Planetology in the laboratory with ice

The solar system seems to have developed out of a tenuous nebula surrounding the sun. This idea, first put forward by Pierre Simon Laplace in the 18th century, used to be highly controversial but is generally accepted now. According to Douglas N.C. Lin of the University of California at Santa Cruz, there is within the solar system a microcosm of what that solar system nebula might have been like: the rings of Saturn. Because some of the parameters of Saturn's rings are difficult to measure precisely, he and his associates Frank G. Bridges and Artie Hatzes of the Lick Observatory (whose headquarters is on the Santa Cruz campus) have been doing what amounts to laboratory planetology. In an interview with SCIENCE NEWS, Lin described the experiments and some of the conclusions his group has drawn both for Saturn's rings and the solar system as a whole.

Saturn's rings are composed of particles that are largely ice. The questions studied involve the stability and evolution of the rings. The basic mechanism of change is collisions between the ice particles in the rings as they orbit the planet. Lin and colleagues first studied the transfer of energy and angular momentum in such collisions. Now they are studying how mass is transferred in such collisions to learn how the size of particles evolves.

As the particles orbit Saturn they tend to collide with their nearest neighbors. Collisions transfer angular momentum — that is, rotary motion — from inner particles to outer ones. A gradual spreading of the rings results as the inner particles fall toward the planet and the outer ones move away. The collisions are partly elastic and partly inelastic. Calculation from theoretical principles is impractical, as solid-state physics does not know precisely enough the characteristics of ice that determine what happens.

Although the particles move around the planet at speeds on the order of 10 kilometers per second, the difference in velocity between nearest neighbors is very small, about 1 millimeter per second —"the speed of a snail on a tabletop," says Lin. To get a simple pendulum to tap together ice balls as gently as that would require an arm 500 meters long, "rather difficult to build," Lin says. But a circular pendulum will do it, a wheel arranged so that part of its mass is adjustable on a screw. Its axle is pivoted on knife edges to rock back and forth. With this arrangement it is possible in principle to get an infinite pendulum period. Coming down from there, the apparatus can be adjusted to the gentle hits desired. A ball of ice mounted on the rim of the wheel is tapped against a standing block of ice.

Lin and colleagues have learned that the rings are fairly stable. In spite of the spreading tendency, they could have lasted as long as the solar system itself. The studies lead also to a determination of the viscosity of the rings — treating the aggregate as if it were a fluid. They can then explain, for example, the filamentation so prominent in the B ring as due to viscosity instabilities. This is similar, Lin says, to a highway with too many vehicles to move smoothly: They tend to clump up.

The thickness of the rings is another datum difficult to determine from observation. It depends on random motion related to the collisions; even probes that have gone close give only upper limits. Lin calculates the thickness at about 5 meters.

The largest particles in the rings, he says, are about 5 meters across. To find out if the size variations are primordial or if the collisions have changed it, the experimenters painted the balls and standing blocks with different kinds of fluorescent dye. After the collisions they examine the areas of contact to see how much matter has been transferred from one to the other. Their tentative conclusion from this latest piece of work is that evolution has had a great deal to do with the size distribution.

Making allowance for the difference of materials, much of what has been learned can be applied to the solar nebula and the formation of the planets. For example, Lin says, the larger planets such as Jupiter and Saturn made gaps in the solar nebula just as Saturn's satellites made gaps in the rings. The planets had to reach their present sizes before making the gaps and depriving themselves of further material. Calculating from their sizes and the viscosity of the nebula, Lin comes to a lifetime for this planet formation of about 1 million years, contrary to most current models. He suggests, therefore, that searches for alien planetary systems in formation concentrate on the very young class of T Tauri stars, which are about that old. —*D. E. Thomsen*

Teacher to ride the space shuttle

The first U.S. astronauts were all military pilots, the only people felt to have enough experience in high-performance jets to prepare them for flying spacecraft. With the coming of the space shuttle, though pilots are still at the controls, the crews have grown to include scientists and engineers, sent along to deploy the satellites, conduct the experiments and operate the other equipment that comprises the shuttle's diverse payloads. This week, President Reagan announced that, probably in late 1985 or early 1986, the shuttle will carry the first U.S. "private citizen" into space — an elementary or secondary school teacher.

Early in October, the National Aeronautics and Space Administration (NASA) will issue an "announcement of opportunity" listing the specific requirements and selection criteria for the job. As the first step in what NASA calls its Space Flight Participant Program, the opportunity will be open to full-time teachers from all public, private and parochial schools in the United States, Puerto Rico, Guam and the outlying U.S. territories, as well as in Defense Department overseas dependents' schools. NASA doesn't know how many teachers will apply, but one agency guesstimate envisions as many as 80,000.

There are medical requirements, but they are modest, such as vision correctable to 20/40 in the better eye and the ability to hear a whispered voice from three feet away, with a hearing aid if necessary. More pointed is the requirement that the selected teachers (including a "backup candidate") will take sabbaticals covering not only the preflight period and the shuttle mission itself, but also a year afterward. (NASA will reimburse the school systems for their salaries.)

That year, says NASA administrator James Beggs, is for the teacher — and other private citizens to follow—to "relate the experience to broad segments of the public." After all, notes an agency fact sheet, "teachers are professionally trained to effectively communicate their knowledge and experience to large groups of students."

Who will follow the teacher? "Well," says Beggs, "I'm on record many times as saying journalists are certainly a category we want to involve." Many have written letters to the agency about the possibility, although, notes the fact sheet, "NASA will not accept applications not submitted in accordance with the Announcement of Opportunity process, nor will it take names of potential applicants." In other words, don't rush the door.

Others who could be selected later on, says Beggs, might include artists, lawyers and a wide range of others. "We would also, I think, like to fly eventually some people from the world of mass entertainment... What else? I don't know. I think any of the professions which are interested and have been kind of part of this we would be interested in flying ... I think sooner rather than later we'll want to fly someone from the labor movement — maybe a worker on the line. I think that's something we should do to involve the folks, to motivate the folks who do the hard work of making this thing possible.

"Now, there are not a lot of opportunities," he told an auditorium full of reporters this week following the President's announcement, "although as time goes on we'll be flying more and more, and the opportunities will increase... There's a good chance that somebody in this room might fly. I certainly hope so," he added with a smile, "because I include myself in that category." —*J. Eberhart*