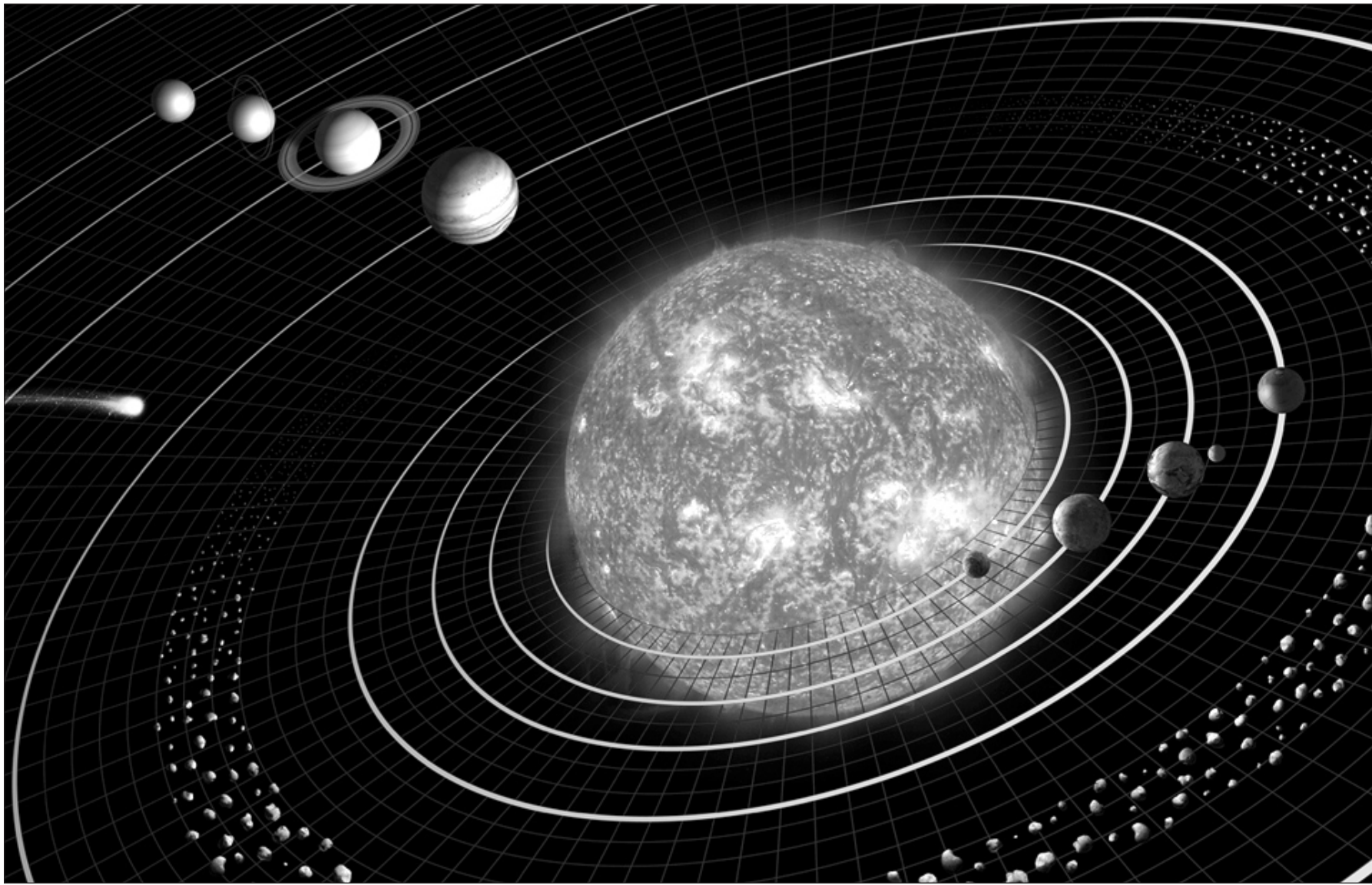


# Of cosmic proportions



The solar system we thought we knew is changing faster than most of us can keep up with part of a larger process of expanding our view of the universe. Planets, once thought to form gradually out of coalescing dust and gas, are now viewed as the survivors of a violent process of collision and accretion, the winners in a Darwinian competition to build up enough gravity to control one's own orbit. A planet the size of Pluto has no place in the 21st-century solar system. But it still has a role to play in science, along with the hundreds of other nearby objects discovered in just the past decade. Understanding them offers us a window on how planets like our own are born and give rise to life.

JERRY ADLER

IT'S a merciful thing that Clyde Tombaugh wasn't around to see this day. Tombaugh, the ambitious Kansas farm boy who discovered the ninth planet, Pluto, in 1930, departed Earth in January 1997, when he died at the age of 90. And then Tombaugh departed it again last January, when his cremated ashes were blasted into space aboard the New Horizons space probe. But while New

according to his 93-year-old widow, Patricia, who added that as a man of science, he would have understood the decision. For her part, though, she confessed some disappointment. "I feel like I sort of got demoted from my job being the wife of the discoverer of Pluto," she told the Arizona Daily Star. "Now I'm the wife of the discoverer of a dwarf planet."

It's not surprising that she should care. But what about the rest of us? Why is the world so captivated by the fate of this

its discovery it didn't get to complete even a third of its orbit. And, of course, it was not really its "fate" that was at stake, but an arbitrary designation whose impact will largely fall on textbook publishers, planetarium gift shops and astrologers. The debate and vote by the International Astronomical Union at its meeting in Prague was a little reminiscent of the earnest discussions a few years back about whether the 21st century began on January 1, 2000, or 2001. But then why was Matthew

visiting the Rose Center for Earth and Space at the American Museum of Natural History, feel a pang of sadness at the news about Pluto? "You grow up and there are nine planets, and now there aren't," she mused. "Imagine all those dorm rooms where they have to scrape Pluto off the ceiling."

But the solar system we thought we knew is changing faster than most of us can keep up with part of a larger process of expanding our view of the universe. Who imagined, even a few decades ago, that we would someday see up close giant hurricane-like storms sweep across the surface of Saturn? The revisions began as long ago as the 1970s, when the Apollo mission brought back evidence that the moon had been formed out of a tremendous collision between Earth and another large object. Planets, once thought to form gradually out of coalescing dust and gas, are now viewed as the survivors of a violent process of collision and accretion, the winners in a Darwinian competition to build up enough gravity to control one's own orbit. A planet the size of Pluto has no place in the 21st-century solar system. But it still has a role to play in science, along with the hundreds of other nearby objects discovered in just the past decade. Understanding them offers us a window on how planets like our own are born and give rise to life.

The sad truth is, Pluto's claim to planethood has been shaky ever since its discovery, which came about more or less by mistake. It is by far the smallest of the canonical nine planets about 2,300 kilometers (1,400 miles) in diameter, smaller even than Earth's moon and with a unique orbit, tilted at an angle to the plane in which the other eight planets all travel. Too faint to be seen by the naked eye and barely crawling across the night sky, it remained unknown to the ancients, who recognized five heavenly planets (Mercury, Venus, Mars, Jupiter, Saturn) traversing the unchanging backdrop of the stars. By 1846, astronomers had discovered Uranus and Neptune, which together with Earth made eight relatively large bodies circling the Sun, some, like Earth, with smaller moons in orbit around them as well.

No one suspected there might be another until the early 1900s, when astronomer Percival Lowell, who founded the observatory that bears his name in Flagstaff, Arizona, detected a perturbation in the orbits of the outermost planets, suggesting they were being tugged by the gravity of something not yet seen. Lowell, who died in 1916, devoted the last years of his life to the fruitless search for this "Planet X." (He was better known up to that point for his regrettable speculations about the "canals" on Mars, which he thought had been built by Martians.)

In 1929, the job of looking for Planet X was turned over to Tombaugh, an amateur astronomy buff who had built a homemade telescope using parts from an old Buick. Tombaugh hadn't even been to college later graduated from the University of Kansas and went on to a distinguished career as an astronomer but he must have had exceptional eyesight and iron patience. His job was to take two photographs of the same part of the sky on different nights using the observatory's new 13-inch telescope and compare them, looking for objects that had moved. Each photographic plate contained hundreds of thousands of stars. Yet in less than a year, he picked out of some 15 million specks of light the one that would be called Pluto, in just the part of the sky that Lowell had predicted.

This was hailed as a triumph of American science, only slightly tarnished when astronomers later realized that Pluto was actually much too small to have any effect on the orbits of other planets. The perturbations Lowell had noticed resulted from incorrect values for the masses of Uranus and Neptune. Pluto just happened to be in the right place at the right time to be found.

At first, no one really knew the size of Pluto. Some calculations suggested about as big as Earth, so calling it a planet was uncontroversial. But as more was known, astronomers began to question whether it belonged in the same category as the other eight planets. Some even wanted to call it a "comet" a class of generally much smaller balls of ice and dust that swoop in and out of the vicinity of the Sun on highly eccentric orbits. When the Rose Center opened in 2000, its solar-system exhibit had only eight planets provoking a flood of angry letters from second graders, according to Michael Shara, curator of astrophysics. "We're trying not to gloat," he said after the IAU vote, "but it's hard not to say we told you so."

This has nothing to do with

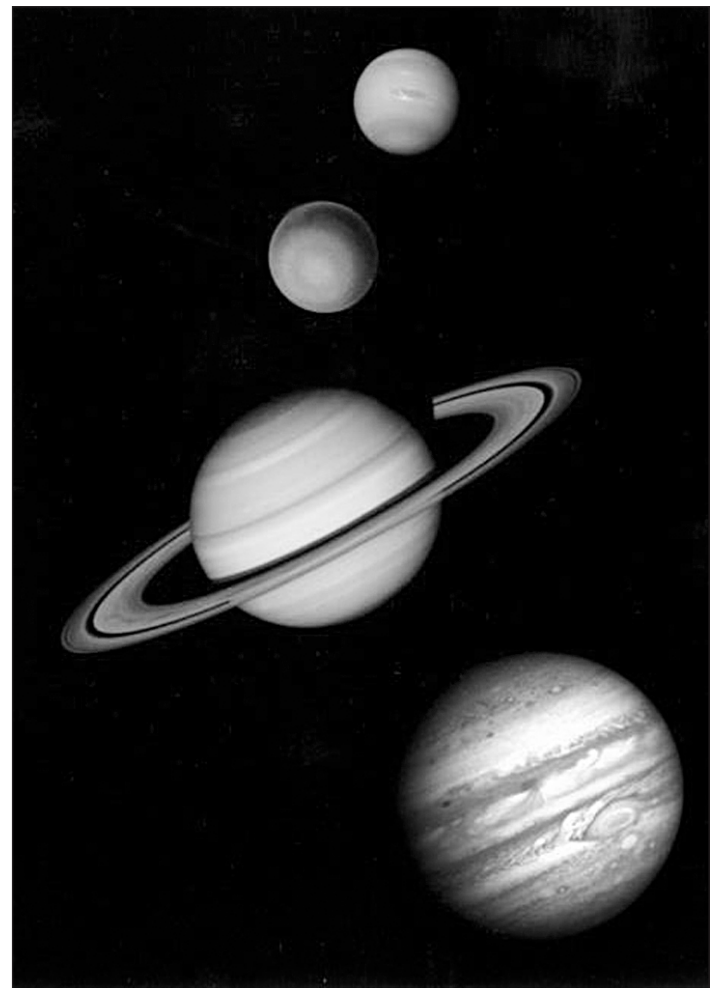
Pluto's inherent scientific interest. "Whether you're in favor of Pluto being a planet or not, every astrophysicist is cheering on the New Horizons mission," says Shara. "We've never been to a dwarf planet before. What's it like? Is it smooth, like an ice cube, or does it have cracks, which would indicate radioactive or volcanic activity?" Pluto's orbit runs through the Kuiper Belt, a doughnut-shaped region of rocks at the very edge of the solar system that astronomers have just begun to explore.

What they are finding there are clues to the origins of planets and of life itself. "When I was a kid, astronomy books would talk about planet formation as if it were a miracle," says Richard Terrile, a planetary astronomer at the Jet Propulsion Laboratory. "It was a very unlikely event. The fact that we were on Earth and had life here seemed to be 20 serial miracles that all had to happen one after the other. And now we know that all of these events are fairly common." The question of how solar systems form is particularly interesting in light of the recent discoveries of planets circling other stars, one of the biggest changes in our mental map of the universe in the last decade. Astronomers have found more than 100, some of them potential candidates to harbor life.

What forced the issue of Pluto's status was a discovery last year by a Caltech astronomer named Mike Brown. Since 1998, Brown and his collaborators, David Rabinowitz at Yale and Chad Trujillo of the Gemini Observatory in Hawaii, have been doing more or less what Tombaugh did back in 1930: taking repeated pictures of the sky and looking for things that move. The pictures are now digital, of course, and computers do the initial screening, flagging as many as 100 objects a night for Brown to look at the next morning. The great majority are meaningless, but every now and then he turns up a new Kuiper Belt object, glinting in the light from the distant Sun. The one he spotted one morning last January, in an image originally recorded in October 2003, was unusual, uncommonly bright and in an orbit that took it far beyond Pluto. No Earth-based telescope can measure the size of a planet at that distance, so Brown had to wait until he could get time on the Hubble Space Telescope. By April of this year, he had his answer: the pinpoint of light officially designated 2003 UB313, but temporarily nicknamed Xena was about 2,400 kilometers across, around 5 percent bigger than Pluto.

Suddenly, the cozy certainties about the solar system with which an entire generation had grown up were called into doubt. Was Brown's discovery the 10th planet? It certainly looked that way if it weren't, then why should Pluto be one? But would the solar system stop at 10? There was no reason to think that the Kuiper Belt didn't hold more objects that are larger. Would they be planets, too? What if one were just a little smaller than Pluto? The whole episode called attention to the fact that astronomers had never formalized exactly what they meant by "planet." It had always seemed obvious, but the definition that seemed to be emerging by default something orbiting the Sun, about the size of Pluto, or bigger seemed embarrassingly ad hoc.

So the IAU proposed, at first, to set a threshold for planethood defined by shape. Planets form out of an accumulation of dust and rocks. Below a certain diameter, roughly 1,000 kilometers, they tend to stay in whatever random shape emerges from that process; above that size, their own gravity molds them into a sphere. So the first criterion was that a planet had to be round. But many moons are large enough to be round, so the second part of the definition was that a planet had to orbit the Sun,



Four gas giants: Neptune, Uranus, Saturn, Jupiter.

and not another planet.

That at least had the virtue of intellectual consistency. But it led to a complicated, 12-planet solar system, not counting all the Kuiper Belt objects that could qualify once their sizes are determined. The definition would include Pluto and UB313, but also Ceres, an asteroid just under 1,000 kilometers across, which in fact had been considered a planet when it was first discovered, in 1801. And, confusingly, it would also include Pluto's own moon, Charon. All other moons in the solar system are much smaller than the planets they orbit, so there's no question about which is which. But Charon is almost half the size of Pluto itself, so in the mathematical description of their orbits, the two objects actually appear to be circling each other. If you wanted to keep Pluto, you'd get all these others as well.

So the IAU perhaps anticipating endless future wrangling over which objects would make the cut, who would get credit for the discovery and what to name them decided that the solar system had enough planets already. More than enough: it added a third condition that a planet had to dominate its own orbit, clearing the immediate region of smaller objects, that in effect draws the line at eight. No asteroids can qualify, no Kuiper Belt objects. And no Pluto. They are now "dwarf planets."

Was this fair? Was it just? It depends on whom you ask. Shara, of the Rose Center, seems happy to be rid of Pluto. "Pluto is a chunk of ice which controls nothing," he says. "Its orbit is a slave to Neptune's orbit." Brown, who lost out on the honor of finding the first new planet of the 21st century, says he's saddened personally, but that it was the correct scientific choice. To single out the object he found among everything else flying around the Kuiper Belt "would be like saying you found the biggest piece of gravel in the pile. It would feel like cheating."

But others considered it an outrage. Some had a vested interest in Pluto, like the researchers involved in the New Horizons spacecraft project, who will now be devoting the next 10 years of their lives to a mission to a "dwarf planet." "I'm troubled by the possibility that people will think that objects smaller than the eight planets are less interesting in some sense, and that's not true," says David Stevenson of Cornell, an authority on planet formation. "Pluto is a very interesting object, and so are the others. Some have atmospheres, there are fluids or

gases that leak out from the interiors. It's not just size that matters."

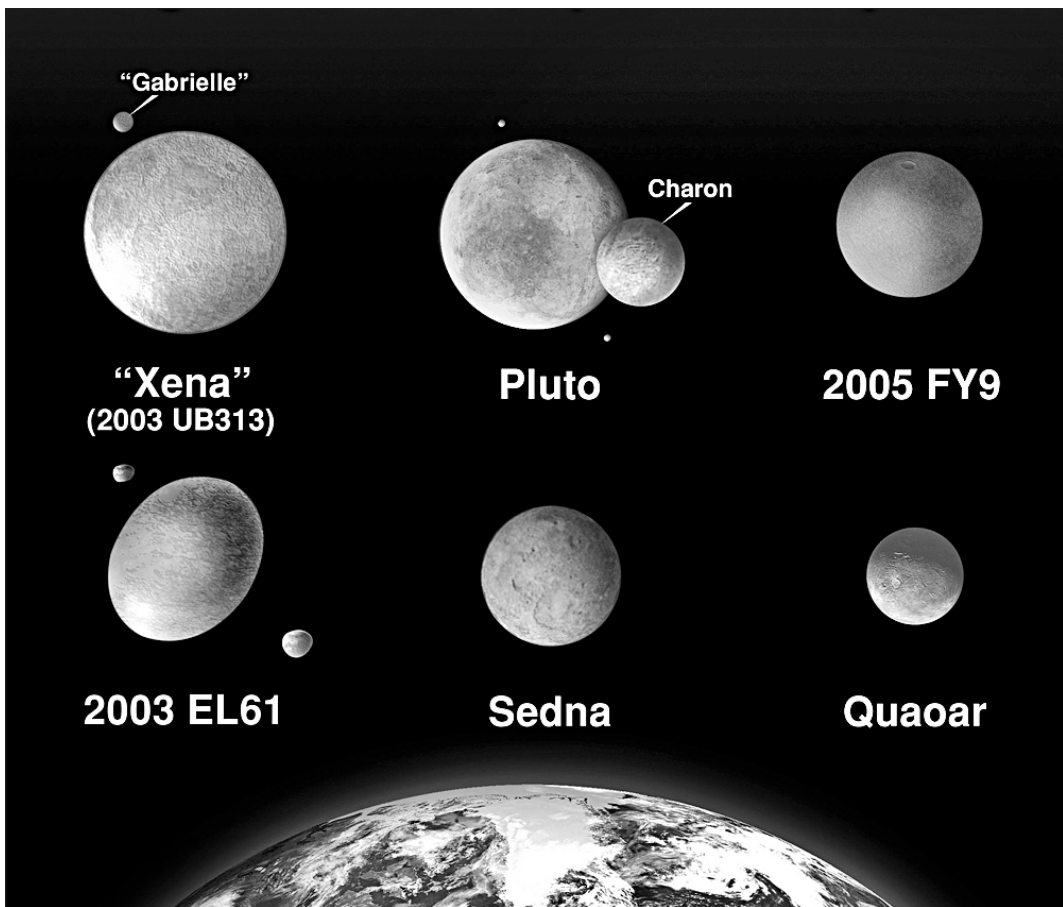
Unfortunately, it is size that matters for some things, like getting money from Congress; at least one prominent astronomer said it was a lucky thing that the New Horizons mission got funded years ago, while Pluto was still a planet. Joel Parker of the Southwest Research Institute, one of the New Horizons' lead institutions, said he didn't think American astronomers would take the vote lying down, and predicted there might be a move to revise the definitions when the IAU meets again in 2009. His preferred solution would be to give Pluto "special dual citizenship" as both a Kuiper Belt object and a planet, in recognition of its special cultural status.

In other words, we are fond of it. "A lot of kids like Pluto because it has a cute name," says Parker, and if even one of those kids grows up to be the next Einsteinor, almost as good, the head of the House appropriations committee shouldn't that be reason enough to keep it? "I have a 6-year-old and a 9-year-old, and it was embarrassing to explain it to them, this definition of a planet that sounds like it was written by a lawyer," says Terrile. But Louis Friedman, executive director of the Planetary Society, doesn't think kids will mind memorizing the name of one fewer planet. "It won't upset the schoolchildren," he predicts. "It's those of us who used to be schoolchildren."

As it happens, the IAU vote wasn't the only astronomy news. Researchers at the University of Arizona said they had found the first proof of the existence of "dark matter" an invisible substance, unlike any known atoms or particles, whose gravity holds galaxies together. If their finding holds up, it could be a major step toward understanding the creation of the universe. But that wasn't what most people wanted to talk about. You don't have to be an astronomer, or an astrologer for that matter, to feel a special kinship to the planets, which, set against the immensity of intergalactic space, seem almost cozy: not "dark matter" or "black holes" but clumps of "rock" and "ice" circling our very own Sun. If people seem unduly concerned with the definition of a planet, perhaps it's for the very good reason that we live on one.

With Mary Carmichael in Boston, Nomi Morrison Los Angeles and A Christian Jean in New York.

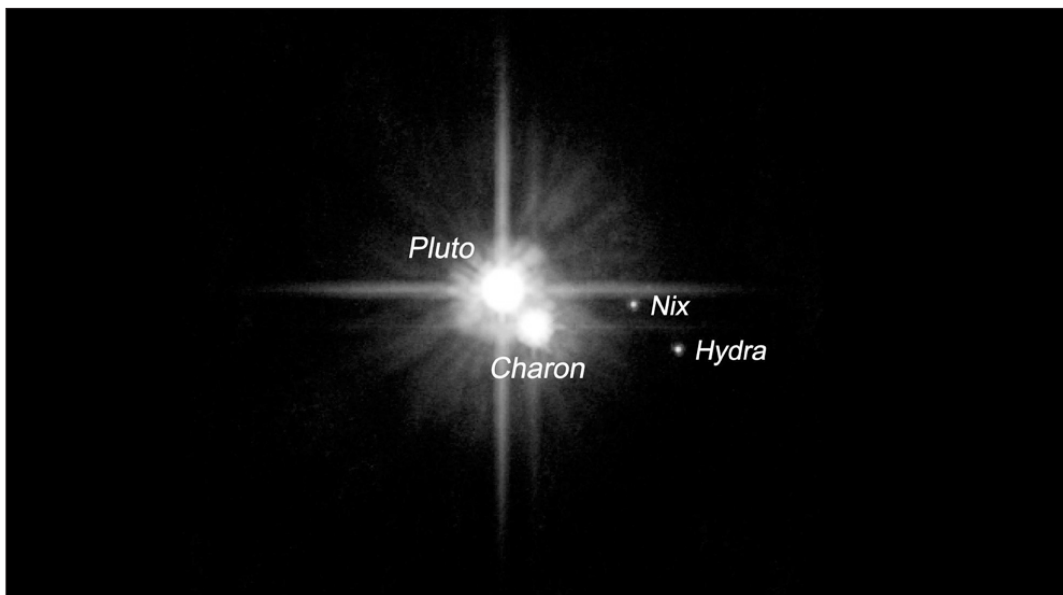
© 2006, Newsweek Inc. All rights reserved. Reprinted by arrangement.



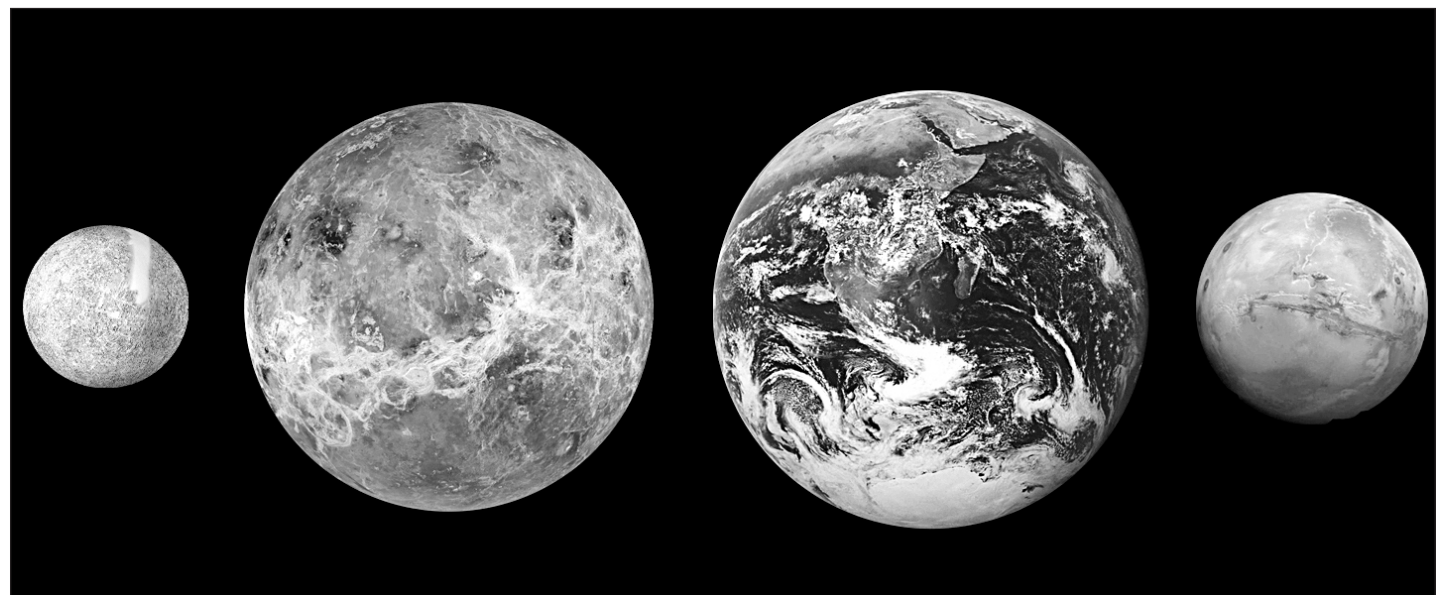
Horizons was streaking through the asteroid belt en route to a rendezvous with Pluto in 2015, a group of astronomers on Earth decreed that its destination now belonged to a new category of heavenly body, a "dwarf planet." Tombaugh knew something like that was afoot before he died,

remote and almost invisible world that, if it landed on Earth, would barely stretch from Boston to Tulsa? This knob of rock and frozen nitrogen dwells so far out in the solar system averaging about 3.6 billion miles, or almost 40 times the distance from Earth to the Sun that in the 76 years since

Malcan, a UCLA astronomer, deluged with e-mails from people he hadn't heard from in years, wanting to talk about the IAU meeting (which he skipped, although he says now if he'd realized what a big deal it would turn out to be he might have attended). Why did Jan Weiss,



Pluto and its moons.



The inner planets: Mercury, Venus, Earth, Mars.