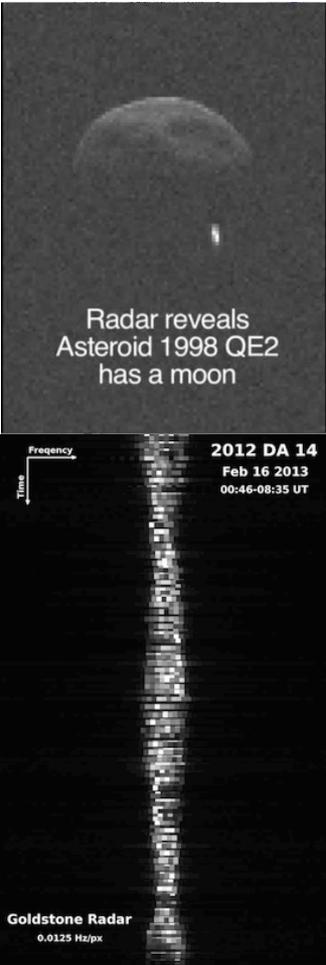


DSN as a Ground(-Space) Observatory



Solar System Radar

Unique solar system science; provides support to most planetary missions, Exploration, NEO Program

Radio Science

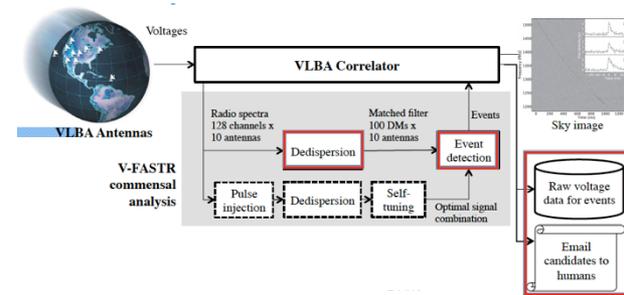
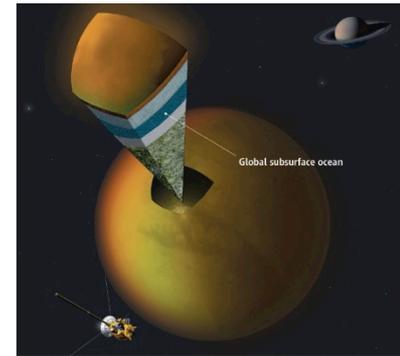
Science measurements on most planetary missions

Astronomy

Radio telescopes for mission science enhancement and international peer-reviewed proposals

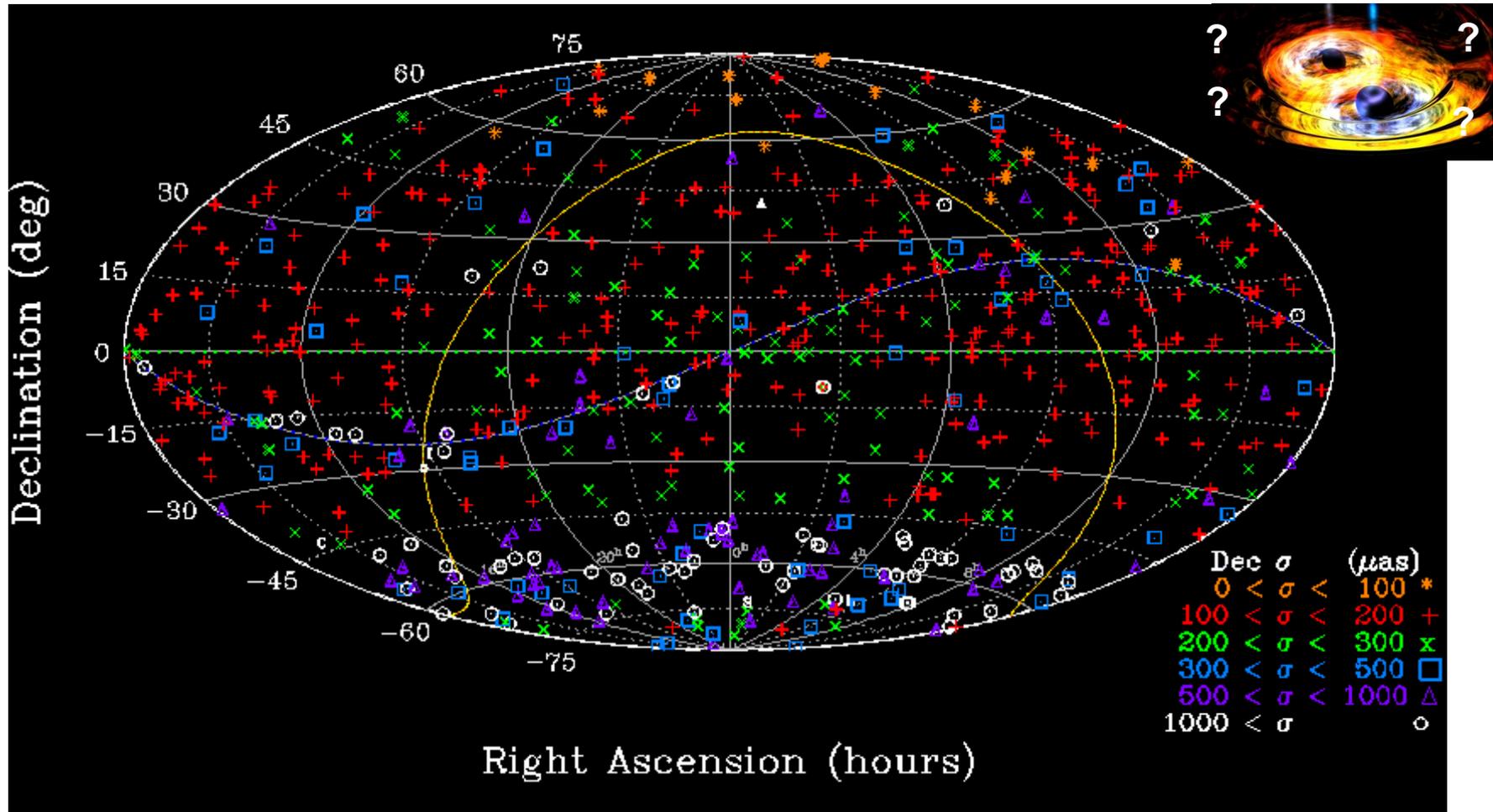
Education and Outreach

Scientists engaging with students and public

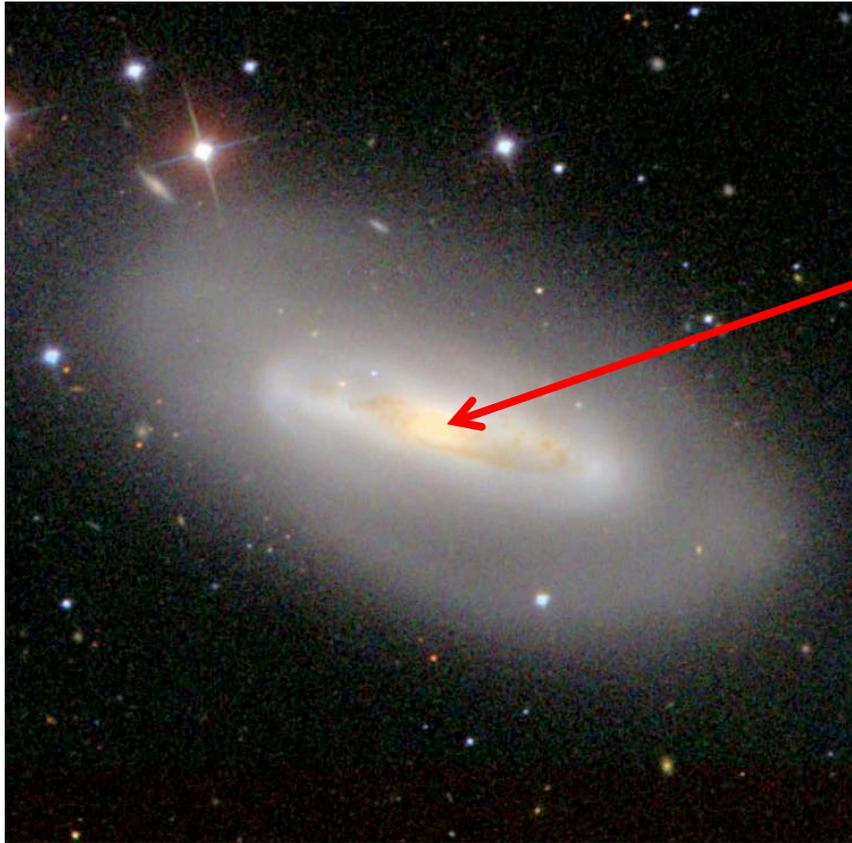


VLBI: Radio Reference Frame

“And all I ask is a tall ship and a star to steer her by;”

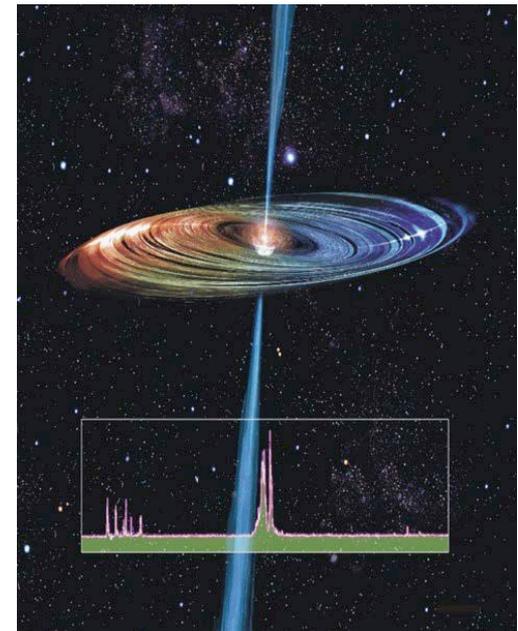
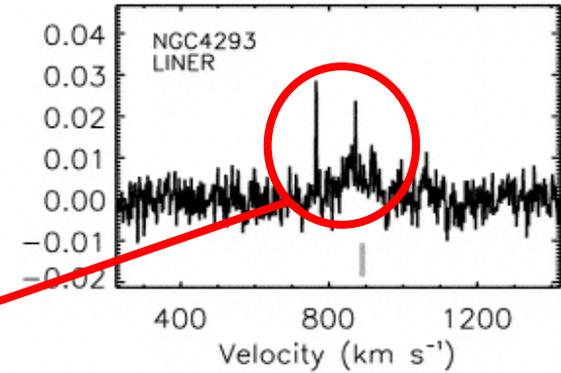


DSS-63 Hunts for Black Holes



NGC 4293

Kondratko, P. T., et al. 2006, "Discovery of Water Maser Emission in Eight AGNs with 70 m Antennas of NASA's Deep Space Network"



Interstellar Chemistry

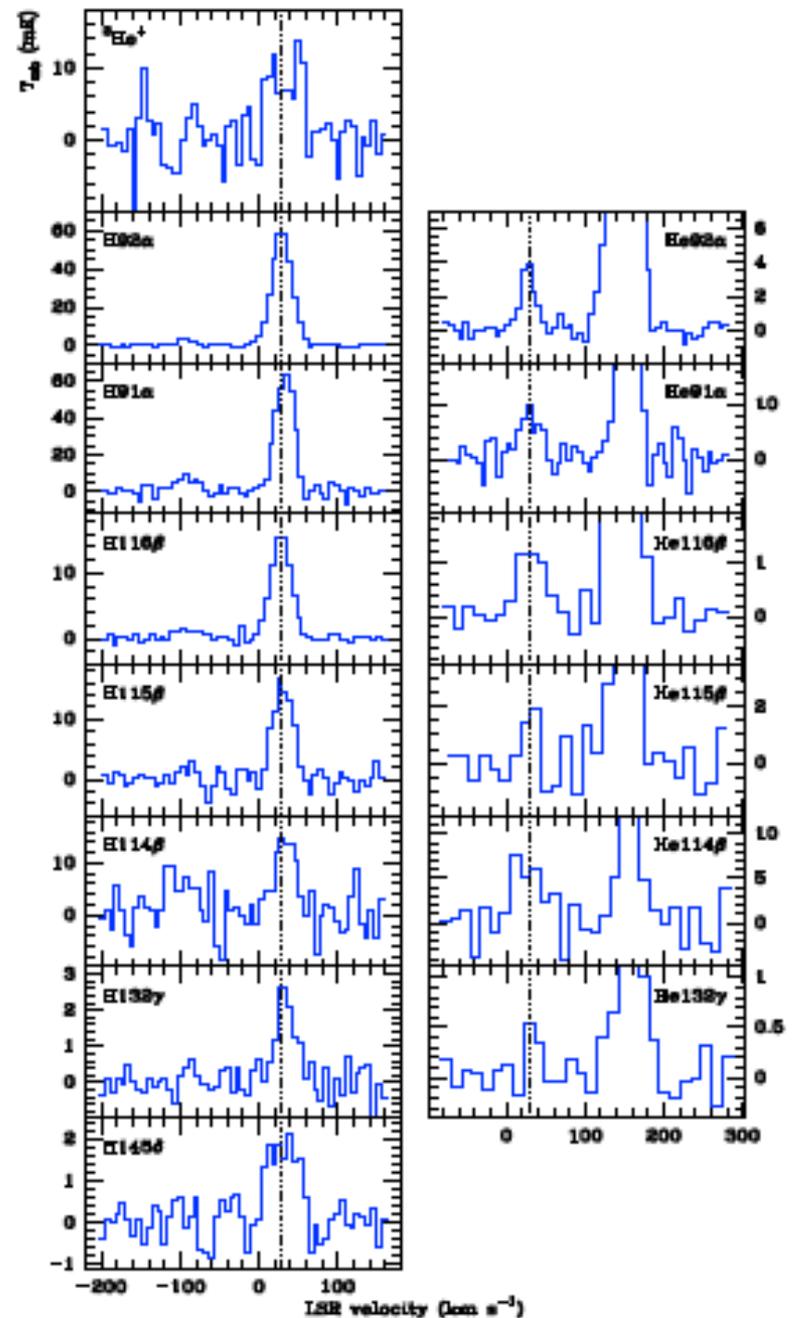
First Detection of $^3\text{He}^+$ in the Planetary Nebula IC 418

Stars like the Sun should produce lots of ^3He

Less ^3He detected than expected

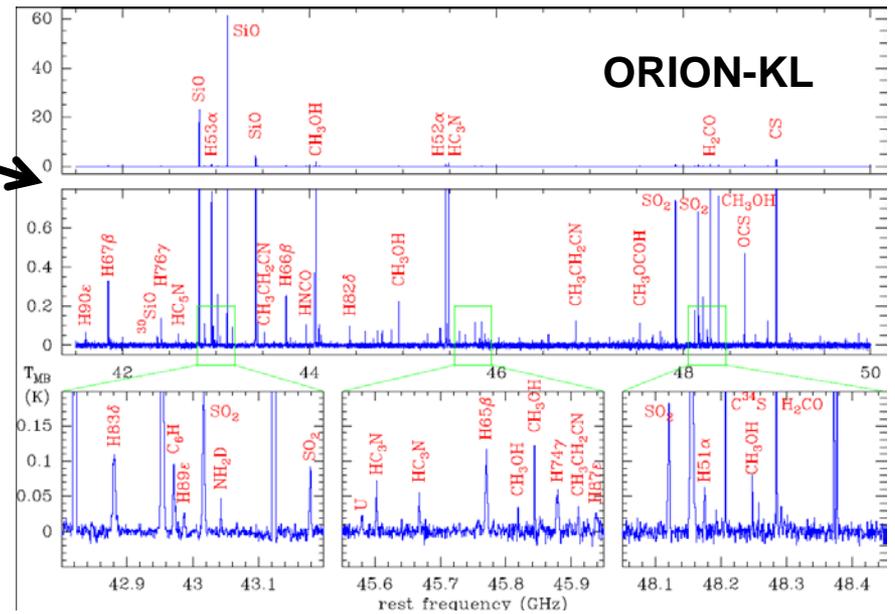
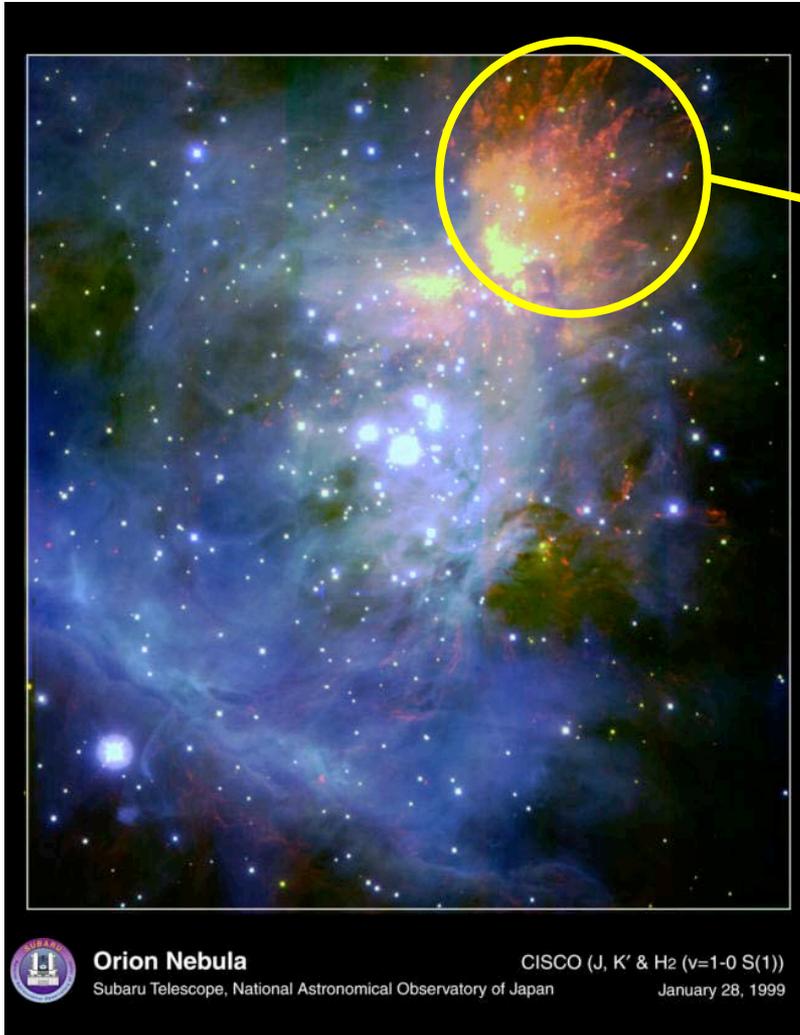
- Planetary Nebulae offer chance to check how much ^3He made by low-mass stars
- Only 3rd detection of $^3\text{He}^+$ in planetary nebulae

Guzman-Ramirez et al.



Interstellar Chemistry

Orion Nebula: Most Sensitive and Widest Spectrum at Q-band!



(Rizzo et al., in preparation)



Orion Nebula

Subaru Telescope, National Astronomical Observatory of Japan

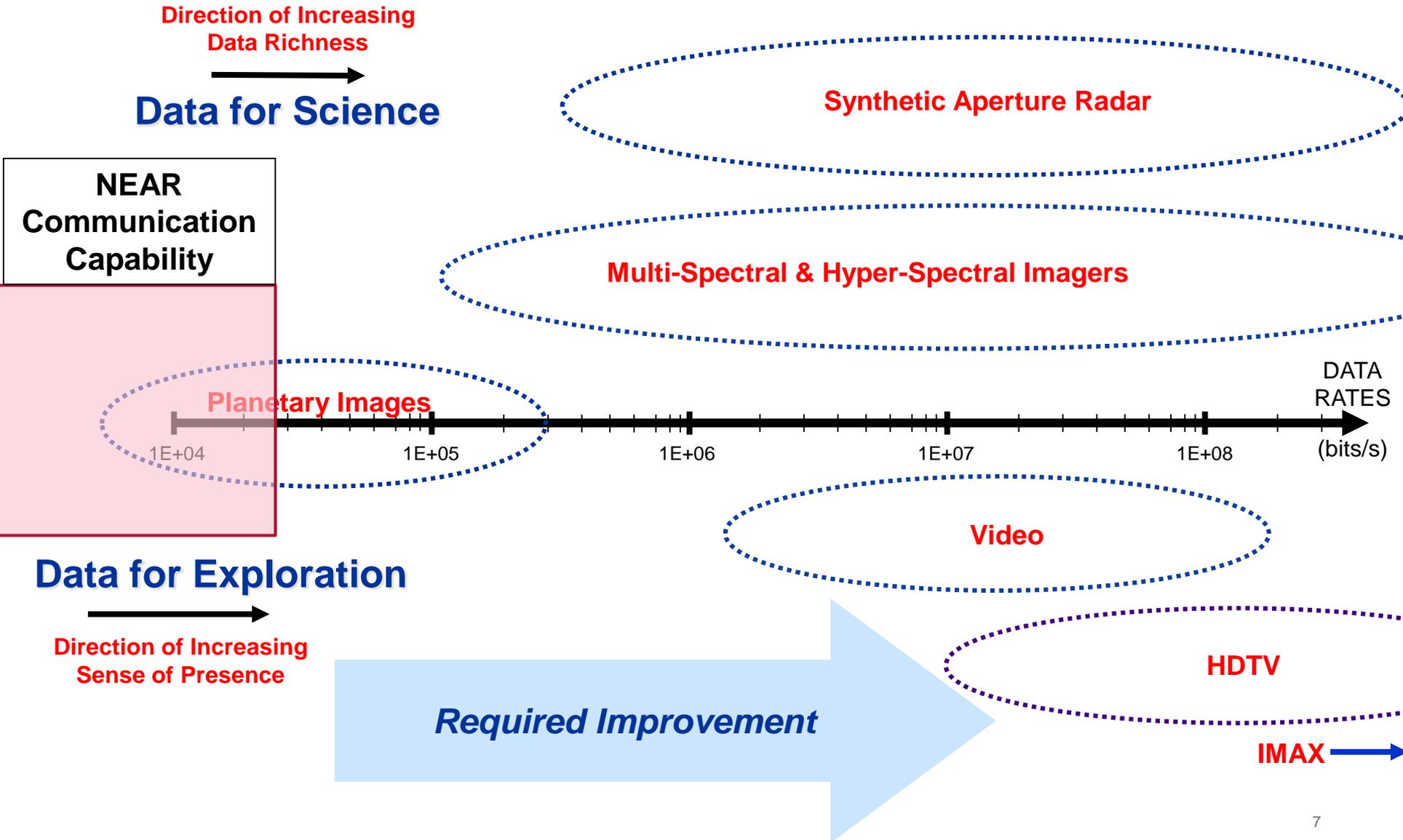
CISCO (J, K' & H₂ (v=1-0 S(1))

January 28, 1999

DSN: Next 50 Years?

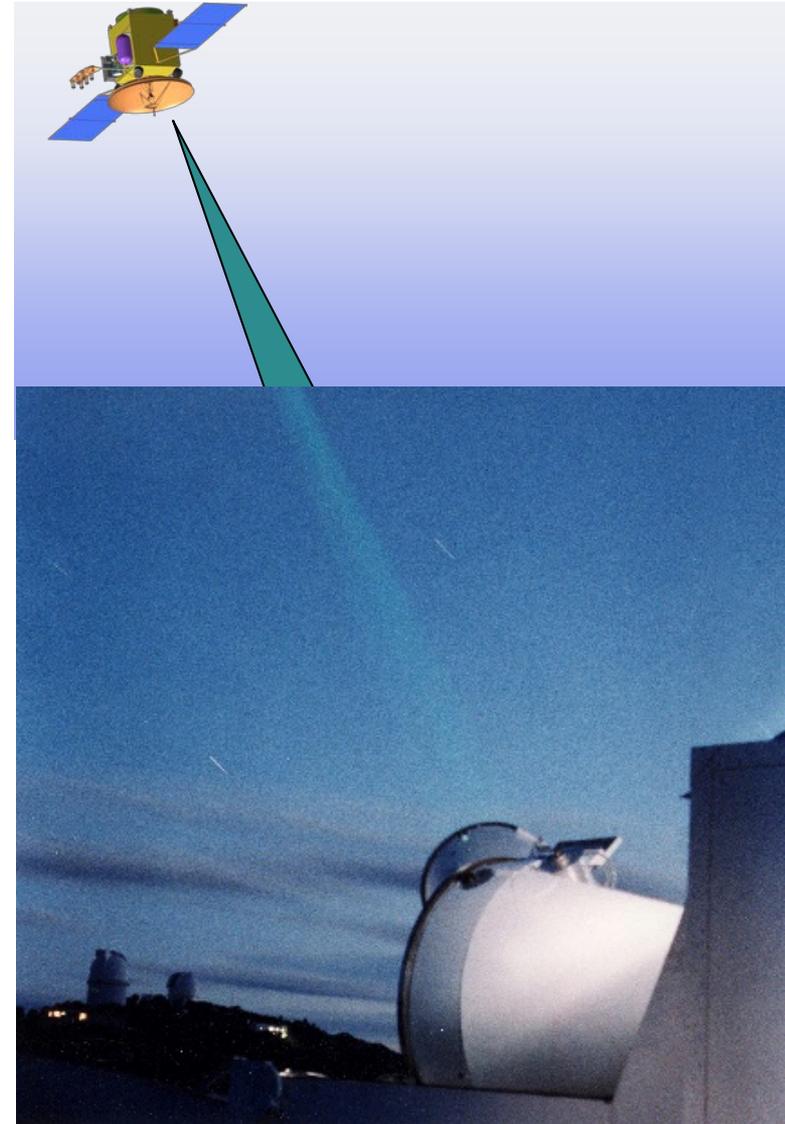


Remote Sensing at Other Planets as at Earth



Laser Communication

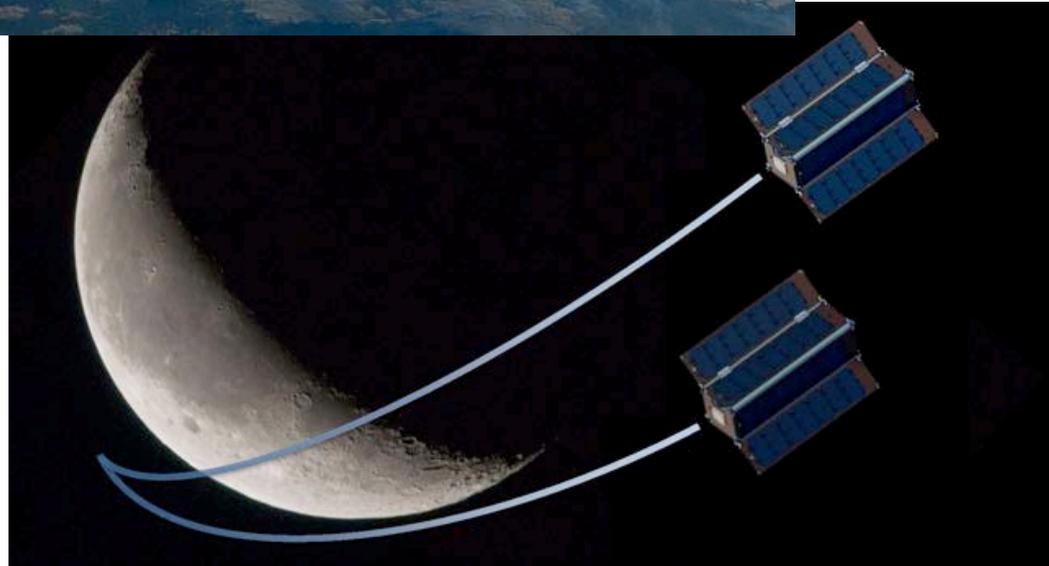
- Lasers have the potential to offer much higher communication bandwidths, i.e., more science data!
 - Like fiber optics, without the fiber
- Already demonstrated ...
 - In cis-lunar space
 - Not yet in deep space ...
 - Discovery AO (~ 2021)



Deep Space SmallSat Constellations

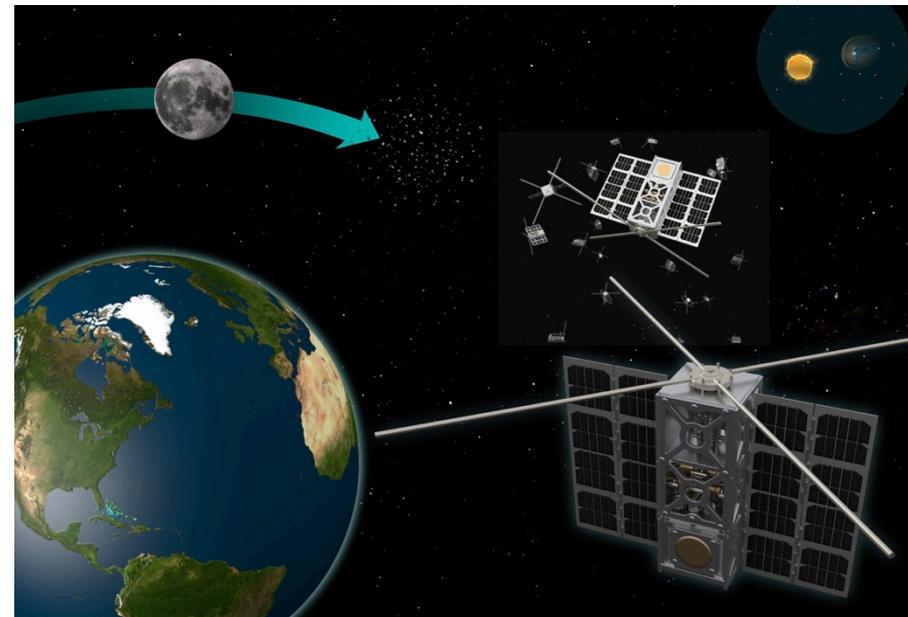
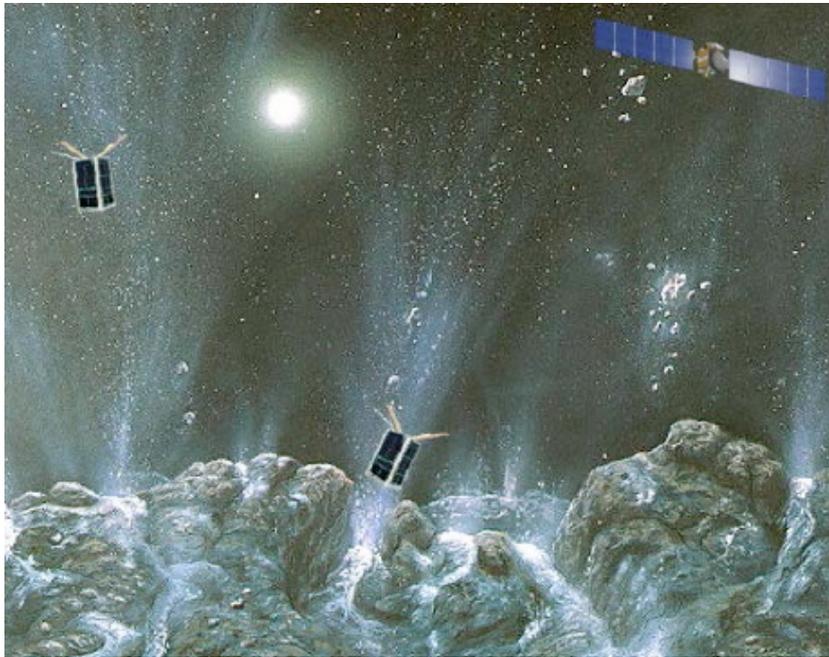
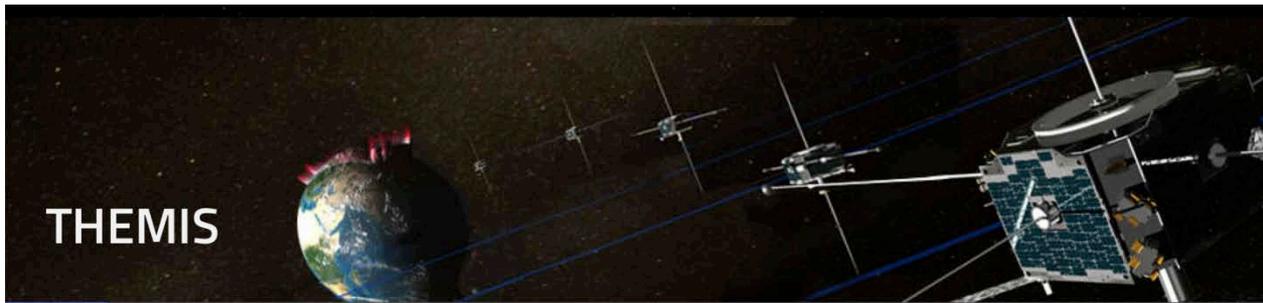
Imagine fleets of spacecraft at other bodies ...

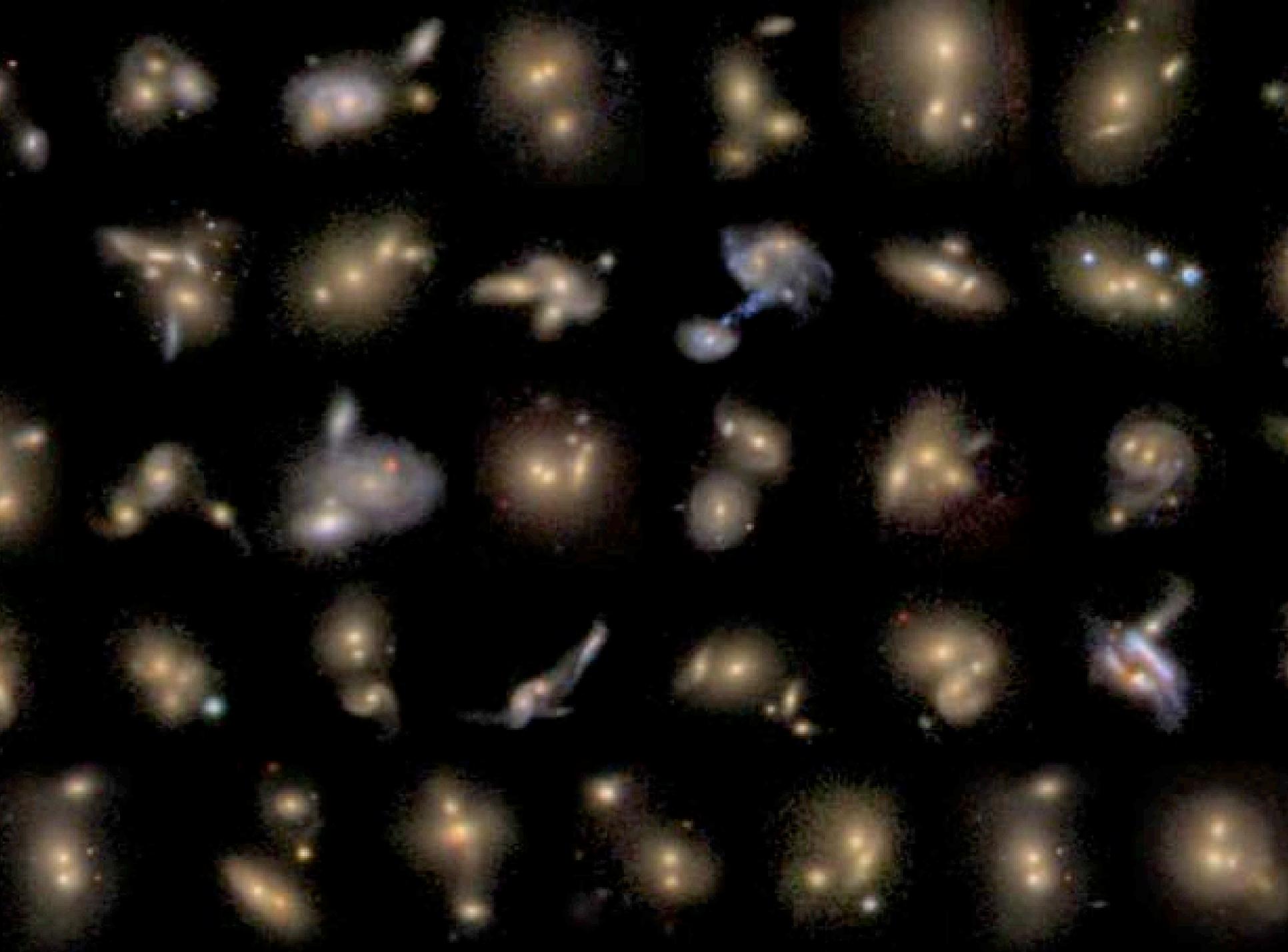
- Possible with “smallsats”?!
- Lunar Flashlight, NEO Scout, Biosentinal attached to E-M 1



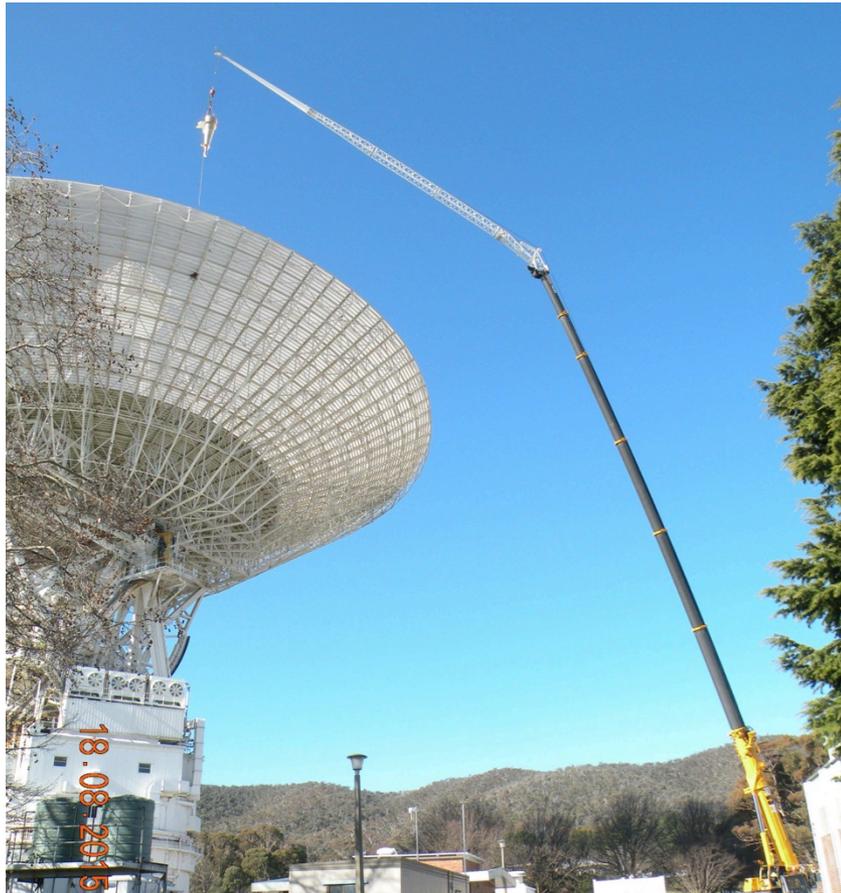
Planetary and Space Science Constellations

An Incomplete List ...





Re-fitting the DSN for Pulsar Timing



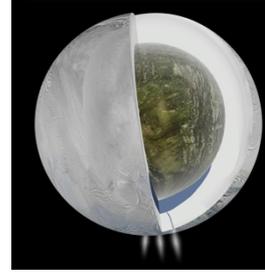
Default DSN system is not sensitive enough

- Upgraded feed to increase bandwidth (sensitivity)



Feed installation, 70 m antenna, Canberra Deep Space Communications Complex (2015 August 21)

Deep Space Network as a Ground-Space Observatory



Three major tracking sites around the globe, with 16 large antennas, provide continuous communication and navigation support for world's deep space missions

- Spigot for science data from most spacecraft instruments exploring the solar system

Partners with ~ 35 spacecraft both for NASA and foreign agencies

- Science instrument in its own right
 - Radar astronomy of most solid system bodies with solid surfaces
 - Radio science probing interiors, atmospheres, and rings
 - Radio astronomy to address fundamental questions

