Seven things we've learned about Ultima Thule, the farthest place visited by humans

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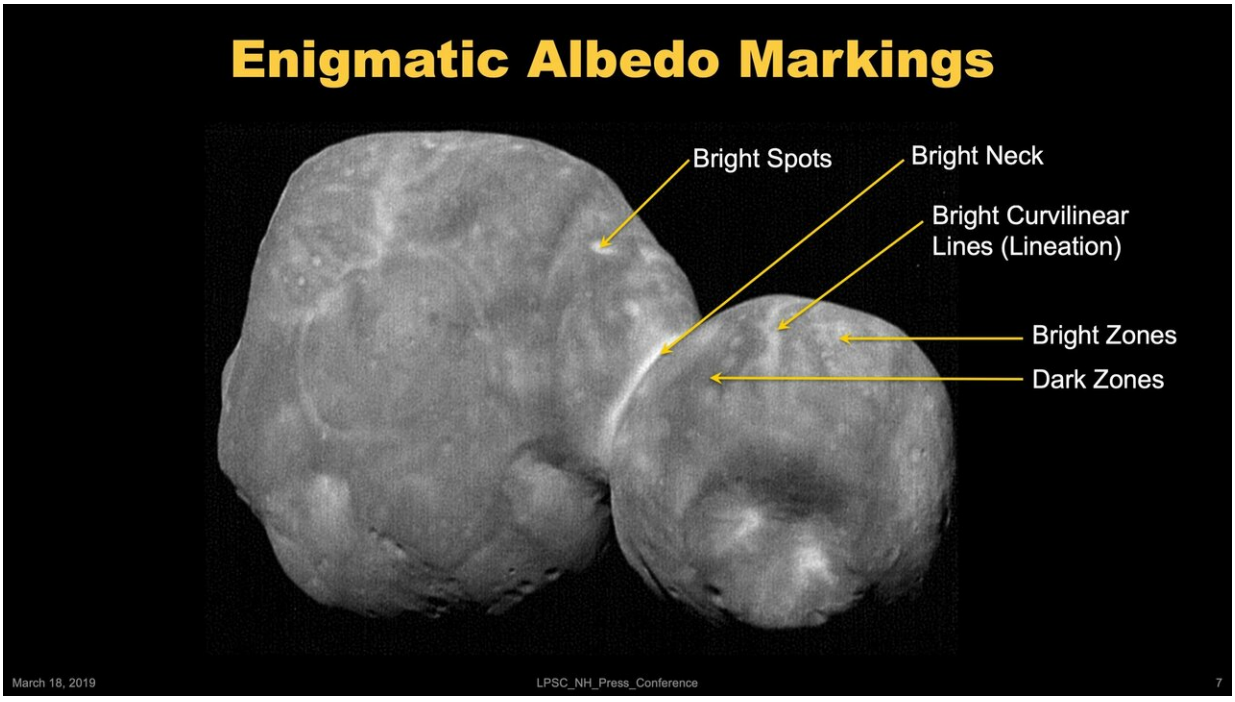

Credit: NASA/Johns Hopkins University Applied Physics Laboratory/Southwest Research Institute

About a billion miles more distant than Pluto is Ultima Thule, a peanut-shaped object in the outer solar system that's the farthest place ever visited by humans.

NASA's New Horizons spacecraft zipped past Ultima Thule on New

Year's Eve (Pacific time), flying within 2,200 miles of the space rock's rust-colored surface. The data it captured is now giving scientists a rare glimpse into the solar system's early days.

Ultima Thule has spent most of its 4.5 billion years frozen in time in the Kuiper Belt, a doughnut-shaped region beyond Neptune that contains remnants from the solar system's early days. Its surface is barely heated by the sun, which is about 4 billion miles away, according to an initial analysis of New Horizons data published in Friday's edition of the journal *Science*.

"We had never seen something that was so primordial, so unchanged since the early formation days," said Alan Stern, the principal investigator for the New Horizons mission.

Ultima Thule is what's called a contact binary object, consisting of two lobes that formed separately through an accumulation of small particles of gas and dust. Only later did they fuse together, scientists believe.

The new report is based on only 10% of all the data collected by New Horizons during its flyby. The full download won't be complete until mid-2020.

Here are seven things we've learned about Ultima Thule so far:

- It has been essentially undisturbed for more than 4 billion years

Ultima Thule is about 43 times farther from the sun than we are, and as a result, it receives 900 times less sunlight than we do on Earth. Since it has never gotten warmer than about -350 degrees Fahrenheit, it has been well preserved since its formation shortly after the solar system was born.

During its 293-year orbit around the sun, some regions of Ultima Thule receive no sunlight for decades at a time, while others face the sun for decades straight. Scientists think variations in daily and seasonal temperatures have probably only affected a very shallow surface layer of the Kuiper Belt object, ranging from a few millimeters to a few meters.

"Different chemical changes that might happen don't occur," said astronomer Will Grundy of the Lowell Observatory in Flagstaff, Ariz., leader of the project's surface composition team. "It just never got warm. At all.—Its lobes came together in a very gentle collision

The larger lobe is nicknamed "Ultima" and the smaller one is called "Thule." They came together in an unusual way.

Collisions in Ultima Thule's section of the Kuiper Belt typically occur at the speed of a bullet, but Ultima Thule doesn't display the scars that would have resulted from such a violent merger.

"They would be very heavily damaged, if not catastrophically destroyed, by such collisions," said Stern, who is based at the Southwest Research Institute in Boulder, Colo.

Instead, scientists estimate that Ultima Thule's lobes made contact traveling only a few miles per hour.

Planetary scientist Cathy Olkin, a deputy project scientist for New Horizons who also works at the Southwest Research Institute, said researchers aren't exactly sure why the lobes came together at such slow speed. They might have lost momentum as a result of having to slog through gases that hadn't yet been pushed out of the solar system at the time, or by interacting with objects such as lumps of dust.

"They would exchange momentum with these other small objects,

sending them far away and bringing Ultima and Thule closer together until they touched," she said.

- There are no moons or rings

Many objects in Ultima Thule's region of the Kuiper Belt are accompanied by satellites, but Ultima Thule itself appears to be flying solo. New Horizons also looked for rings around the object and didn't find any of those either.

If there had been a moon, it would have helped scientists determine the density of Ultima Thule. Instead, all the study authors could say is that it's most likely to resemble the nuclei of comets.

- It is lightly cratered

Both lobes have pits, but the team identified only two possible impact craters, in a depressed region on Thule called Maryland.

Scientists said the relative dearth of possible impact craters they have found so far may point to a deficit of small objects on the Kuiper Belt.

"There are fewer things to crash, and when they do crash, they are crashing at smaller speeds," Grundy said.

- Its surface has patches of brightness

Ultima Thule is extremely dark and reflects no more than 12% of the light that strikes its surface. For the sake of comparison, potting soil reflects about 10% of its light, Stern said.

The surface has three types of bright patches: circular or oval spots; lanes that are either straight or gently curved; and what Stern described

as broad, diffused regions. The brightest spots are at the object's neck—the junction between both lobes—and on Maryland.

It's unclear how these bright patches came about. They "are generally correlated with low regions," Stern said, and they could have been created by bright, fine-grained particles that slid downhill.

- There's little water on the surface

There are indications of water ice on Ultima Thule's surface, but it doesn't appear to be abundant. Whatever water ice might be there is probably either limited or masked behind other material, Grundy said, but it likely hasn't evaporated.

"It's not that easy to get rid of water ice at those kinds of low temperatures because it's basically a rock," he said.

- Ultima is unusually flat

Ultima is wider than Thule, and it's significantly flatter too.

New Horizons project scientist Hal Weaver, a planetary scientist at Johns Hopkins University, said that the flatness could have resulted from "natural variability" during its formation, when an elongated swarm of small particles collapsed around a core clump of matter.

"The stuff is streaming with a particular speed and preferred direction," he said. "It's that directional thing that's giving you an elongated shape."

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