Turning the galaxy's heart to a watermelon

If forced to move along a rotating disk shrouded in smog, you'd find it tough to see what's behind or in front of you and nearly impossible to decipher the pattern of objects looming above. That explains the problem facing Earth-bound astronomers as they attempt to map the overall shape of our dusty galaxy, the Milky Way. Scientists have known since the 1700s that many of the Milky Way's star clusters concentrate along a flat plane, somewhat like a cosmic phonograph record; astronomers early in this century deduced that a spherical concentration of stars and gas sits above and below the disk's center like two halves of a grapefruit. Two astronomers now say the shape of this central structure may actually resemble a watermelon rather than a sphere—a suggestion with surprising implications.

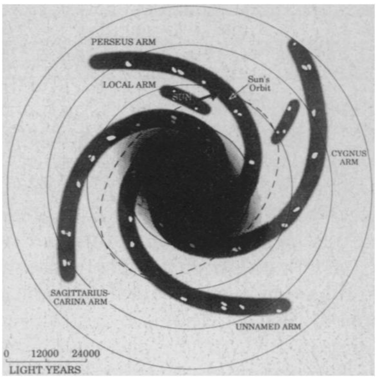
The gravitational force exerted by such a nonspherical distribution, the researchers say, causes the solar system to orbit the galactic center along an ellipse rather than a circle as commonly assumed. The scientists also say their computer-derived model explains anomalies in the observed velocities of galactic gases that have puzzled astronomers.

Leo Blitz of the University of Maryland at College Park and David N. Spergel of Princeton (N.J.) University base their model on data from several research groups that observed the Milky Way at radio wavelengths, which can penetrate the galaxy's dusty byways. During the 1970s, in observing radio emissions from atomic hydrogen near the galaxy's edge, those groups noted that some of the gas seemed to be heading inward — toward the solar system and the galactic center—at a rate of 15 kilometers per second. That phenomenon, says Blitz, can be explained if the sun is now heading away from the galactic center and toward the gas, in the elliptical orbit predicted by the watermelon model. Supporting evidence for the model comes from other observations of molecular clouds orbiting the galaxy close to its center, he says. Despite the near-perfect circular shape of the gas clouds' orbits, researchers observed that portions of these clouds seemed to be speeding away from the solar system, also at 15 km per second. Both the atomic hydrogen and gas cloud observations fit with the same elliptical orbit for the sun, Blitz says.

"We didn't know about this [inner gas velocity] problem until later, when we were looking for confirmation," Blitz says. He and Spergel reported their findings this week at the annual meeting of the American Astronomical Society in Arlington, Va. "Our model makes a clear prediction about this phenomenon," Blitz contends, but some researchers remain skeptical about the watermelon scenario.

MIT astronomer Alar Toomre says the watermelon-shaped mass distribution is plausible but "is on equal footing" with other possible explanations for the radio-emission findings, including the notion that the Milky Way contains pockets of gas devoured from other galaxies. The gravitational force exerted from the extra gas might similarly cause the solar system to follow an elliptical orbit, Toomre says. Blitz argues that such a scenario, while possible, could not explain all the observations. Further calculations, he adds, may resolve another possible objection cited by Toomre by showing how the watermelon distribution of stars could have retained its shape over billions of years.

"The model of [Blitz and Spergel] is very plausible," comments astronomer Carl Heiles of the University of California, Berkeley. However, he adds, "I'd like to see even more velocity measurements to verify the picture." *— R. Cowen*



Blitz/Nono Kusuma

Milky Way, viewed from above, shows proposed watermelon-shaped distribution of stars (shaded area) at galaxy's center and elliptical orbit (dotted line) of the sun.

Expanding sand into spacier materials

It would take about 20 gallons of paint to cover a surface area comparable to that in a sugarcube-sized chunk of some newly made microporous materials. Their labyrinthine interiors could potentially serve as cozy sites for catalyzing chemical reactions or as minuscule sieves penetrable only by molecules of certain shapes and sizes. They might also prove useful in efforts to design specialty glasses that, for instance, bend light to prespecified degrees.

The crystal structure of sand led chemists to the architectural principle behind the new materials. On the molecular scale, a grain of sand is primarily a nonporous, three-dimensional framework known mineralogically as silicate. It consists of alternating silicon and oxygen atoms with two additional oxygen atoms attached to each silicon atom.

Kenneth J. Shea and Douglas A. Loy of the University of California, Irvine, working with Owen W. Webster of the Du Pont Co. in Wilmington, Del., reasoned that they might create a huge variety of silicate-like structures, some with built-in networks of predesigned pores, by learning to insert molecules of specific lengths as spacing units between silicon atoms at regular intervals in the framework. To test their reasoning, they constructed components, or monomers, for the frameworks by attaching silicon-based chemical groups to either end of a single benzene ring or to a rigid string of several rings. Dissolving these monomers in a solvent such as ethanol and then adding an acidic water solution triggers the several-hour, framework-forming reaction.

The reaction initially produces soft, fragile and transparent gels. Removing most of the water during a careful, two-day drying process yields hard, glassy materials with an interior Shea likens to a "rat's nest." Such sol-gel reactions are becoming increasingly important for making ultrapure glasses, ceramics, coatings and fibers, the researchers write in the November/December CHEMISTRY OF MATERIALS. So far, they report making amorphous materials that lack the long-range atomic or molecular order and predictability of crystals and of zeolites (an important class of molecular sieves used most notably for producing gasoline). The work illustrates scientists' increasing ability to dictate the properties of a macroscopic material by controlling its assembly on a molecular level, Shea says.

By doping the materials with compounds that absorb and reemit specific wavelengths of light, researchers may someday design components for the forthcoming technology known as photonics, Shea says. Instead of manipulating and channeling the flow of electrons as do today's microelectronic devices, photonic devices would govern the flow of light.

At last November's meeting of the Materials Research Society, chemist Larry L. Hench of the University of Florida in Gainesville reported using related sol-gel techniques to create microporous glasses. Hench says he suspects the technique could allow engineers to make precision optics without time-consuming grinding and polishing steps. His group already has fashioned potential radiation-detecting glasses by filling the nanometer-scale pores in the glass with chemicals that emit visible light after absorbing either gamma rays or ultraviolet light. *— I. Amato*