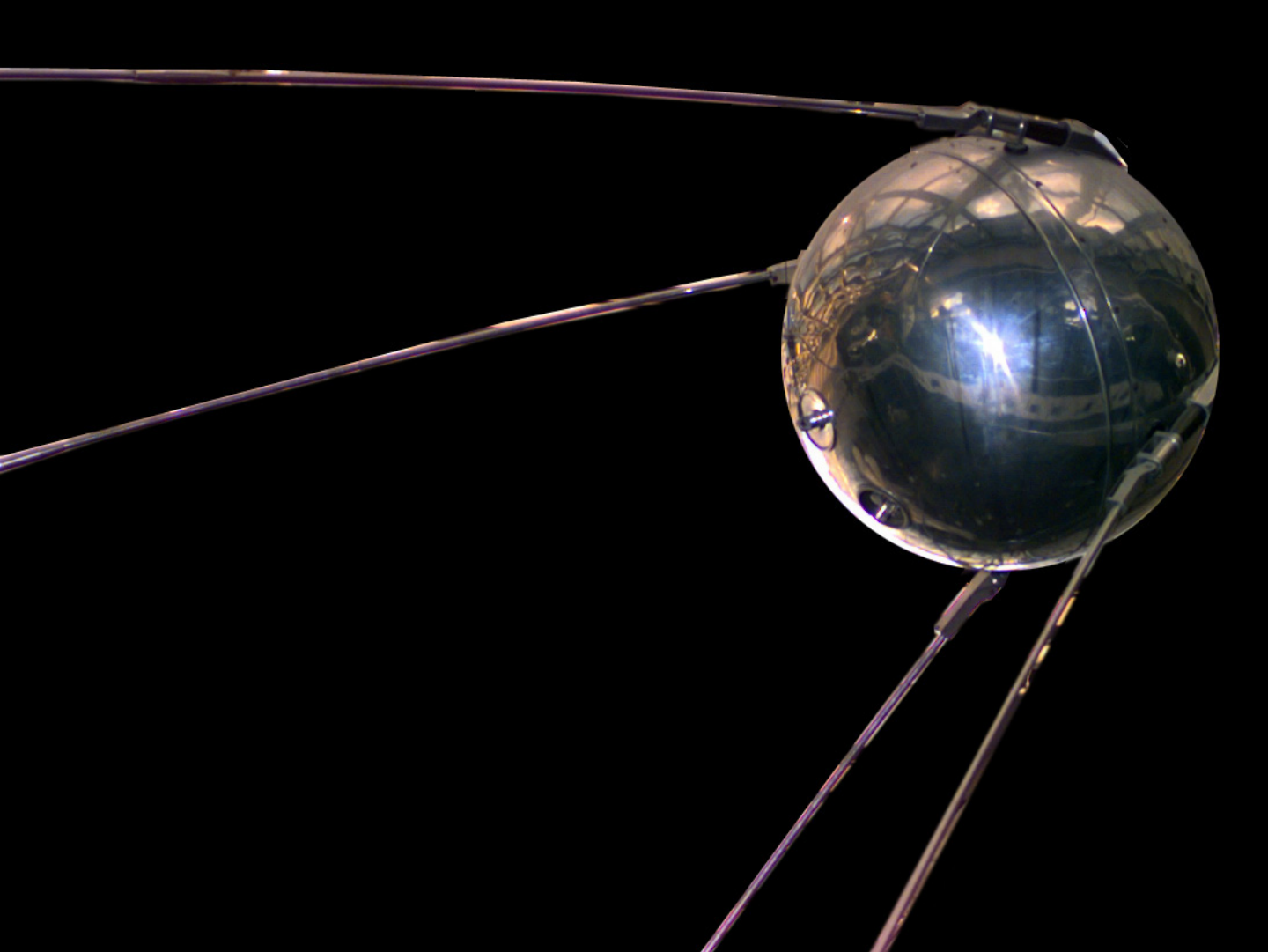
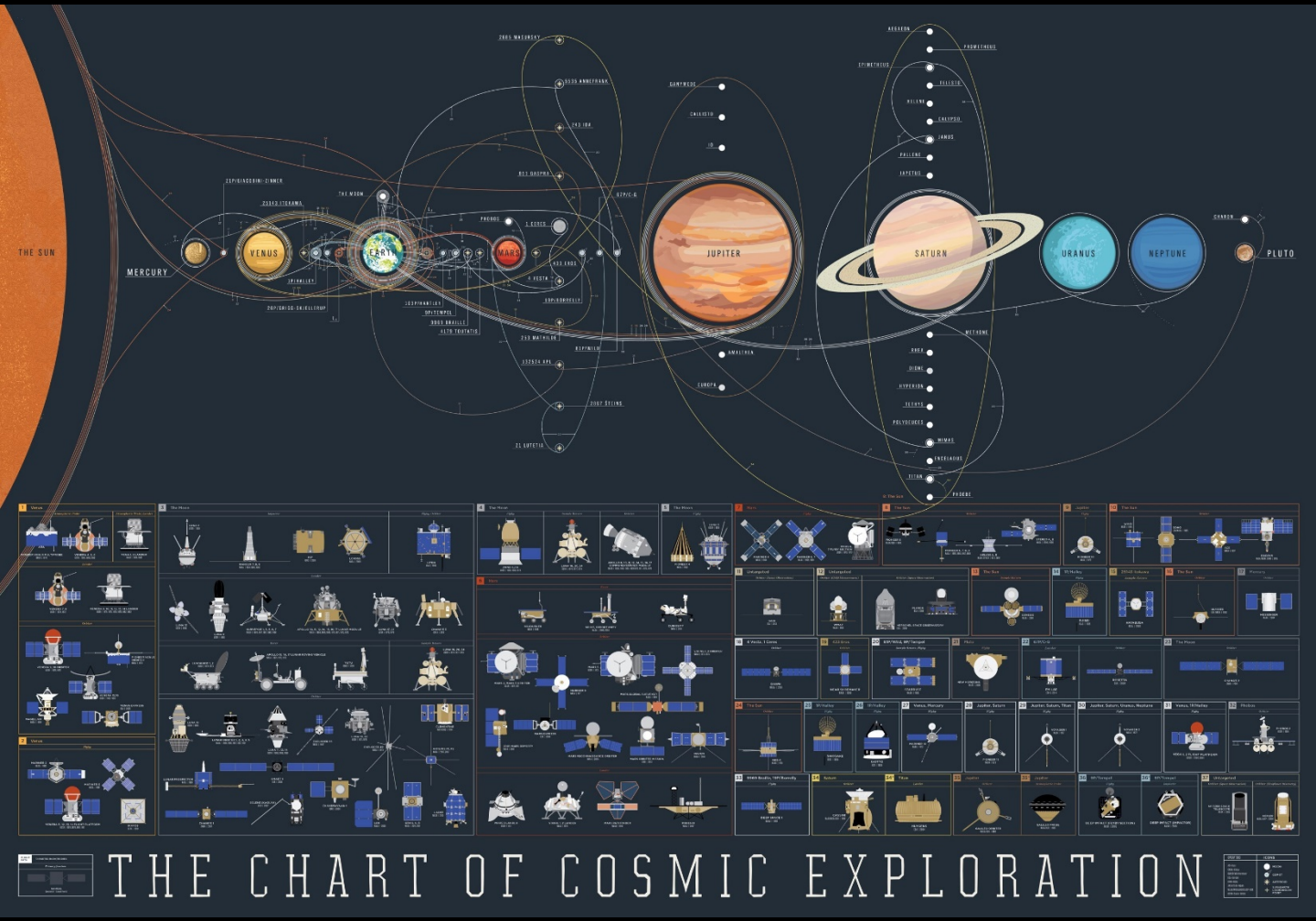
Exploring the Solar System

Visiting other worlds

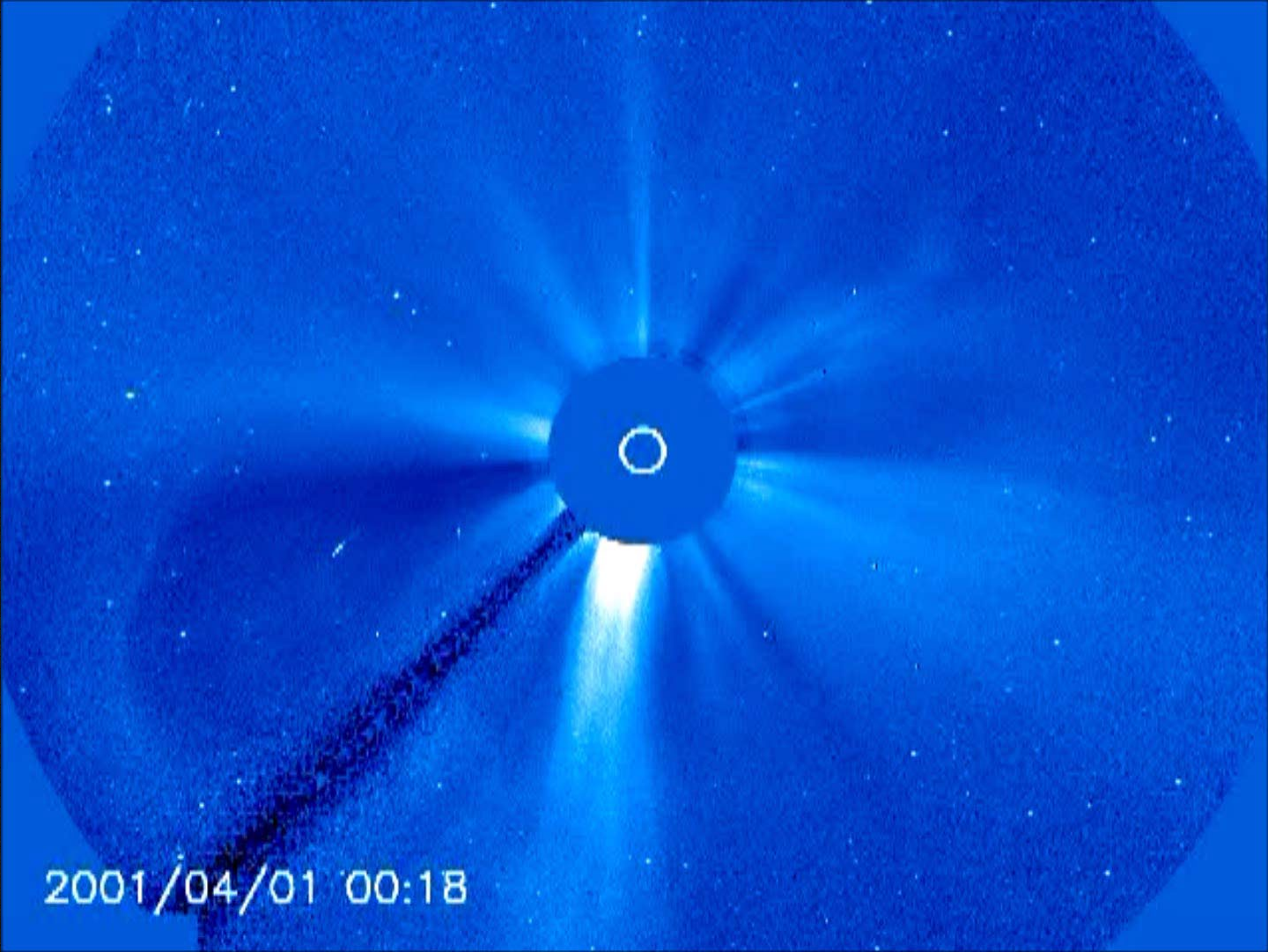
Dr. Jonathan Crass

UNIVERSITY OF NOTRE DAME





THE CHART OF COSMIC EXPLORATION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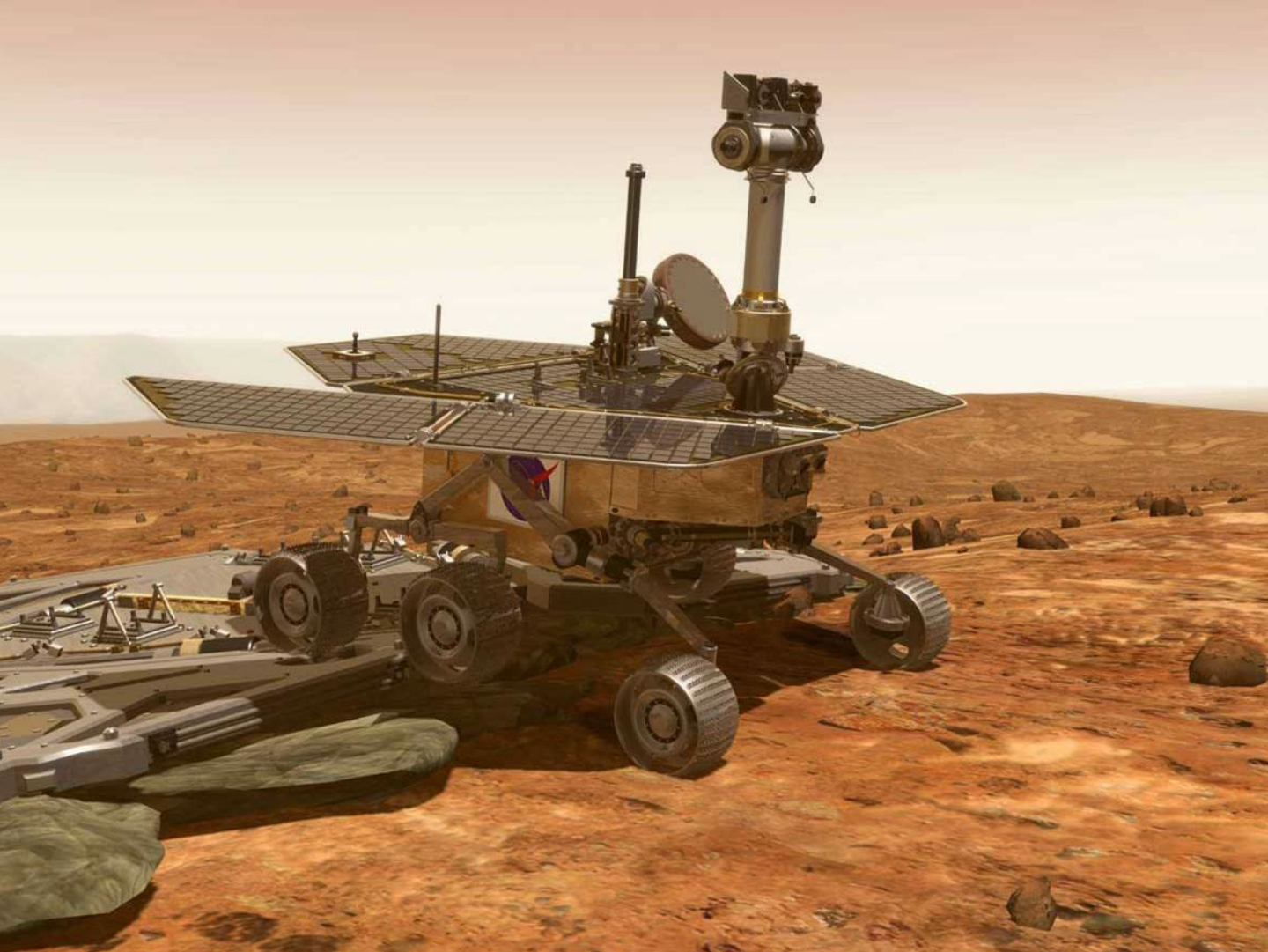

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By Jonathan Amos
BBC Science Correspondent

27 November

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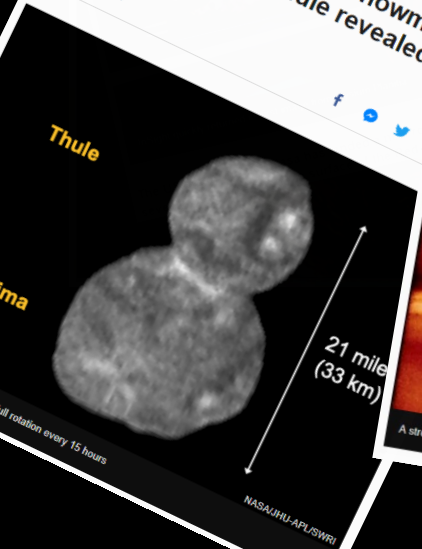
BBC Science Correspondent

2 January 2019



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BBC Science Correspondent

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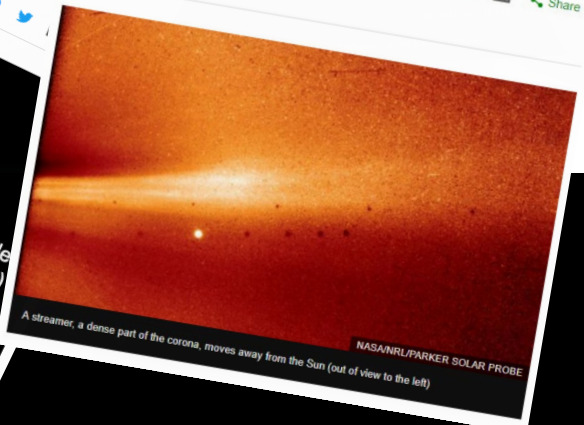
BBC Science Correspondent

12 December 2018

AGU meeting



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By Victoria Gill
Science correspondent, BBC News, Washington DC

10 December 2018

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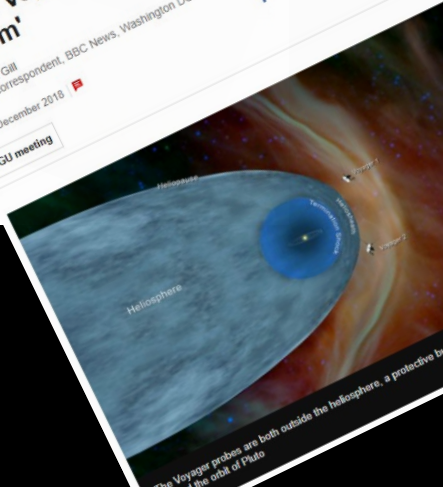
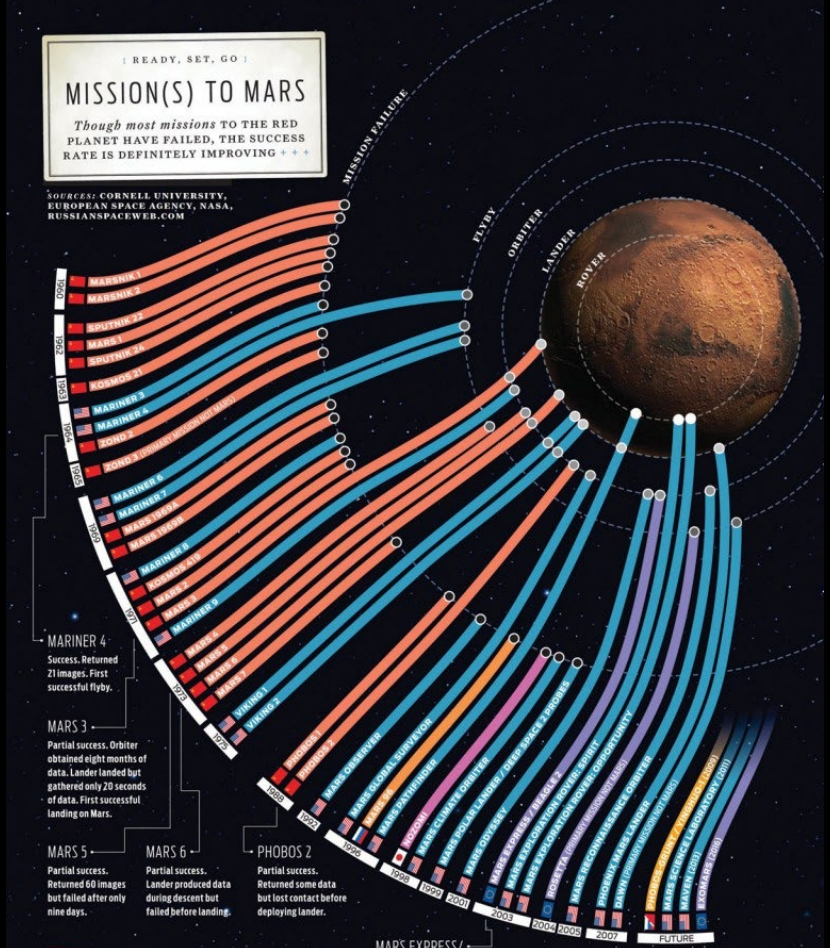


[READY, SET, GO]

MISSION(S) TO MARS

Though most missions TO THE RED PLANET HAVE FAILED, THE SUCCESS RATE IS DEFINITELY IMPROVING + + +

SOURCES: CORNELL UNIVERSITY, EUROPEAN SPACE AGENCY, NASA, RUSSIANSPACEWEB.COM



MARINER 4

Success. Returned 21 images. First successful flyby.

MARS 3

Partial success. Orbiter obtained eight months of data. Lander landed but gathered only 20 seconds of data. First successful landing on Mars.

MARS 5

Partial success. Returned 60 images but failed after only nine days.

MARS 6

Partial success. Lander produced data during descent but failed before landing.

PHOBOS 2

Partial success. Returned some data but lost contact before deploying lander.

MARS EXPRESS/ BEAGLE 2

Partial success. Orbiter completed primary mission in November 2005 and is still in orbit on extended mission. Beagle 2 lander lost on arrival.

DAWN

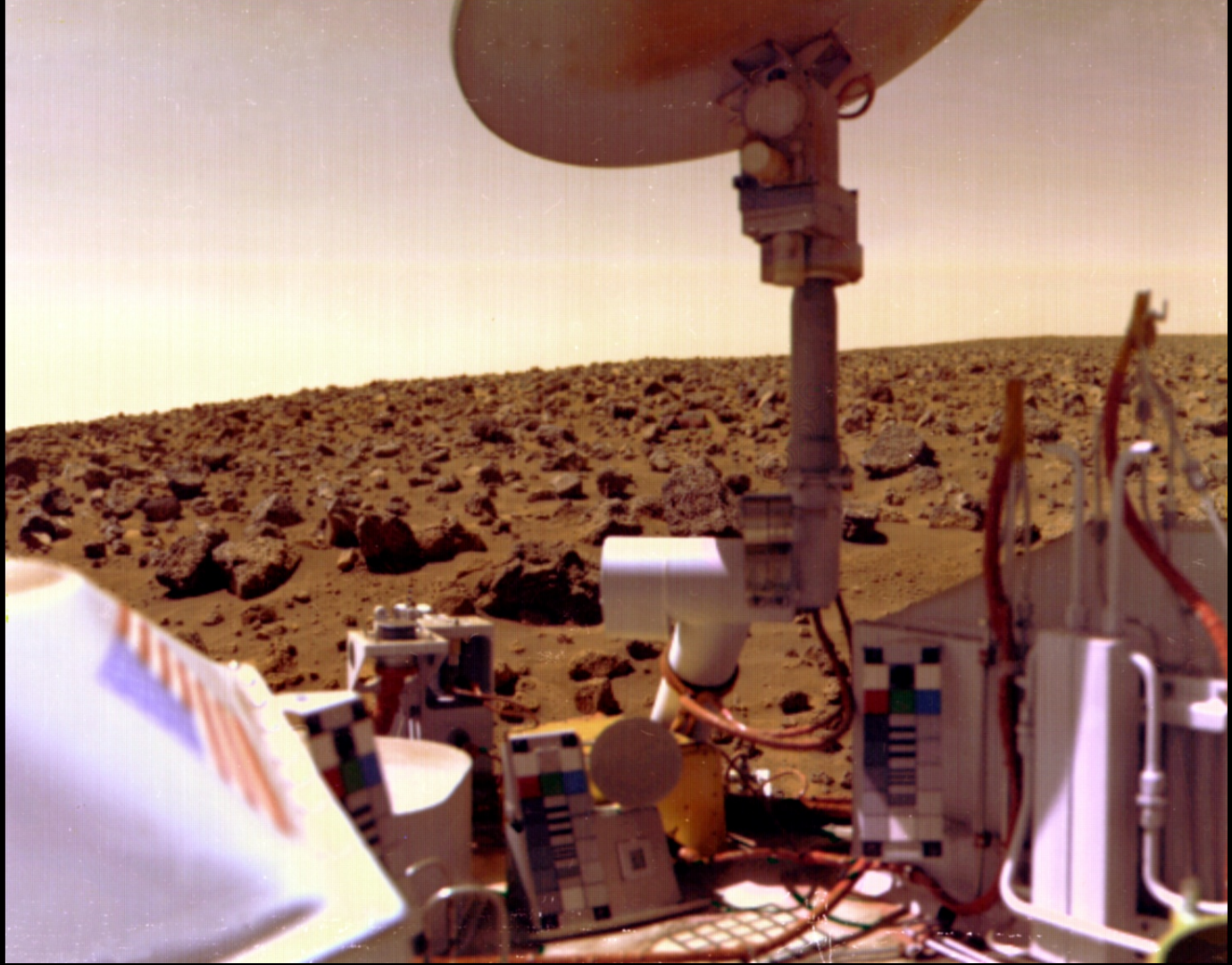
On its way to proto-planets Vesta and Ceres. Completed Mars flyby in February 2009.

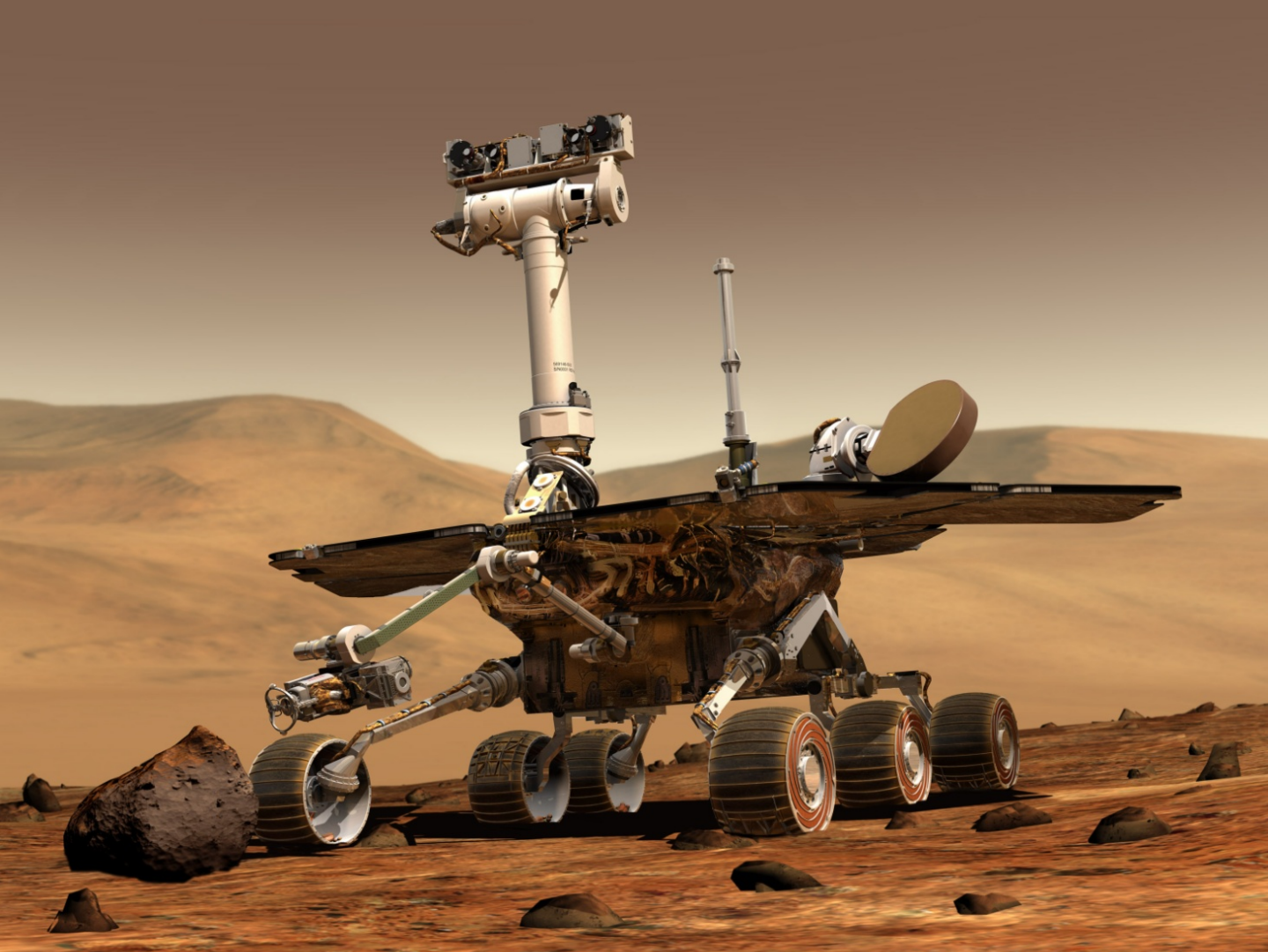
FUTURE

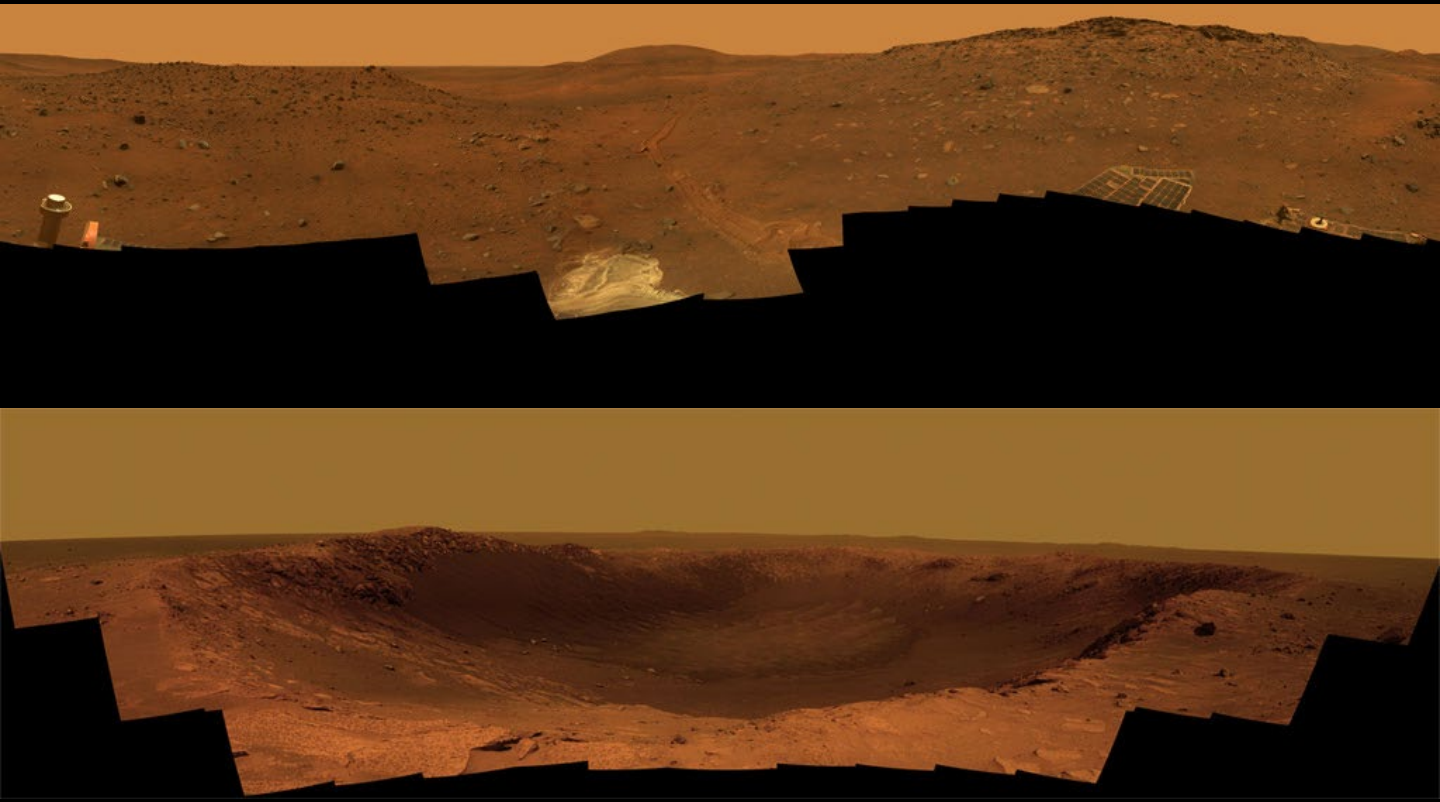
Phobos-Grunt/Yinghuo-1 will be a sample-return lander/orbiter, Mars Science Laboratory will be a rover, MAVEN will be an orbiter, and ExoMars will be an orbiter/lander/rover.

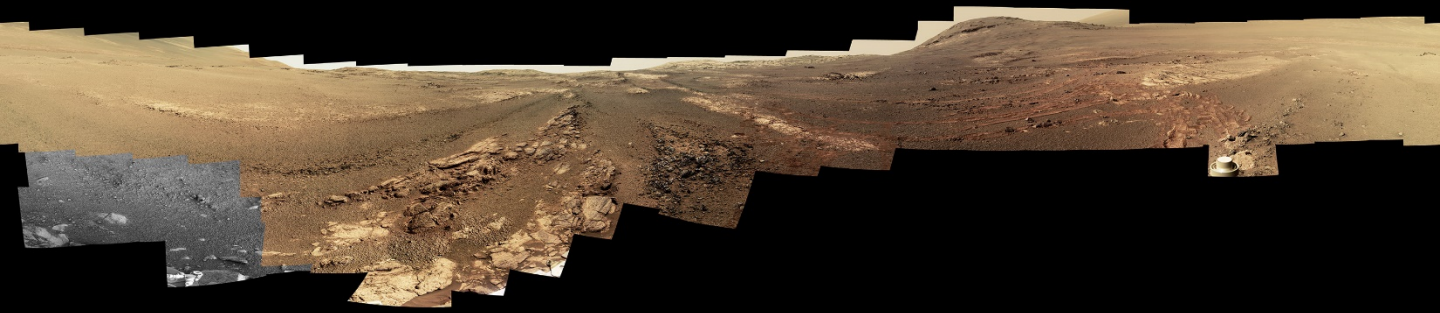
- SOVIET UNION
- UNITED STATES
- RUSSIA
- JAPAN
- EUROPEAN SPACE AGENCY
- RUSSIA/CHINA

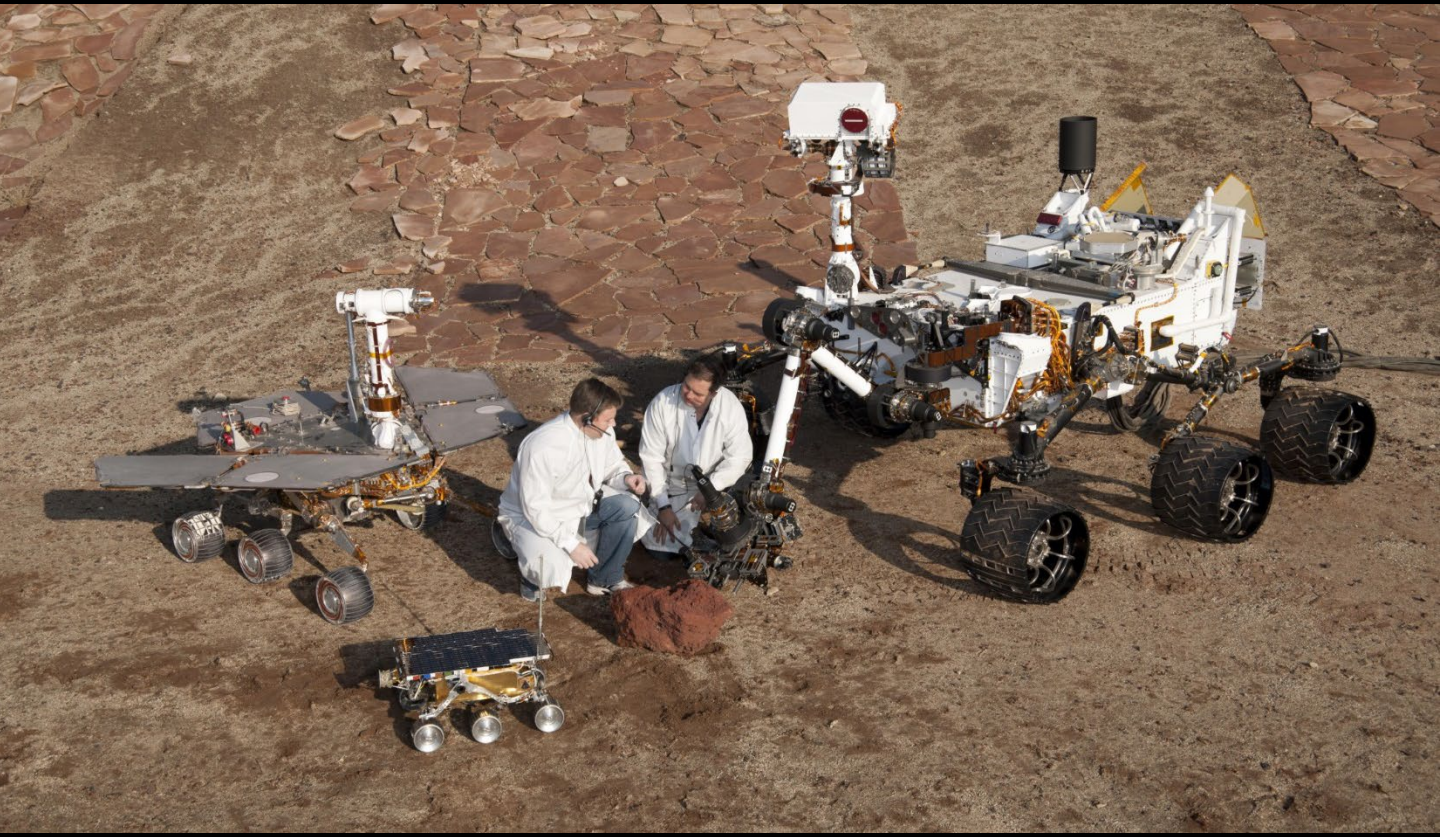
- MISSION FAILURE
- FLYBY
- ORBITER
- LANDER
- ROVER







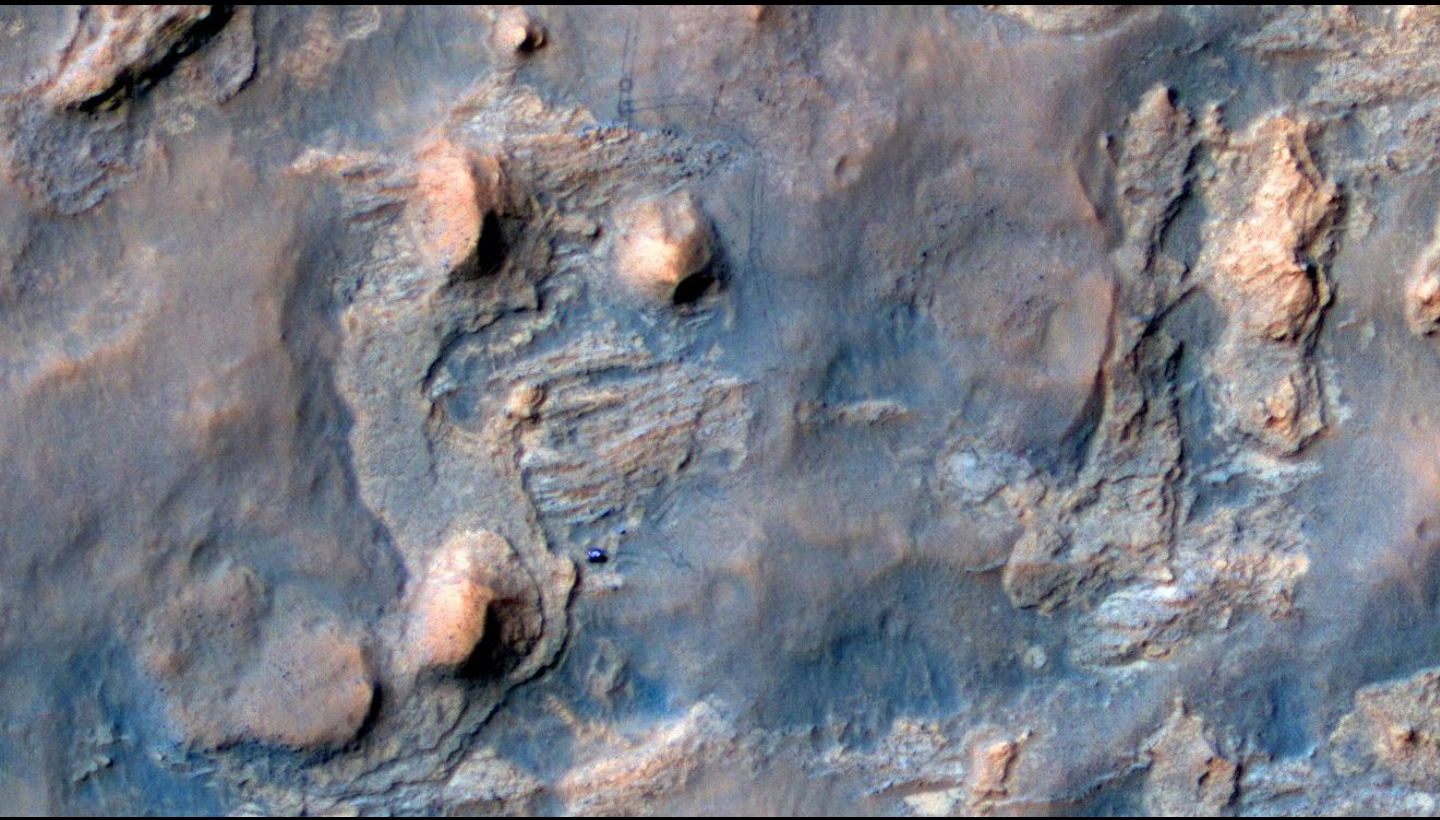


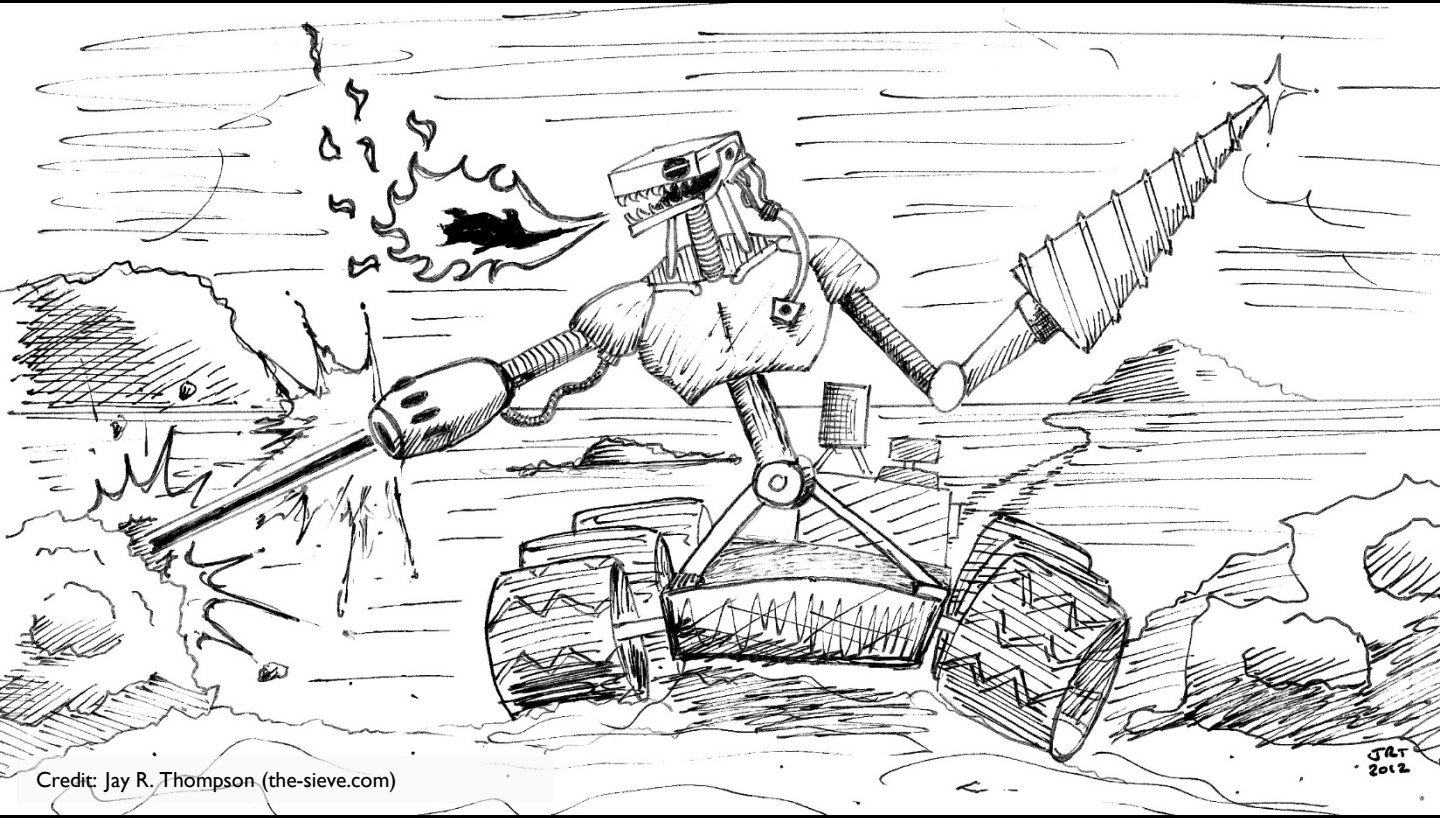


Landing

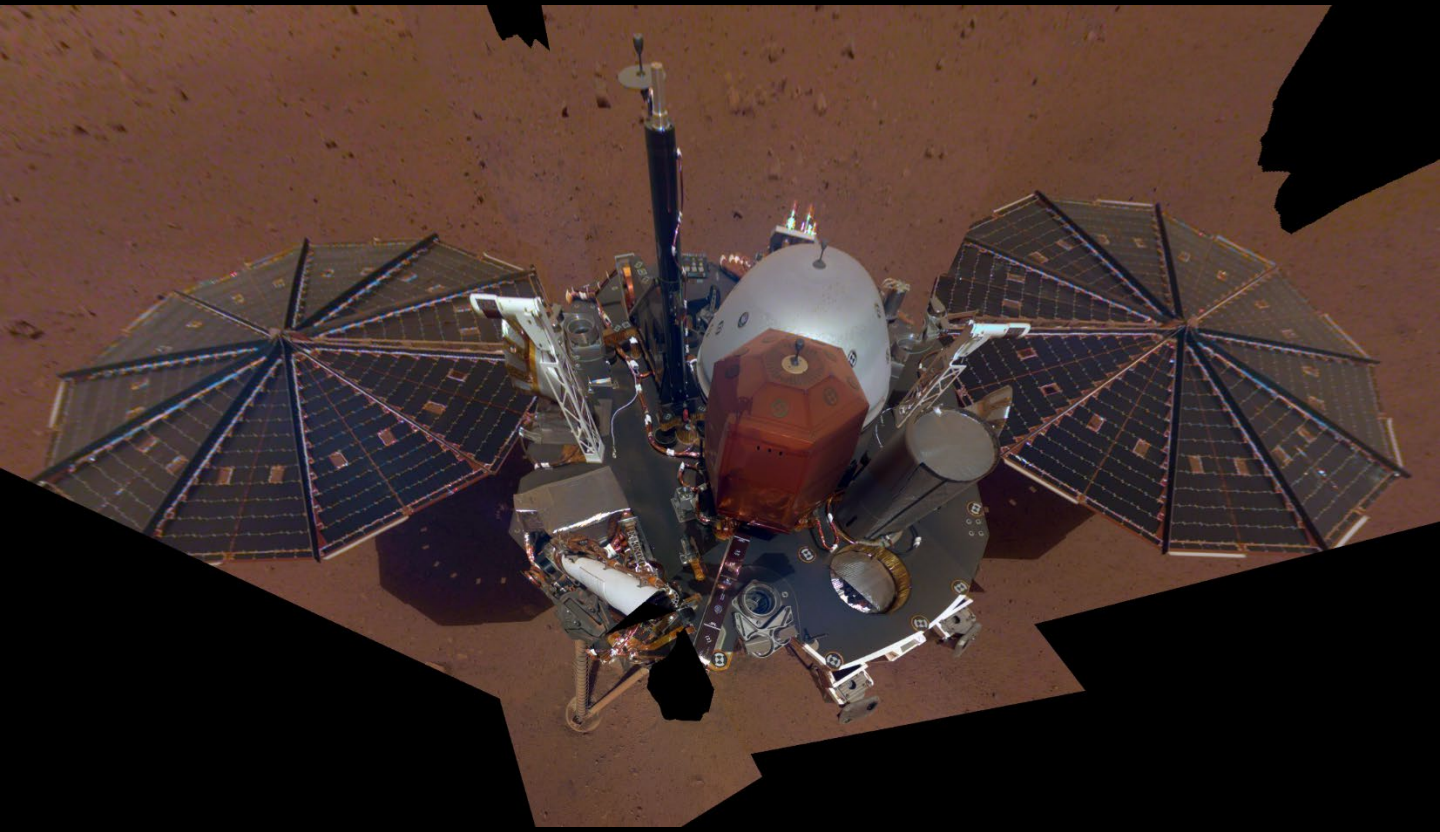
- Friction
- Parachute
- Thrusters
- Air bags

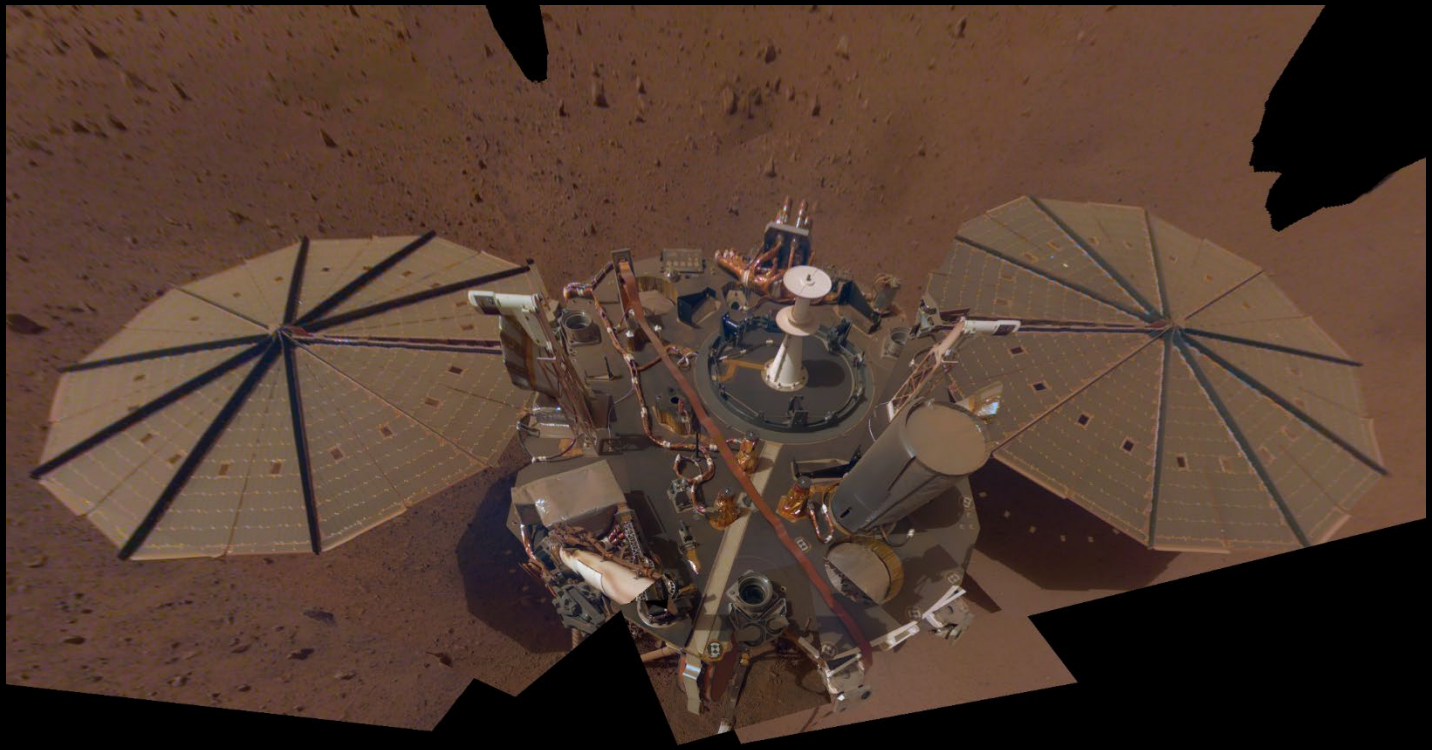
“The overall scientific goal of the mission is to explore and quantitatively assess a local region on Mars' surface as a potential habitat for life, past or present.”

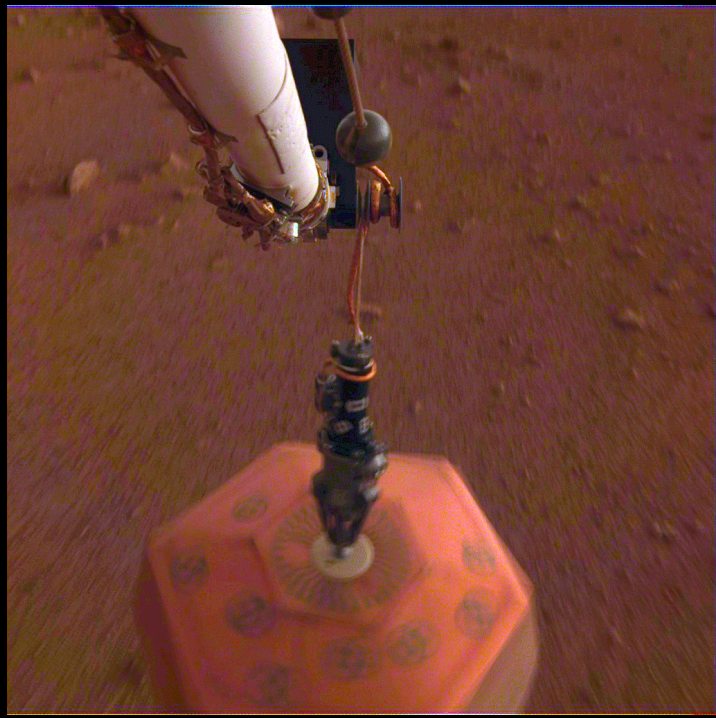


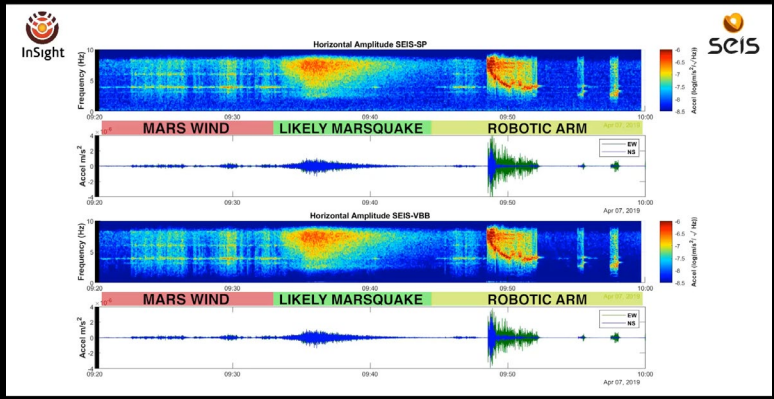


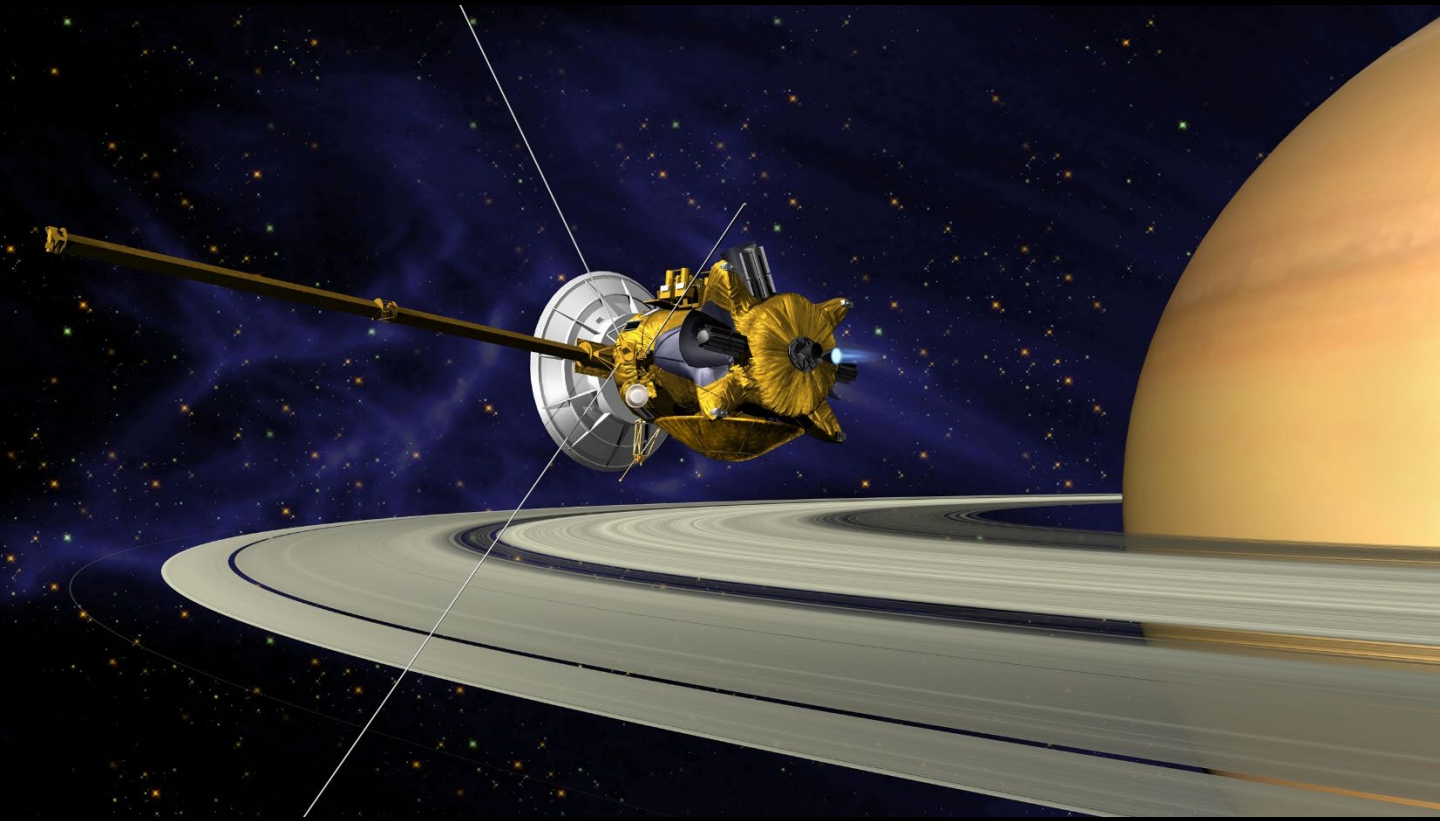
Credit: Jay R. Thompson (the-sieve.com)

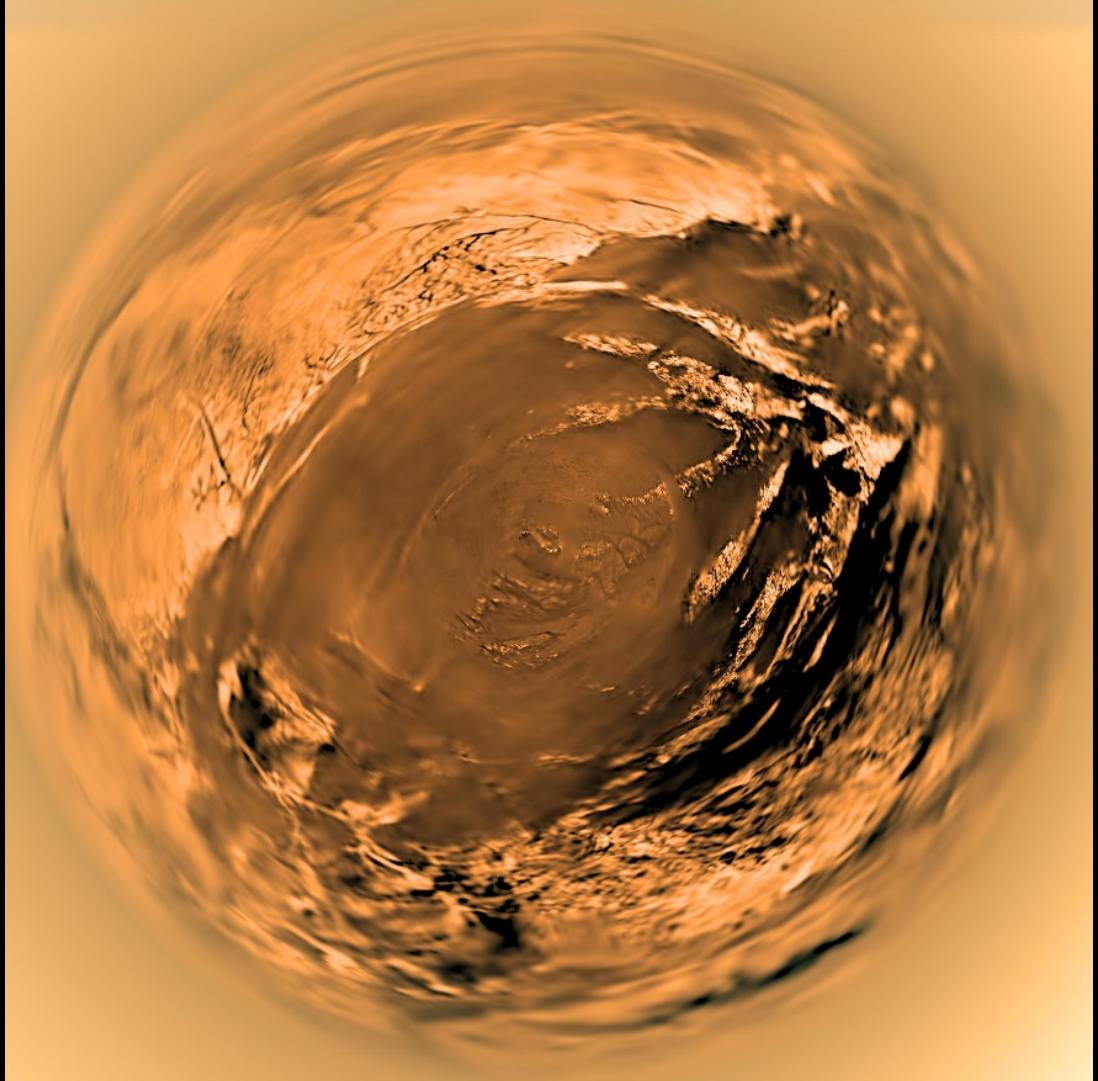


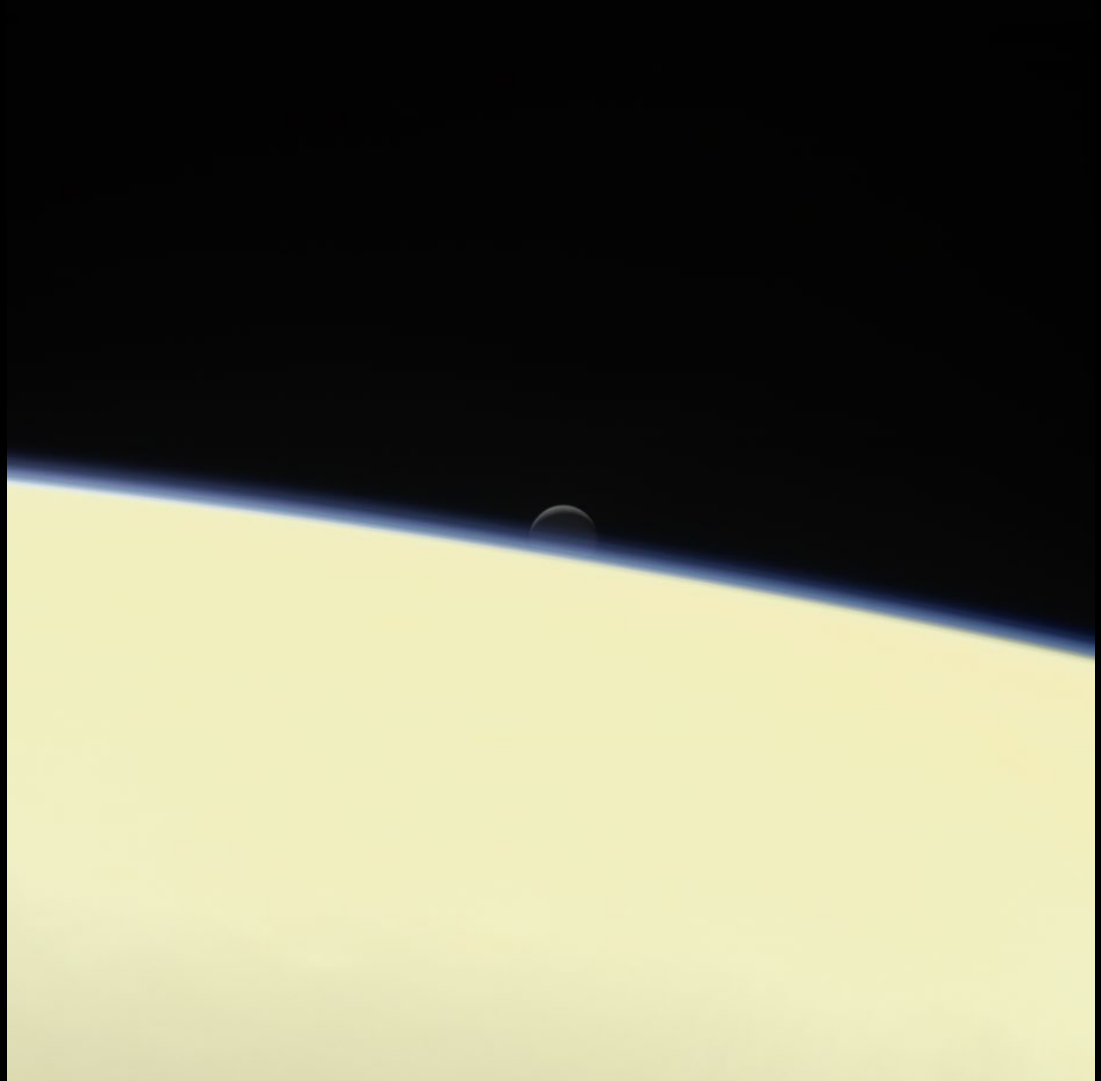


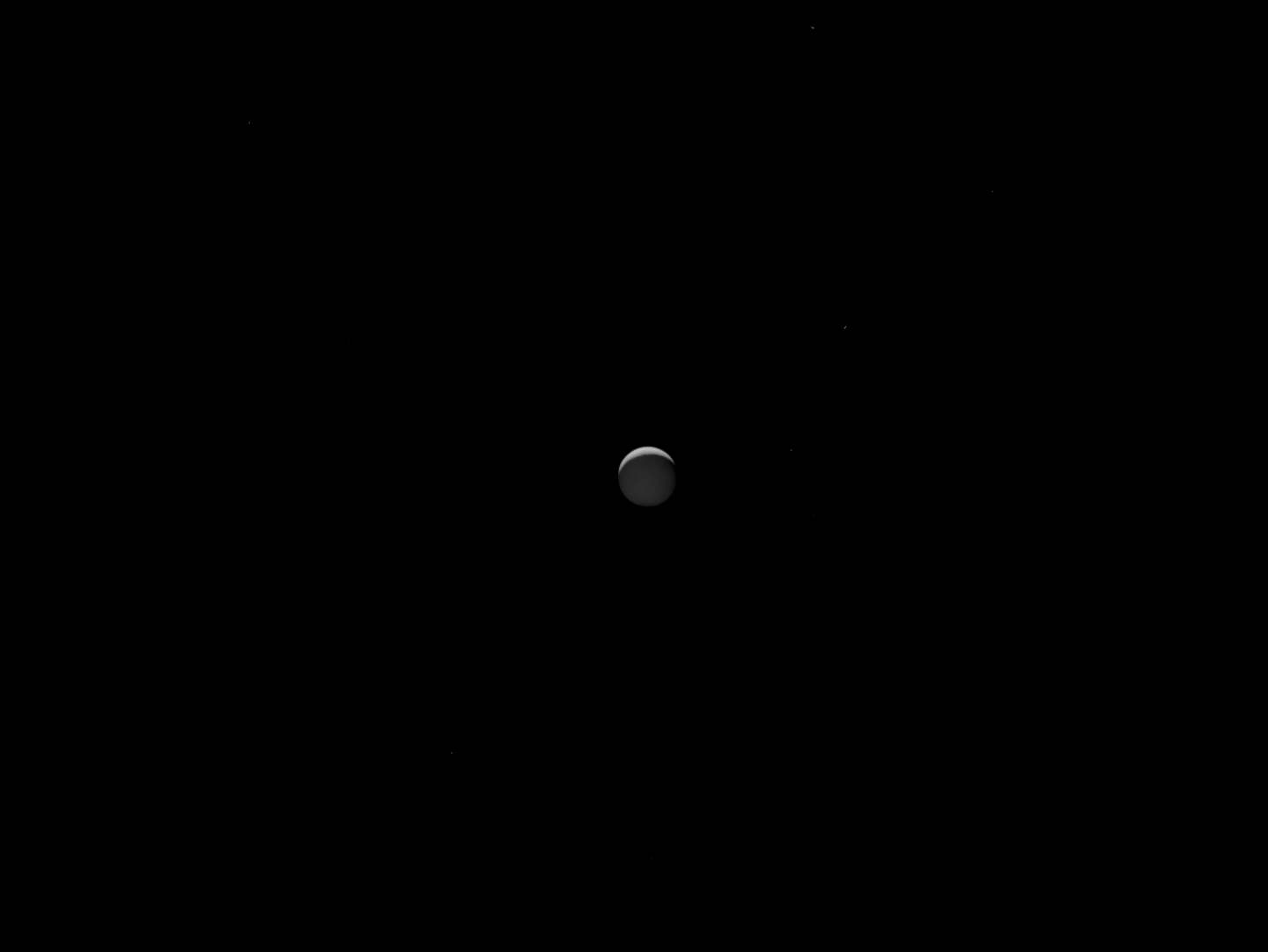


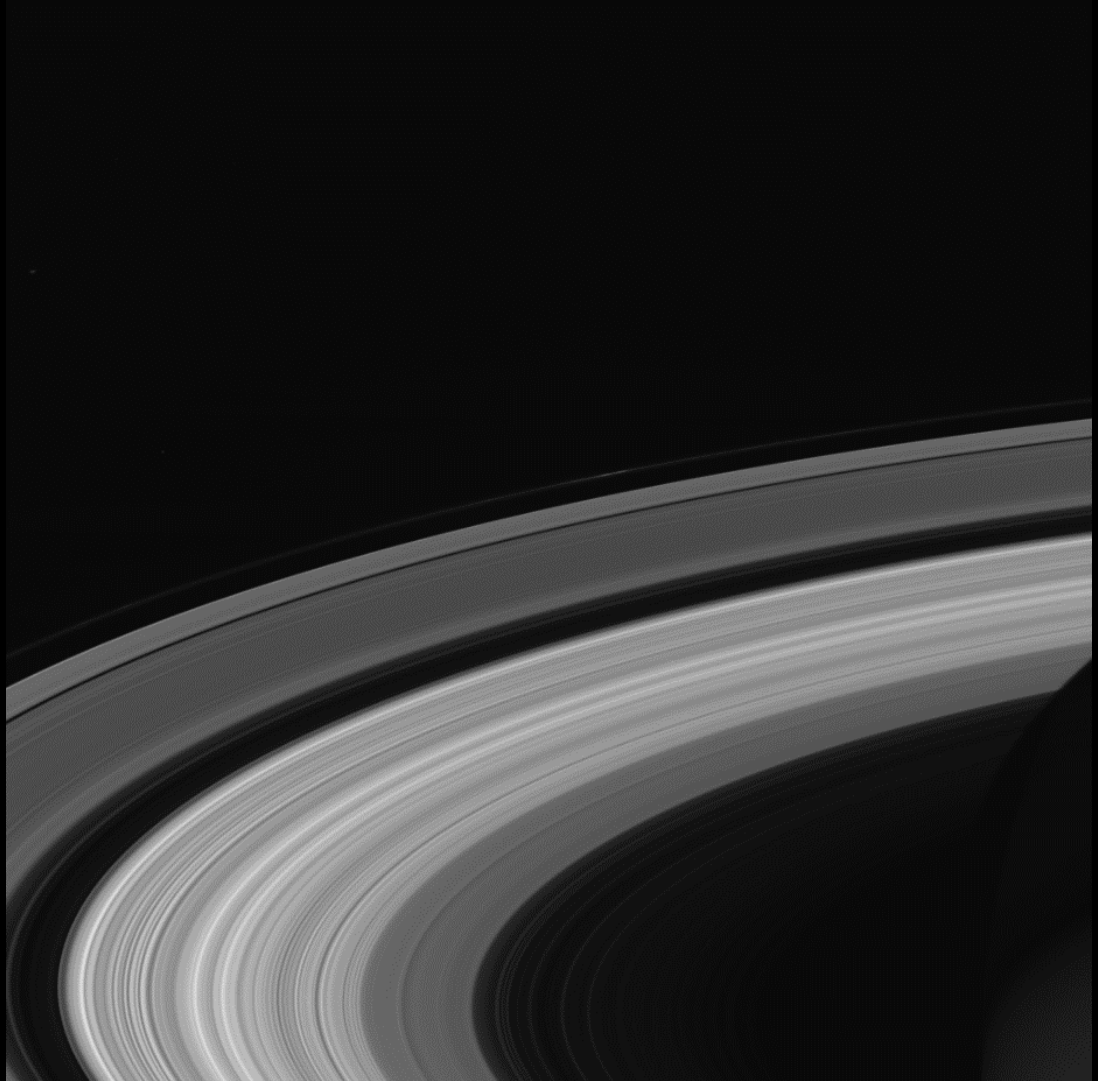

InSight
SEIS
Horizontal Amplitude SEIS-SP
Frequency (Hz)
MARS WIND
LIKELY MARSQUAKE
ROBOTIC ARM
Accel m/s²
EW
NS
09:20
09:30
09:40
09:50
10:00
Apr 07, 2019
Horizontal Amplitude SEIS-VBB
Frequency (Hz)
MARS WIND
LIKELY MARSQUAKE
ROBOTIC ARM
Accel m/s²
EW
NS
09:20
09:30
09:40
09:50
10:00
Apr 07, 2019

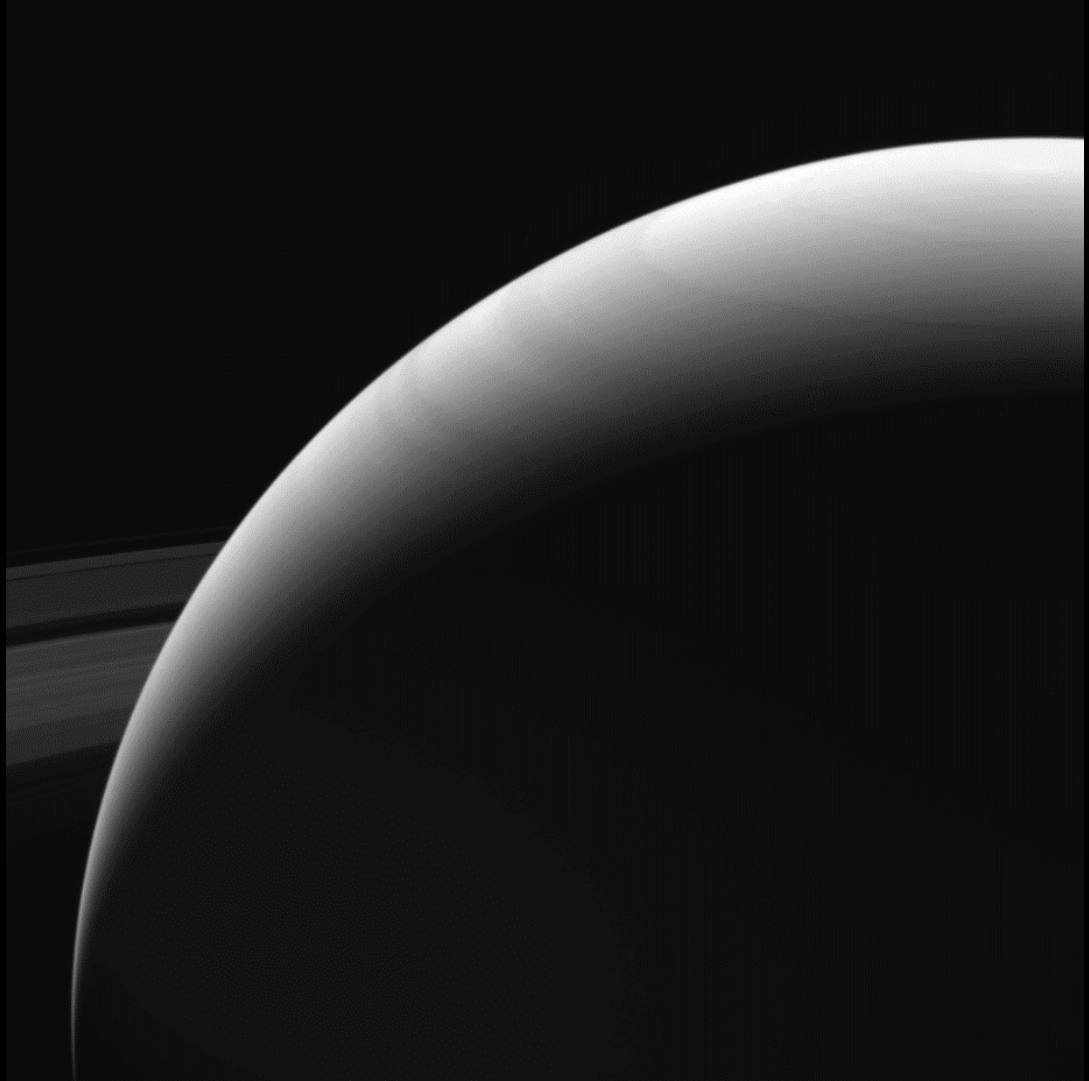


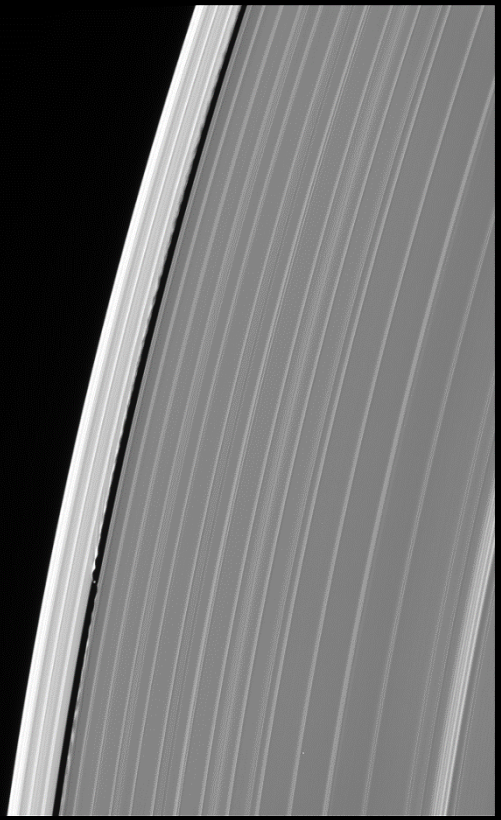


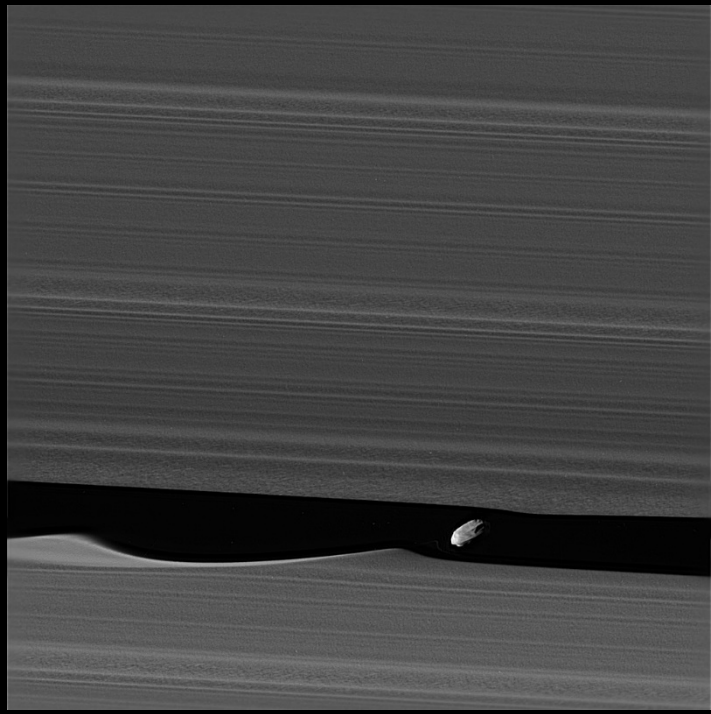












- How long is a day on Saturn?

- How long is a day on Saturn?
- Saturn's Rings are Relatively New

- How long is a day on Saturn?
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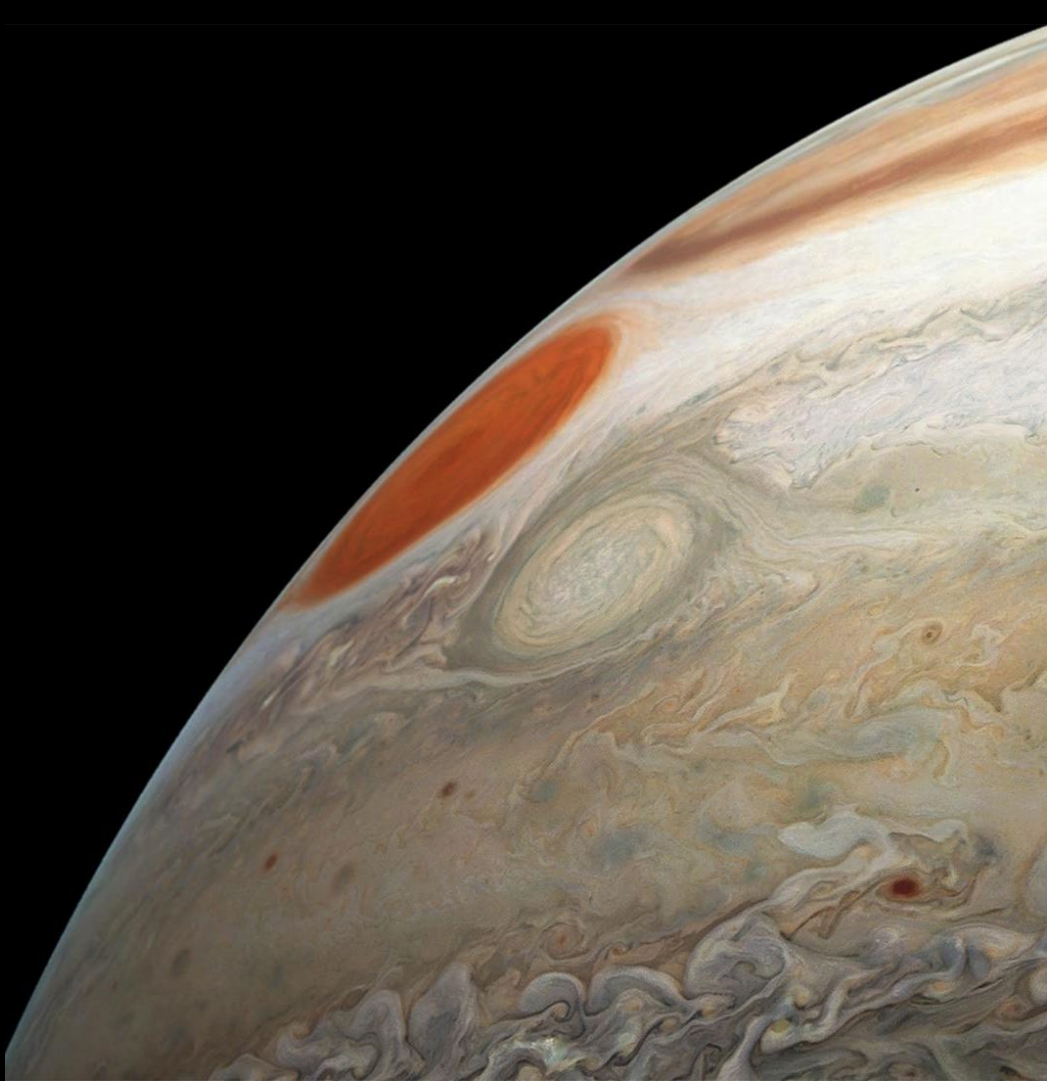
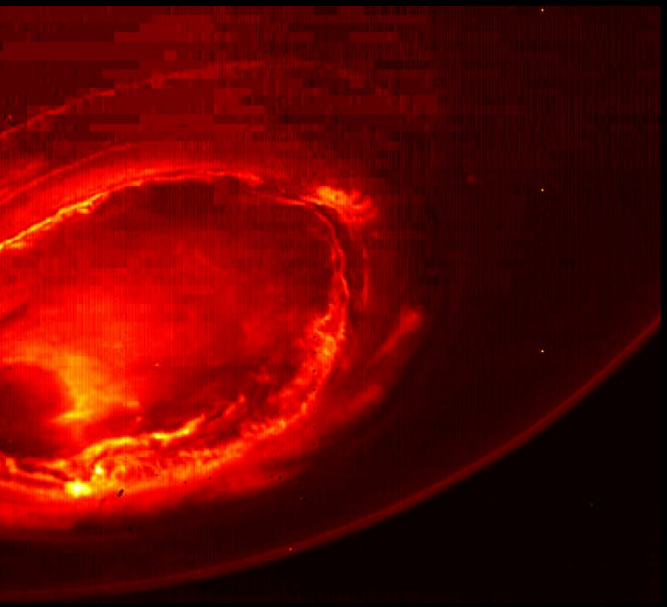
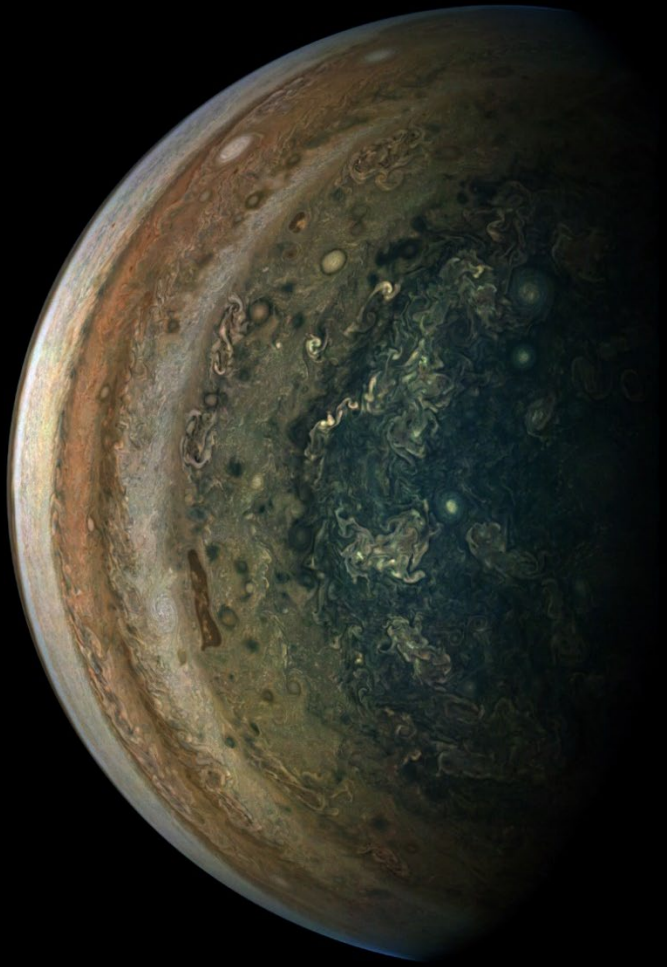
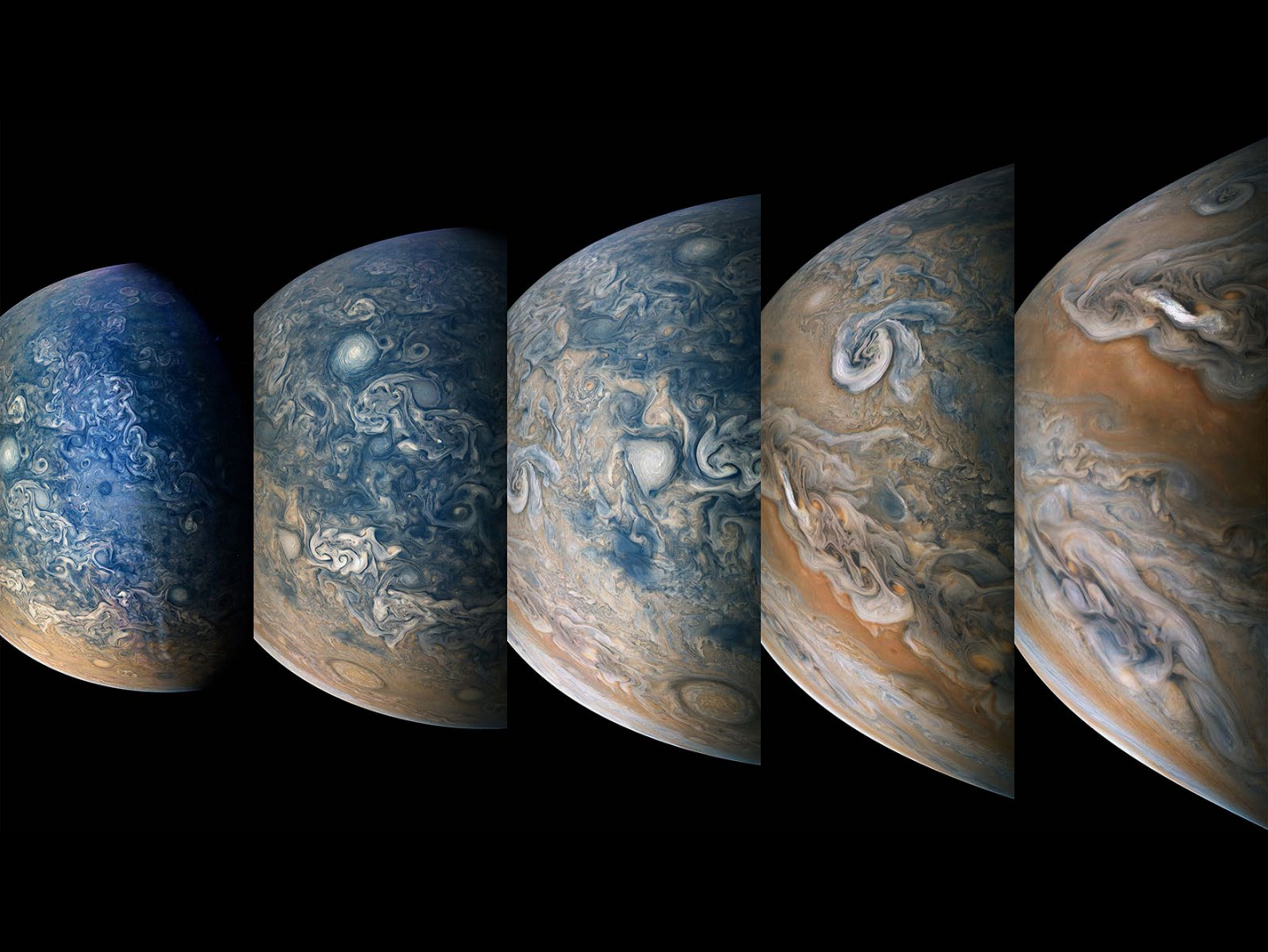
- Particles spiral into Saturn directed by its magnetic fields

- How long is a day on Saturn?
- Saturn's Rings are Relatively New
- Particles spiral into Saturn directed by its magnetic fields
- Grinding Saturn’s rings into nano-particle smoke





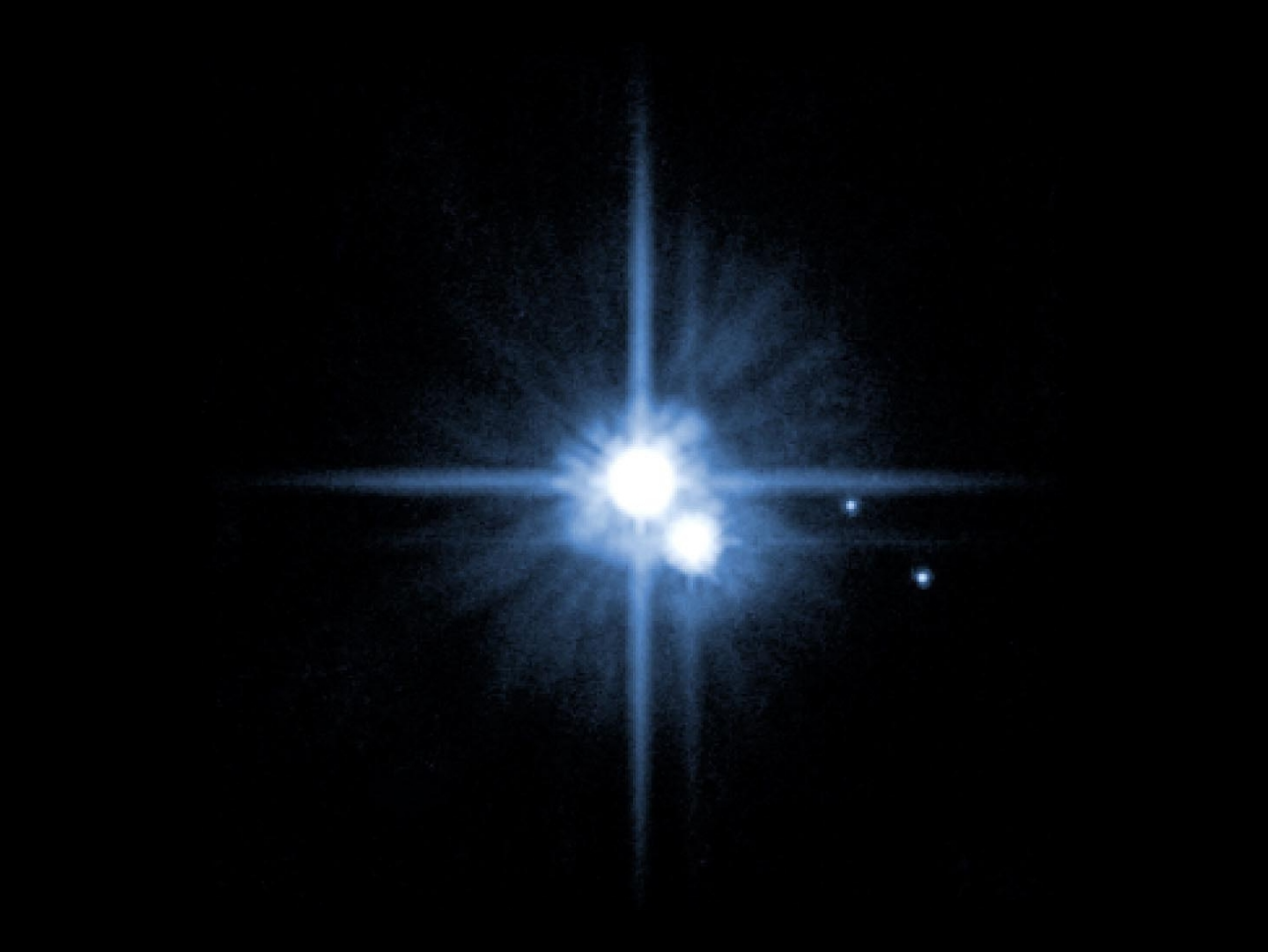




- Waves in the Jovian Atmosphere

- Waves in the Jovian Atmosphere
- Lightning on Jupiter

- Waves in the Jovian Atmosphere
- Lightning on Jupiter
- Jupiter's magnetic field



The Demotion of Pluto

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Astronomers detect '10th planet'

By Dr David Whitehouse
Science Editor, BBC news website

Astronomers in the United States have announced the discovery of the "10th planet" to orbit our Sun.

The new planet has a highly inclined orbit

The largest object found in our Solar System since Neptune in 1846, it was first seen in 2003 - but important details have only now been confirmed.

Designated 2003 UB313, it is about 2,800km across - a world of rock and ice and somewhat larger than Pluto.

Scientists say it is three times as far away as Pluto, in an orbit at an angle to the orbits of the main planets.

Astronomers think that at some point in its history, Neptune probably flung the small world into its highly inclined 44-degree orbit.

A comparison of 2003 UB313 and other distant objects

It is currently 97 Earth-Sun distances away - more than twice Pluto's average distance from the Sun.

Bigger than Pluto

Its discoverers are Michael Brown of Caltech, Chad Trujillo of the Gemini Observatory in Hawaii, and David Rabinowitz of Yale University.

David Rabinowitz told the BBC News website: "It has been a remarkable day and a remarkable year. 2003 UB313 is probably larger than Pluto. It is fainter than Pluto, but three times farther away.

> **"It's not every day that you find something Pluto-sized or larger!"**
> Chad Trujillo

"Brought to the same distance from the Sun as Pluto, it would be brighter. So today, the world knows that Pluto is not unique. There are other Plutos, just farther out in the Solar System where they are a little harder to find."

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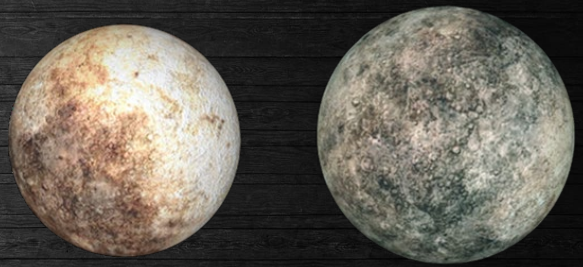


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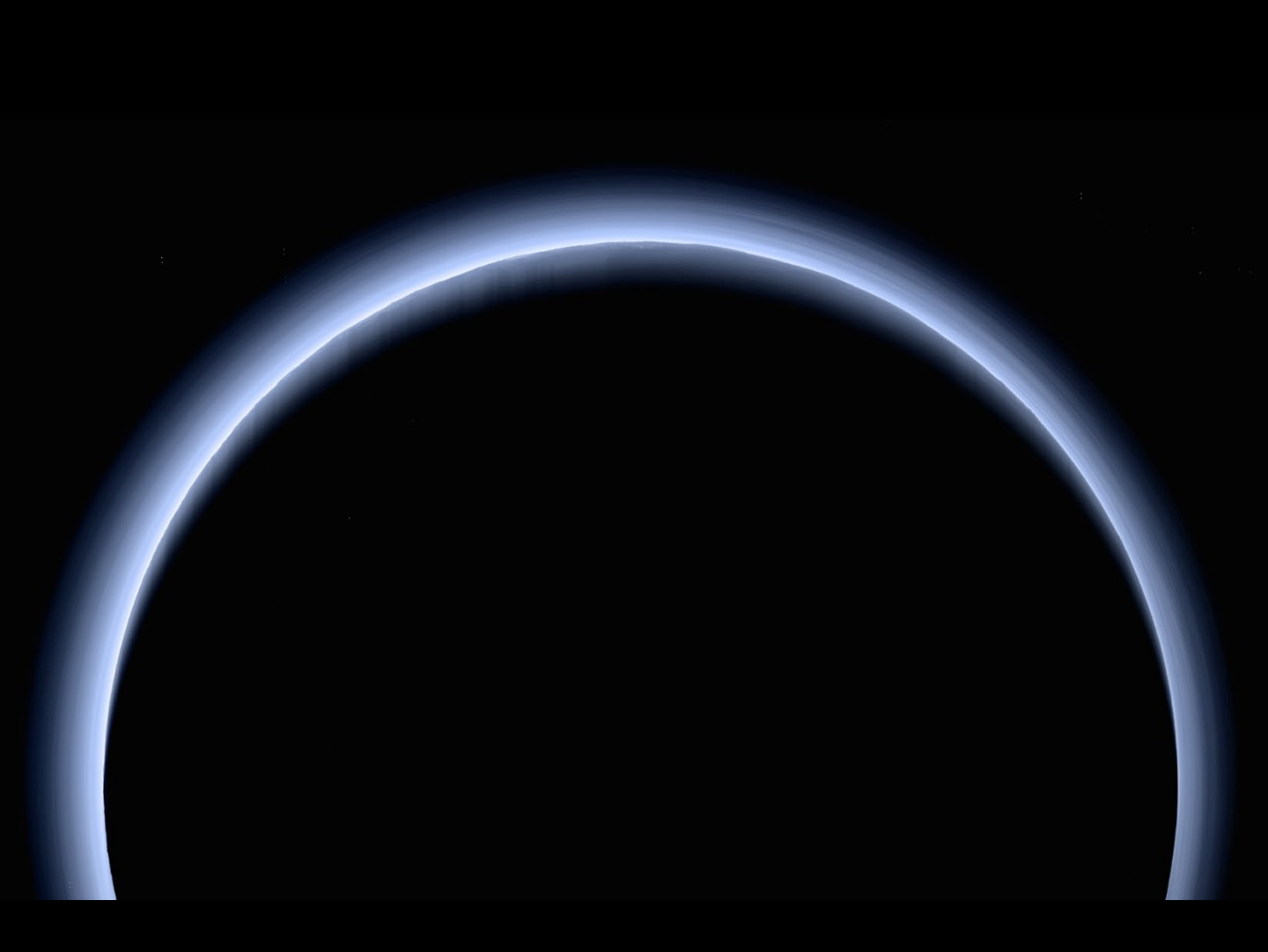

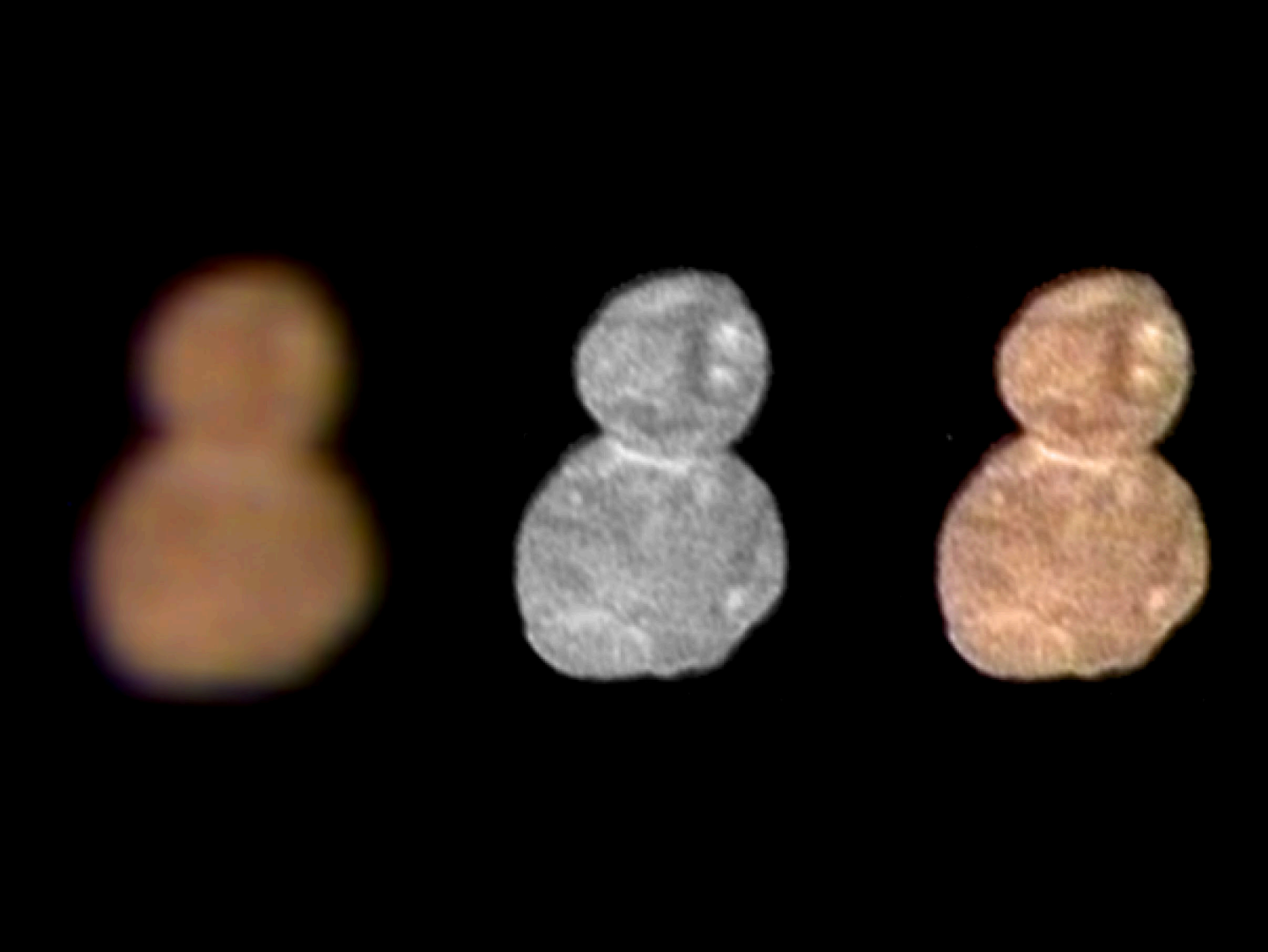

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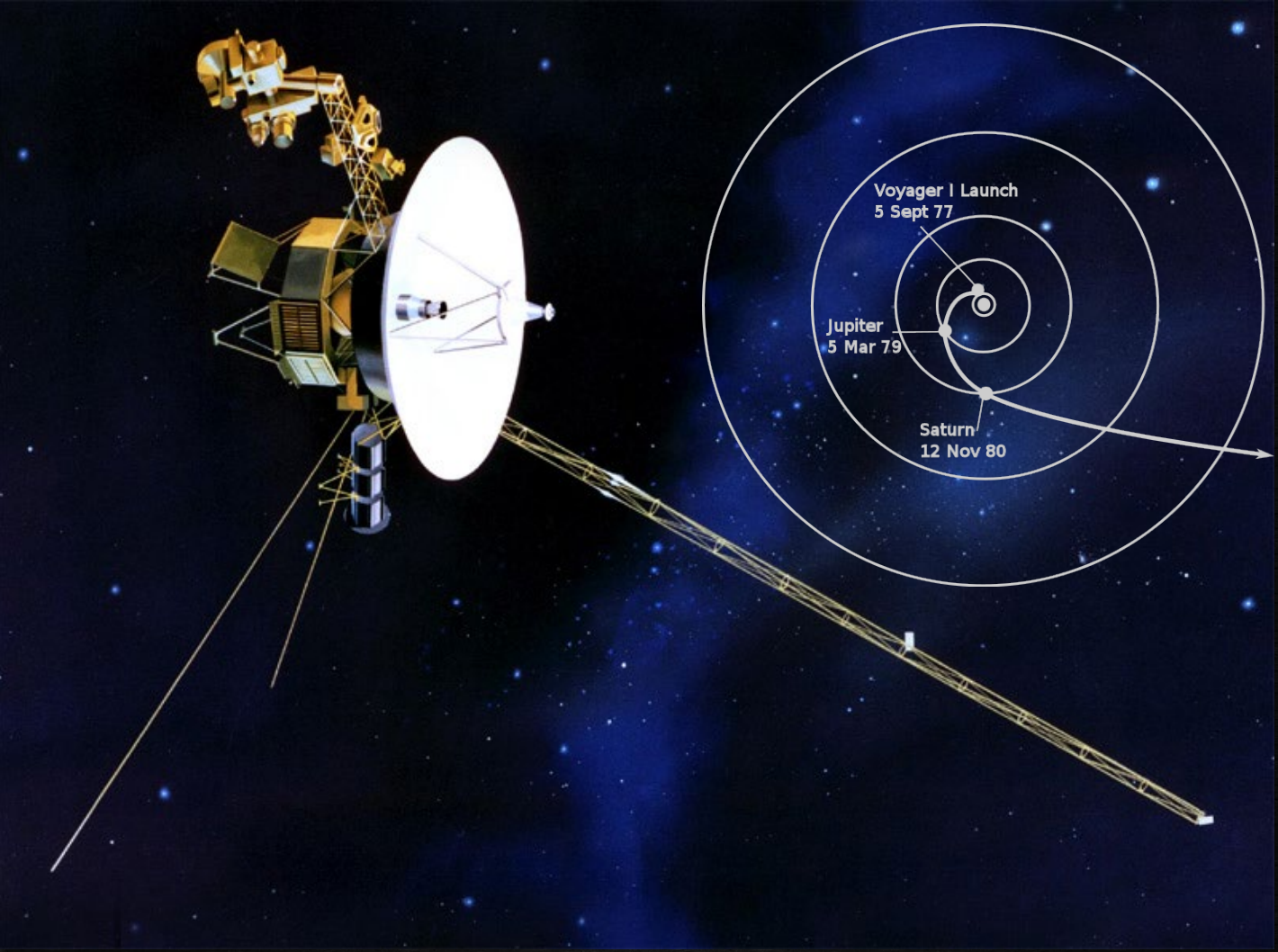
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Saturn
12 Nov 80