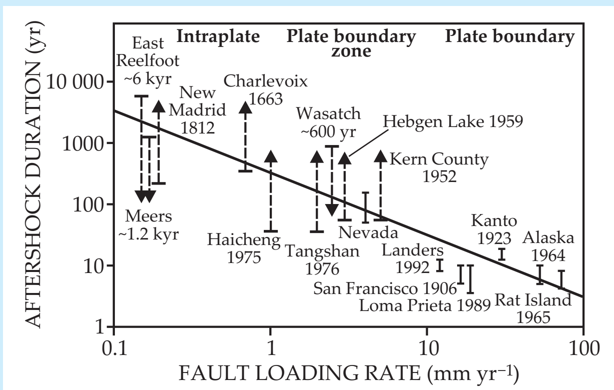
key melodies feature an interval, the minor third, with a 6:5 frequency ratio. How is that interval dichotomy mirrored in speech? The Duke team asked 20 subjects to read a word or short passage in an excited or subdued manner (see the texts in the online version of this item). They then analyzed the ratios of the two lowest—and strongest—frequencies of vocal-tract resonance associated with each vowel sound. The prevalence of major-third intervals (5:4 ratios) as compared with minor thirds (6:5) was much greater in excited than in subdued speech. Musically speaking, at least, our thrills are major; our disappointments, minor. (D. L. Bowling et al., *J. Acoust. Soc. Am.*, in press.) —SKB

Putting a sound stop to convection. The phenomenon of dynamic stabilization can be demonstrated with an inverted pendulum: If the pivot point vibrates fast enough and strongly enough, the pendulum aligns with the vibration direction and can stably stand upside down, even at an angle, seeming to defy gravity. Physicists Greg Swift and Scott Backhaus (Los Alamos National Laboratory) looked at an analogous situation with gas in a so-called pulse tube that has one end much hotter than the other. Colder gas is denser and therefore sinks below the hotter gas; a vertical tube with the cold end down is like an undisturbed pendulum with the heavy bob at the bottom. However, raise the cold end above the hot end and convection sets in—the cold gas falls due to gravity and the hot gas rises in a natural convective flow. Such orientation-dependent effects are undesirable for cryogenic thermoacoustic pulse-tube refrigerators, like the commercial one shown here, in which the gas is used to transmit acoustic power but not heat. (For more on thermoacoustics, see PHYSICS TODAY, July 1995, page 22.) Swift and Backhaus found that suppression of convection when these refrigerators run at high enough frequency and amplitude is related to the well-understood stabilization of the inverted pendulum. Although their experiments and theoretical analysis are beginning to unravel the essentially nonlinear physics at the core of the system, many mysteries remain, including the actual role of the oscillating pressure. (G. W. Swift, S. Backhaus, *J. Acoust. Soc. Am.* **126**, 2273, 2009.) —SGB

Interpreting intracontinental earthquakes. Our historical record of seismic activity is very short, by geological time scales. So extrapolating that record to predict future earthquakes can lead to nasty surprises, such as 2008's devastating earthquake in Sichuan, China, which occurred on a fault that had seen little recent activity. Large earthquakes are typically followed by aftershocks whose frequency decays to some background level of seismicity, following an empirical relation known as Omori's law. But determining the time scale of the decay and the baseline activity can be difficult. A new model by Seth Stein of Northwestern University and Mian Liu of the University of Missouri–Columbia posits an inverse relationship between the aftershock-sequence durations and the slip rates along faults. Large earthquakes are most common along the boundaries of tectonic plates, and the occurrences of aftershocks tend to decay quickly—within a decade or so—to a relatively high background. The relative plate motion at such boundaries can



be rapid, faster than 10 mm/yr. Continental interiors, far away from plate boundaries, deform much more slowly, typically less than 1 mm/yr. And thanks to that slower rate of fault loading, aftershocks can last hundreds of years or longer, as shown in the figure. Thus, warn the researchers, interpreting continental earthquakes as steady-state seismicity can overestimate the hazard in presently active areas and underestimate it elsewhere. (S. Stein, M. Liu, *Nature* **462**, 87, 2009.) —RJF