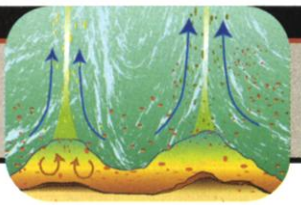


PAGE 1274 ▫ A sea change at the core

1277 Post-election puzzle

SOLAR SYSTEM EXPLORATION

Push to Revive Pluto Mission May Mean Competition for JPL

For a planet that some astronomers argue is too small even to be called one, Pluto is asserting a surprisingly strong pull on Earth. An unusual coalition of scientists, activists, and politicians is pressuring NASA to rethink a September decision to put a 2004 mission on hold because of budget constraints. The growing clamor is shaking up the planetary science community, which is also preparing for a mission at mid-decade to Europa, a moon of Jupiter. The biggest impact may be felt at the Jet Propulsion Laboratory (JPL) in Pasadena, California, which could face serious competition for the first time in decades on contracts to build planetary missions.

NASA managers have paired the Pluto and Europa missions, although they are separate undertakings. JPL estimated a few years ago that it would cost about $650 million to launch both missions, but a more conservative approach in the wake of two Mars failures has sent the cost soaring to as high as $1.4 billion. That figure prompted NASA space science chief Ed Weiler to put the freeze on Pluto (*Science*, 22 September, p. 2018).

Now the agency may ask outside organizations to come up with cheaper and faster alternatives for sending a probe to Pluto. This week a NASA scientific advisory panel backed the idea of an open competition if JPL can't come up with a better plan by the end of the month. The panel also urged the space agency to delay work on the Europa mission, despite its glamour, if that would free up money for Pluto.

Researchers and White House staffers are excited about the proposal to search for signs of life in oceans that may lie underneath Europa's icy crust. But Pluto's advocates say that delays could mean the forfeiture of important data. A 2004 Pluto launch would take advantage of Jupiter's transitory position to rocket the spacecraft and its plutonium generator to its destination in 8 to 12 years; any delay would push the arrival time at Pluto beyond 2020. By that time, researchers fear that the planet's atmosphere, which cools as Pluto recedes from the sun, may have frozen and collapsed, burying clues about the origin of the solar system. "If Pluto waits, science will be lost," says Alan Stern, an astrophysicist at the Southwest Research Institute in Boulder, Colorado. "If Europa waits an extra 18 months, no science will be lost."

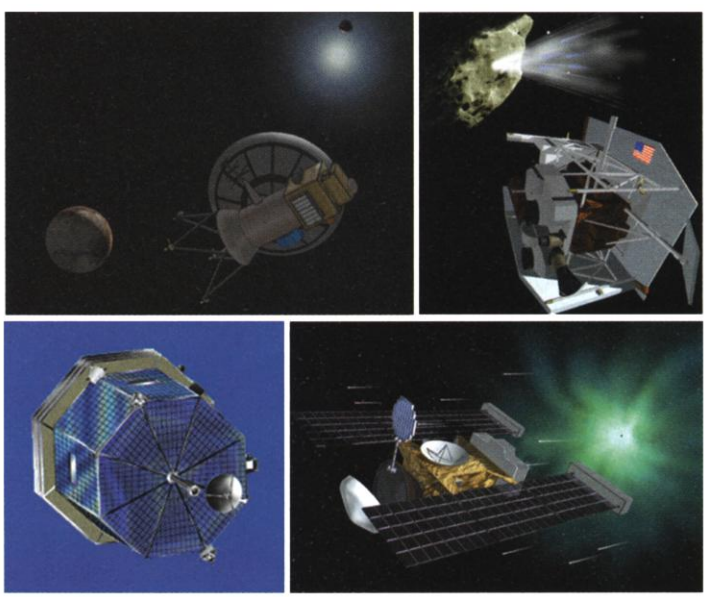
NASA managers say they would consider an open competition for the Pluto shot but that delaying Europa is more problematic. "We like the idea of competition," says Jay Bergstralh, acting science chief of NASA's solar system exploration division, noting that a request for proposals could go out as early as January. But delaying the Europa mission—tentatively slated for a 2006 launch—would require White House approval. And given the current uncertainty over who will be in the White House, Bergstralh adds, "the timing couldn't be worse."

The open competition and the Europa delay were proposed in a letter due out this week from the agency's solar system exploration advisory panel, chaired by planetary scientist Michael Drake of the University of Arizona in Tucson. "If polled, the science community likely would agree that the Europa mission is more important," says Drake. But "most people also like the idea of going to the edge of the solar system."

Among those who particularly like the idea are scientists and engineers at three organizations eager to prove that they have the right stuff to build potentially lucrative and prestigious planetary missions. Managers at Johns Hopkins's Applied Physics Lab (APL) in Laurel, Maryland; Lockheed Martin of Bethesda, Maryland; and Ball Aerospace of Boulder, Colorado, all say they have plans to bid on a Pluto mission. Each organization has a part in NASA's Discovery program, which provides experience with small planetary missions, and each would like a slice of JPL's much larger planetary pie. Also, each plans to use the spacecraft structure developed for Discovery missions as the basis for their Pluto entries. "Don't underestimate the innovative ideas which could arise out of competition," says Stamatios Krimigis, APL's space science chief.

But given the constraints of orbital mechanics, launch vehicles, propulsion, and electrical systems, JPL managers say they are skeptical that any dramatic new cost cuts will emerge from the competition. "We've looked at everything conceivable—even every wacky idea," says Richard Terrile, JPL's chief scientist for the outer solar system. "I don't think you will see [budget] numbers very different from ours." But he adds that bringing a contractor on board could increase the program's political clout. "Industry can bring in more congressional districts and get more political support than we can, and that's a good thing."

Weiler's decision to put Pluto on hold in



Dogfight? JPL faces competition to its Pluto mission *(top left)* from, clockwise, Ball Aerospace, Lockheed Martin, and Applied Research Laboratory, shown with models of comet missions built for NASA's Discovery program.

CREDITS: (CLOCKWISE FROM TOP LEFT) JPL/NASA; BALL AEROSPACE/JPL/NASA; JPL/NASA; APPLIED PHYSICS LABORATORY/JOHNS HOPKINS UNIVERSITY

September triggered a campaign by scientists and members of Pasadena's Planetary Society to boost congressional interest in the once-obscure mission. It appears to be having the desired effect: On 28 October, Representative James Walsh (R–NY), who chairs the House panel that approves NASA's budget, noted that "Pluto remains the only planet in the solar system" unvisited by spacecraft. He also said that the mission would provide data on the small bodies beyond Pluto that populate the Kuiper belt. Walsh has asked NASA for an explanation for the announced delay to "clear up any confusion on the part of our members."

That pressure has put NASA managers in a delicate position. Agency officials say they would like to keep Pluto on track despite rising costs and an uncertain budget. But they don't want to get into a fight with the White House over the Europa mission. Proponents hope to tip the balance in favor of the outermost planet without upsetting those more focused on Europa. "NASA is going to see it will be greatly to their advantage to restart [Pluto] expeditiously," says Stern. "They missed a bet—this mission is a keeper."

–ANDREW LAWLER

NEUROBIOLOGY

Heretical View of Visual Development

In the 1960s, two Harvard neurobiologists turned thinking about brain development on its head, showing that experience itself could alter the structure of the brain as it continues to mature after birth. David Hubel and Torsten Wiesel found in monkeys and cats that seeing out of both eyes is necessary for the normal arrangement of so-called ocular dominance columns—neat columns of brain cells that respond to visual activity from one eye or the other. This work led to the deeply rooted belief that the columns form as a result of visual activity—a belief now being called into question.

In work described on page 1321, Duke University neuroscientists Justin Crowley and Lawrence Katz report that ocular dominance columns in ferrets appear long before the columns can be modified by visual experience. Even more heretical, they present data suggesting that neural activity from the eyes has little influence over the formation of the columns. They propose instead that innate molecules that guide growing axons to their locations in the developing brain may be primarily responsible for building these columns.

"It's a very beautiful study," says Harvard neuroscientist Carla Shatz. "There's no question that they showed that ocular dominance columns form earlier than we thought." But Shatz and others contest the conclusion that neural activity is not required for constructing the columns, arguing that there are other explanations for the researchers' findings. "I'm agnostic about that [conclusion]," Shatz adds.

If the Duke team's conclusions are correct, however, they may once again drastically alter the way scientists view how the brain matures. What's more, if the purported molecular signals that shape sophisticated visual structures can be found, they may provide a new handle on the cause of myriad visual or other brain-related birth defects that now go unexplained.

But those are big "ifs." For years, research confirmed and extended Hubel and Wiesel's findings. In 1978, three of their Harvard protégés, Simon Levay, Michael Stryker, and Shatz, showed that in cats, the ocular dominance columns don't appear in the visual cortex, a region near the back of the brain, until 3 weeks after birth. That coincides exactly with the "critical period" in the animals, the time when Hubel and Wiesel had found that shutting one eye could disrupt the structure of the columns. So the scientists concluded that visual stimulation from both eyes is essential for the columns' initial formation.

But later work cast doubt on this analysis. Biologists showed several years ago, for example, that the columns are present at birth in monkeys and so must form before the critical period when they could be modified by visual experience. Still, researchers refused to retreat entirely from the idea that neural activity is essential, arguing that the spontaneous firing of neurons from the retina before the eyes open shapes the columns.

Three years ago, Crowley and Katz set out to test this hypothesis in ferrets. These animals were ideal because their nervous systems at birth are 3 weeks less developed than those of cats, enabling the detection of earlier developmental events. In work published last year, the researchers removed both eyes from newborn ferrets in an attempt to cut off any neural activity from the eyes that might influence the development of the columns.

Next the researchers wanted to find out whether that operation had in fact blocked column formation. When the animals reached adulthood, the researchers injected a tracer into eye-specific cells in the lateral geniculate nucleus (LGN) of the brain, through which visual signals travel en route to the cortex. Once the tracer traveled to the cortex, it revealed neatly ordered ocular dominance columns. So, says Crowley, "we concluded that retinal activity could not be as important as we thought it was" for forming the columns.

Premature? The micrograph shows ocular dominance columns in the ferret visual cortex before the onset of the critical period.

But still, questions remained. Crowley and Katz wondered whether they had removed the eyes early enough—that is, before the columns had formed. So in the current study, they used their tracer technique to time the formation of the columns. They found that the columns were not present at birth but appeared as early as 16 days later, which is equivalent to a week before birth in cats. "In pushing the day back," says Stryker, now at the University of California, San Francisco, "it becomes even clearer that the formation of the ocular dominance columns precedes the onset of plasticity" in the critical period.

But even though lack of input from both eyes hadn't affected the columns, skeptics argued that it might take an imbalance in input—for instance, having signals from one eye but not the other—to disrupt ocular dominance formation, as it does later during the critical period. To counter such claims, Katz and Crowley removed just one eye from each of six ferrets at an age when

CREDIT: J. CROWLEY AND L. KATZ