released as heat by the fall of helium raindrops must in fact be fueling Jupiter's infrared "glow," which is brighter than anything the solar energy reaching the planet could account for. "Jupiter is clearly a planet that is evolving compositionally," says Stevenson, "and it derives a large part of its energy output from helium raining into the interior."

Galileo team members with a bit more immediate interests—figuring out what makes Jovian weather tick—had some frustrations of their own. In keeping with its reputation as a Jovian Sahara, the hot spot's atmosphere was "relatively clear," says Boris Ragent of the San Jose State University Foundation, principal investigator of the cloud-sensing nephelometer instrument. Theorists had expected the probe would penetrate three dense cloud layers—the ammonia clouds obvious from Earth and ammonium hydrosulfide and water clouds beneath—but the nephelometer found only one cloud layer for sure, and that was of uncertain composition and unimpressive bulk—"a light fog with visibility of a mile perhaps," says Ragent.

This fair weather has momentarily frustrated researchers hoping for insights into the heat-driven, vertical circulation of Jupiter's atmosphere. Just as a towering thunderhead on Earth traces a column of rising air, planetary meteorologists hoped the Jovian cloud structure would deliver clues to how convection works on Jupiter. Pulling together observations from several atmospheric instruments besides the nephelometer should help, but one feature of the Jovian weather has already come through clearly: the vertical extent of the fierce winds that shape Jupiter's distinctive globe-girdling bands.

Before Galileo's arrival, some planetary meteorologists thought that the winds are most likely driven by solar energy absorbed by the clouds, which implies that they peter out not far below the cloud layers. Others preferred the idea that the winds are probably driven by a combination of heat left over from Jupiter's formation and the heat generated by the helium rain, in which case they persist deep into the interior.

By tracking the Doppler shift in the frequency of the probe's radio carrier signal as it fell through the atmosphere, David Atkinson of the University of Idaho and his colleagues clocked the powerful westerly winds, which blew at 360 kilometers per hour at the cloud tops. "There was no evidence the winds were decaying toward zero" at greater depths, he says.

"If that's right, it simplifies things a good deal," says planetary meteorologist Peter Gierasch of Cornell University, a probe team member. "It says the meteorology is deep, which rules out [the shallow-wind] hypotheses." How deep is "deep" remains to be seen, but rotating fluid-filled spheres—a laboratory model for stars and the largely fluid Jupiter—suggest that if the winds are driven by internal heating, they could extend as deep as the rocky core of the planet. The heat source driving the winds is also uncertain; even Galileo team members have yet to agree whether the observed winds require or merely suggest a deep energy source.

The Galileo orbiter's leisurely inspection of the Jovian atmosphere and especially its hot spots during the next 2 years should help put some of the probe's results in better context, but planetary scientists are never ones to think small. They are already talking about how useful another probe mission to Jupiter would be.

–Richard A. Kerr

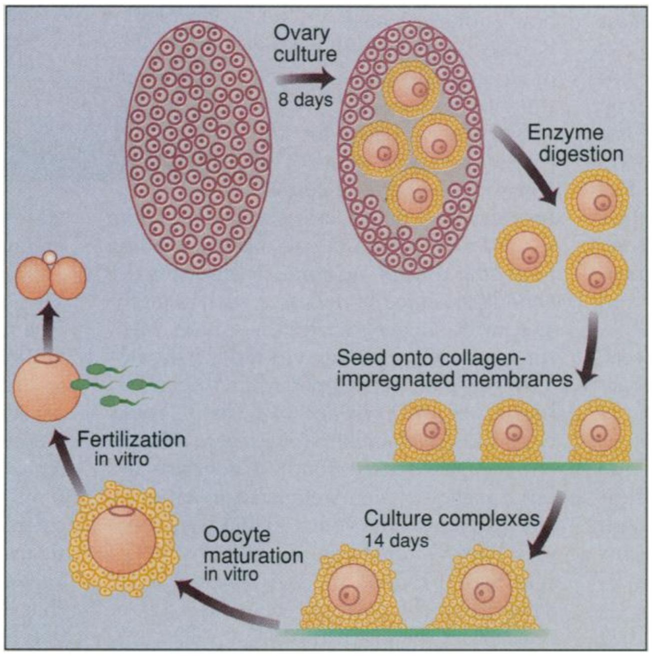
DEVELOPMENTAL BIOLOGY

Fertile Results: Bringing Up Baby (Eggs)

Developmental biologist John Eppig and research assistant Marilyn O'Brien are proud to announce two births: a healthy mouse pup and a new era of reproductive biology. The mouse heralding this new era is the product of an egg grown in vitro, all the way from its primordial precursor to maturity, when it was fertilized. In mice, this process normally takes 3 weeks; biologists have been struggling to replicate it for years.

The birth announcement, in the January issue of *Biology of Reproduction*, explains why. Female mammals are born with thousands of these egg precursors, called oocytes, but only a few at a time mature into eggs. And that limits opportunities for in vitro fertilization (IVF) in humans and other species, as the procedure can only be carried out on mature eggs. Now Eppig and O'Brien, from Jackson Laboratory in Bar Harbor, Maine, have devised a successful two-step "oocyte farming" technique. Not only does the technique promise to open a new window on what governs oocyte development, but because oocytes can be harvested in greater numbers than mature eggs can, it could also revolutionize assisted reproduction in humans and in endangered species.

Eppig's colleagues are handing out verbal equivalents of celebratory cigars. "Beautiful work," says John Biggers, a reproductive biologist at Harvard Medical School. "A tour de force," comments Richard Schultz, a developmental biologist at the University of Pennsylvania. And while the efficiency of the procedure is still low, "just having one mouse born means it is possible," says Joanne Fortune, a reproductive physiologist at Cornell University's College of Veterinary Medicine. "That's the important first step that we all needed to see."



SOURCE: J. EPPIG/THE JACKSON LABORATORY ILLUSTRATION: K. SUTLIFF

Egg harvest. Egg precursors called oocytes (*pink*) are first grown in organ culture, then isolated; the process yields mature fertilizable eggs.

Eppig hit on the technique while investigating the developmental signals passing between mouse oocytes and the so-called "granulosa cells" that surround them. These biochemical conversations begin at birth in female mice and are thought to prepare oocytes to begin growing into fertilizable eggs. Eppig and O'Brien thought they might be able to eavesdrop on these chats if they transferred oocyte-granulosa cell complexes from days-old mice into a culture dish, where they could expose the cell complexes by using collagenase enzymes to digest away surrounding ovary tissue.

Unfortunately, the granulosa cells preferred to walk instead of talk: They kept moving away from the oocytes and attaching themselves to the dish itself. So Eppig began years of what he calls "messing around" with conditions in the culture dishes. And in doing so, Eppig and O'Brien recently found the way to make an oocyte develop. First, they cultured entire newborn mouse ovaries for several days before isolating the oocyte-granulosa cell complexes.

This allowed the granulosa cells time to multiply and stick to each other in layers rather than to the dish. Then they doused the cells with growth factors and stimulatory hormones. The results—14 days later—were mature eggs.

Then the duo tried test-tube fertilization. "We were just immensely excited when we discovered that about 40% of the oocytes matured in this way after growth in vitro were actually able to undergo fertilization and cleavage" to the two-cell embryo stage, says Eppig.

Only one of 190 such two-cell embryos transferred to the oviducts of surrogate mothers grew into a live-born pup. (The pup is now 7 months old.) Finding out why the success rate was so low should give researchers a sharper picture of how oocytes grow into viable eggs, says Schultz. By changing the chemical environment to which the cultured oocytes are exposed to improve the success rate, he explains, Eppig and other researchers "may be able to get a molecular understanding of what is involved in acquiring embryonic competence. ... Eppig has laid the groundwork for some potentially really neat science."

And also for some potentially revolutionary wildlife conservation procedures and human medical treatments. In endangered, hard-to-breed species such as pandas, slices of ovary could be removed from females and their many oocytes grown and fertilized in the lab for implantation into surrogate females of related species. With infertile human couples, oocytes could be extracted and developed in preparation for test-tube fertilization. That would eliminate the need to treat prospective mothers with large doses of hormones called gonadotropins, which prompt them to ovulate the multiple eggs needed for the hit-and-miss process of conventional IVF—but whose long-term health effects are uncertain.

While significant hurdles will have to be overcome before Eppig's procedure can be attempted in humans and other species—for example, human oocytes develop very slowly, so the material would have to be kept alive in culture for a long period—researchers such as reproductive biologist Robert Clarke, laboratory director of the Center for Assisted Reproduction at Boston's Brigham and Women's Hospital (BWH), say Eppig's advance has helped clear the way for the next technological leap. BWH, in fact, plans to offer an oocyte-storage service to women at risk of becoming infertile from cancer chemotherapy. "The technology for culturing primordial human oocytes isn't there yet," Clarke says. "[But] I think the concept is probably one of the most important advances that will come through in this field in the next several years."

–Wade Roush

ASTRONOMY

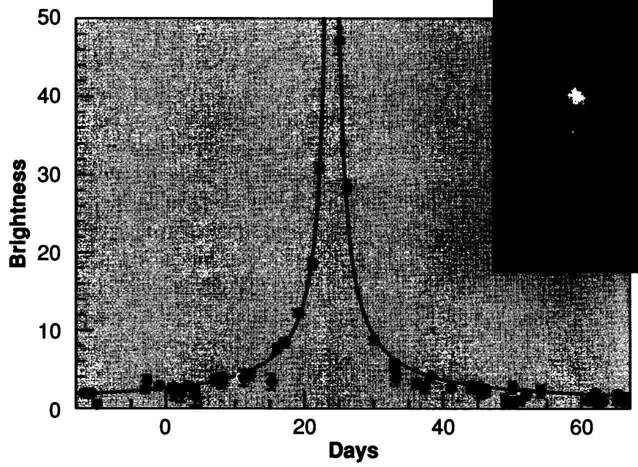
Is the Dark Matter Mystery Solved?

SAN ANTONIO—To judge from the headlines, astronomers have solved one of their field's greatest mysteries: the identity of the long-sought "dark matter." A widely reported press conference at a meeting of the American Astronomical Society held here last month left the impression that the hitherto undetectable mass whose gravity keeps our own Milky Way and other spiral galaxies from flying apart as they spin on their axes has now been found. But astronomers—including the dark-matter hunters themselves—say reports of the mystery's solution may have been premature.

In their presentation at the meeting, a multi-institutional team of astronomers announced that MACHOs—for massive compact halo objects—most likely make up 50% of the dark matter in our galaxy, more than doubling the team's earlier estimate, which they published less than a year ago in *Physical Review Letters* (*Science*, 5 May 1995, p. 642). Because MACHOs consist of ordinary matter, such as the burnt-out normal stars known as white dwarfs, the revision—if it holds up—could mean that all the galaxy's missing mass consists of ordinary matter rather than the exotic particles some theorists favor. The rest of the mass, some astrophysicists suggested, could be in objects larger than the team has searched for yet, or too far away to detect. "My sentiment is that if half of it is ordinary stuff, then the rest of it is ordinary stuff, too," said astrophysicist John Bahcall of the Institute for Advanced Study in Princeton, New Jersey, who is not a MACHO team member, at the press conference.

And that could pose problems for current astrophysical theories, including some predictions of the big-bang scenario for the origin of the universe and its later evolution. Many theorists believe that during the big bang, a cosmos of purely "ordinary stuff" would have had trouble cooking up observed elemental abundances unless the matter's overall density was extremely low. And later, the primordial soup might not have collapsed into galaxies and the large galaxy clusters known to exist. Some theorists argue, too, that the universe as a whole should have enough mass to slow its expansion toward a standstill. That would require far more mass than could be supplied by ordinary matter and has led some cosmologists to favor swarms of massive neutrinos or other, more exotic particles as candidates for the dark matter, both within galaxies and in the vast reaches in between.

For these reasons, says the University of Chicago's Michael Turner, "if indeed [the MACHO group] has solved the dark-matter problem, they would have started a revolution." But Turner and others, including MACHO team members, note that the data so far are too sketchy to really settle the dark matter issue. "We still only have less than two handfuls of events," concedes team member Kem Cook of Lawrence Livermore National Laboratory.



Sky high. The stars of the Large Magellanic Cloud provided the backdrop for detecting the brightenings caused by MACHOs, such as the one illustrated by the graph.

SOURCE: MACHO PHOTO: NASA

Even if they're plentiful, after all, MACHOs are hard to find. By definition, these clumps of dark matter can't be seen directly. To detect them, the team, including astronomers from Livermore, the Center for Particle Astrophysics at the University of California, Berkeley, and the Mount Stromlo Observatory in Australia, instead takes advantage of the fact that a MACHO's gravity bends rays of light. When it passes between Earth and a distant star, the MACHO acts as a lens, temporarily increasing the star's apparent brightness.

The group scanned for the objects in the Milky Way's spheroidal halo, where theory says the dark matter should be, using the Large Magellanic Cloud (LMC), a nearby galaxy, as a starry backdrop. The researchers monitored 9 million LMC stars each night for any that showed such transient brightness