



From Earth (~1500) to Pluto (2015), and Some Changes On the Way

Robert L. Staehle

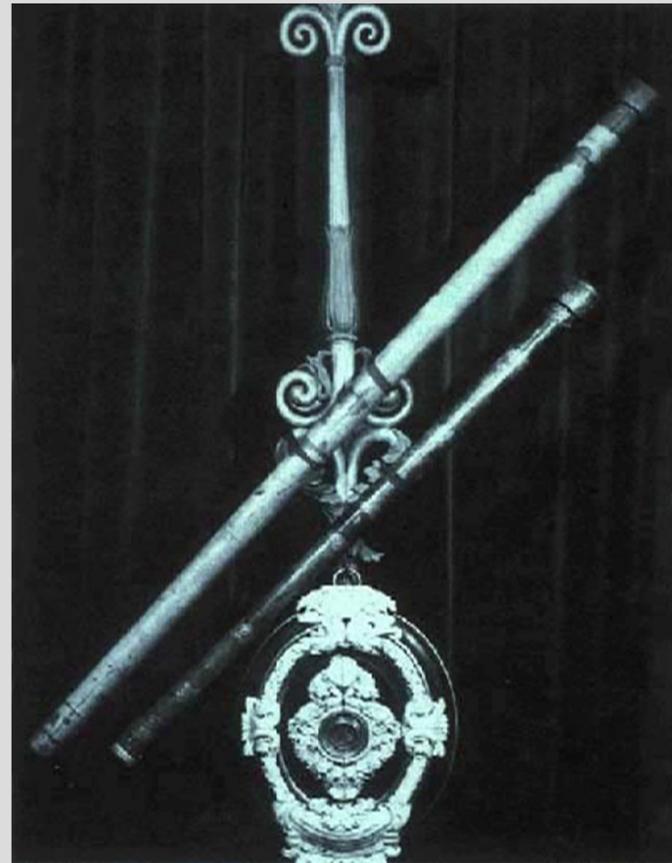
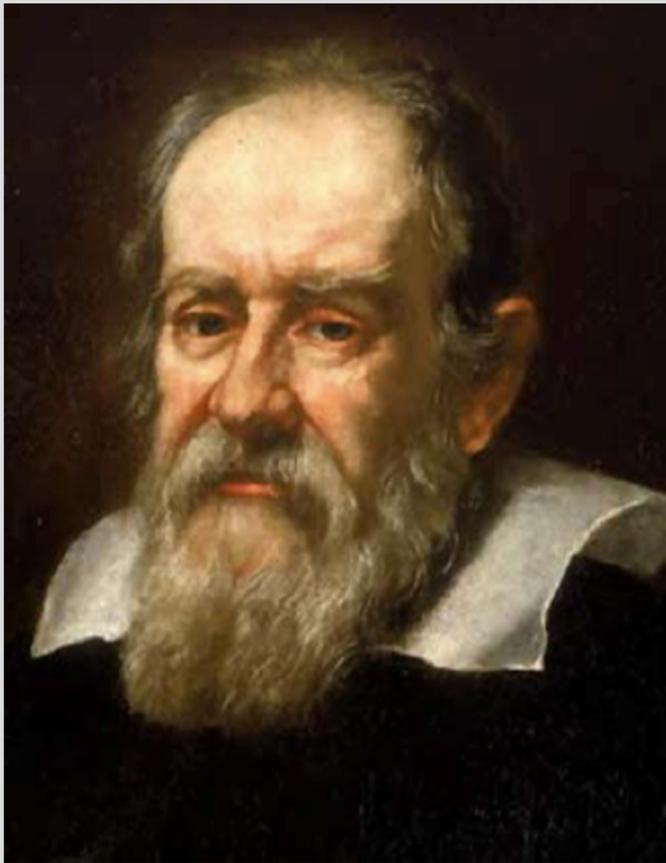
Jet Propulsion Laboratory, California Institute of Technology

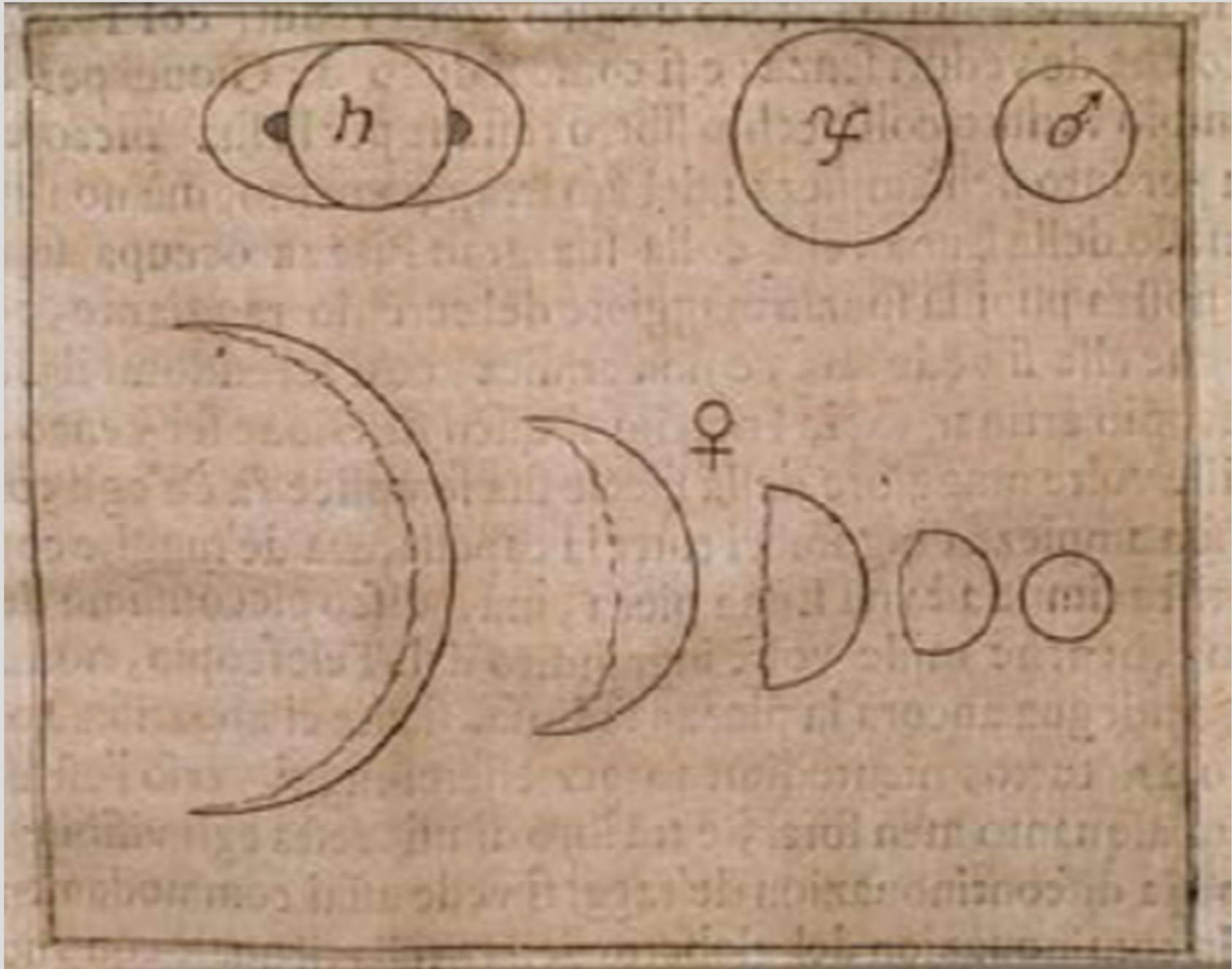
2011 October 11

On the occasion of
Space Week St. Denis
Isle de la Réunion

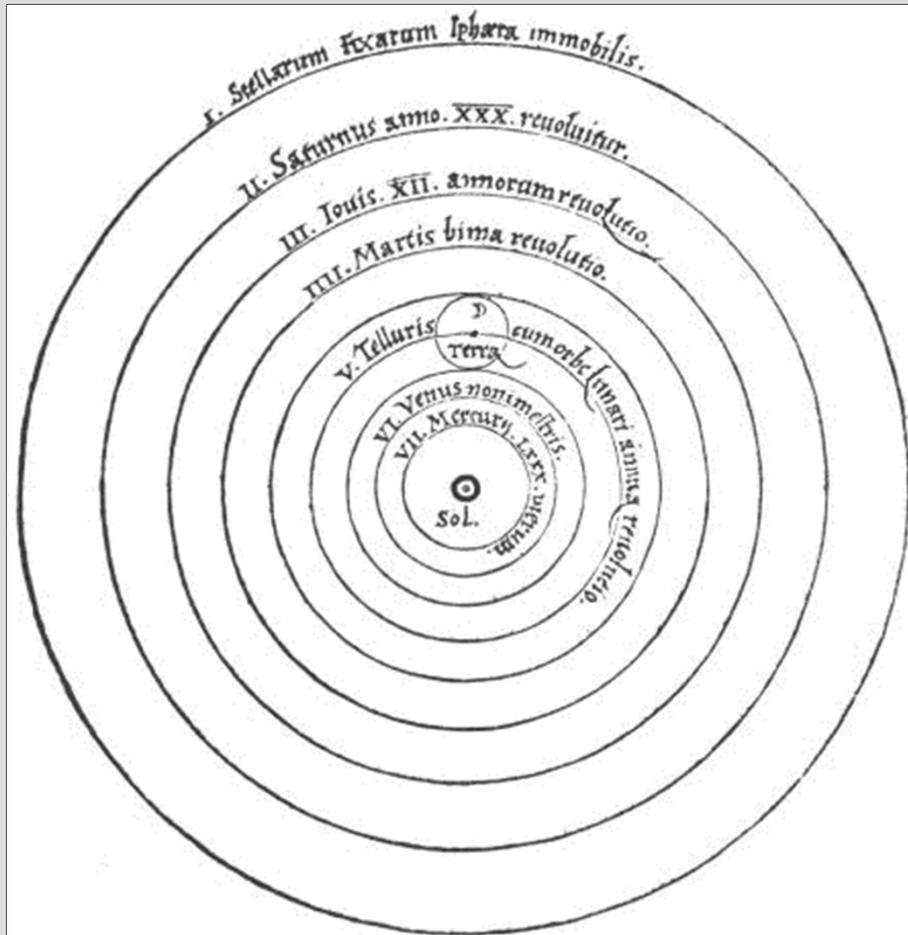
It takes a long time to get to Pluto:

1609 Galileo Galilei makes first astronomical observation with a telescope





1600s - 1700s Copernican view of Solar System generally accepted



Millennium Mathematics Project

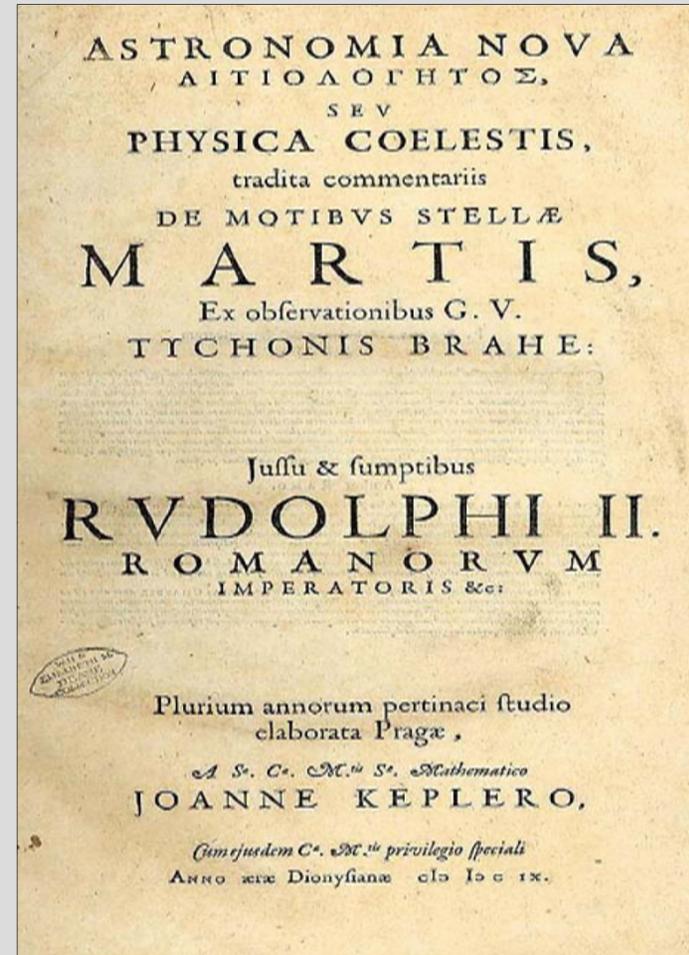


Image: Wikipedia

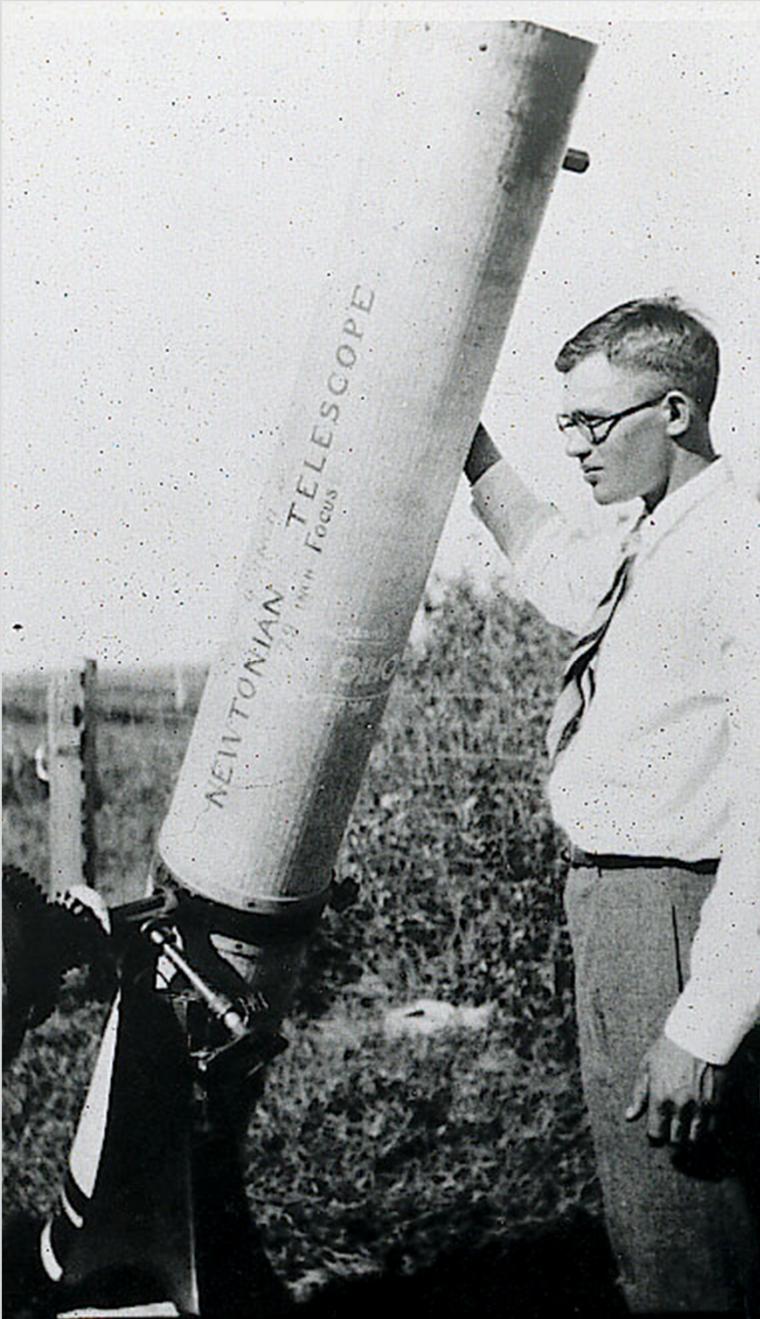


1920s to 1940s Liquid propellant rockets developed

NASA



Pluto was there... but we
had to discover it



Kansas City Historical Society



Lowell Observatory via Alan Stern

Which one is it?

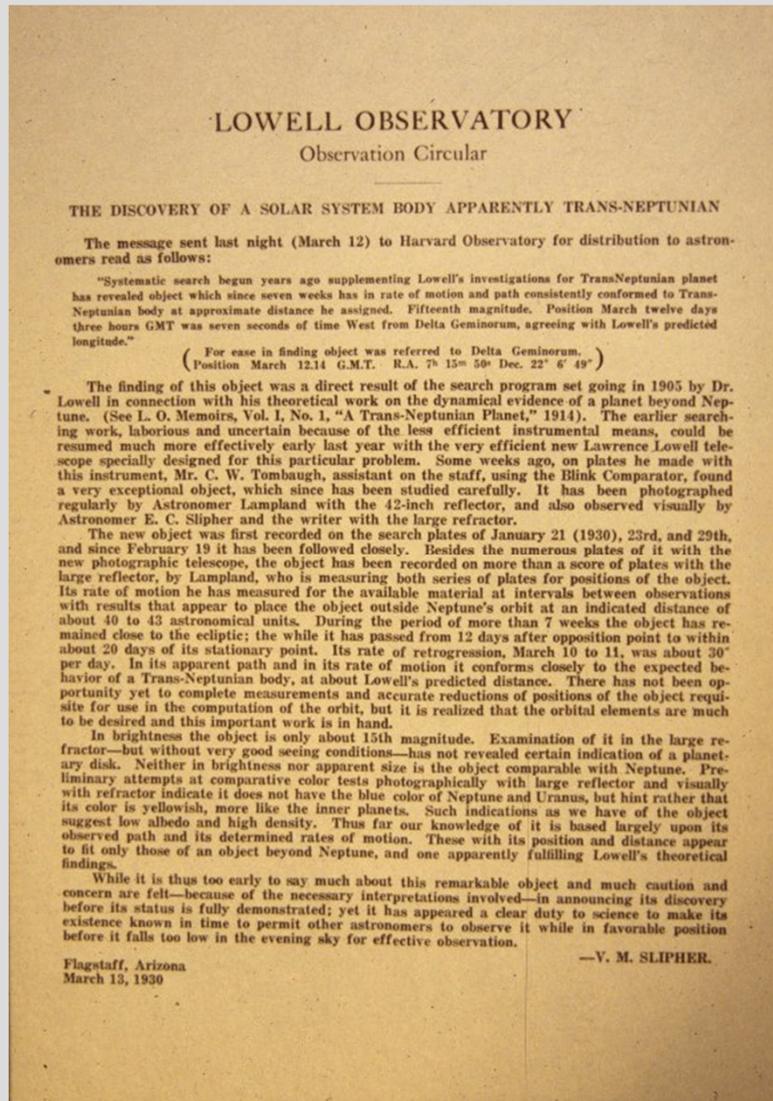


January 23, 1930



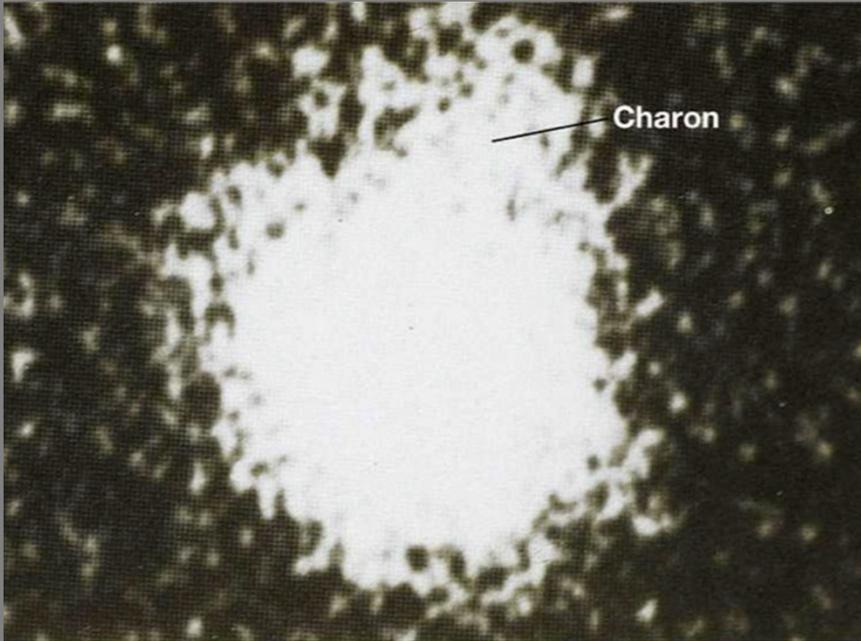
January 29, 1930

An American Scientific Sensation



Lori L. Paul/JPL

Charon, Pluto's primary satellite



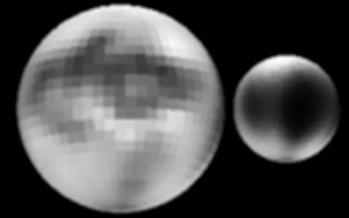
US Naval Observatory



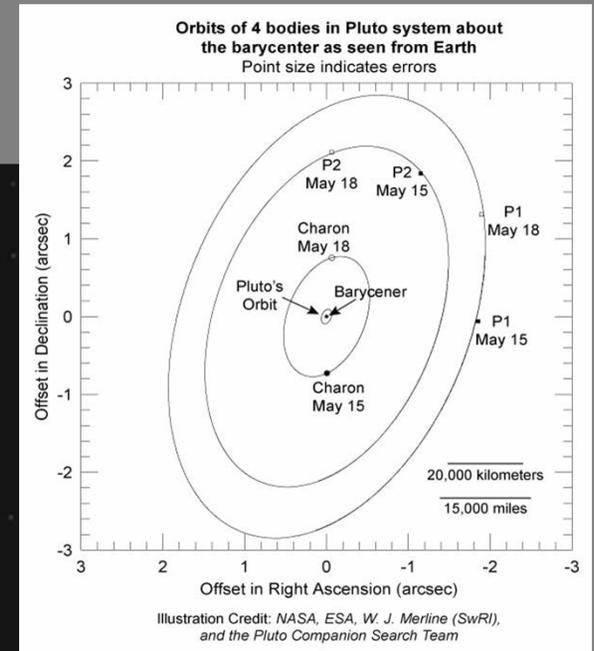
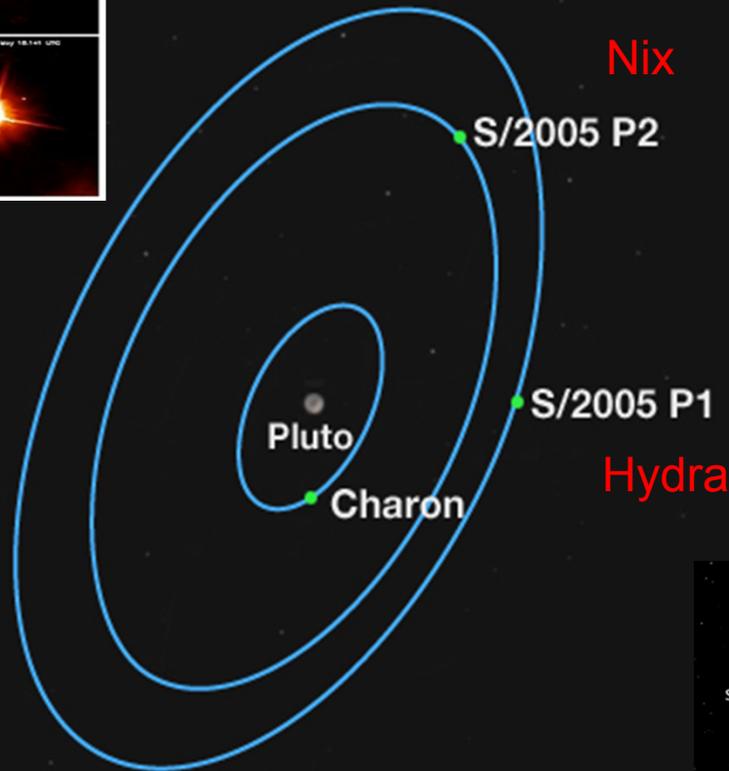
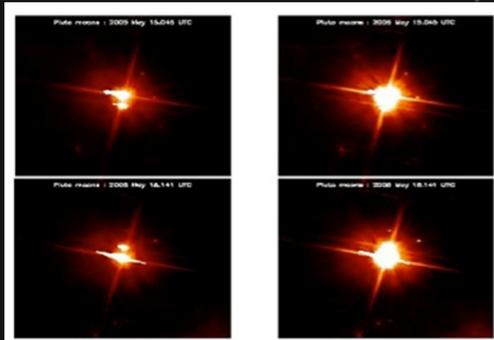
Robert L. Staehle/JPL & Lori L. Paul/JPL

The Mission to Pluto Begins!

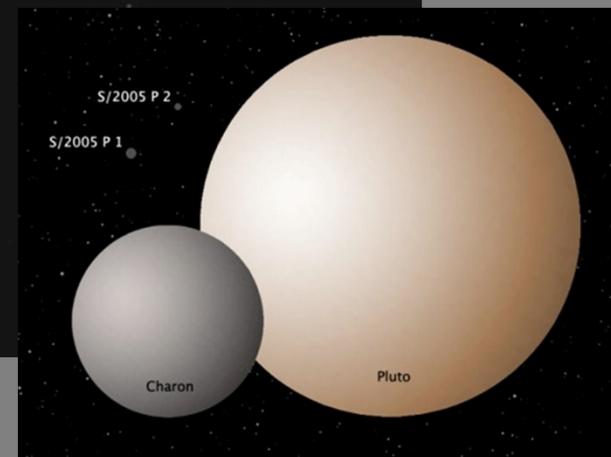




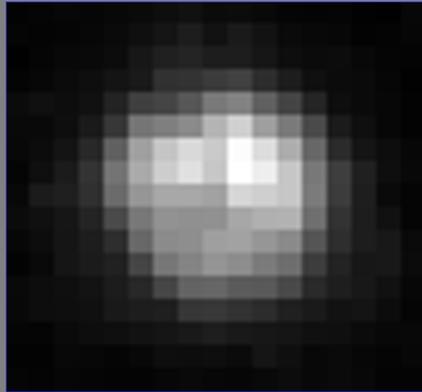
Two more satellites were discovered



Weaver, Stern, Mutchler, Steffl, et al. (2005)



WHY GO?



**Pluto at Best
Hubble Space
Telescope
Resolution**



**Earth's Moon
at the Same
Resolution**

We had to get Professor Tombaugh's permission to visit his planet



We formed a team to figure out how to get there



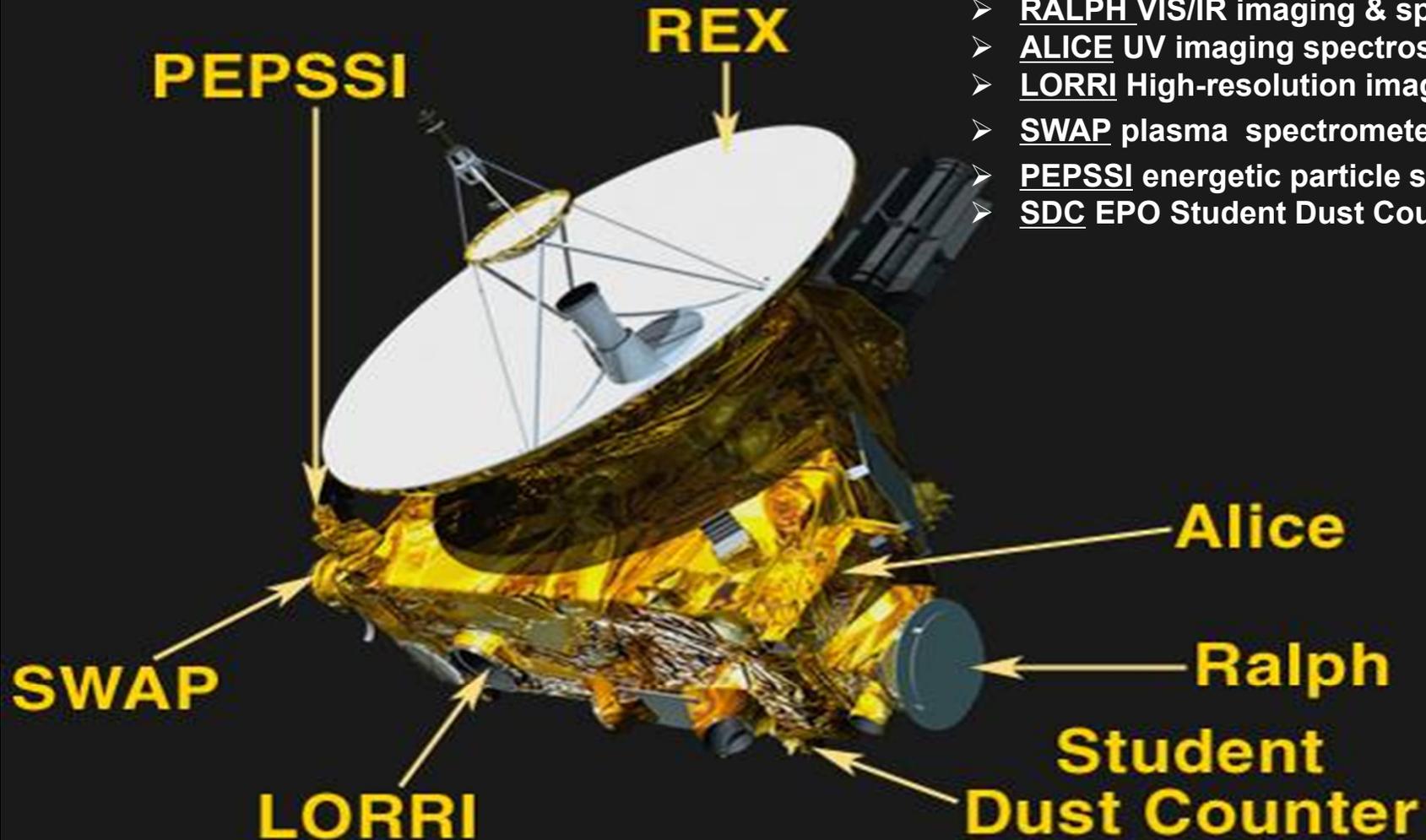
2005 November: Preparation for Launch

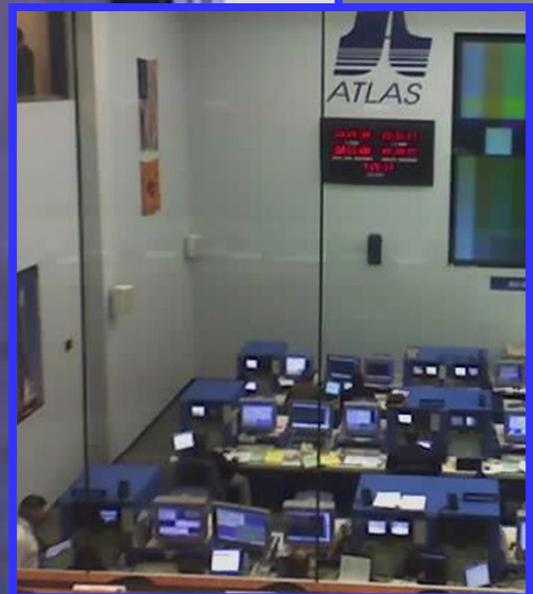


SCIENTIFIC PAYLOAD

Instruments:

- REX radio science & radiometry
- RALPH VIS/IR imaging & spectroscopy
- ALICE UV imaging spectroscopy
- LORRI High-resolution imager
- SWAP plasma spectrometer
- PEPSSI energetic particle spectrometer
- SDC EPO Student Dust Counter





Go! 2006 January



Lori L. Paul



Robert Staehle

A blue sky with scattered white clouds. A bright white streak, possibly a comet or meteor, is visible in the lower-left corner, pointing towards the center of the frame.

Allez!



sur La Réunion...



DERNIERE STATION AVANT LE VOYAGE VERS PLUTON

le 19 janvier 2006, la NASA a installé ici l'ultime station de poursuite pour le lancement de la sonde interplanétaire « New Horizons » vers Pluton et les Objets de Kuiper.



Cette plaque a été posée le 20 décembre 2009
par le Dr. Robert STAEHLE, initiateur de la mission vers Pluton
et M. Bruno MAMINDY-PAJANY, Maire de Sainte-Rose



Our knowledge grows up with us!

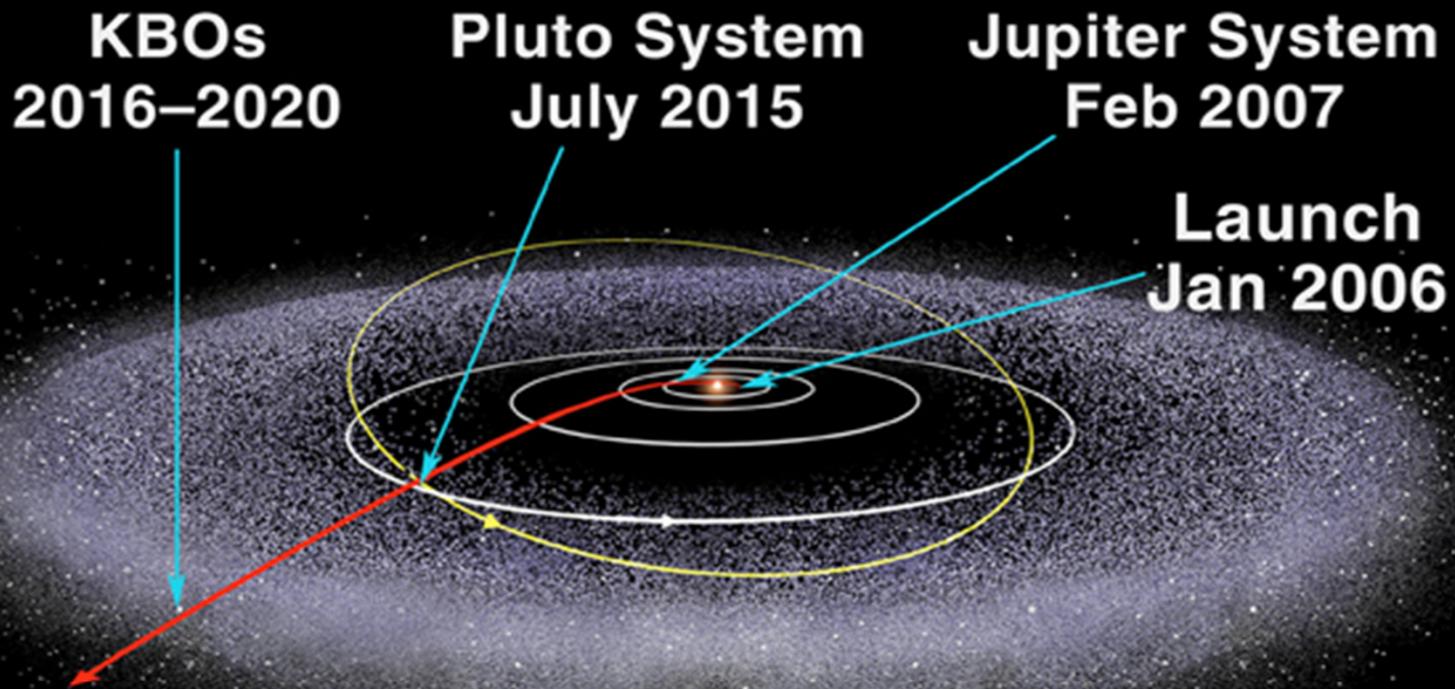


Photos clockwise from top left: Lori L. Paul, Guy Pignolet, Domie Lebas, BBC



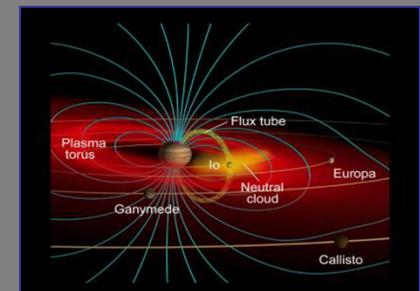
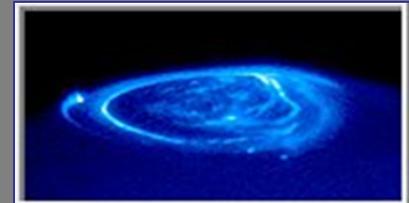
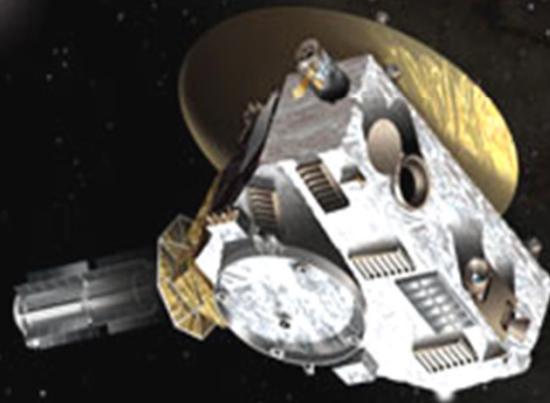
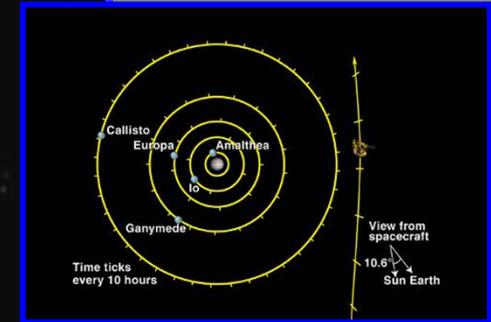
Bon voyage!

From 1609 to 2006... Then it takes another 9 years from launch



Going past our largest planet

Closest Date	28 Feb 2007
Range	32 R_{Jupiter}



Science at Jupiter: Jovian meteorology, geology of satellites, aurora, and magnetospheric physics.

Alan Stern/SwRI



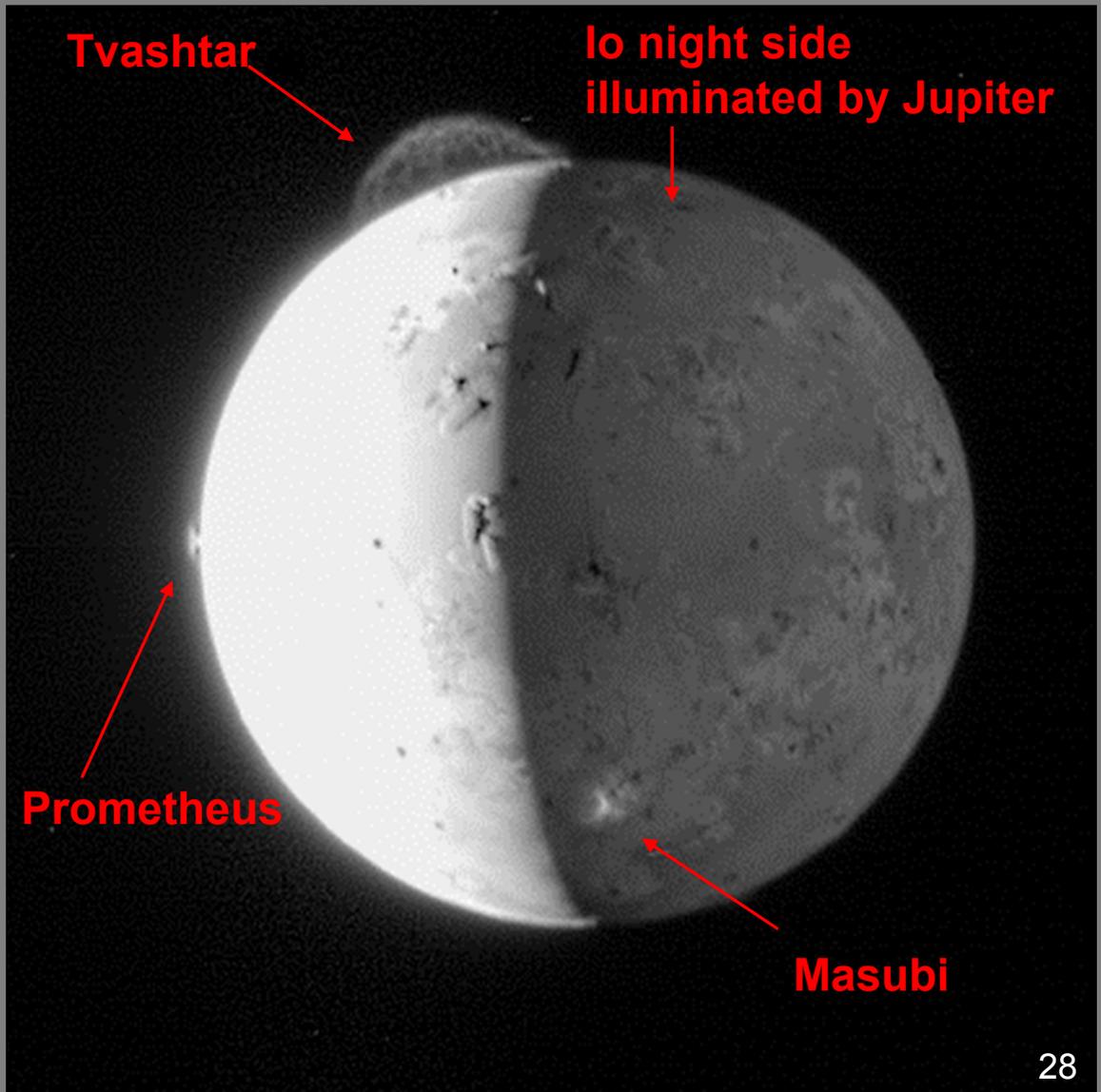
Jupiter Flyby

Objectives Met

1. Flew through Pluto aim point
2. Served as flyby/encounter pathfinder
3. Collected diverse scientific data

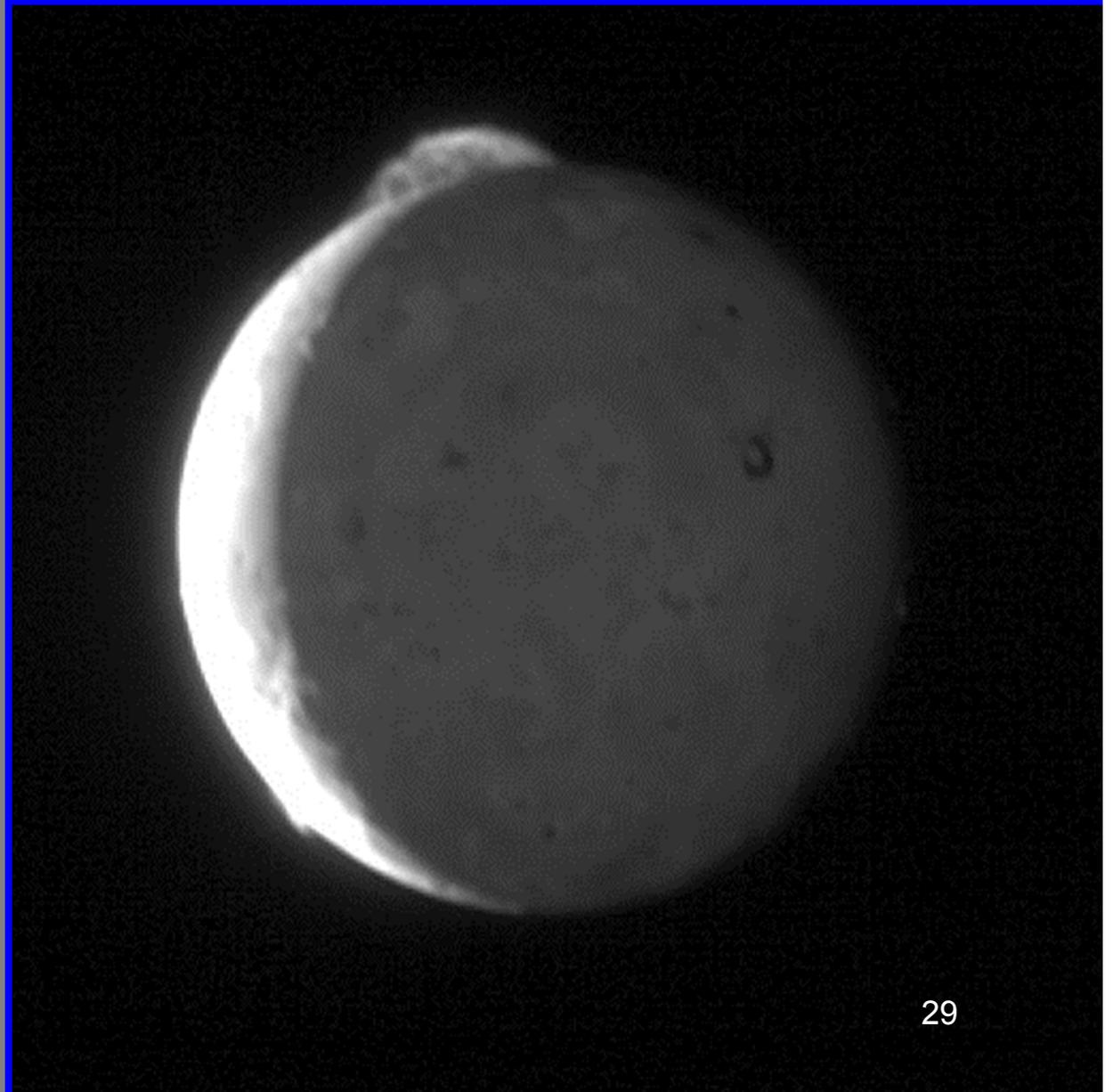
Volcanoes of Io

- **At least 11 volcanic Plumes.**
- **Obtained the most detailed view ever of a volcanic plume on Io.**
- **Tvashtar is near Io's North pole: always visible.**
- **Tvashtar stretches ~340 km above the surface.**



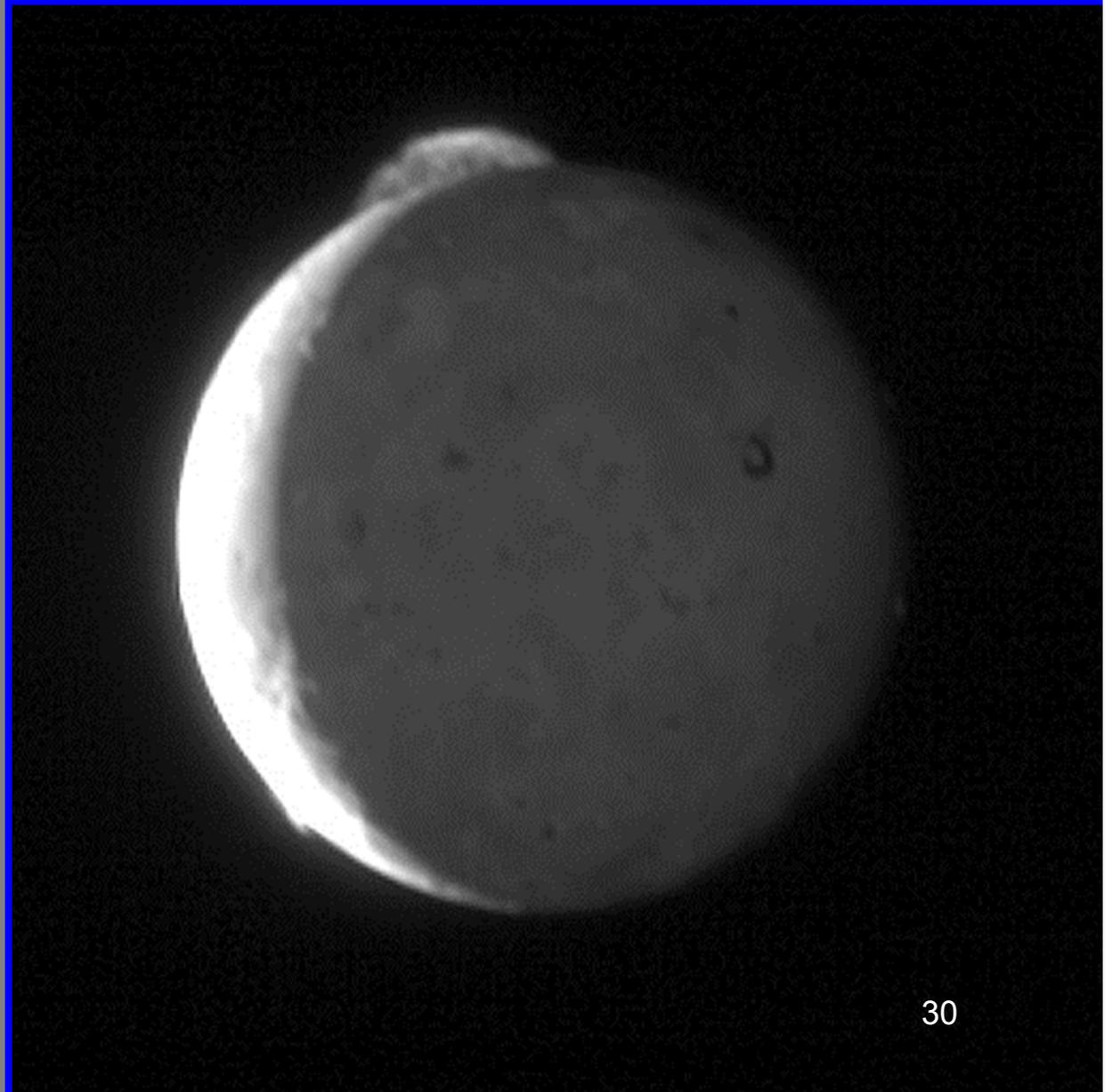
TVASHTAR MOVIE

- **5 frames**
- **8 minutes**



TVASHTAR MOVIE

- **5 frames**
- **8 minutes**



TVASHTAR MOVIE

- **5 frames**
- **8 minutes**



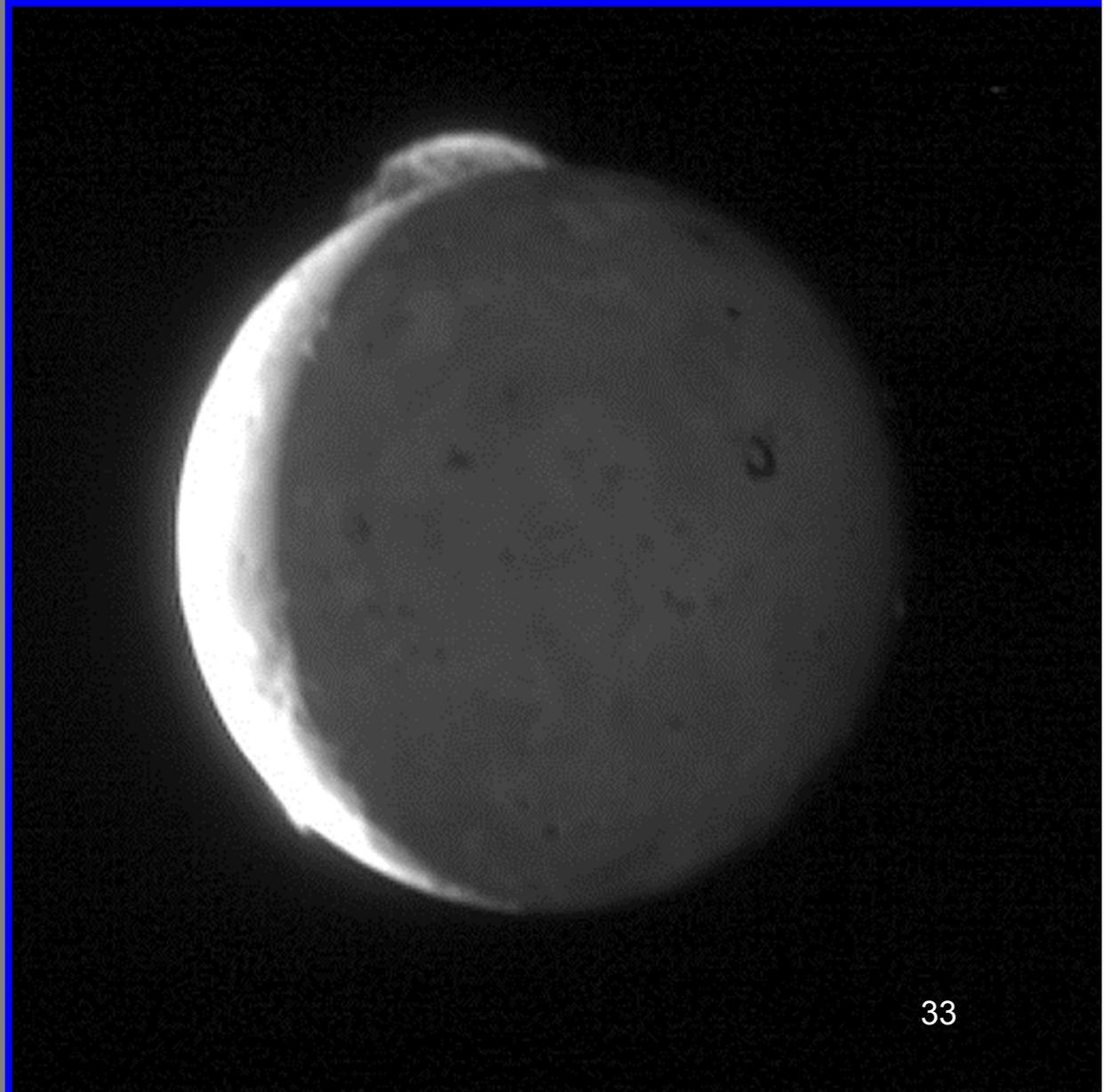
TVASHTAR MOVIE

- **5 frames**
- **8 minutes**



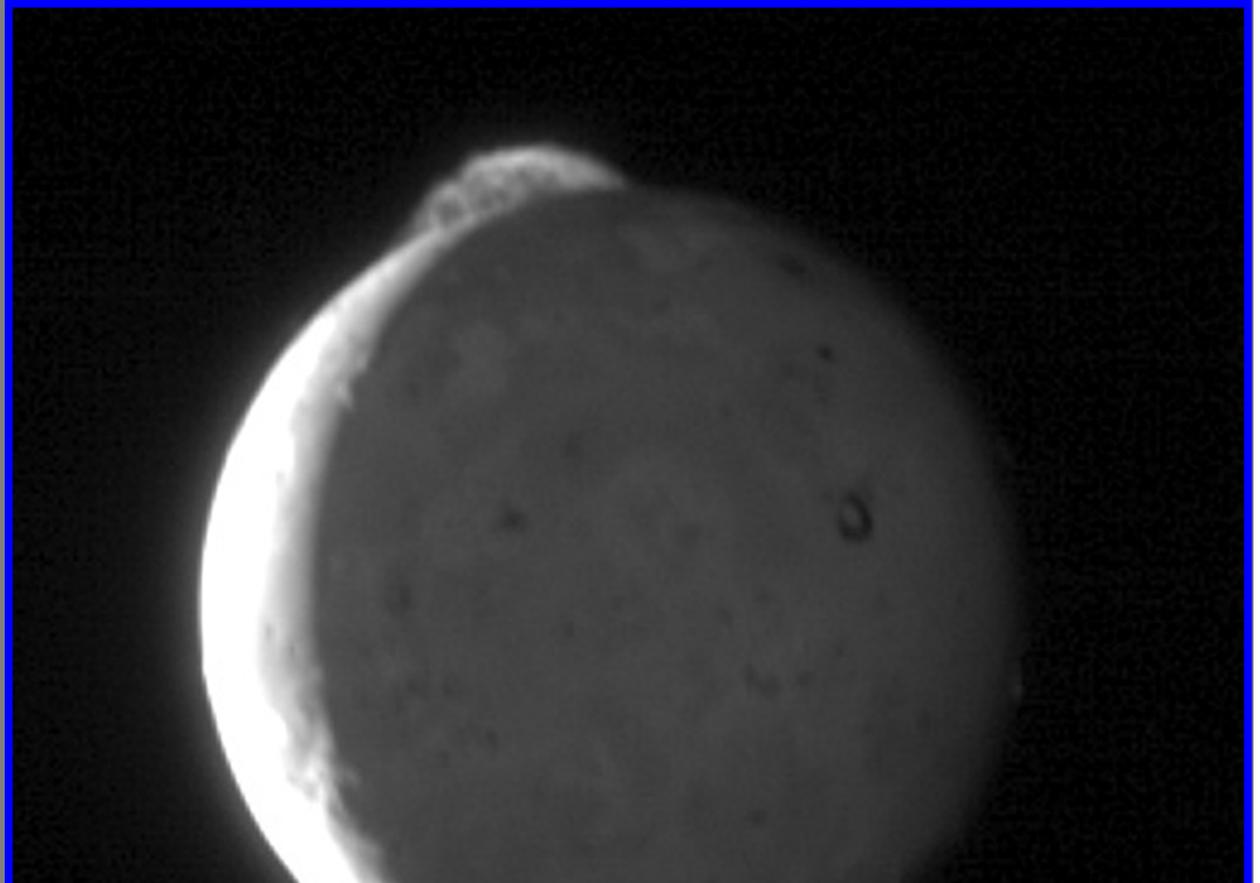
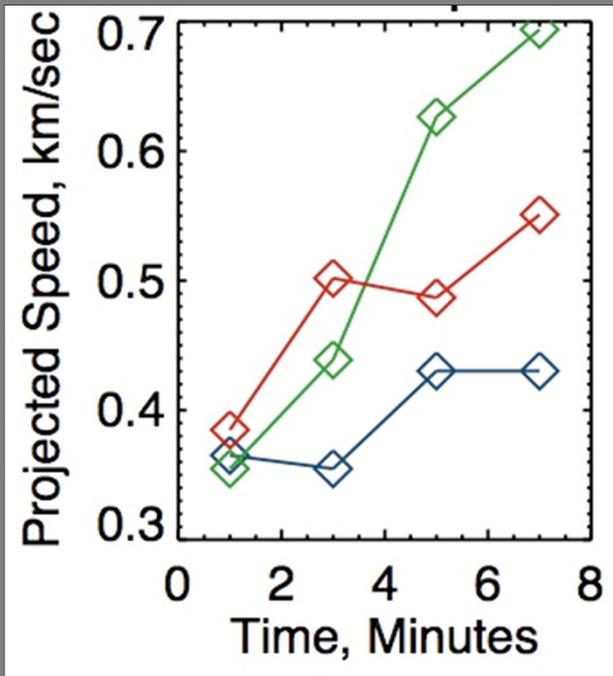
TVASHTAR MOVIE

- **5 frames**
- **8 minutes**



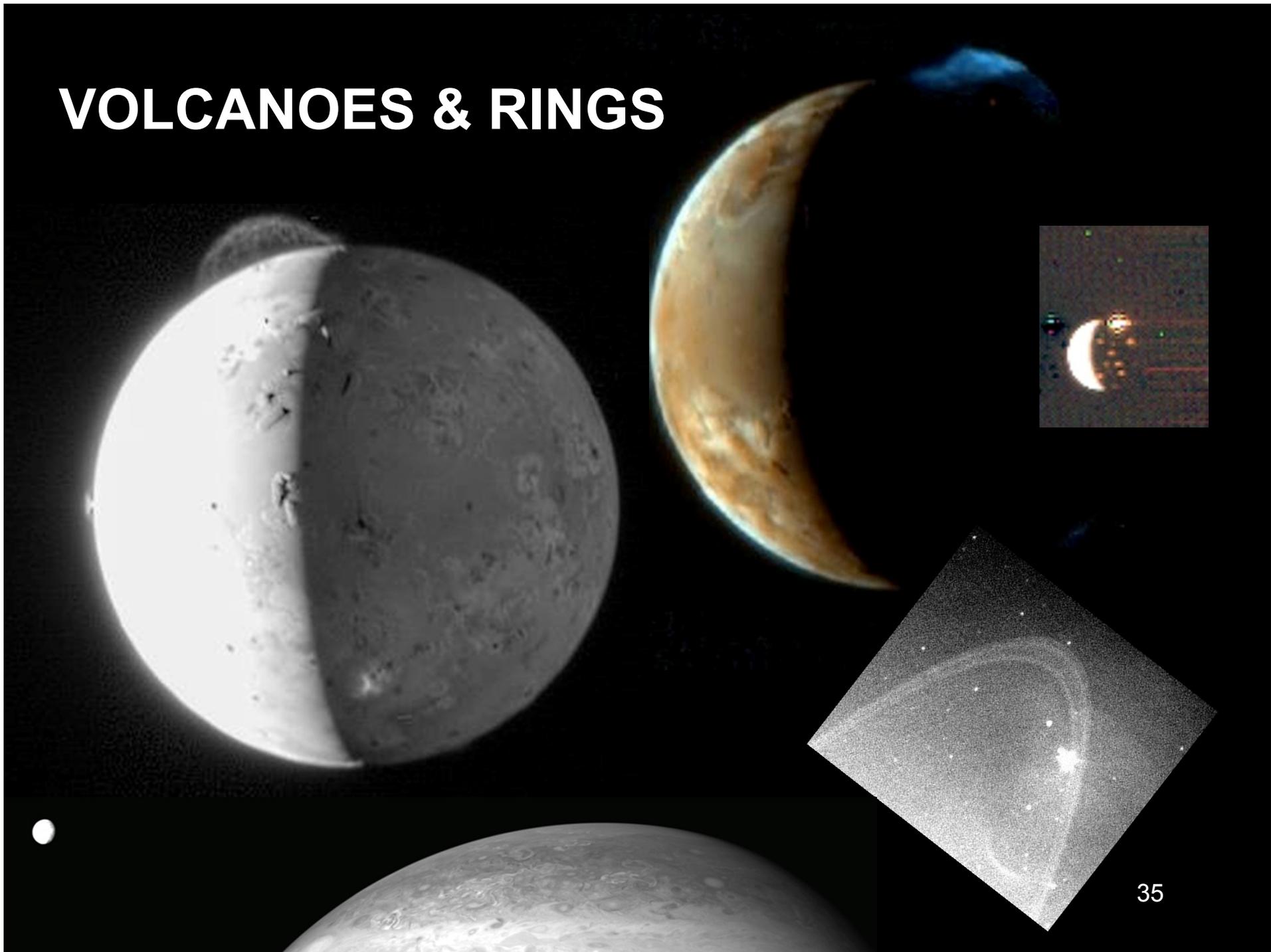
TVASHTAR MOVIE

- **5 frames**
- **8 minutes**



- **First direct measurements of plume dynamics.**
- **Ejection speed ~ 1 km/sec.**
- **Acceleration during descent.**
- **Apparently non-ballistic trajectories.**

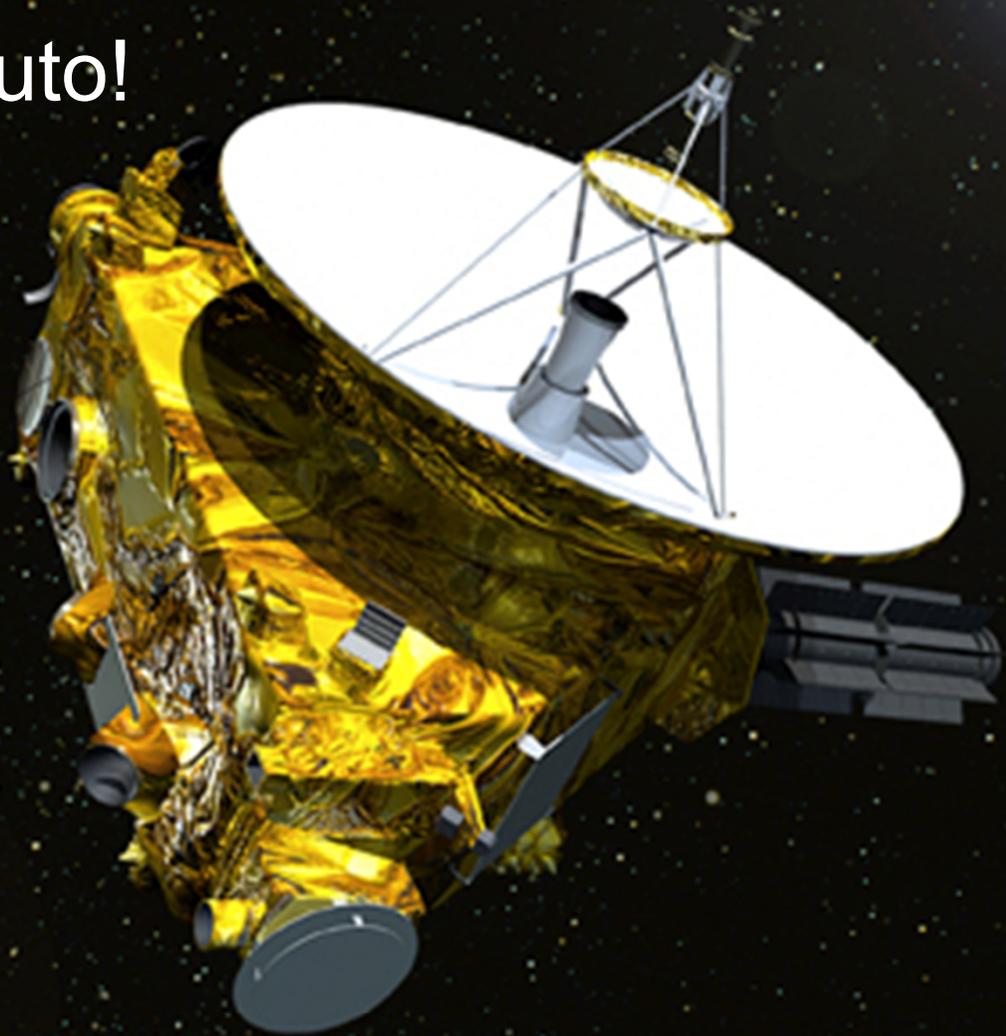
VOLCANOES & RINGS



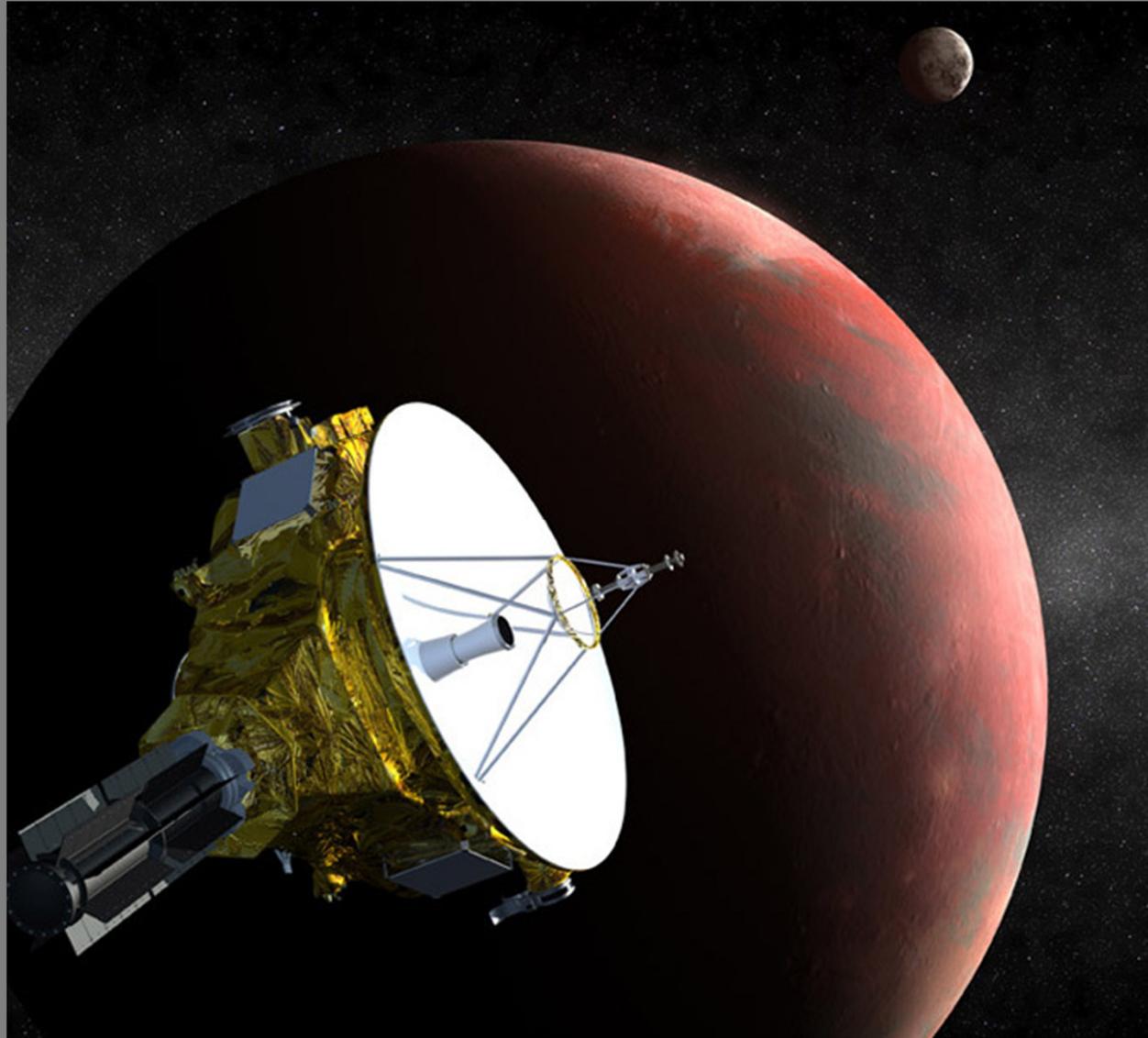


Goodbye Jupiter ...

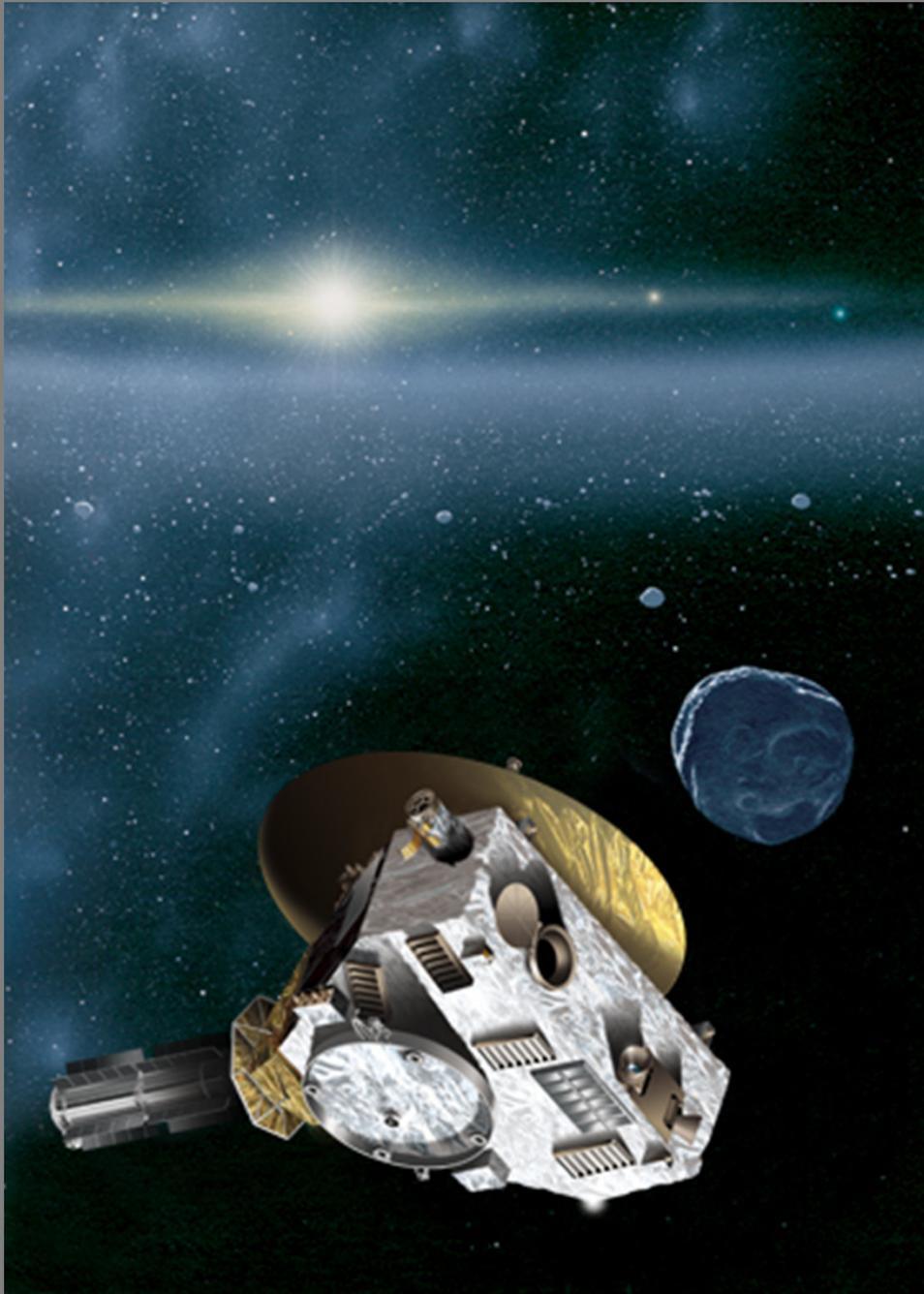
... 2015: Hello Pluto!



Arrival 2015 Bastille Day



JHU-APL/SwRI

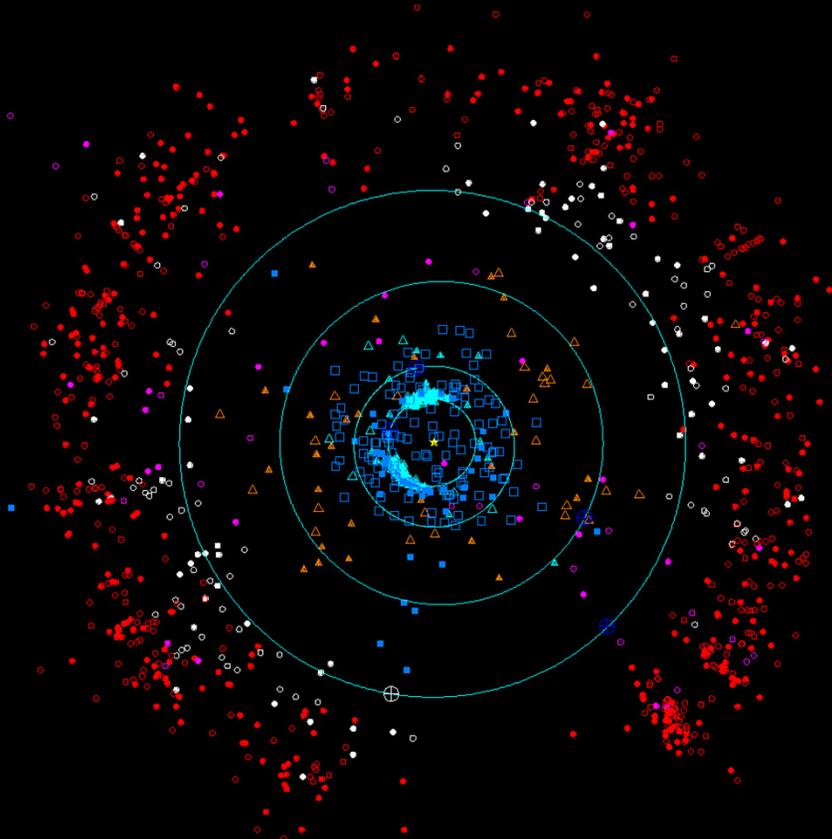


JHUAPL/SwRI

**The journey
continues
2016 to 2020...**

Many Plutos

These “ice dwarf” planets are planetary embryos



Plot prepared by the Minor Planet Center (2004 Mar.23).

Some of the Largest Known Objects in the Kuiper Belt and Oort Cloud

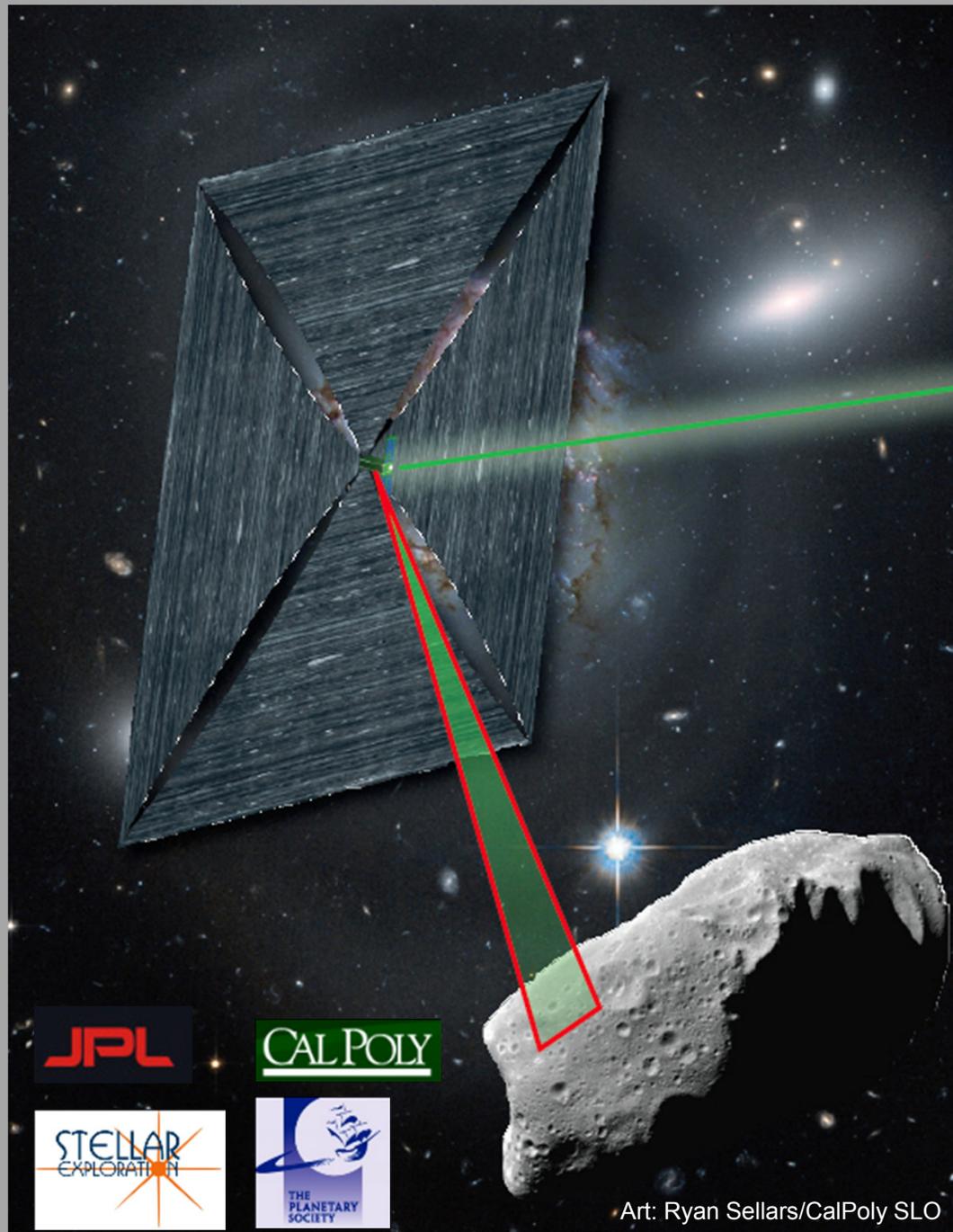
Discovered in the Kuiper Belt



The largest objects Discovered in the Astroid Belt

Scale
1000 km





JPL

CALPOLY

STELLAR
EXPLORATION

THE
PLANETARY
SOCIETY

Art: Ryan Sellars/CalPoly SLO

Interplanetary CubeSats: Opening the Solar System to a Broad Community at Lower Cost

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Hamid Hemmati

Martin Lo

Pantazis Mouroulis

Paula J. Pingree

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Jet Propulsion Laboratory/

California Institute of Technology

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The Planetary Society

Tomas Svitek

Stellar Exploration

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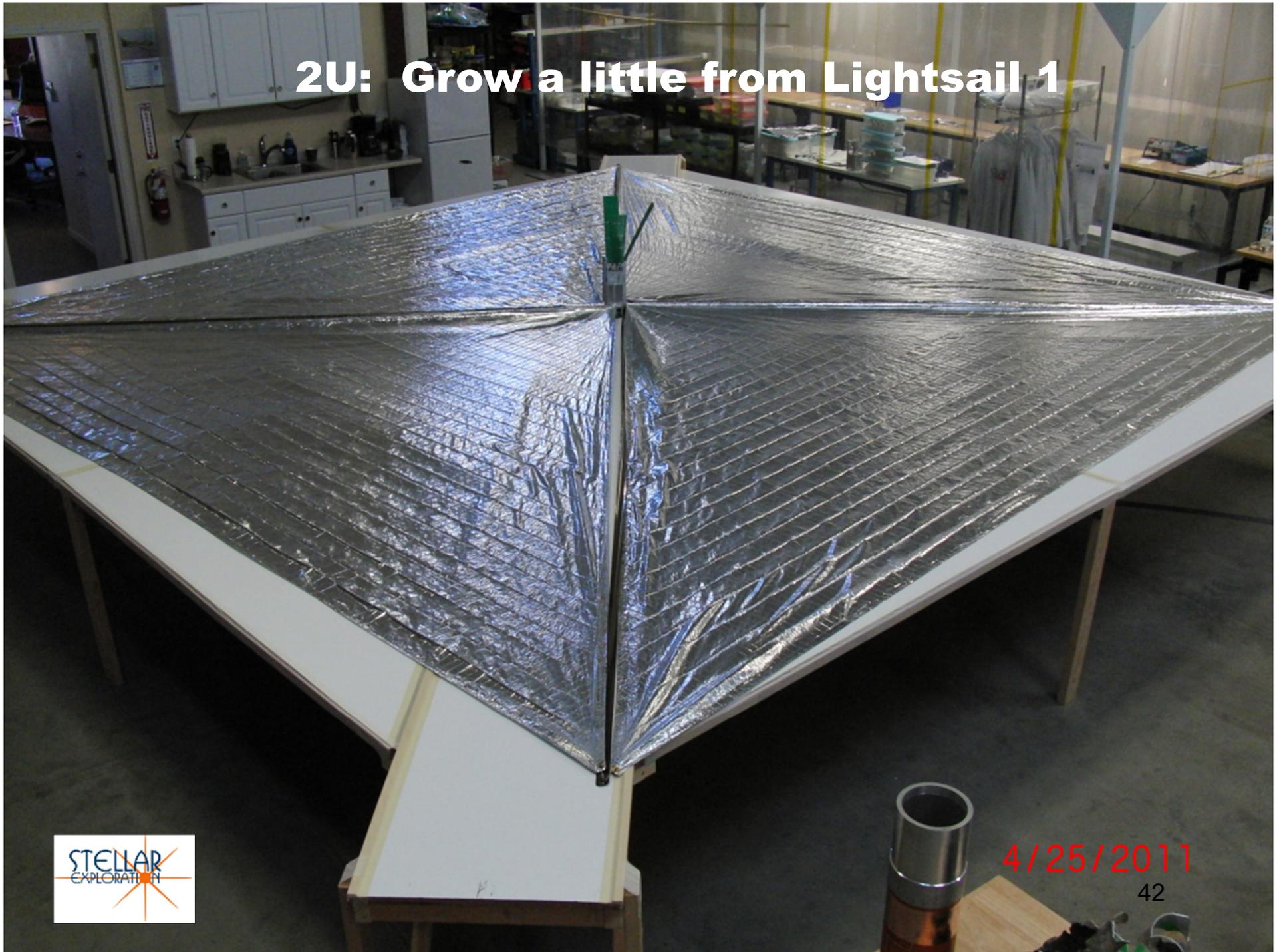
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2U: Grow a little from Lightsail 1





LightSail 1 Spacecraft

