Searching for evidence of ringing galaxies

Strike a bell, and it rings. Perturb a galaxy, and it, too, should oscillate.

Computer models in which hundreds of thousands of particles attract each other according to the law of gravity indicate that a small disturbance can make these particles move in a coordinated fashion somewhat like the motion of a vibrating bell. This finding suggests that galaxies, which typically contain billions of stars and large amounts of interstellar gas and dust, may also vibrate in characteristic ways. Such galactic oscillations, if they exist, would probably have originated in the violent processes that led to galaxy formation.

Now, researchers are developing a catalog of effects that astronomers can look for when seeking to determine whether galaxies actually oscillate. Richard H. Miller of the University of Chicago, working with Bruce F. Smith of NASA's Ames Research Center in Mountain View, Calif., and his coworkers, described some of these potentially observable effects at a meeting of the American Astronomical Society's Division on Dynamical Astronomy held last week in Washington, D.C.

The oscillations represent an important, fundamental dynamical process that previously had not been suspected in galaxies, much less taken into account, Miller contends. However, "there's no smoking gun yet to prove they exist."

Miller and his colleagues created their simulated galaxies using powerful computers at the Numerical Aerodynamic Simulation Facility at Ames. Their numerical experiments typically involved tracking the behavior of about 400,000 particles distributed in a sphere.

The researchers found two characteristic oscillations, or fundamental modes, that can be large enough to produce observable effects in galaxies. In both cases, simulations indicate that a single galactic oscillation would take from tens of millions to hundreds of millions of years and that the oscillations could go on undiminished for billions of years.

In the first fundamental mode, the entire galaxy expands and contracts, with material farther from the center moving faster than material closer to the center. In a rotating spiral galaxy, such a radial motion would alter the velocities of hydrogen atoms distributed in vast sheets moving with the galaxy.

Obtaining detailed radio measurements of these velocities and interpreting the numbers is no simple matter, however. In checking six candidate galaxies, Gregory R. Roelofs, now at Philips Research in Palo Alto, Calif., found it difficult to differentiate between effects due to oscillations and those caused by a tilted or slightly twisted flat disk.

National Optical Astronomy Observatories

Edge-on view of a spiral galaxy with a large central bulge.

In the second fundamental mode, particles closer to the center move in the opposite direction of those farther away, creating an intermediate region where no particles move. This type of motion either piles up material at a galaxy's center to produce a bulge or takes it away to create a hole. The fact that bulges and holes in different galaxies sometimes have comparable dimensions supports this scenario, Miller says.

The researchers are now studying how galactic disks respond to oscillations in a surrounding halo of dark matter.

— I. Peterson

Lacewings have their armor and eat it too

Some green lacewing mothers produce an unusual compound that both protects their eggs from marauding ants and serves as their offspring's first meal, researchers say. Someday, the chemical may enable humans to repel ants too.

Before depositing their eggs, green lacewings release from their reproductive glands a substance that forms stalks for their eggs to sit on, keeping them out of the way of hungry predators.

One species of green lacewings takes an additional precaution, however. *Ceraeochrysa smithi* females produce droplets of an irritating fatty liquid that they deposit on the stalks to repel invaders, assert Thomas Eisner of Cornell University and his colleagues. Moreover, when the larvae emerge from the eggs, they imbibe the liquid. This snack may provide them with nutrients or make them less attractive to ants, the team speculates.

Many species of insects protect their eggs with chemicals, but scientists have found no others whose offspring ingest the defensive substance, the team contends in the April 16 PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES.

"As an insectan 'mother's milk' that seemingly combines the attributes of 'guns and butter,' the egg-stalk fluid of *C. smithi* is evidently unusual," they observe.

"It's a surprising and very interesting finding," agrees entomologist Charles S. Henry of the University of Connecticut in Storrs.

The researchers first noticed the droplet-covered stalks in the late 1960s, but they put their discovery on the back burner until better techniques for extracting the oil and examining its ingredients came along, explains Eisner. They found the stalks in Florida on palmetto fronds and on the leaves of a creeping fig tree.

Recent analysis with gas chromatography reveals that the stalk fluid consists primarily of concentrated fatty acids that make other insects itch. It also includes trace amounts of aldehydes, volatile chemicals commonly found in plants. Although another team reported recently that wasps impregnate their nest stalks with similar fatty acids to deter ants, few other insects' defensive juices have any of the green lacewing's ingredients, Eisner says.

He and his coworkers also compared how ants respond to the egg stalks of *C. smithi* and to those of *C. cubana*, which have no protective fluid.

"In not a single test were any of the *C. smithi* eggs taken by the ants," they report. "Upon touching a stalk, ants abruptly backed off." In contrast, ants stole two to four of *C. cubana*'s five eggs during each of the five tests. When removed from the stalks, both species' eggs got snatched with equal regularity.

Eisner

Gardeners prize green lacewings because they devour aphids, but it's the droplets on the egg stalks (insert) of one species of green lacewings that particularly impress scientists.

Eisner plans to test how well the oil works against ants in a regular kitchen. When the scientists put a drop of a synthetic version of the compound on cockroaches, the bugs began scratching themselves within 3 to 6 seconds. He doubts the chemical can scare off the hardy cockroach, however.

— T. Adler