

STALKING THE **EBOLA** VIRUS
GANDHI'S LIVING LEGACY

JULY 2015


NATIONAL
GEOGRAPHIC

DESTINATION
PLUTO

FIRST LOOK AT THE
DWARF PLANET







**ALMOST A DECADE
IN FLIGHT, THE NEW
HORIZONS SPACECRAFT
IS APPROACHING THE
ENIGMATIC DWARF
PLANET. WHAT IT
WILL FIND THERE IS
ANYBODY'S GUESS.**

PLUTO AT LAST

By mid-July NASA's vehicle will have traveled over three billion miles and will pass within 8,000 miles of Pluto, illustrated here with Charon, the largest of its five known moons.

1930

Kansas farmer Clyde Tombaugh built this telescope in 1928 using the crankshaft of his father's 1910 Buick and some discarded farm equipment. His drawings of Mars and Jupiter led to a job at Lowell Observatory. There, two years later, he discovered Pluto.





2005

At Florida's Kennedy Space Center, the New Horizons spacecraft waits to be wrapped in the fairing that will protect it during its launch and flight through Earth's atmosphere. The fastest spacecraft ever at launch, it will reach Pluto on July 14, 2015.



2006

New Horizons blasts off from Cape Canaveral Air Force Station aboard an Atlas V rocket. After passing Pluto, the craft will continue into the farthest reaches of the solar system.

Small, cold, and absurdly far away, Pluto has always been selfish with its secrets.

Since its discovery in 1930, the dwarf planet has revolved beyond reach, its frosty surface a blurred mystery that even the most powerful telescopes can't bring into focus. We know about Pluto. But we don't really know it.

That will change on July 14, when NASA's New Horizons spacecraft is scheduled to fly within 8,000 miles of the frozen dwarf. It's a risky maneuver, but if all goes well, the fleeting close encounter will unveil the last of the classical solar system's unexplored worlds. We'll finally get to meet the former ninth planet face-to-face—to really see its surface and that of its largest moon, Charon. Scientists have some guesses about what they might find, but the only thing they can say for sure is that Pluto promises to be a surprise.

"The Pluto we imagined will just go away like smoke," says Alan Stern, New Horizons' principal investigator.

The X-Files

It wouldn't be the first time Pluto has confounded expectations. In 2006, the year New Horizons was launched, Pluto vanished from the list of planets and reappeared as a "dwarf planet." That, of course, had more to do with astronomers on Earth than any celestial sleight of hand, but the truth is, Pluto has been a tough world to crack since before it was discovered.

As early as the 1840s, a tricky calculus foretold the existence of a planet beyond the orbit of Neptune. Calculations based on Neptune's mass suggested that the ice giant's orbit, and that of its neighbor Uranus, didn't quite fit the predictions of planetary motion. So some astronomers

reasoned that at least one large, undiscovered world at the edge of the solar system must be jostling the ice giants and causing them to trace errant paths around the sun.

By the turn of the century, the hunt for that missing planet had gathered momentum: Whoever found it would earn the shiny distinction of discovering the first new planet in more than 50 years. Calling the rogue world "Planet X," Boston aristocrat Percival Lowell—perhaps best known for claiming to have spotted irrigation canals on the surface of Mars—vigorously took up the search. Lowell had built his own observatory in Flagstaff, Arizona, and in 1905 it became the epicenter of the search for Planet X, with Lowell calculating and recalculating its probable position and borrowing equipment for the hunt. But Lowell died in 1916, without knowing that Planet X really existed.

Fast-forward to 1930. Late one February afternoon, 24-year-old Clyde Tombaugh was parked in his spot at Lowell Observatory. A transplant from the farm fields of Kansas, Tombaugh had been assigned the task of searching for Lowell's elusive planet. He had no formal training in astronomy but had developed a skill for building telescopes, sometimes from old car parts and other improbable items.

He was also something of a perfectionist. "When I planted the kafir corn and milo maize," he wrote in his 1980 memoir, "the rows across the field had to be straight as an arrow or I was unhappy. Later, every planet-suspect, no matter how faint, had to be checked out ... It was the most tedious work I'd ever done."

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Tombaugh spent about a year searching for the missing world, using an instrument called a blink comparator. The noisy machine let viewers flip back and forth between long exposures of the sky, often containing hundreds of thousands of stars, taken several days apart. Anything that traveled a significant distance during that time—a planet or an asteroid, for example—would appear to move as the images flipped.

On that late afternoon—it was February 18—Tombaugh was manning the comparator and squinting at thousands of stars, evaluating each one by eye. Suddenly, in photos taken six days apart in January, he spied a small speck of light that didn't stay put. In one image, it was to the left of two bright stars. In the next, it had jumped a few millimeters to the right of those stars. Tombaugh flipped back and forth between the images and watched the spot leaping in and out of its original position. He grabbed a ruler and measured the precise difference in the spot's position. Then he found another photo of the sky, taken earlier in January, and searched for the same spot. Finally, he used a hand-magnifier to confirm the potential planet's presence in one more set of photos, taken by a different camera. After 45 minutes, Tombaugh was convinced.

He had found Planet X.

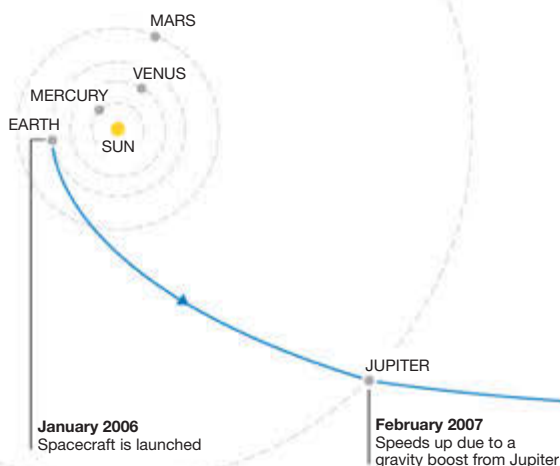
"You look at the spot that is Pluto, and it's a pretty dinky little spot," says Will Grundy, a New Horizons team member who works at Lowell Observatory. "You really had to stare at these things. How he didn't just go blind, I don't know."

After weeks of follow-up observations, Lowell Observatory announced Tombaugh's find on March 13, which happened to coincide with the 75th anniversary of Lowell's birth.

But almost immediately, astronomers knew something was wrong. The jumping point of light was much too faint to be Planet X. Even the best telescopes of the day couldn't resolve the planet's disk, which meant the object was small—much too small to account for the meanderings of the ice giants.

See for Yourself Tune in to the National Geographic Channel on July 15 at 8 p.m. for *Pluto Encounter*, a film about the New Horizons mission.

New Horizons
mission
milestones



“They were expecting something brighter than that, something bigger than that,” says Owen Gingerich, an emeritus astronomer and historian at the Harvard-Smithsonian Center for Astrophysics. “But they assumed, nevertheless, that it was probably Earth size. So, much smaller than Uranus and Neptune, but a respectable sort of planet.”

Indeed, the world’s size has never deterred its fans. Right away, Lowell Observatory had to figure out what to name the new planet. Hundreds of letters poured in. “Minerva” was an early front-runner. Lowell’s widow, Constance, who’d held up the search for Planet X while battling the observatory for Lowell’s fortune after his death, suggested “Percival” and “Lowell”—and then, abandoning humility altogether, “Constance.”

Across the ocean, an 11-year-old English girl named Venetia Burney casually proposed the name “Pluto,” after the Roman god of the underworld. It seemed an appropriately dark name for a planet on the dusky fringe, and it followed the mythological naming convention. Conveniently, the word also contained Percival Lowell’s initials. And so on May 1, Lowell Observatory announced that Planet X would be named Pluto.

But with its peculiar, tilted orbit and confoundingly small size, the world remained an enigma. Over the years the estimated mass of Tombaugh’s planet continued to shrink and shrink... and shrink, until it finally shrank itself out of planethood altogether and was rechristened a dwarf planet in 2006.

By observing Pluto’s interaction with its satellite Charon, scientists now know Pluto’s mass is a mere two-thousandths that of Earth. Discovered in 1978, Charon is almost half the size of Pluto—so big the two actually form a binary system. They revolve around a point in the space between them, a double-dwarf planet churning away in the center of an astoundingly complex system containing at least four more moons.

Scientists suspect there may be yet more moons around Pluto, some perhaps sharing or swapping orbits and maybe chaotically rotating instead of gracefully pirouetting.

“I would not be surprised at being surprised

by finding something really pathologically weird like that,” says Alex Parker, a postdoc on the New Horizons team.

By the late 1980s, NASA’s Voyager 2 spacecraft had swept through the realm of the giant planets and revealed the real mass of Neptune. When that number, which is the equivalent of about 17 Earths, is plugged into those old equations used to predict the existence of a ninth planet, everything works as expected. Uranus traces a predictable, boring path around the sun. There never was another large planet tugging at its orbit. But if not for the faulty math, and one man’s prodigious patience, we could have waited decades to discover the little world that really is out there.

Violent Birth

No longer a planet and no longer a misfit, Pluto isn’t even one of a kind anymore. It’s one of thousands of worlds populating the Kuiper belt—a vast debris ring beyond Neptune that’s home to countless comets and icy dwarfs. Long ago erased from Earth, fingerprints from the early ages of the solar system are still pressed into these 4.6-billion-year-old chunks, waiting to be matched with theories describing the solar system’s turbulent early years.

The Kuiper belt’s architecture points to a violent rearrangement of the giant planets early on, a great migration that sent small bodies flying and turned the solar system into an overgrown shooting gallery. Scientists are hoping to use the craters dotting Pluto’s and Charon’s surfaces to take a survey of the Kuiper belt population and reconstruct how it has changed over time. Although tricky to make, those measurements are essential for reconciling ideas about how the migration of the giant planets sculpted the early solar system. “We think the Kuiper belt was a lot more massive early on,” Stern says.

What we learn from the dwarf planet could also give scientists a peek at the processes that shaped an early Earth into the planet we know. Once, a gassy envelope of hydrogen and helium surrounded our infant world. Over millions of years, that atmosphere escaped into space. Pluto is the only place in the solar system where

NGM ART. SOURCE: JOHNS HOPKINS UNIVERSITY APPLIED PHYSICS LABORATORY

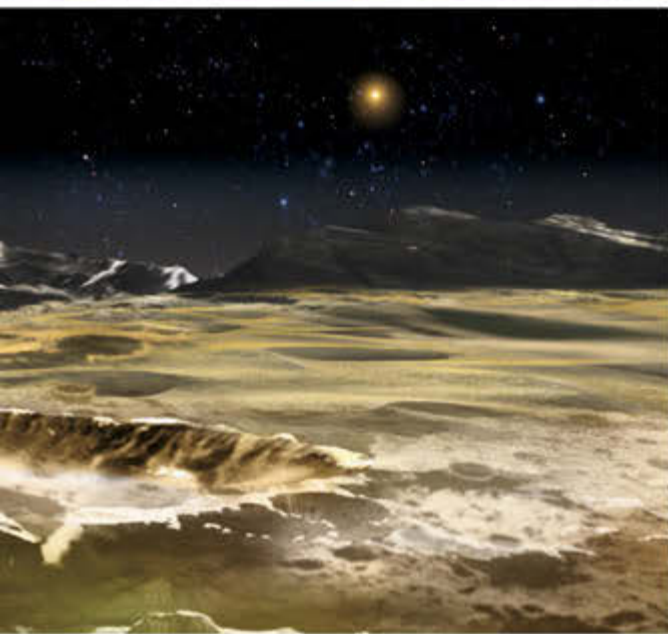
PLUTO

March 2011
Passes through
Uranus’s orbit

August 2014
Crosses Neptune’s orbit,
then enters the Kuiper belt

July 14, 2015
Flies by Pluto





THREE POSSIBLE PLUTOS

The dwarf planet's landscape is shaped by extreme seasonal fluctuations and dominated by an exotic mix of methane, nitrogen, and carbon monoxide ices. NASA's New Horizons mission will reveal more details during the summer of Pluto's 248-year orbit, when the sun's warmth is at its peak. These scientifically plausible "Plutoscapes" illustrate how the surface might look. Charon hovers in the distance.

Three scenarios, from top to bottom:

TECTONIC SURFACE

Layers of frozen methane turn brown and yellow from the ultraviolet irradiation of ice-bound molecules. The rugged topography, active geysers, and distant rift suggest Pluto has dynamic geological processes that erase the scars of impact craters and could indicate a warm planetary core.

WINDSWEPT SURFACE

Strong winds may be generated when ices change state from solid to gas and back again, helping sculpt Pluto's crust. Eroded peaks remain from ancient impact craters, with water ice forming at the higher elevations. UV radiation strips hydrogen from frozen methane, leaving a swath of dark carbon dust.

UNDULATING SURFACE

As Pluto's ices continually change state by escaping into the atmosphere and condensing back to the surface, they may fill in Pluto's low-lying areas, smoothing its surface into an undulating terrain. The ices react with sunlight and cosmic radiation at different rates, forming an icy gravel (foreground).

we can study something similar happening today, Stern says, even though its atmosphere is made from nitrogen. The similarities don't end there. Scientists think Pluto's moon Charon formed out of a giant impact, much like the one that produced our own moon. But while our moon congealed out of the molten disk of debris created by the collision, Charon was blown off from Pluto relatively intact. And while our moon's growth left our skies relatively clear, Pluto's weaker gravity allowed debris from the smashup to fly farther afield, seeding the binary system with space rubble that could make New Horizons' visit more than a little treacherous.

Dangerous Passage

Launched from Florida's Cape Canaveral, NASA's spacecraft shot through the solar system, covering an average of nearly a million miles a day. It arrived at Jupiter just over a year later, and used the giant planet's gravity as a speed booster to shave almost four years off the total travel time. But even with that boost, New Horizons would still take another eight years to reach the former planet, which is on average about 40 times as far from the sun as Earth is. It's pretty chilly that far out. Temperatures on Pluto can reach close to -400 degrees Fahrenheit.

Scientists don't really know what they will find there—or if the spacecraft's sizzling speed will take it safely through the Pluto system, booby-trapped as it might be with hidden moons and deadly dust particles. "Anything the size of a grain of sand is potentially dangerous to the spacecraft," says the SETI Institute's Mark Showalter, a member of the mission's hazard assessment team. "If it cuts an electrical connection or hits a computer processing unit, it could damage the spacecraft irreparably."

The weeks leading up to the Pluto encounter will be punctuated with tense analyses of the newest images from New Horizons. As Tombaugh did eight decades earlier, the team will be searching for anything that moves, telltale pixels signaling a hidden moon that might be shedding dust. "We're on the crow's nest ... looking out for rocky shoals ahead," Showalter says.

Scientists have planned several alternate trajectories through the Pluto system, should such perils appear. All the alternatives would come at a cost to mission science. But nothing is worth setting a course that would put the spacecraft

at risk. "The reason we go to places we haven't been before is to see what's there," Showalter says. "We're going for the surprise, and I just hope it's not the wrong kind of surprise."

Team members are placing bets on what those good surprises will be. They already know that the dwarf planet will be reddish, a hue imparted by sunlight reacting with organic molecules on its surface, and covered in different ices. Blurry Hubble images have revealed both extremely dark and extremely bright patches on Pluto, and some scientists suspect that smears of organic compounds are painting parts of the dwarf planet dark. Other regions of the surface show hints of seasonal frosts forming across the multicolored terrain, and scientists would not be shocked to see plumes erupting from Pluto, as on Neptune's largest moon, Triton. Hovering overhead is a puffy nitrogen atmosphere, potentially 350 times as voluminous as Pluto itself.

"I suspect we're going to see hazes and maybe thick clouds," says team member Fran Bagenal of the University of Colorado Boulder.

But team members are guessing about everything from Pluto's diameter to the number of new moons to whether there will be craters, canyons, or cryovolcanoes on Pluto and Charon. Some team members even think Charon might steal the show from its sibling. "It's an amazingly rich system for such a small place, and probably a lot of what we think we know is wrong," says John Spencer of the Southwest Research Institute in Boulder, Colorado.

To truly know Pluto, we must go there, set aside the mirrors and lenses of Earth, and stare at the world from its doorstep. It's taken 85 years, but we are at last going to meet Tombaugh's contentious little planet. And in a way, he will too: Tucked aboard New Horizons is a small vial of Tombaugh's ashes, a symbolic envoy that will sail by Pluto and head farther into the Kuiper belt, perhaps chasing down another little world to explore. □

■ ONE MORE THING



The cosmos has always been a part of Nadia Drake's life. Her father, astronomer Frank Drake, conducted the first SETI (search for extraterrestrial intelligence) experiment, in 1960. Read more of her work at ngm.com/phenomena.

PLUTONIC LOVE



Cloak of mystery

1 Just how big is little Pluto? Scientists calculate it's over 1,400 miles across, but the dwarf planet's atmosphere and its great distance from Earth hinder precise measurement. The New Horizons spacecraft should provide the answer.

Spin cycle

2 On Pluto, the sun rises in the west and sets in the east—approximately once each Earth week. This is because Pluto rotates in the opposite direction from Earth, and it spins very slowly.



A speck in space

3 Pluto is only two-thirds the size of our moon. Its five known moons circle in tight, nested orbits. Strung end to end, nearly three Pluto systems would fit between Earth and its moon.

9

quick takes on the former ninth planet



Why not a planet?

4 According to the International Astronomical Union in 2006, planets in the solar system are round, they orbit the sun, and they have enough gravitational heft to clear their orbits of most debris. Unless that last rule is removed, Pluto will remain a dwarf planet.

Celestial census

5 While studying photographic plates of the sky over 14 years, Pluto's discoverer, Clyde Tombaugh, spotted 29,500 galaxies, nearly 4,000 asteroids (775 of them new), and at least one new comet.

Precious payload

6 There are nine "stowaways" aboard the New Horizons spacecraft, among them a vial of Tombaugh's ashes. The other items include two U.S. flags, an unintentionally ironic U.S. postage stamp reading "Pluto: Not Yet Explored," and a Florida state quarter, given to New Horizons Principal Investigator Alan Stern by then Governor Jeb Bush.



What's in a name?

7 Venetia Burney, the English 11-year-old who casually suggested calling the new planet "Pluto" over breakfast, isn't the first person in her family to have named an astronomical object. Her great-uncle Henry Madan named the Martian moons Phobos and Deimos. Burney (later Venetia Phair) never could brook people thinking that she'd



borrowed the name from Walt Disney's lovable hound. And indeed,

although the cartoon dog did first appear in 1930, he didn't acquire the name Pluto until May 1931—a year after Burney had named the planet. "So, one is vindicated," she said.

Bottled up

8 One slight hesitation in the naming of Pluto had to do with an American laxative. Called Pluto Water, the popular tonic promised, "When Nature Won't, Pluto Will."

Bullets are slower

9 New Horizons gained a gravity-assisted speed boost from Jupiter in 2007, reaching a top speed of 51,000 miles an hour. It has enough fuel to continue sailing far beyond Pluto and the Kuiper belt.