PHYSICS UPDATE

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SPECIALIZED VOCAL ORGANS GIVE SOME BIRDS THEIR UNIQUE SONGS

As any experienced birdwatcher will tell you, songbirds have distinguishing chirps and tweets that vary from species to species. Some birds have significant neural control over the sounds they produce, and they learn their songs by mimicking older members of their species. However, a group of birds known as tracheophones, which includes the variable antshrike pictured here, will develop adult song even when raised in isolation. Each tracheophone species has a distinctive structure to its tracheal membrane; there are differences not only in its size but also in its collagen–elastin composition, and those differences produce vocalizations at varying frequencies. Until recently, biologists believed the tracheal membranes were largely responsible for the sounds that tracheophones produce.

A new study, however, shows that the tracheal membrane is only one of three sound sources that tracheophones use to produce their songs. Biologists Sarah Garcia and Franz Goller at the University of Utah led a team that used a fiber-optic camera to film the tracheae of five tracheophone species. The biologists collaborated with physicist Gabriel Mindlin at the University of Buenos Aires to analyze and model their data. The birds' songs, it turned out, emanated not only from their tracheal membranes but also from two pairs of structures called labia that line the top of the bronchial tubes.

Tracheophones therefore have the largest number of vocal sound sources of any known animal, and tracheophone vocalizations differ from species to species due to differences in both the tracheal and bronchial structures. The findings provide new evidence for the theory that two evolutionary paths account for vocal diversity in birds: one in which birds evolved complex neural control over their vocal organs, and one in which physiological changes to the vocal organs produced a species' characteristic song. (S. M. Garcia, C. Kopuchian, G. B. Mindlin, M. J. Fuxjager, P. L. Tubaro, F. Goller, *Curr. Biol.* **27**, 2677, 2017.) —MB

FRANCESCO VERONESI

NEUTRINO DETECTION GOES SMALL

The traditional recipe for neutrino detection calls for a very large detector to compensate for the neutral particles' extraordinarily meager rate of interaction. Yet theory has long offered a means of spotting neutrinos in a much smaller volume. In 1974 Daniel Freedman proposed measuring a low-energy neutrino's interaction with an entire atomic nucleus. The probability that a neutrino would exchange a Z boson with a nucleus and in the process provide a subtle kick would roughly scale with the square of the nucleus's neutron count. But there was a catch: The heavy nuclei that would maximize the interaction rate would also barely budge when struck by a feeble neutrino, so their recoil would be difficult to spot.

Researchers with the COHERENT collaboration have now overcome that challenge and measured the neutrino-induced recoils of nuclei in a 15 kg detector, a prototype of which is shown in the photo. They placed their experiment in a basement corridor just below Oak Ridge National Laboratory's Spallation Neutron Source. The facility generates plentiful neutrinos as a byproduct of its neutron production, and it does so in regular pulses that facilitate isolation of background events. In addition, an intervening layer of concrete and gravel prevents neutrons and cosmic rays from reaching the detector, which is made of a transparent, scintillating crystal of sodium-doped cesium iodide. The crystal's nuclei are neutron-rich enough to encourage neutrino interactions but lightweight enough for their recoil to generate measurable photons.

After collecting more than 300 days' worth of data with the neutron beam on and 150 days' worth with it off, the COHERENT team detected between 112 and 156 events consistent with the elastic scattering of a neutrino off a cesium or iodine nucleus. The results favor the presence of neutrino–nucleus scattering at a 6.7-σ level. The researchers say that future detectors sensitive to the process could monitor nuclear reactors and provide improved constraints on interactions between neutrinos and quarks. Such understanding could prove useful in astrophysics, since some scientists have proposed that neutrino–nucleus scattering may play a role in the explosion of supernovae. (D. Akimov et al., *Science*, in press, doi:10.1126/science.aao0990.) —AG

JEAN LACHAT/UNIVERSITY OF CHICAGO