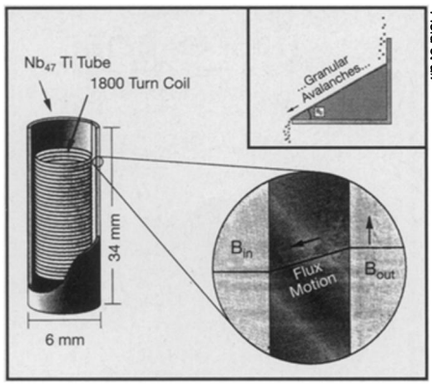
Vortex avalanches in superconductors

A steeply sloped sandpile represents a precarious balance between the friction keeping individual grains in place and the inexorable downward pull of gravity. Dropping additional particles onto the slope readily triggers avalanches, which can range in size from the movement of a few grains to massive slides along the entire slope (SN: 10/10/92, p.231).

Researchers have detected similar avalanche behavior in magnetic materials (SN: 3/31/90, p.207) and among cascading water droplets (SN: 10/23/93, p.261). Now, they have observed such activity among whirlpools, or vortices, of magnetic field trapped in a superconductor.

"Our work provides direct experimental confirmation of the existence of these vortex avalanches, as well as new insights into the nature of collective particle transport at the threshold of instability," says Stuart B. Field of the University of Michigan in Ann Arbor.



Field *et al.*

As new vortices of magnetic flux push into a superconducting tube from the outside, existing vortices spill into the tube's hollow interior. This leakage occurs in avalanches, like those that can happen in sandpiles (inset).

Field and his collaborators use a hollow tube made of a niobium-titanium alloy. Immersed in a liquid helium bath, this material becomes a superconductor, losing its electrical resistance.

An external magnetic field can penetrate the tube, creating vortices of magnetic field within the tube wall. Defects in the crystal structure of the superconducting alloy normally pin these vortices in particular locations.

Slowly increasing the magnetic field drives additional vortices into the tube's outer wall, pushing aside vortices already present. Some vortices spill into the tube's hollow interior, where a detector records the electrical pulses caused by these exiting bundles of magnetic field.

"The striking feature of the signal is that it consists of a succession of very pronounced pulses with a wide distribution of sizes and lifetimes," Field says.

In other words, vortices emerge from the tube not at a smooth, steady rate but in erratic surges. These vortex avalanches may vary from as few as 50 to as many as 5,000 vortices. Such behavior resembles that observed in sandpiles and other physical systems existing in a critical state on the verge of instability.

Field described his team's work last week at an American Physical Society meeting held in San Jose, Calif.

— I. Peterson

Hubble constant: Controversy continues

Like contestants in a never-ending tennis match, teams of cosmologists continue to argue back and forth about the numerical value of the Hubble constant. This hotly debated number, which relates the recession velocity of a galaxy to its distance from Earth, provides a measure of the age and size of the expanding universe.

Last fall, Wendy L. Freedman of the Carnegie Observatories in Pasadena, Calif., and her colleagues announced a new distance to the galaxy M100, a member of the Virgo cluster of galaxies, based on Hubble Space Telescope observations. From this measurement, they calculated a Hubble constant of 80 kilometers per second per megaparsec. This indicates a cosmos between 8 and 12 billion years old (SN: 10/8/94, p.232).

That poses a predicament because it makes the universe appear younger than its oldest stars, believed to be 16 billion years old.

Last week, cosmologists heard from Allan R. Sandage of the Carnegie Observatories, a longtime proponent of a smaller Hubble constant and an older universe. He announced that two new observations with the Hubble telescope have each yielded a Hubble constant of about 50. The findings, which agree with his team's earlier results, would make the cosmos about 20 billion years old, avoiding any conflict with the age of its elderly stars.

"I firmly believe there is no [cosmological] crisis," Sandage asserted at the Particles, Strings, and Cosmology symposium in Baltimore.

In their study, Sandage and his collaborators employed a special strategy to measure the distance to two galaxies, NGC 4496A and NGC 4536. Using one type of distance indicator, youthful pulsating stars known as Cepheid variables, the team calibrated the true brightness of another indicator in the same galaxies, exploded stars known as type 1a supernovas.

Critics argue that Sandage and his coworkers underestimate the Hubble constant because they don't account for the possibility that some of their 1a supernovas may be intrinsically brighter than average (SN: 2/18/95, p.106). But Sandage argues it's unlikely that all five of the exploded stars his team has examined are unusually bright.

However, Mark M. Phillips of the Cerro Tololo Inter-American Observatory in La Serena, Chile, says that's a distinct possibility. Sandage's team relies on 1a supernovas in galaxies that contain lots of Cepheids. Such galaxies may tend to harbor 1a supernovas with higher intrinsic brightnesses, Phillips notes. He adds that published data on two of the stellar explosions, one in 1895 and another in 1960, aren't reliable.

Meanwhile, Freedman says that her team has corroborated their initial finding and expects much more data. "It feels like we're drinking from a firehose. Within a year to 18 months we'll have much more to say about the Hubble constant."

— R. Cowen

Think big to save birds on the edge

Bird lovers often take comfort in the small plots of forest left in their neighborhoods, thinking that these trees provide a haven for forest-loving birds.

But a new, large-scale study shows that small nature preserves fail to protect birds' nests from predators, such as cowbirds, which lurk along forest edges, report Scott K. Robinson of the state-run Illinois Natural History Survey in Champaign, Ill., and his colleagues.

Indeed, in some small woodland plots certain species now lose so many of their eggs and nestlings that their overall deathrates exceed their birthrates. Birds moving in from heavily forested areas help sustain the populations in the smaller forests, the scientists assert in the March 31 SCIENCE.

To do their study, Robinson and his many coworkers staked out more than 5,000 nests in five midwestern states between 1989 and 1993. They monitored eight species of neotropical migrant birds, which breed in North America and winter in the tropics, and observed nests of the northern cardinal. The species in the study have become scarcer in recent years, although none is yet in danger of extinction.

The nests occupied nine plots from 20 to 200 hectares in size on land ranging from more than 90 percent agricultural to more than 90 percent forested. Nests in areas with less forestation suffered higher rates of destruction and cowbird invasion, Robinson and his colleagues report.