THE TENTH PLANET

It's bigger than Pluto.

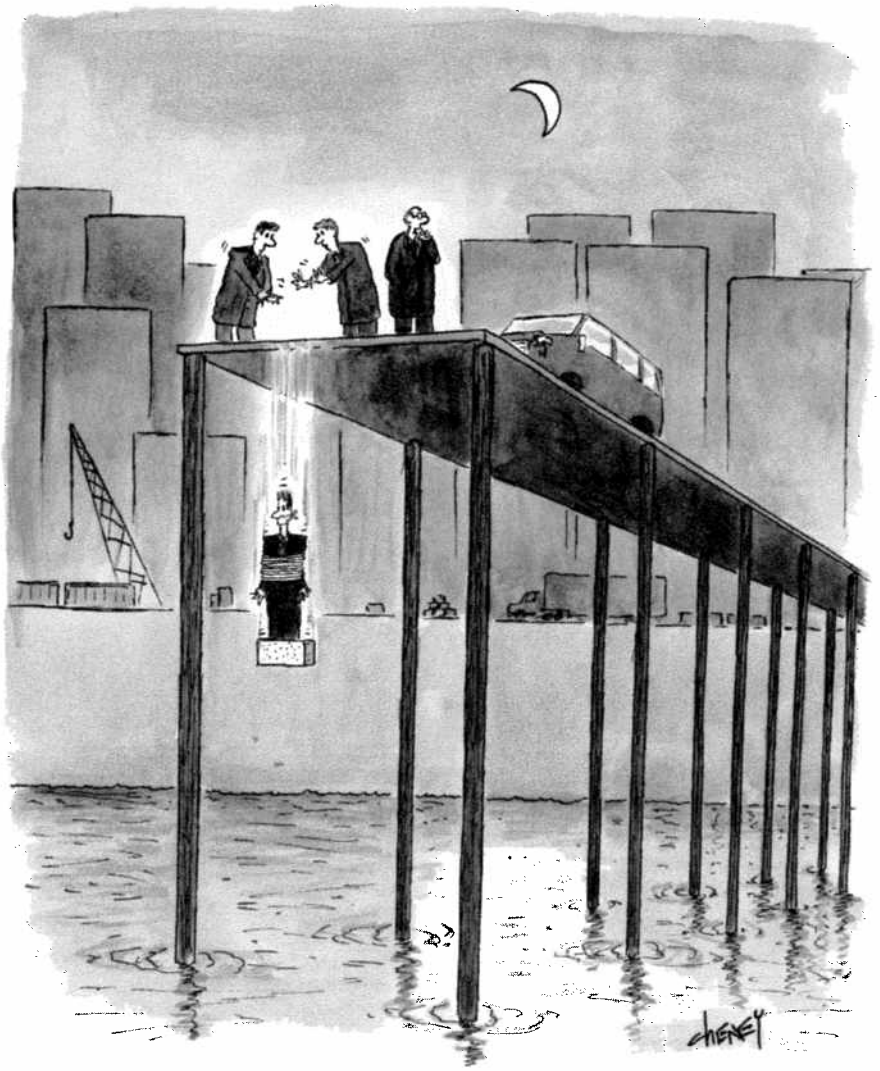
BY ALEC WILKINSON

There are nine planets in our solar system. Or there are eight. Or there are ten, or maybe even twenty-three. No one knows. A planet is an arbitrary thing, a notion. In a matter of weeks, however, the International Astronomical Union, meeting in Prague, is likely to issue a definitive description. For many years, the planets have been the nine largest objects in orbit around the sun. The case for nine regards Pluto as the ninth planet, as it has been since it was discovered, in 1930, by Clyde Tombaugh, who grew up on a farm in Kansas and was twenty-four when he found Pluto, after painstakingly observing the sky for months by means of photographs he took through a telescope in Arizona. The case for eight eliminates Pluto. It says that Pluto, the smallest planet and the most remote, is more properly regarded as a transneptunian object—that is, a body of rock and ice resident in the region past Neptune. The transneptunian region is also called the Kuiper Belt, after Gerard Kuiper, who predicted its existence in 1951; it was discovered in 1992. Pluto is the second-largest transneptunian, or Kuiper Belt, object. The case for ten planets accepts Pluto and considers the largest Kuiper Belt object, currently called 2003 UB313, as the tenth planet, since it is larger than Pluto. The argument for twenty-three planets regards a planet as any big, round object in our solar system. Very large bodies can only be round—the force of their gravity insists on it. If you were to disassemble one somehow—if you could take a hammer to the moon, for example, and shatter it like a piece of pottery—it would become round again. Slightly smaller than Pluto is the size at which an object might deviate from round, so Pluto and perhaps fourteen other objects qualify.

2003 UB313 was discovered on January 5, 2005, by an astronomer named Mike Brown, a professor at Caltech. It is the largest object discovered in the solar system since Neptune's moon Triton, in 1846. Beginning in the late eighteen-hundreds, astronomers spent a good deal of time searching for a new planet, which they called Planet X. Eventually, they decided that all the planets had been found, and the search was abandoned. Partly in their honor, Brown calls his object Xena. Brown, however, is a serious person, and does not intend to suggest Xena as a name. He wishes he could call it Proserpina, after Pluto's wife. Pluto was the lord of the underworld, and Proserpina lived a third of the year in the underworld with him and the rest on earth. When she was underground, the earth was in winter. Xena spends part of its orbit near Pluto's, and the rest at some remove. Unfortunately, there is already a minor planet called Proserpina, and the I.A.U.'s rules won't allow the name to be used twice.

Brown found Xena in a region of the sky where astronomers hadn't expected there to be a planet. Other than Pluto, the planets pursue their orbits on a plane that is called the ecliptic, which is very roughly level with the equator. Pluto's orbit is at seventeen degrees to the ecliptic; Xena's is at forty-four. Excluding the Milky Way, which is so bright that it is impossible to take clear photographs of territory near and within it, Brown intends to examine a hundred per cent of the sky in the Northern Hemisphere. He has so far seen two-thirds of it. He suspects that he might find in the Southern Hemisphere other objects the size of Xena. He has already found the seven largest objects in the solar system that aren't currently thought of as planets—he has also found the ninth

When Mike Brown asked his college professors what he should do for a living, one of them said, "There really need to be more astronomers out there looking for things."



"Fixing a leak—and you?"

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largest—all of which reside in the Kuiper Belt. If the I.A.U.'s definition allows twenty-three planets, Brown will have found eight of them, more than anyone else ever has. He will, in other words, have discovered nearly half of all the planets.

Brown began teaching at Caltech in 1997, when he was thirty-one years old. On a stormy night, he was at the university's Palomar Observatory, waiting for the weather to clear so that he could use a telescope he had reserved, when he decided to take a walk. Palomar is on a mountain, and at the time had four telescopes. (It now has six.) He came to one that he had not visited before, the Samuel Oschin Telescope, which is relatively small. Unlike the newer telescopes designed to look at tiny areas of the sky, this one took in large areas. If you were to hold your hand at arm's length, with your palm facing the sky, it would cover approximately the area that the telescope encloses. The big ones cover roughly the amount of sky framed by the head of a pin held at arm's length. No one was using the Oschin telescope, and Brown realized that its range would allow him to look at whole regions of the sky and find objects that he could point the big telescopes at. "It isn't that I had thought to look for planets," he says. "It's that if you don't have this telescope you don't know that it can be done."

In the middle of July, 1998, Brown began looking at the sky above Palomar. The telescope recorded what it saw on photographic plates that were fourteen inches square. The plates were exposed for twenty minutes, and then developed like film. The only way to know whether an object in a frame is a star or a planet is to observe it moving. "You look at one picture, there's a star," Brown says. "You look at two, there's still a star, but it's moved. It doesn't take college training to know that." Brown took photographs of each section for three nights in a row. "If you have enough plates and enough time to cover a particular swath," he says, "presumably you're eventually going to enter the swath where any new planets might be." He did this for three years, then he ran out of plates. (Kodak, the manufacturer, had stopped making them.) He had covered about five per cent of the sky, a not insubstantial area. On July 31, 2000, he wrote in his logbook, "Found nothing. But how deep did I go?"

As Brown was preparing to write up his results, which would take a year, he heard from some astronomers at Yale who had a new digital camera that could capture large tracts of sky. They needed a telescope to try it out on and wondered if they could share the Oschin telescope with him. With a digital camera, Brown could photograph a patch of sky three times in one night, instead of once every three nights. The digital format absorbs the image more quickly, can photograph objects that are fainter, and requires no developing. Also, the image could be installed immediately on Brown's computer.

In 2000, Brown made a bet with a friend that someone—he hoped it would be him—would find a new planet before December 31, 2004. At stake were five bottles of Veuve Clicquot. "In eighth-grade physics, after you learn about pulleys and levers, you learn about the scientific method, which is misleading," Brown says. "You learn that a scientist formulates a hypothesis, then does experiments, and if the results support the hypothesis it becomes a theory. I couldn't come up with any reasonable explanation why Pluto should be the largest thing out beyond Neptune. Of course, it could have been true, it appeared to be true, but I wasn't persuaded. I knew that no one had ever looked, really, and that, if you look, you'll

find something. So to say that I had a hypothesis is not correct. I had a bet."

One afternoon recently, I looked at images of planets with Brown on the computer in his office. He has a round face and reddish-blond hair, and wears glasses with delicate metal frames in the shape of ovals. He is married to a woman named Diane Binney, a school fund-raiser, and has an infant daughter, Lilah.

Some of the images were archival ones that he hadn't yet managed to look at, and some had been taken the night before. The stars appeared on the screen as notations of light against the blackness of the night sky. They looked like a pattern from a kind of linoleum tile that I remember from my childhood. When I said so, Brown said, "Really? To me they just look like stars." From two thousand photographs taken the night before, the computer had selected fifty-nine objects that appeared to be moving. It displayed three frames over roughly two seconds.

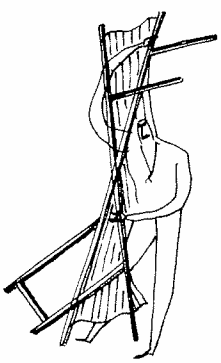
Of the first series, which had a kind of glowing aura on part of the right-hand side of the frame, Brown said, "There's a bright star just beyond the frame that's throwing up all kinds of junk and light, which fools the computer." He went to the next sequence. "Nothing on that one," he said, and moved quickly through the rest. "Junk, not real, black sky, another bright star, another bright star."

He shrugged. "Now we're going to run the code for looking at the really slow-moving objects," he said. "The chances of finding anything are very small; there's been two in three years, one of them the tenth planet. I'll go through them very fast."

He sat scrolling through them. "Smudge, smudge, smudge, nothing, nothing. Come on, it would be really great to find an object. Smudge, nothing." After a couple of minutes, he said, "Four left, come on," then shook his head. "That's it," he said. "We didn't find any new objects, but we did fill in one more section of the sky."

Brown thinks very quickly and somewhat dispassionately. A few years ago, he was living alone in a cabin in the hills above Pasadena, and his cat chased a rattlesnake into the kitchen. The rattlesnake hid under the refrigerator. Before confronting it, Brown emptied his ice trays on the floor and pushed the cubes under the refrigerator to slow it down. Brooding, he often pulls at strands of his hair and chews his nails. He punches the numbers on a phone very quickly, with two fingers. He is remorselessly competitive. Recently, he took a group of first-year geology students on a camping trip, where they held stick races on a stream that ran below a footbridge. Being scientists, they went to some trouble to find the proper sticks. Some chose sticks that had leaves, thinking they would act as sails, while others pulled the leaves off to streamline them. They raced long sticks and short sticks, but Brown won every race. "The trick, it occurred to me, is to throw your stick toward the water as fast as you can," he says. "So we start the race, they drop their sticks, and because they're so intent to see the finish they bolt toward the other side of the bridge without noticing how I had launched my stick. It's not sportsmanship, but it's a great way to impress Caltech freshmen."

Brown has an older brother, Andy, and a younger sister, Cammy. His mother, Barbara, says that his competitiveness comes from trying to do everything as well as his older brother. From materials in their chemistry set, they made gunpowder together as boys. Brown also had a contemplative side. "He definitely was the sit-back-and-think-about-it sort of person," Barbara says. "In high school, we always figured he would be an absent-minded professor. He could never find his wallet or his shoes. He would always just sit and stare into space and think."



Brown was born in 1965, in Huntsville, Alabama, where the Marshall Space Flight Center is. His father, Thomas, an engineer, worked on rockets for the Apollo mission. "As a child, I thought that when you grew up you built rockets," Brown says. "The only other thing I knew people did for sure was be an astronaut. We had astronauts living down the street."

When Brown was four, his parents came home from a vacation in Florida with an enthusiasm for sailing. Neither had sailed before. They bought a sailboat and joined a sailing club on the Tennessee River—"a shack where people gathered to drink beer and sail" is how Brown describes it. Brown's parents divorced in 1973, when he was in the third grade, and his father eventually moved to Houston to work on the space station. For the rest of his life, his father kept a sailboat. His ambition was to sail around the world, but in 1992, as he was preparing to leave on a shakedown cruise of the Caribbean, he learned that he had cancer. He died in 1999. Each year on the anniversary, Brown and his brother talk on the phone and drink rum-and-Cokes, their father's signature drink.

Andy remembers Brown's receiving, one Christmas, "a crappy little telescope and setting it up in the back yard," and his mother recalls his asking in seventh grade for a subscription to the magazine *Astronomy* ("That was a surprise," she says), but Brown says that astronomy was only one of the things he was interested in. He also wanted to fly airplanes. In eighth grade, he liked physics best. "In high school," he says, "I became really enamored with the idea of what you could calculate—how you make things move, how they fall, how do these actions calculate out? A roller coaster goes to the top of its track and drops. It's all meant to be calculable, it's all known, it's not magic. My freshman science teacher asked us whether it was possible to describe the parabola of a trajectory, and we said that it wasn't. Then she reached into her desk and got a ball and threw it at a kid and he caught it, and that part amazed me, that somehow your brain can calculate all these motions and rules, but, even so, another part has to learn how to do it. You have to be taught something you already know."

For as long as Brown can remember, he has looked at the night sky whenever he steps outdoors. During his sophomore year, above Alabama, Jupiter and Saturn were very close to each other. "I know this now," he says. "I didn't know it then. What I saw was two bright stars doing this fantastic dance around each other over the course of the winter. From night to night you didn't notice it, but from week to week you did. That was when I went

and learned about the constellations."

Brown wanted to study physics in college. Looking up college rankings at the library, he discovered that the undergraduate physics program at Princeton was rated the highest. He had never heard of Princeton, and wasn't sure where New Jersey was.

"Princeton was perfect for me," Brown says. "The campus is very cocooned and insular, very inward-looking, and for a naïve kid from Alabama it was what I needed when I first left home." At the time, many physicists were involved in derivative trading, and Brown thought that he might go to Wall Street. He asked his professors what they thought he should do, and one of them said, "There really need to be more astronomers out there looking for things."

To decide which graduate school to attend, Brown went back to the library. Harvard and the University of California, Berkeley, had the most highly regarded astronomy departments. Brown went to Berkeley for an interview and stood on the roof of the astronomy building, looking out at San Francisco Bay with sailboats all over it, and made his decision. He bought an old twenty-seven-foot sailboat and lived on it in the Berkeley marina.

Scientists on the advance edge of astronomy are occupied with the most distant and ancient galaxies and the borders of the universe. In general, the farther away the thing an astronomer studies, the more respect he or she receives. After the universe comes the galaxy, then the distant stars, then the solar system and the planets. Brown studied with a professor named Hyron Spinrad, who was interested in comets. "Nobody wanted to work on comets," Brown says. "Too close, not cool, so the only way he could get students to do it was more or less to force them to for six months." Unexpectedly, Brown liked comets. Several bright ones came through the sky during the period, and he was able to see them through binoculars. The far edge of the universe began to seem abstract and theoretical to him, and the solar system concrete and more appealing.

In Brown's third year, as he was searching for a thesis topic, he heard a lecture by a visiting professor who talked about Io, one of Jupiter's moons, which had volcanoes. The materials they released seemed to be picked up by Jupiter's magnetic field and then returned forcefully to Io in such a way that they smashed into the surface and knocked loose more material. It was a body under bombardment by its own contents—"a self-flagellating moon," Brown says—but no one knew much about the process.

It occurred to Brown that the university owned one small telescope that no one cared to use—you couldn't see anything far enough away with it. "What could you do with it?" Brown says. "Look at big things, and you can look at them night after night." The telescope was at the Lick Observatory, on a mountain east of San Jose. "I moved my sailboat to the southern end of the Bay and spent six months watching Jupiter," he says. "No one cared, because it was a small telescope. At least I wasn't wasting real telescope time." After a few months, a tremendous volcano erupted, and Brown watched it happen.

Professor Spinrad says that he was impressed by the way in which Brown conducted his research. "I started out with some skepticism about him," Spinrad said over the phone. "He was obviously a bright guy, but I don't think he applied his brilliance, or what appeared for a while to be pseudo-brilliance, as well as some students I've had. This completely turned around when he got interested in the magneto-belt of Jupiter. It's not the most extreme frontier of modern astrophysics, but he got spectacular results and used very creative methods of hardware and software analysis to exploit these peculiarities which you can't find elsewhere in the solar system."

At Palomar, with the digital camera, Brown and his team, which included Chad Trujillo, a Caltech postdoc, and David Rabinowitz, from Yale, began finding big things. In June, 2002, they found an object that appeared to be two or three times larger than Pluto. I say appeared, because the only way to estimate the size of an object that is so far away that you can't see its dimensions is by how bright it is. Brightness is a measure of how much sunlight a surface reflects. Kuiper Belt objects were thought to be about as dark as charcoal. The new object was farther away than Pluto, but appeared to be very bright. Brown arranged for a photograph to be taken of it from the Hubble Space Telescope, and determined that it was actually about half the size of Pluto but more reflective than he had thought. It was still the biggest object found in our solar system since Tombaugh found Pluto.

Someone who has found a minor planet can suggest a name, but the International Astronomical Union must approve it. The name cannot be longer than sixteen characters. It should be one word; it must not be difficult to pronounce, at least not in the language it comes from; and it must not be offensive. Names of military or political heroes or events are not suitable until they are more than a hundred years in the past. Names of pets are unwelcome. So are names of companies. In parts of the sky, specific rules pertain. Asteroids near Jupiter called Trojan asteroids must be named for heroes of the Trojan War. Minor planets with orbits between Jupiter and Neptune but not directly engaged with them—not moons, that is—are called centaurs and are named after them. Objects whose orbits approach Neptune's, or cross it, but are not satellites are named for mythological figures associated with the underworld. Brown's object fell into the category including objects sufficiently distant from Neptune's orbit that they are not substantially affected by it—the technical word is "perturbed." Such objects are named for figures from mythology that have to do with creation.

Brown and his group thought that it would be nice to have a name from a mythology close to California. They typed into Google "creation god, los angeles, indian," and were referred to a site that discussed the creation myths of a tribe called the Tongva, who lived in the Los Angeles Basin and were also known as the Gabrielino Indians. Brown liked the name Kwawar, which was one of the Tongva's creation gods. Since the Tongva still existed, Brown and Trujillo thought that they should ask the tribe's permission. Calling the phone number on the tribe's Web site, Trujillo reached the chief.

"He did what any good chief would do," Brown says. "He delegated." The

THERE WERE RAINBOWS EVERY DAY

There were rainbows every day
for three or four days afterward.
I sat in the large soft bed
with silence and stillness falling
around me like snow. Cross Fell
was icy white with a shock
of frozen cloud on its uppermost
tip. The carpet by the bed,
washed several times on the last
day you were home, took a week
to dry to a nubbly paperiness.
The henhouse filled with wind,
the roof was ripped away.
First one side of it split
open, then the other.
The garden shed blew apart,
the timbers of the frame rattled loose.
Rain lashed the windows.
The trees strained. The back door
blew open. Greenhouse glass
smashed. You were beautiful.
Your forehead smelled of powdered
millstone grits and moss.
Your ruby lips and throat
glistened. A red dot stood
on your eyebrow. (Did I nick
you slightly when I snipped
those troublesome hairs you'd swiped
me off from trimming?) Your Top
Man shirt and navy soft wool
waistcoat. A barely visible
smudge on your chin where the last
few mouthfuls of soup spooned in
had dribbled out again.
Your gray eyes dry and sinking,
like a Grünewald's overcome with wonder.

—Josephine Dickinson

chief referred Trujillo to the tribe's historian. The historian was delighted, but said that the tribe preferred the spelling Quaoar. The historian was also the tribe's chief dancer, and he choreographed a dance in honor of Quaoar, although Brown has not yet seen it.

The next thing Brown discovered, in November of 2003, after having looked at about fifteen per cent of the sky, was bigger than Quaoar and far more anomalous. It was the most distant object known to orbit the sun and also the coldest. It is so far away that Brown can't be sure of its size. Astronomers describe distance in terms of astronomical units, or AUs. One astronomical unit is ninety-three million miles. Earth is one AU from the sun. Jupiter is slightly more than five AUs from the sun. Pluto, when it was discovered, was about forty AUs from the sun. At the closest range of its orbit, it is about twenty-nine. The minor planet that Brown had found was ninety AUs distant.

Since the object was so cold, Brown decided that it would be sensible to have a name that derived from the creation mythology of a cold culture. The closest one to Los Angeles was that of the Inuit. Their mythology includes a goddess named Sedna. "Easy to spell, easy to say," Brown says. "And unbeknownst to me it was Andes backward."

Sedna is so far away that it is not likely even part of the Kuiper Belt. It is part of whatever region lies beyond it, but since it is the only object of its kind yet found, no one knows what to call that region or how to characterize it. Describing it is part of the science that Brown hopes one day to do.

By late 2004, Brown still hadn't found a planet—a body larger than Pluto, that is. "I thought, I'm going to lose that bet," he says. "I would not have thought that Pluto was the largest object out there, but it seemed that it was."

Two weeks before the bet expired, Brown found an object "in the shape of a stepped-on football with half the air let out." The football has two moons. It is as long as Pluto is wide. It spins end over end and revolves completely every four hours, but it wasn't a planet. Because it was December, Brown called this object Santa.

By December 31, 2004, Brown had looked through about a hundred thousand images from a revised search. (He had rewritten his computer program so that it would show him only the slowest-moving objects.) That evening, he sent an e-mail to his friend, saying that he was done looking at the sky for the day, and that she had won the bet. He went out to buy the champagne. On January 2nd, he went back to work and continued looking through the archival images. Three days later, he was looking at images from October 21, 2003. The computer had identified fourteen slow-moving objects, a fairly typical amount. "I did the usual thing," Brown says. "Flip, flip, flip, nothing, nothing, nothing." In the center of one of the screens, however, was an object moving just below the threshold that Brown had set during the original search. It was very bright. "I had been looking at these images for months and I never really expected to find anything," he says, "but I was being thorough, because it would be so important if anything really was there. If I did find something, I certainly didn't expect it to be bright, because it's so far away. Sedna had been quite faint, barely detectable, so the first thing I thought was, Is this a mistake? This can't be real. Slowly it sank in that it was real, and I pressed my little button here

for the computer to calculate how far away it is and the estimate put it about four times farther from the sun than Pluto—actually, it's three times. It took another while for it all to sink in: it's there, it's moving slowly, it really is farther than Pluto, and it's very bright. I didn't know how bright it was, exactly, because I didn't know how reflective it was, but, by any stretch of the imagination, I'm thinking, This is bigger than Pluto.

"So I run my quick calculations, guessing that it reflects the same amount of light as Quaoar, and the calculations say it's seven thousand kilometres across. Pluto is twenty-three hundred. The first thing I do is pick up the phone and call my wife and say, 'I just won the bet.'" He also sent his friend an e-mail asking if she would be willing to extend the bet's deadline, and she said she would.

After he hung up with his wife, he did some more calculations. "The key parameter is how much light an object reflects," Brown says. "The technical term is albedo. Charcoal has an albedo of about four per cent. Earth is forty per cent. Everybody thought that objects in the Kuiper Belt were between four and ten. At four per cent, this planet was eleven thousand kilometres. Mars is sixty-eight hundred. Mercury is five thousand. Earth is twelve thousand seven hundred. Then you temper your excitement. I thought I would throw in a ridiculously high number, such as forty per cent albedo, which made it nearly the size of Mercury. Eventually, we used the Hubble Telescope, which is very difficult to get time on. We got the data in December of 2005, and by April, 2006, we knew for sure. The answer is that it is a little bit larger than Pluto. It's eighty-seven per cent albedo. Freshly fallen snow on the earth is something like eighty per cent. A melting lake is seventy per cent. We're still working on what accounts for it, but I think the answer is that this thing is so far from the sun at the moment, and so cold, that its atmosphere is frozen. It's a big shiny ball."

Sometime after Brown had calculated the object's orbit, he realized that if he had taken with the cumbersome old photographic plates an image on the nights of October 17th, 18th, and 19th of 1998—in other words, during the first year of his search—one frame south of the southernmost image he collected, the image would have included Xena.

Having discovered Xena, Brown and his colleagues began studying it in order to describe it in a paper. In April, they found another notable object, one that was brighter than Pluto, and that they called Easterbunny. Brown calls Santa, Xena, and Easterbunny the Kuiper Belt Triumvirate, because they are the region's three brightest objects. "So it's spring of 2005, and I'm a little overwhelmed," he says. "I want to do the science correctly before announcing—figure out the orbits and what characteristics I can. I don't want just to have a press conference and say, 'Look at these crazy bright objects!'" Brown's daughter was due in July and he was busy with teaching, so he decided to announce the Kuiper Belt Triumvirate in the fall.

Brown hadn't told anyone about his findings except his wife and the members of his team, and he had asked that they keep them secret. Concerned that someone else might find one of the objects in the meantime, he decided to introduce the smallest one, Santa, at a conference of astronomers held in England in September. In July, the conference published on the Internet an abstract of Brown's presentation describing the brightest object in the Kuiper Belt. A week later, a team of astronomers in Spain announced that they had found the brightest object in the Kuiper Belt.

"I look up their work, and, sure enough, it's Santa," Brown says. "My heart sinks. You try to think, This is great for the world, but you get over that. Even so, my despair is only momentary. I start to think, Maybe this isn't so bad, really, let's spread the wealth. I wouldn't have felt anything like as generous if it had been the big one, but that is the chance you take. These objects are not faint, they're not hard to see, once you know where to look. They are bright enough to discern with amateur telescopes, and with the right camera you could take a picture of them, so it is conceivable that one day someone somewhere would look, even by chance, in the right part of the sky. By insisting on scientific papers instead of announcing, we were taking that risk. Somebody found something I'd known about for six months. What can you say except 'I should have written that paper sooner.'"

The Spanish team knew no details about the object—they had found it only two days before. Brown sent an e-mail congratulating them. They had thought that it was bigger than Pluto. Brown told them that it was actually

"They're from a vanity chartmaker."

about thirty per cent of Pluto's mass, and that it had a moon. He sent a second message saying that when they had a name for the object perhaps they would tell him, and he would give the moon a compatible name. The Spanish team replied that this sounded like a good idea.

To announce the finding of a minor planet, an astronomer sends its coördinates to a man named Brian Marsden, whom Brown describes as "the emperor of the solar system." Marsden is the director of the Minor Planet Center, which is run by the Smithsonian Astrophysical Observatory for the I.A.U. They share quarters in Cambridge, Massachusetts, with the Harvard College Observatory. Marsden used archival images to check the coördinates of the object sent to him by the Spanish astronomers, and published the finding on the center's Internet newsletter. About half an hour later, he received an e-mail from an astronomer asking whether he was aware that Brown's abstract describing a similar object had been published several days earlier, and Marsden wrote back that he hadn't. The abstract didn't say where in the sky the object was, but Marsden wrote to Brown asking whether there might have been a leak.

The next morning—it was July 29th—Brown typed into Google Santa's technical name, which had been given in the abstract. "To my utter shock and dismay, it comes up with a Web page in Ohio," he says. To follow the object, Brown had used a telescope in South America. On the Ohio Web page was a record of where the telescope had been pointed, including where Brown had aimed it. Any astronomer could find what Brown had been looking at. Brown was appalled to see that his confidential research wasn't secret at all. Furthermore, he had also aimed the telescope at Easterbunny and Xena.

"Now everything starts to unravel," Brown says. From Marsden he heard that an astronomer in Germany had found other objects on the Ohio Web site and had calculated their orbits. One of these objects was Xena. The German astronomer was merely bringing the objects to Marsden's attention, but Brown, anxious and tired, misread Marsden's e-mail as saying that someone had claimed the discovery of Xena. "No one has an observation of Xena at this point, no photographs—they haven't pointed a camera at it—but, if the sun goes down, that's the game, and in Europe the sun's going down before it goes down in California." Brown called someone he knew at NASA and said that there needed to be a joint press conference that day. "It's while foam is falling off the space shuttle," Brown says, "and NASA, understandably feeling unprepared, is saying, 'People are going to accuse us of trying to divert attention from the shuttle. We can't do this.' I said, 'You're in or you're out.' And in about three hours, on very little sleep and lots of caffeine, I held a press conference at four in the afternoon, Pacific time. The cat was so thoroughly out of the bag that I didn't feel I had much choice. I might have waited until Monday, but I don't think so."

"Yes, you've shown me a thing or two—but over twenty-plus years that's not much."

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Early in August, Brown got a call from the astronomer in Ohio who maintained the Web page that had reported the telescope's movements. He said that he had examined the site's log and noticed that, two days before the Spanish scientists announced their finding, several visits had been made by someone using an I.P. address of a computer in Spain. The e-mails to Marsden announcing the discovery had come from the same computer.

Brown is not by nature suspicious. Marsden was less sympathetic. The Spanish astronomers had told him that they had found Santa in photographs they had taken two years earlier. "Someone who had got the name of the object from the abstract and Googled it and found the telescope pointings could then calculate the object's orbit," Marsden said. "Then they could work out where it was two years ago and go back to their records and find it. They had images of it, they were real, but we don't know if they saw the object in those images. They might have faked the discovery, which would have been patently dishonest. My experience goes back to the nineteen-fifties, and I have never seen anything like it. When Galileo discovered the satellites of Jupiter, there was another person who claimed the discovery. Galileo was able to demonstrate what he had done, and he accused the man of plagiarism."

On August 9th, Brown wrote an e-mail to the Spaniards saying that, having supported them, he was dismayed to learn that they had been looking at the records of his work. He said that he regarded this as a "breach of scientific ethics," and asked for an explanation.

"I hate the way I look in a bathing suit."

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He waited through August for a reply, and there was none. He assumed that the Spanish scientist in charge was on vacation. On September 1st, he sent another e-mail. "We know which pages you looked at and when you looked at them," he wrote. "What you have done is the equivalent of making a discovery, going to the library and finding a book describing the same discovery, and then days later claiming the discovery as your own."

A reply arrived a few days later. The Spanish astronomer did not dispute anything Brown had to say. Instead, he accused Brown of hiding objects, "so I did not expect to have this sort of conversation with you on ethics." Further, he wrote, he continued to "hold the hope that you are sensible and reasonable and you will change your way of doing things." If Brown was willing, the astronomer said that he would consent to seek a name for the object that satisfied both of them. The citation would say that it had been discovered by Brown and reported by the Spanish astronomer. "I think this is a generous offer," he wrote. "Think it over, take your time. And remember, the only reason why we are now exchanging e-mail is because you did not report your object. Do not blame anything else."

The Spaniards did not answer e-mails I sent them. Brown did not pursue the matter. Marsden says, "If the Spaniards were ever to send me a name, I would be very unhappy about it."

In 1999, the Minor Planet Center suggested removing Pluto from the list of planets. Marsden got a lot of mail from people who told him that Pluto was their favorite planet. He tended to write back saying that his favorite planet was Earth.

Brown was uncertain whether to call Xena a planet or not. He thought that he might call it a planetoid or a large Kuiper Belt object. His brother told him to call it a planet and let others sort it out.

"I'm perfectly willing to have eight or ten planets," Brown says. "Nine would bug the bejeezus out of me. It's foolish for several reasons. It's arbitrary—anything discovered up until 1930 is a planet, and nothing after is. Also, I don't think you want to make a ruling that sucks the excitement out of exploring the solar system. People will accept the definition, but you have taken the inspiration from a kid who wants to find the next planet. You have said there is no next planet, nothing else out there. Why would you do that?

"Ten requires the subtlest argument. You add Xena, but why would you, if you have any credibility? Some people think I might like to force the issue, to be known as the guy who found it, but I don't feel that way. When I used to argue for eight, I felt as if there was a public sentiment that you couldn't get rid of Pluto. If you did, you were a mean person, is what it felt like. I wondered why there appeared to be an emotional attachment to an inanimate object that most people who are arguing about had never seen. The epiphany was understanding that people love planets the way they love dinosaurs. Planets are like continents. 'Continent' is a good geological word, but, like 'planet,' it has no scientific meaning whatsoever. There is no scientific reason why Asia is a continent and Europe is a continent, and India is not. If you said you were going to take away Australia as a continent, people would not like it.

"The concept of a planet is also part of the mental geography of the world around us. Pluto doesn't fit as a piece of science, but it does culturally. Initially, I thought, We can't have it this way, we can't have culture determine such questions. Then I thought, There are places where science reigns, and others where culture does. Science doesn't have to win this one. So I thought, I'm willing to give up the hard-nosed science view of what a planet is in lieu of a cultural view, and that view includes Pluto, so it includes anything bigger than Pluto.

"The only one that bugs me slightly less than nine is twenty-three. It smacks of science—the object has gravity and is round—but it's just as arbitrary as many other things you might propose. A planet must have an iron core, for example. If you accept the characteristic of being round, you're stuck with a couple of problems. The first thing most people would think of that's round is the moon, which is definitely not a planet. So the definition becomes immediately modified to anything that is round and primarily orbits the sun. So you start to count, and, sure enough, the nine things we call planets all qualify. Then you realize what you have to

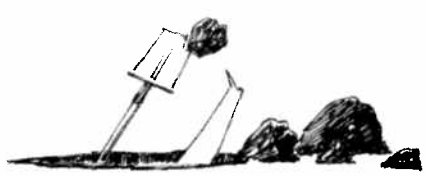
add. The very first is the asteroid Ceres, discovered in 1801, which was the original eighth planet. It's still up there, you can see it with binoculars. If you add Ceres, Pluto stays.

"If you started from scratch and looked at the solar system, you would come up with four categories, each quite distinct. First is Jupiter, Saturn, Uranus, and Neptune—big planets unlike anything else in the solar system. Second is Mercury, Venus, Earth, and Mars—rocky but not nearly as big as those in the first group. Third are asteroids, hundreds of thousands, from the big ones to the kilometre-sized ones we find now. They often get crazy names—there are asteroids named for each of the Beatles, and there is one named for Frank Zappa, although for some reason it is Zappafrank. And there is one called Mikebrown. A colleague named it for me. I've never seen it. Fourth category would be Kuiper Belt objects. They're outside Neptune and many miles farther away. They're made more of ice than of rock. That is probably where Pluto properly resides."

The day after I looked at images of the deep sky with Brown, we sat down and looked at some more. "Fourteen candidates," Brown said. "Bright star nearby," he went on, scrolling through the images. "Another bright star, bright star again. Bright stars are a problem I haven't really solved. I can live with them." Perhaps a minute passed before he said, "That was the fourteen. Now I do the slow interesting ones, of which there are sixty-three." He went quickly through about twenty of them before letting one repeat. He rubbed his chin with one hand. "Occasionally, the problem with the really slow ones is that when you're on the edge you can't always tell." He pointed to an object about the size of a dot you would make with a pen. In each frame, it occupied a different position, while everything around it remained the same. It didn't move dramatically, though, and in the second frame it was hardly visible. We watched the sequence about fifteen times. "If this was real, what would it be? The answer is, the most distant object ever seen, because it's moving even more slowly than Xena was when we found it. The telescope can shake, though. One of the things I do is check the area on other photographs to see if the object appears."

Brown opened on his computer screen a window for a database called Skymorph. "You can enter the coördinates for exactly this part of the sky and see it. Of course, if the object were in there it wouldn't be moving, because they have only one image." Brown typed in the figures, then said, "Damn, it's too far north. Very few people look this far north, so we have a backup." He went to a Web site run by NASA. "The backup is a set of photographic plates, like the ones I did in 1998. They're a standard image of the sky, taken by the Palomar telescope, the same one I'm using." We waited for the NASA file; meanwhile, the pattern kept repeating.

"You find the tenth planet, and you realize you have looked in only about half of the sky," Brown said. "And it's pretty clear that in the other half maybe there's one, maybe two, or maybe zero. It's probably one of those three numbers. And it's very tempting to find that one or two. In some ways, it's quite exciting to have found the tenth planet, and to do it again—well, no one's ever pulled the lever on that slot machine, and it's primed. But I have to stop myself, because I think there are more important scientific goals out there, as opposed to things that may make you remembered through the ages. There's very important science involved in looking for things like Sedna. The Kuiper Belt, we understand why it's there—it's just outside Neptune, and it consists of material that was left over after the planets were formed and what remains wasn't large enough to cohere. Sedna, which is the most remote large body in space, is way outside the Kuiper Belt, and it shouldn't be. How the heck do you get something out there? We don't know. My favorite scenario, if I had to bet, is that Sedna is the fossil record of the earliest formation of the sun. The sun formed four and a half billion years ago. Stars as they form tend to be part of clusters. It looks like if you form the sun with other stars around it something could be ejected to where Sedna is. The science of answering such a question is far more profound than the science of finding a planet. Finding a planet is important culturally, but it isn't Nobel Prize stuff. I was going to say it doesn't rewrite the textbooks, but I guess it does. But to figure out what environment the sun was born in, and to find the fossil record—that history is exciting. You can't do it yet, because Sedna is only one object, one fossil. You look at one fossil and you think, Is that a fin or a wing? Did that thing live in the ocean? You can't quite figure it out. So we desperately need to find more of these things, and I think that, once you do, the fossil record will be incredibly clear."



While Brown was talking, the image arrived. "It's turned sideways, but it's the same field, and it's a lot smaller," he said. "Too small." The plate was powdered with stars. Some were streaks. The oblong blur near the center of the frame was a galaxy, Brown said.

Brown drummed his fingers on the desk. "This is a new problem," he said. "We are so far to the north that these are the only available data to compare with, so that things that are very faint are just barely on the edge of what we can see. I haven't had this problem before. I haven't had one so close to the edge."

He typed something on his keyboard, but he had so many windows open that I couldn't see what had changed. "The sun is eight light-minutes away from Earth," he said. "Xena is twelve light-hours. These stars on the screen are probably hundreds of light-years from us." He folded his arms across his chest. "I don't actually think this is real. I was on the edge with Sedna, though, too, because Sedna's pretty faint. Still, I'm skeptical." He shrugged. "There's one solution, and this we'll have to do," he said. "Take another picture tomorrow."

He closed the window containing the images. "That's not really the problem, though," he said. "The real problem is that this big camera is designed to be porous to a degree." He chewed a fingernail. "We've found these big and rare objects, but what's also clear is that we've missed one or two. The sad thing is, we don't know where we missed them." ♦