Solar system search from space station

President Reagan's order of a year ago that NASA develop a permanently manned U.S. space station (SN: 2/4/84, p. 69) came only four months after a National Academy of Sciences panel had reported finding "no scientific need" for such a station "during the next 20 years" (SN: 9/24/83, p. 199). Some space researchers have feared that visible support might result in their field's being saddled with a disproportionate share of the station's multibillion-dollar cost, and proposals for scientific studies to be conducted from the facility have been relatively slow to emerge.

Last week, however, NASA and the University of Arizona signed a memorandum of understanding to pursue what Eugene Levy, director of the university's Lunar and Planetary Laboratory in Tucson, calls "the most exciting scientific project that one could think of doing from this space station."

Its goal: the detection and study of planetary systems around other stars.

The plan calls for the development of an extremely accurate astrometric telescope, designed to detect the presence of planets it cannot actually see but which would make their presence known by their gravitational effects on the motions of the stars they circle. The instrument, to be based on the design of one now in operation at the University of Pittsburgh's Allegheny Observatory, would be carried up by the space shuttle and installed on the station to operate for as long as 20 years. Above earth's atmosphere, says Levy, it could be capable of detecting planet-caused stellar "wobbles" as small as 0.00001 second of arc, and the long lifetime is needed because even a massive planet may have to circle its star completely to produce an observable effect. (Jupiter takes about 12 years to orbit the sun.) Such an instrument could be flown as an independent satellite, Levy admits, but it would then be necessary to provide all of a satellite's "housekeeping" functions, whereas the space station might already have them available. The station could also be a far easier way to deal with whatever servicing needs might show up during two decades in space.

Furthermore, Levy says, locating individual planets is not really the point. "The real question of intellectual substance," he says, is to find out whether planetary systems are a "general, natural consequence" of star formation.

The plan (if it gets funded) calls for the NASA Ames Research Center at Moffett Field, Calif., to manage the design, construction and deployment of the telescope, while the University of Arizona establishes control facilities on the ground and manages the observing program.

— J. Eberhart

Survival: Sizing up the sexes

Among mammals, more males than females die as juveniles, especially when food is scarce. A widely accepted explanation holds the mother responsible, arguing that under certain circumstances she will make a larger investment in her daughter than in her son. Now zoologists at the University of Cambridge in England propose an alternative explanation that does not insist on parental bias. They suggest in the Jan. 10 NATURE that male juveniles, because they grow faster and for a longer period than do females, are more susceptible to food deprivation.

Red deer on an island off Scotland were observed by T. H. Clutton-Brock, S. D. Albon and F. E. Guinness. They report as much as 20 percent greater mortality in male deer than in females during the first two years of life. The scientists also surveyed published reports on the sex ratio among juvenile birds and mammals. They found that the discrepancy between male and female survival is greatest in species in which there is the greatest difference between male and female adult size.

Several lines of evidence support the new theory of differential survival, say Clutton-Brock and colleagues. Sex differences in mortality extend throughout an animal's period of growth, long after weaning — for instance, among many hooved animals the greatest sex differences in mortality occur during the first

and second winters. In addition, experiments with young rats and pigs on inadequate diets show that, even in the absence of parents, males are more likely to die than are females.

Some aspects of the sex ratio remain unexplained by the nutrition theory, the scientists admit. These include the greater tendency of males to die during the early stages of gestation and at birth or hatching, even in species with little size difference between male and female adults. Furthermore, when the adult female is larger than the male, as in the European sparrowhawk, there is no evidence that the juvenile female has a lower survival rate than the male.

Whichever theory is correct, the scientists suggest an "evolutionary explanation": that sexual selection favoring large adult size in males has increased the male growth rate to the point at which this growth is balanced by its cost to juveniles.

— J. A. Miller

Planet X and the killer comets

Another entry has just been added in the contest to devise an astronomical theory explaining the periodic showers of comets that are thought by many to wipe out life forms on earth every 26 million years or so (SN: 10/11/83, p. 212). Astrophysicists Daniel P. Whitmire and John J. Matese at the University of Southwestern Louisiana in Lafayette created the new theory by merging two ideas that were proposed in the past for reasons totally unrelated to periodic comet impacts and mass extinctions: a tenth planet, dubbed Planet X and envisioned to reside beyond the orbit of Pluto; and a disk or belt of comets thought to lie in the plane of the solar system beyond Neptune.

By fashioning a complex motion for Planet X, the theorists designed a model in which the planet periodically crosses near the belt of comets, disrupting their orbits and sending them to rain on the solar system.

So far their paper, published in the Jan. 3 NATURE and presented Jan. 11 at a symposium on the Galaxy and the Solar System (held just before the annual meeting of the American Astronomical Society) in Tucson, Ariz., has received limited scrutiny. Other scientists, including proponents of rival theories, call the Planet X concept imaginative, even ingenious, but say that it is too hard to judge the model without more detailed calculations.

In the scenario developed by Whitmire and Matese, Planet X would move at an average distance from the sun of 100 astronomical units (AU), or 100 times the distance between the earth and the sun, in a moderately elliptical orbit that is inclined from the plane of the solar system at an angle of about 45 degrees. Planet X is envisioned to complete one orbit every 1,000 years. But the orbit itself, like the orbits of other planets, would revolve, or precess, around the sun in this model because of the gravitational tugs from the other planets. Comet showers would be triggered every 28 million years — whenever the orbit moves close to the comet belt.

Whitmire and Matese propose that the belt, which was orginally hypothesized in

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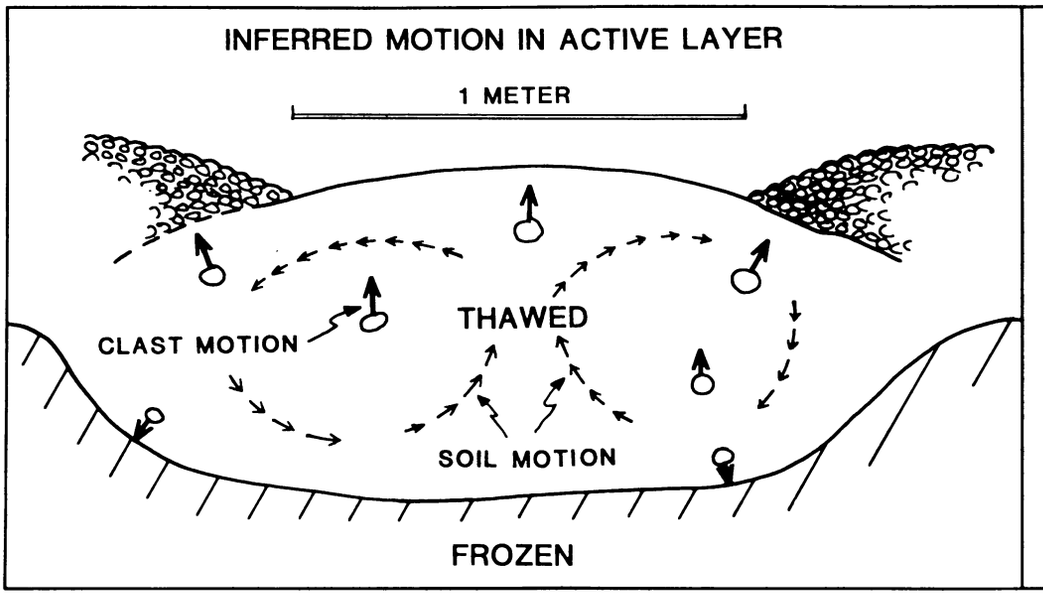

This vertical cross section of a sorted circle shows schematically Hallet's theory of soil convection. The soil at the top of the mound thaws first and becomes more dense than the soil beneath it. This density inversion causes the soil to move in cells as shown. The larger clasts, or large rocks, are separated out from the soil by a combination of two motions: the soil movement and a process called upfreezing in which the clast moves relative to the soil. The end result after many seasons is a sorted circle.

really address the question of how the larger stones are sorted from the fine soil. According to Hallet, large rocks, or clasts, commonly freeze up through the soil. "Farmers find boulders in their fields and people who build highways find that rocks go right up through the base of the road and through the pavement," he says.

Hallet's group has examined this "upfreezing" process in the laboratory. After four cycles of thawing and freezing in the laboratory, they found that a stone buried in the soil moved 3 centimeters above its original position. The researchers believe that the top of the rock freezes first and is pulled up by the inflated frozen soil. When the soil thaws, the rock settles down, but not quite as far, so that after a number of seasons the combined action of the soil convection and the clast movement results in a sorted pattern.

In the coming months at Spitsbergen the researchers want to verify and map the density profile as it changes, chart the freezing and thawing fronts that are thought to move through the soil mounds and search for soil motion that might accompany freezing as well as thawing. They are also interested in seeing if some motions they observed, such as the border rings appearing to shrink slightly, are erased or enhanced during a complete freeze-thaw cycle.

"Our study of gravitationally sorted patterns is far from being finished," says Hallet. "But I think we're on the right track."□

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conjunction with theories on the origin of the solar system, extends from 35 to 70 AU. From 70 to 130 AU, Planet X would have cleared a gap in the belt, which then resumes beyond 130 AU. While this comet belt has never been seen, says Whitmire, it is widely thought to exist, especially the section of the belt closest to the sun. The gravitational pull of Planet X would dislodge comets near the gap when either the perihelion (point on the orbit closest to the sun) brushes by the inner edge of the gap, or the aphelion (point farthest from the sun) graces the outer gap edge, although Whitmire believes the former effect is stronger than the latter since the comet belt is most dense closest to the sun.

Whitmire sees two major advantages of the Planet X approach over the competing Nemesis theory, of which Whitmire was in fact one of the original creators. Nemesis is the name of the proposed sister star to the sun that is envisioned to intrude on the so-called Oort cloud of comets at distances much farther from the sun than the proposed orbit of Planet X (SN: 4/21/84, p. 250).

With Planet X, "we're not postulating the existence of anything that hasn't already been postulated before for other reasons," says Whitmire. The idea that there could be an extra planet cruising the periphery of the planetary system has been put forth a number of times over the last 100 years in order to account for the observed deviations in the motions of the known outermost planets from their predicted courses (SN: 1/31/81, p. 68). While other suns are known to have companion stars, there is no independent astronomical evidence that Nemesis exists, Whitmire says. Moreover, past studies have concluded that the "missing planet" should have 1 to 5 times the mass of the earth and should be found 50 to 100 AU from the sun, characteristics consistent with Whitmire and Matese's Planet X theory for comet impacts.

The second advantage, according to Whitmire, is that the orbit of Planet X, being much closer to the sun than Nemesis, would be very stable. Recent calculations on the orbit of Nemesis, on the other hand, indicate that its period has changed by 15 percent over the last 250 million years because of the gravitational nudges from other bodies (SN: 11/3/84, p. 279). "This is not necessarily a fatal objection to Nemesis, but it's the one that's most often raised," he explains.

Both the Planet X and Nemesis ideas can accommodate a range of values for the period, which is an asset at present because there is some uncertainty and disagreement over the exact period for the fossil, crater and other geological records. But this flexibility is also a disadvantage, says Richard B. Stothers at the NASA Goddard Institute for Space Studies in New York, because the period can't be used to make testable predictions with either theory.

Stothers and co-worker Michael R. Rampino prefer a model in which the solar system oscillates through the galactic plane at the known time interval of 33 million years — corresponding to periodicities the researchers claim to see in geological records (SN: 1/12/85, p. 24).

All of the scientists involved in the debate do agree that the solution will depend on more accurate dating of the geological and fossil records. Astronomers have also been looking for Nemesis. And, according to Ray Reynolds at NASA Ames Research Center in Moffett Field, Calif., who with co-workers had been planning to search for Planet X for a number of years, the data from the Infrared Astronomy Satellite (IRAS) have just been put in a form that can be analyzed to look for Planet X.

One of the reasons why Planet X may not have been found in the past, says Whitmire, is that previous surveys concentrated on the Northern Hemisphere while recent calculations show that Planet X, if it exists, is more likely to be found in the Southern Hemisphere. The IRAS data cover both hemispheres.

In the meantime, comments Stothers, "I think we haven't seen the last of the astronomical mechanisms. I have a stack of preprints related to all this on my desk.... The field is full of flowers." —*S. Weisburd*