thin, when the meteorite hit; Moore estimates that the ice floated on liquid water just 10 kilometers below.

All these features look very fresh to geologists, so they have little trouble imagining that the ocean they imply is still there today. But they are reserving final judgment about the age of Europa's surface to a small subgroup of their colleagues—the crater counters. These specialists count the number of impact craters in a given area, estimate the rate at which asteroids and comets have been bombarding the surface—a far more contentious question—and from those two quantities calculate how long it has been since geologic processes last wiped the surface clean of craters.

So far, the cratering ages have been in conflict. At the meeting, Clark Chapman and his colleagues at the Southwest Research Institute in Boulder, Colorado, offered an age of 1 million to 10 million years, a geologic blink of an eye, for one area that for all the world looks like Arctic ice floes caught in a freshly frozen sea. Such recent resurfacing would persuade even the most skeptical geologist that an ocean is reshaping the surface even now. But Gerhard Neukum of the German Aerospace Research Organization (DLR) in Berlin, like Chapman a Galileo team member, has been advocating a truly ancient age for parts of Europa: 3 billion years. Few would agree with Neukum's pivotal assumption—that a swarm of asteroid impacts billions of years ago, rather than the steadier rain of comets assumed by Chapman, dominates Europa's cratering record—but most geologists take the controversy as a sign that the final age for the surface of Europa is not in.

Variations in Europa's surface features also make some geologists hesitate to endorse a present-day ocean. While the maculae suggest a thin ice layer, noted Moore, the large crater Pwyll looks more like a classic crater, suggesting the ice there was far thicker at the time of impact. Pappalardo also notes that the fractures and ridges, apparently formed when the ice was thin, seem to have preceded the pits, domes, and spots that formed when a thicker layer of warm ice was convecting. That would suggest that at least in some places, the ice has been thickening in geologically recent times. Europa's interior may be cooling because the store of heat from its formation is dwindling or because of variations in another source of heat, the tidal massaging of the moon by Jupiter's gravity.

Proving that a global ocean or even local lakes still lie below the Europan ice could take a while. Galileo will take an even closer look during its extended mission starting in December, improving the resolution of its best images from 70 meters to 10 meters. If an even sharper look at Europa fails to convince everyone, the job will probably fall to a future geophysics mission in which a spacecraft would orbit the moon and probe it with ice-penetrating radar, finally plumbing the depths beneath its tantalizing exterior.

–Richard A. Kerr

Additional Reading

Abstracts from the Division for Planetary Sciences meeting can be found at http://www.aas.org/~dps/

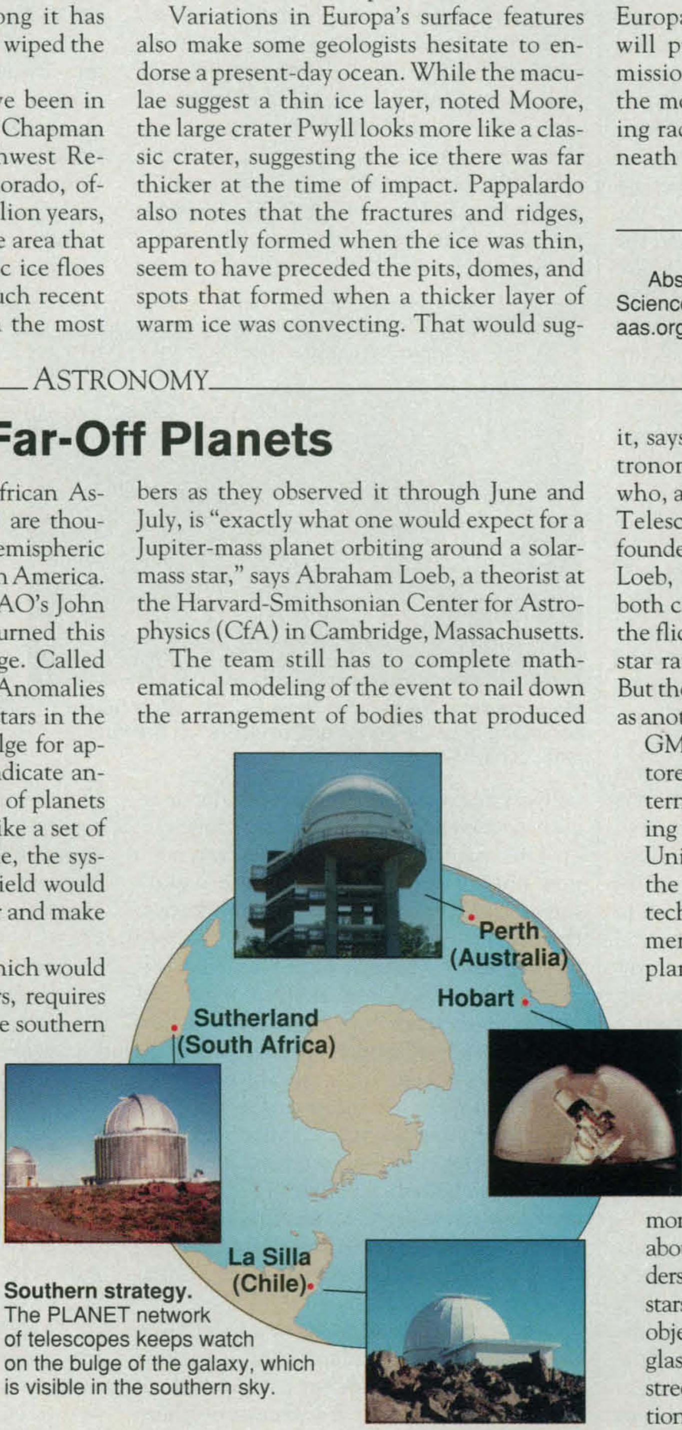
ASTRONOMY

Flickers From Far-Off Planets

The telescopes of the South African Astronomical Observatory (SAAO) are thousands of kilometers from their hemispheric counterparts in Australia and South America. But two and a half years ago, SAAO's John Menzies joined a project that turned this geographic isolation to advantage. Called PLANET—for Probing Lensing Anomalies Network—the project monitors stars in the Milky Way's crowded central bulge for apparent brightenings that could indicate another, dimmer star with a retinue of planets drifting across the line of sight. Like a set of lenses passing in front of a candle, the system's complicated gravitational field would bend light rays from the bulge star and make it seem to flash and dim.

Tracking these fluctuations, which would take place over a matter of hours, requires round-the-clock monitoring of the southern sky, where the galactic bulge can be seen. So SAAO's perch between collaborators in Chile and Australia was crucial to the project. And now the lonely watching may have paid off. In recent months, this unusual collaboration has uncovered two strong candidates for companions circling stars thousands of light-years from Earth. The most spectacularly fluctuating event, sketchily described in Internet alerts by PLANET team members as they observed it through June and July, is "exactly what one would expect for a Jupiter-mass planet orbiting around a solar-mass star," says Abraham Loeb, a theorist at the Harvard-Smithsonian Center for Astrophysics (CfA) in Cambridge, Massachusetts.

The team still has to complete mathematical modeling of the event to nail down the arrangement of bodies that produced it, says Penny Sackett of the Kapteyn Astronomical Institute in the Netherlands, who, along with Kailash Sahu of the Space Telescope Science Institute in Baltimore, founded PLANET in early 1995. She and Loeb, who is not a member of PLANET, both caution that the system responsible for the flicker could turn out to be, say, a binary star rather than a single star with a planet. But the data themselves are likely to be solid, as another international collaboration called GMAN (*Science*, 7 March, p. 1416) monitored the same star and saw a similar pattern of brightening and dimming, according to team member David Bennett of the University of Notre Dame in Indiana. If the planet discoveries are confirmed, the technique could take its place as astronomers' most sensitive means of finding planets around other stars.



Southern strategy. The PLANET network of telescopes keeps watch on the bulge of the galaxy, which is visible in the southern sky.

The idea of searching for planets by watching for gravitational lensing can be traced to Shude Mao of CfA and Bohdan Paczyński of Princeton University. Paczyński had realized that by scanning large chunks of the sky for stars that gradually brighten over weeks or months, astronomers could say something about how often unseen stars or stellar cinders drift across the lines of sight to those stars. The symmetric gravity of each passing object would act like a single magnifying glass slowly passing in front of a distant streetlight. That insight spawned collaborations including MACHO (Massive Compact Halo Object) and OGLE (Optical Gravitational Lensing Experiment), which are scanning the skies for the gradual "Paczyński curves" in order to estimate how much unseen matter might be swarming through the galaxy in the form of such objects. While such lensing events are rare toward the galaxy's thinly populated outskirts, they are plentiful toward the bulge.

In a 1991 paper, Mao and Paczyński expanded on the idea. They pointed out that adding a planet around such a star would be akin to spattering water on the magnifying glass, embellishing the more gradual curve with rapid spikes in brightness. Sahu and Sackett realized that well-spaced telescopes of moderate size—a meter or less—could sample lensing events detected by MACHO and OGLE on much finer time scales, searching for planetary anomalies. So they formed PLANET, which now includes telescopes operated by SAAO, Perth Observatory and the University of Tasmania in Australia, and the European Southern Observatory and Cerro Tololo Inter-American Observatory in Chile.

Each night, PLANET keeps an eye on a handful of events reported by MACHO, immediately stepping up the sampling rate if any of them shows anomalous variations. "When anomalies are detected ... e-mail and phone services run very hot," says John Greenhill of the University of Tasmania.

The glimmer that galvanized PLANET and GMAN began with a sharp spike around 19 June, followed by a slow rise like a Paczyński curve, and—by some accounts—a strange, double-humped peak around 24 July before a final downturn. Follow-up observations and analysis that could eliminate an ordinary binary-star system as the cause should be completed in a few months, says Sackett.

The candidate planet circling around this putative dim star is a massive one, like the other extrasolar planets detected so far. But the search method could be sensitive enough to detect planets as small as Earth, unlike techniques that rely on finding a "wobble" in the parent star as a giant planet whirls around it (*Science*, 30 May, p. 1336). On the downside, it gives just a brief glimpse of the planet, and because of the very gradual convergence of light bent by gravity, any planets it reveals are so far out in the galactic blackness that they can't be studied by any other method. Says Jean Schneider of the Observatoire de Paris-Meudon in France, "I would be frustrated by the impossibility of investigating the planet any further."

For now, PLANET observers like SAAO's Menzies are simply enjoying the chase. "It is interesting to speculate," he says, "that one may be the only person on Earth to be aware, while watching the light curve unfold, of the existence of this other possible world."

–**James Glanz**

ARCHAEOLOGY

New Respect for Metal's Role In Ancient Arctic Cultures

When English naval officer Sir William Parry was searching for the elusive Northwest Passage in the Canadian High Arctic in 1821, he got a vivid glimpse of the Inuit passion for iron tools. Wherever Parry's party went, they encountered aboriginal groups eager to barter their most cherished possessions for iron nails and hoops; on one occasion, he wrote in his journal, he even witnessed an Inuit woman offer a 4-year-old child in exchange for a metal knife. His experience was shared by others who ventured into Arctic regions in the early 19th century. When British explorer Robert M'Clure's ship *Investigator* became jammed in the ice off northern Banks Island in 1853, for example, aboriginal families flocked from hundreds of kilometers away to salvage metal for making tools.

Metal traders. Remains of Thule Eskimo winter house, consisting of whale bones and boulders, on Bathurst Island, central Canadian Arctic.

A. MCCARTNEY/UNIVERSITY OF ARKANSAS

This ardor for iron, it turns out, was not a new phenomenon sparked by the metal's novelty. Archaeologists have long known that prehistoric Arctic cultures possessed tools crafted of iron scavenged from meteorites and fashioned from native copper. But only recently have they come to realize how widely dispersed and relatively abundant metal objects were in the ancient Arctic. By employing metal detectors in their excavations, searching for rust stains on wooden and bone handles, and studying slots that might have held metal blades, four independent research teams have recently recovered and identified troves of metal artifacts and other clues to its use at five sites in the Canadian Arctic and Greenland.

The discoveries are giving new insight into the complexity of ancient Arctic society. Metal objects were common at sites hundreds of kilometers from the few known northern sources of copper and iron, implying the existence of elaborate trade networks. And at some sites, the possession of metal objects seems to reflect patterns of social ranking. The desire for metal implements, says Peter Whitridge, an archaeologist at the University of Northern British Columbia in Prince George, both "united distant communities and divided them internally."

Researchers have been slow to recognize this brisk commerce in metal and the material's importance in prehistoric Arctic cultures largely because metal objects were so precious that they were rarely left behind for archaeologists to find. The Thule Inuit, who inhabited the Canadian Arctic and Greenland from A.D. 1000 to historic times, and their predecessors, the Dorset people, recycled broken pieces over and over again. While many tool handles bear rust stains, for example, few are found today with metal blades in place, suggesting that their owners thriftily removed the precious iron when an implement cracked or broke. "Metal is a material that you can keep reusing until it is dust practically," notes veteran Arctic researcher Allen McCartney, a professor of anthropology at the University of Arkansas, Fayetteville. "So it's been hard to find, because if it was big enough for someone to have seen it, they walked off with it." This realization led McCartney, in an influential paper published 6 years ago, to urge his colleagues to intensify the search for metal with electronic metal detection and other recovery techniques.

Several groups of researchers took this advice to heart. In the 1994 field season, for example, a team led by James Helmer and Genevieve LeMoine of the University of Calgary in Alberta recorded and confirmed 288 pieces of copper and iron with the help of a metal detector in two Dorset villages on Little Cornwallis Island in the Canadian High Arctic. Of 98 pieces ultimately collected—blades, points, needles, fasteners, and debris unearthed in dwellings dating from A.D. 450 to 1250—53 were made of copper and 45 of iron.

There's no obvious source of metal anywhere near Little Cornwallis Island, and ancient Arctic peoples did not smelt metal ores, as they lacked both trees for fuel and a tradi-