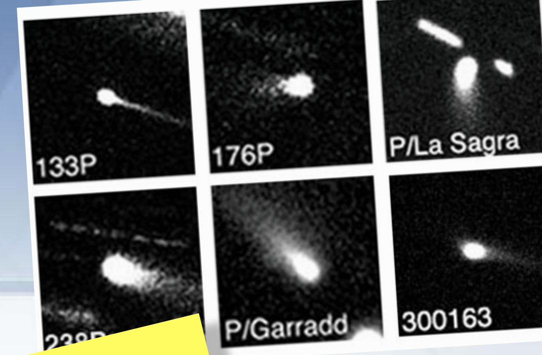
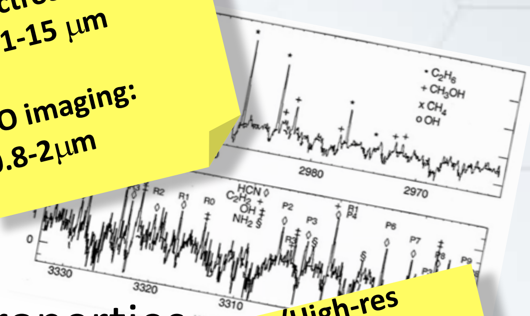
Small bodies



- Asteroids: dry <u>or</u> wet <u>or</u> active (main-belt comets)
  - Satellites search and characterization
  - Shape and collision models, Near-Earth Objects
  - Surface composition, search for water & organics

Low-res spectroscopy: λ= 1-15 μm

AO imaging: 0.8-2μm

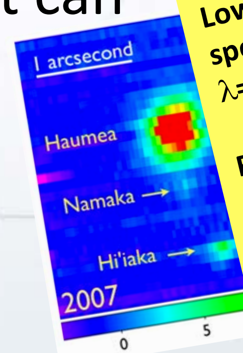


- Comets
  - Near-IR and infrared regions are fundamental to study properties of released molecules
    - D/H ratio, nuclear spin temperatures of some species (e.g. NH_3, H_2O and dissociated products)
    - Organic and prebiotic chemistry

Low/High-res spectroscopy: λ= 0.5-15 μm

Vis/near-IR imaging (MCAO)

- Centaurs & Trans-Neptunians are faint, BUT brightest can be observed with AO (directly or star appulse)
  - cryo-volcanism activity, ring structures, satellites
    - e.g. Chariklo, Chiron?, Haumea
  - Surface properties and collision history



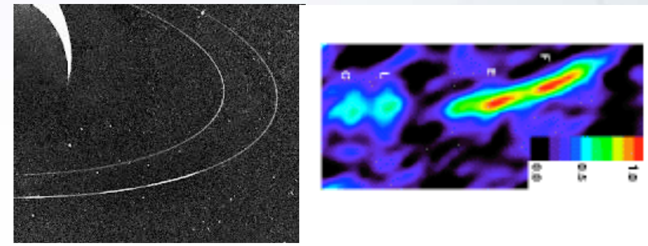
Low-res spectroscopy: λ= 1-2.5 μm

Fast photometry (occultations)

AO imaging: 0.8-2μm

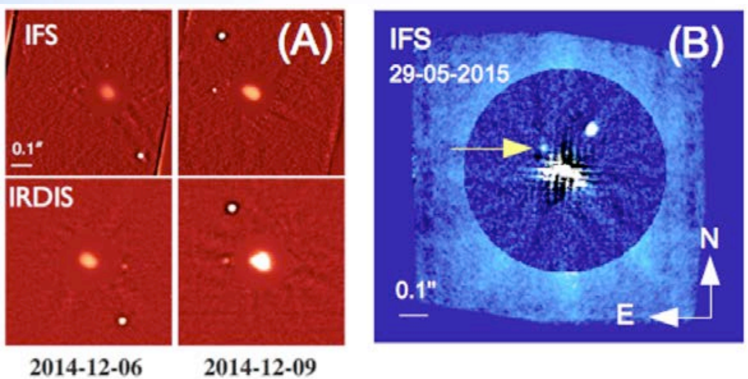
Small bodies & their immediate neighborhood

- Moonlets and rings: A study of planetary evolution, solar system dynamics and collisions

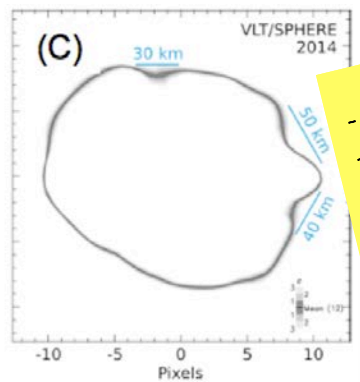


Neptune's ring... Voyager and HST/Nicmos

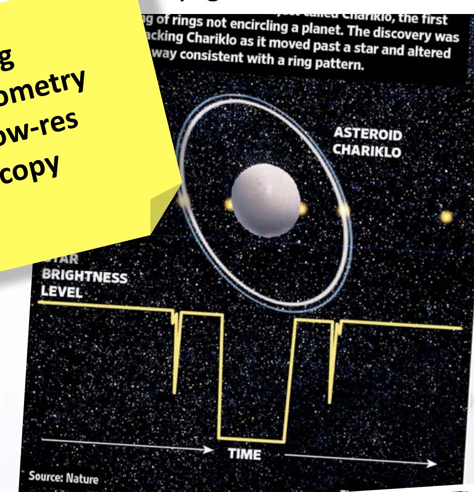
- AO imaging
- Fast photometry
- near-IR low-res spectroscopy

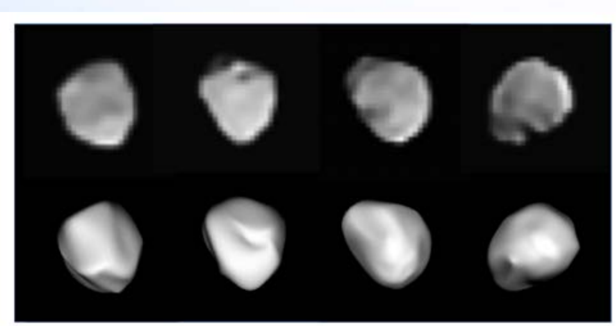


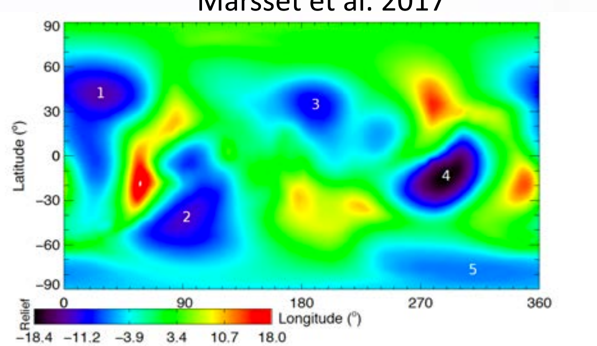
Triple asteroid Elektra and Minerva. Yang et al. 2017

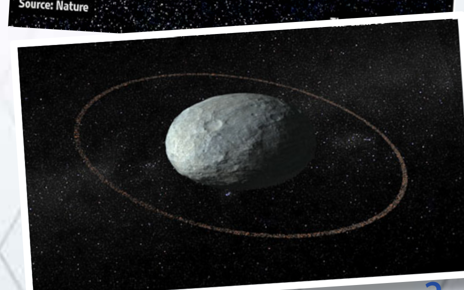


Asteroid Hebe
Marsset et al. 2017



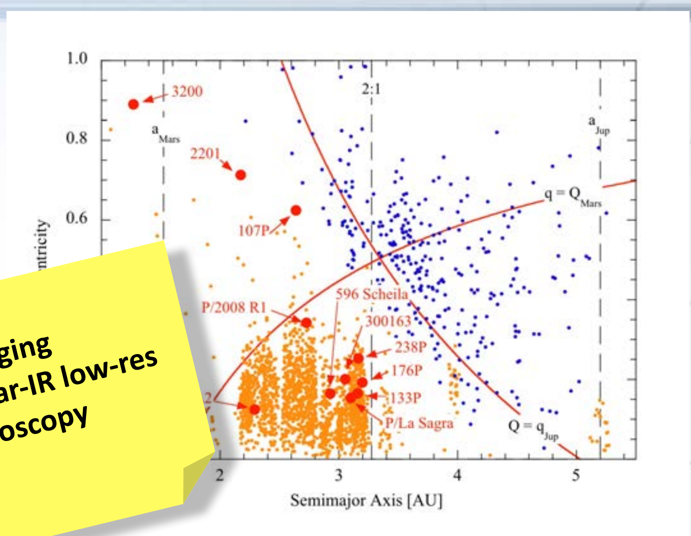




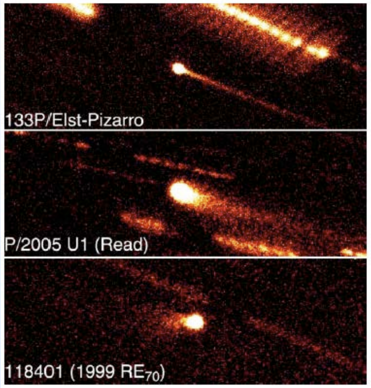


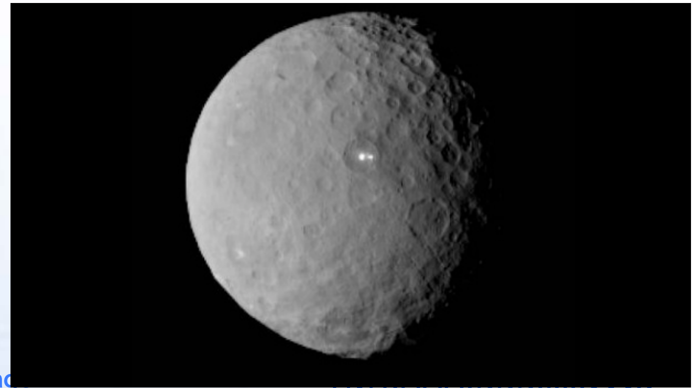
Origin of water on Earth

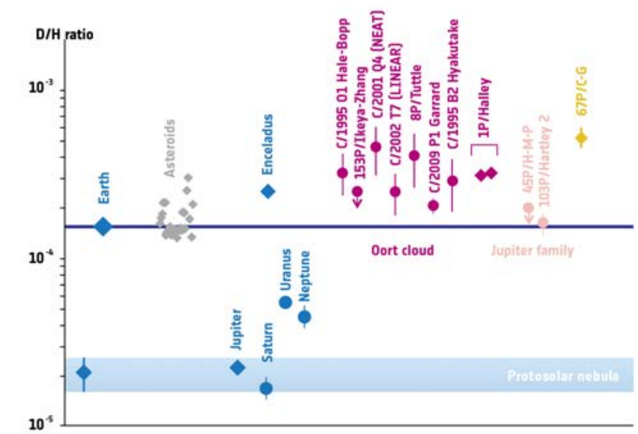
- Terrestrial planets got their water via transport from small solar system bodies such as asteroids, comets, trans-Neptunians
- A compositional of the most primitive/icy objects of our solar system (comets, asteroids) will help understand the origin of Earth's water



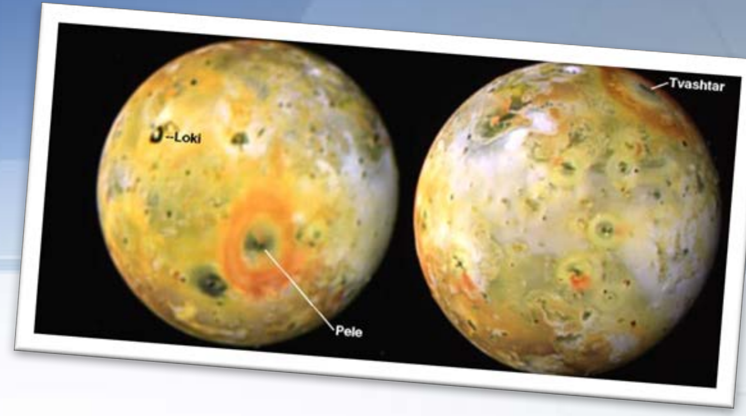
- AO imaging
- UV/near-IR low-res spectroscopy



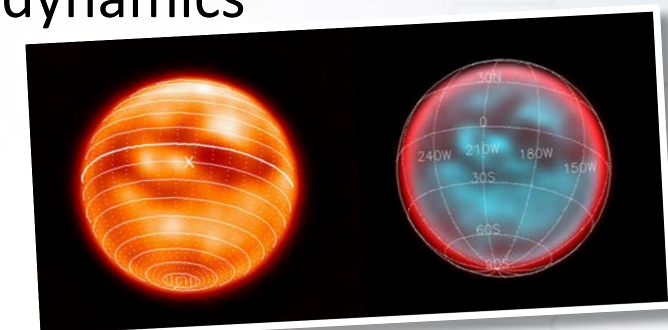




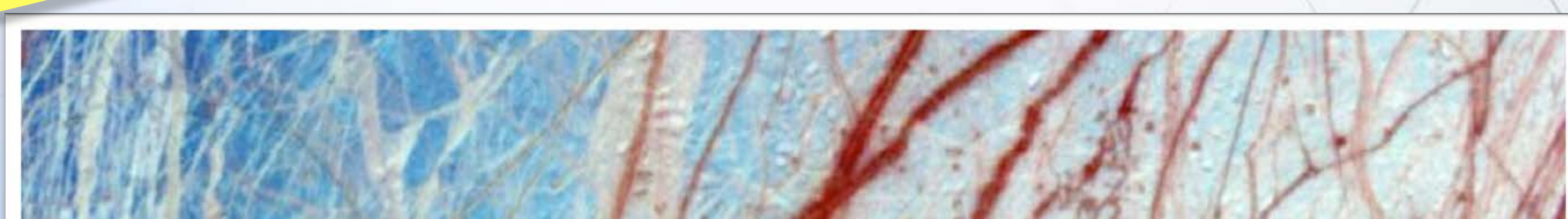
Solar system (Cont'd)



- Giant planets & satellites
  - Atmosphere composition, circulation/dynamics
  - Energy budget
  - Isotopic ratios and abundances
  - Satellites
    - (cryo-)volcanism (e.g. Enceladus, Triton, Pluto)
    - surface/atmosphere composition and boundary conditions
      - Titan: Lake formation and surface/atmosphere interaction
      - Monitoring of Io's volcanoes and Europa's surface
      - Mapping of Europa and search for signature of organic material

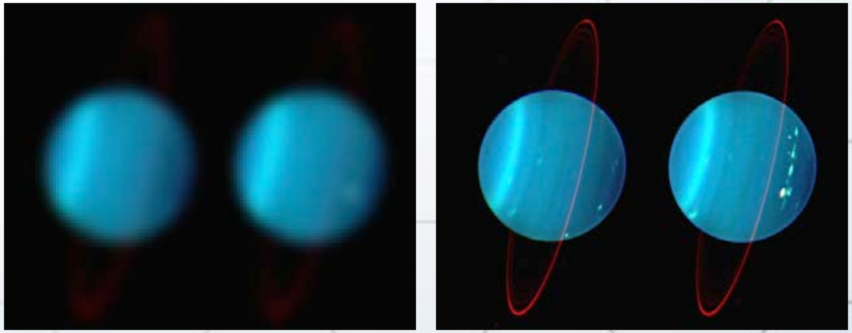


AO imaging
near-IR low/high-res spectroscopy

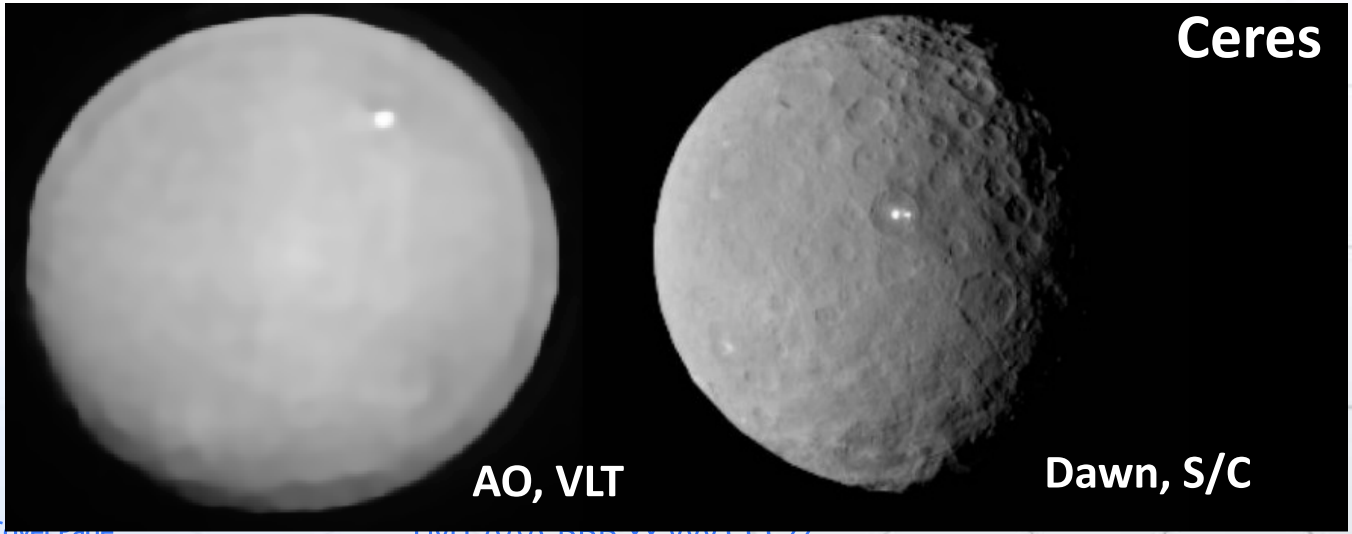


Pushing the limits of solar system exploration

- ELTs will provide dramatic boost in:
  - **Sensitivity:**
    - ~ D^2 (~10 times the collecting area of Keck, or ~150 times that of HST).
    - ~ D^4 for background limited observations of point sources with Adaptive Optics (AO) (i.e. ~200 times that of today's 8m telescopes)!
      - Fainter, smaller objects become accessible
      - Near-IR spectrophotometry of small/distant bodies/structures near bright objects (e.g. small satellites of giant planets)
  - **Angular resolution:**
    - AO will provide ~12 times better spatial resolution than HST



TMT spatial resolution at 1µm and at opposition for selected solar system bodies						
Target	Diameter (km)	Distance (in AU)	Angular diam. (")	Nb resolution elements across apparent diam.	Nb resolution elements across apparent surf.	Spatial resolution (km)
Ceres	952	1.63	0.81	130	17012	7
Pallas	545	1.29	0.58	94	8920	6
Io	3644	4.09	1.23	199	39442	18
Europa	3122	4.09	1.05	170	28951	18
Titan	5152	8.09	0.88	142	20156	36
Triton	2706	28.87	0.13	21	436	130
Chiron	220	15.96	0.02	3	9	72
Pluto	2390	34.05	0.10	16	245	153
Charon	1210	34.05	0.05	8	63	153
Mars	6780	0.64	14.55	2352	5531644	3
Jupiter	143000	4.09	48.23	7794	60740203	18
Saturn	120500	8.09	20.55	3321	11026150	36
Uranus	51120	18.24	3.86	624	389997	82
Neptune	49530	28.87	2.37	382	146085	130

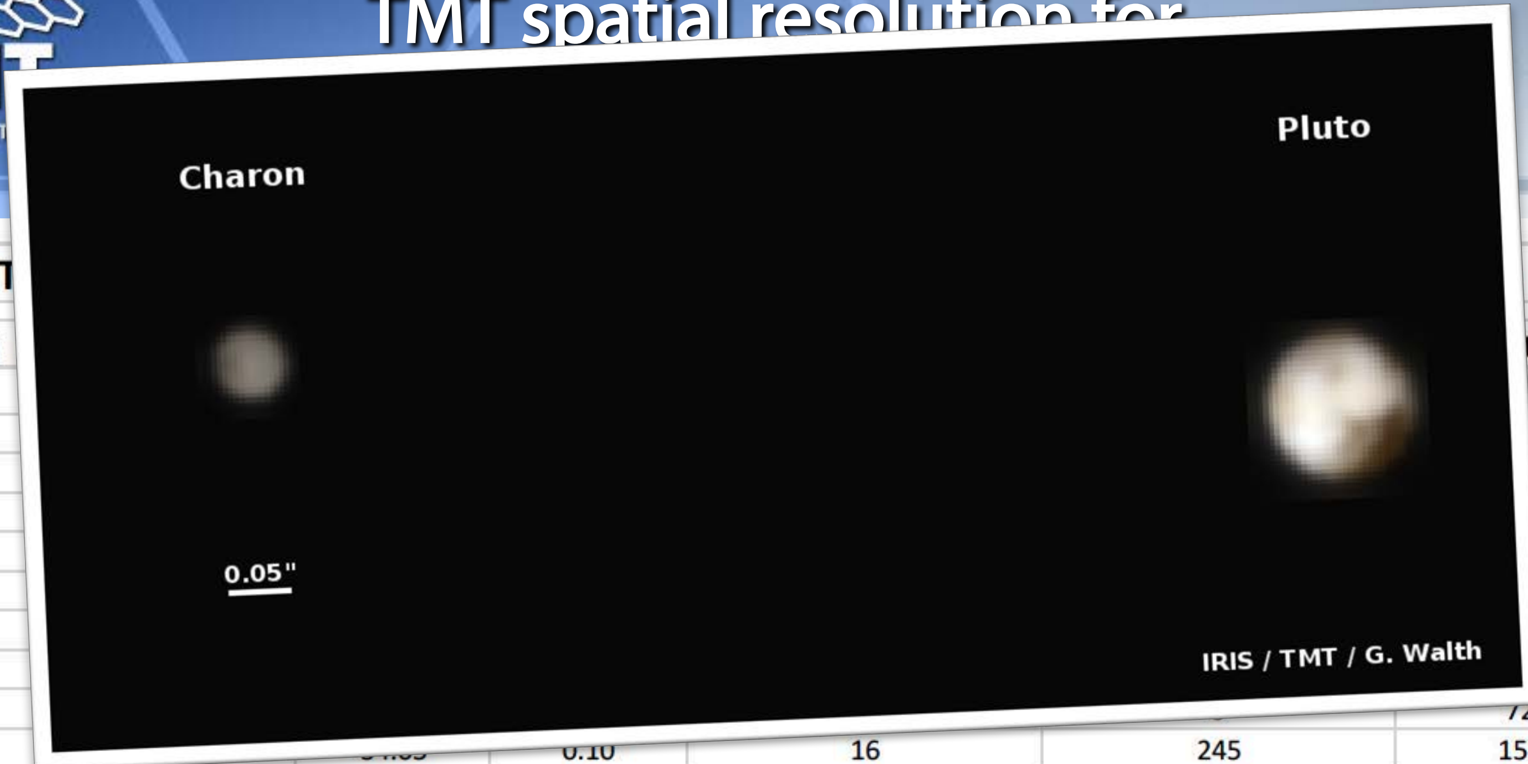


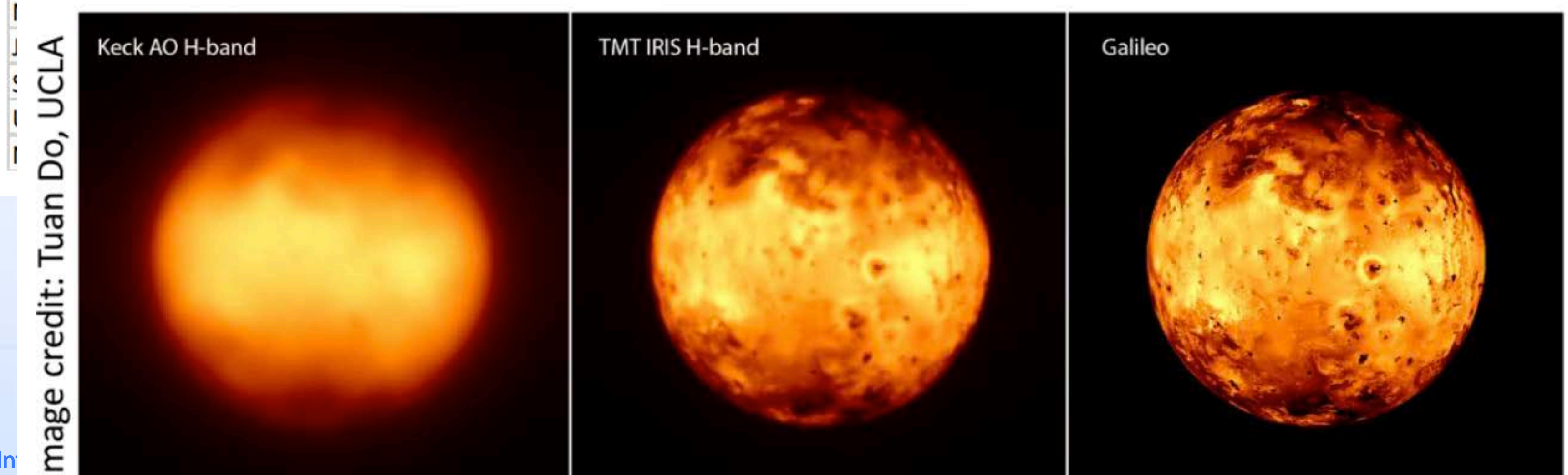
TMT

Thirty Meter T

TMT spatial resolution for

Target						tial on (km)
Ceres						
Pallas						
Io						
Europa						
Titan						
Triton						
Chiron						72
Pluto		[illegible]	0.10	16	245	153
Charon	1210	34.05	0.05	8	63	153





Summary

- Widespread use of AO (@ high-contrast whenever it makes sense)
  - Deformable mirrors with high density of actuators
  - Low noise-level wavefront sensors
  - Fast real-time-controllers

- Combination of AO with spectrographs
  - IFUs and low/medium-res near-IR spectroscopy (mineralogical study)
  - Fiber-fed high-res VIS/near-IR spectroscopy (planet atmospheres, isotopes studies)

Summary (Cont'd)

- Operations constraints:
  - Fast instrument mode switch
  - Capability to track at non-sidereal rates (including for fast moving targets like NEOs or comets)
  - Fast observatory (ToO) and fast target acquisition
  - Flexible queue scheduling
  - PSF characterization/modeling (deconvolution, PSF reconstruction) for adaptive optics