National Aeronautics and Space Administration

NASA

NASA HQ Planetary Science Division View of Ground-Based Facilities for Small Bodies Science

EXPLORE SCIENCE

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Planetary Science Division – Use of Telescopes

- PSD flight missions generally send spacecraft to individual targets
- PSD leverages IRTF, ground-based partnerships (*e.g.,* Keck) and space telescopes in SMD's Astrophysics Division, and other ground-based telescopes to support its scientific mission, but does not develop new ground facilities of its own
- PSD also is tasked with planetary defense - to detect, track and characterize any potentially significant impact by a near-Earth object (NEO) – requiring telescopic observations
  - Planetary defense operations often result in small body discoveries important for broader science (*e.g.,* 'Oumuamua) and for identifying spacecraft mission targets

Planetary Science Division – Use of Telescopes

Telescopes are used to:

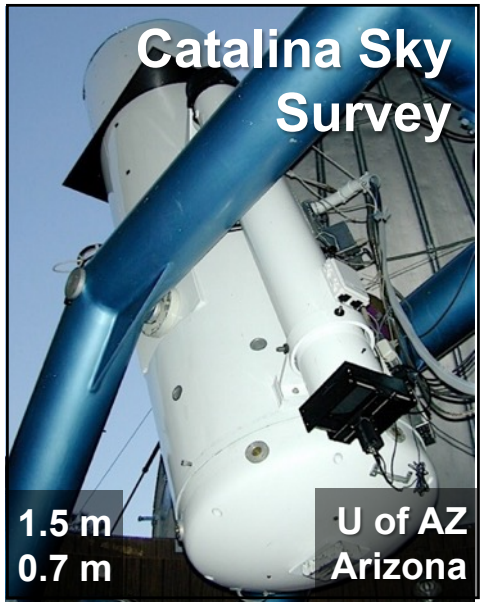
- Find, track, and characterize near-Earth objects (NEOs)
- Discover or determine flight mission targets
- Advise spacecraft design and mission planning
  - Target physical characteristics for informing instrument requirements and spacecraft operations planning
  - Determine spacecraft trajectory
- Achieve spacecraft Level 1s/Mission Success (*e.g.,* DART)
- Enhance or complement spacecraft observations
- Address some elements of Decadal science

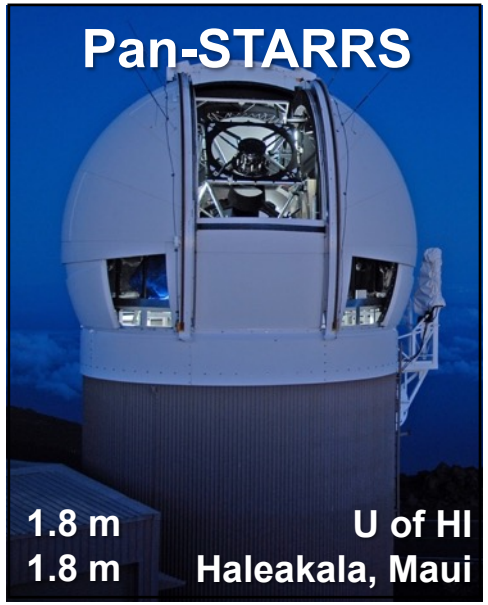
Ground-based Asset We Own: NASA's Infrared Telescope Facility (IRTF)

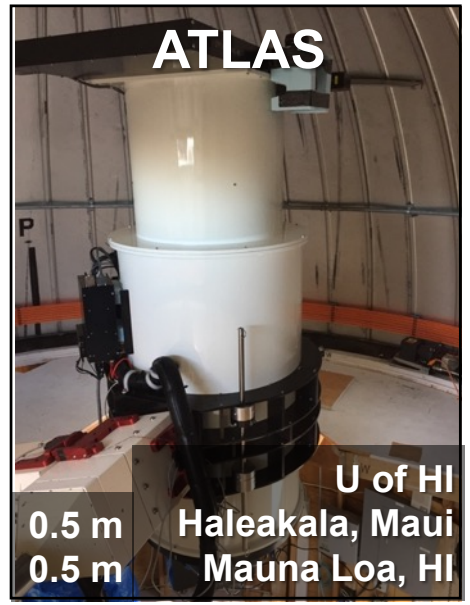
- 3-meter, infrared-optimized telescope on Maunakea, Hawai'i
- Built in 1979 to provide observations of the outer planets in support of the Voyager missions, but currently supports almost all planetary missions and Decadal science
- NASA's primary means to rapidly determine near-Earth object compositions with IR spectroscopy, and fully-funded by the NEO Observations Program since 2014
- Operationally, about half of the available nights are awarded for planetary investigations and half for astrophysics investigations relevant not only to SMD missions but also to the National Science Foundation, which historically had supported instrument development and visitor operations through competitive awards
- Facility operations and science are managed for NASA by the University of Hawai'i under contract

Ground-based Assets We “Rent:” For NEO Survey

NEO Survey (discovery and tracking) - In 2005, Congress tasked NASA to find and characterize 90 percent of the NEOs 140 meters in size and larger to detect any potential impact hazard to Earth. To support this continued search effort, the following ground-based surveys were assessed through peer-reviewed competition and are currently utilized:







Sites in Chile and South Africa to be commissioned in 2021

Also processing of data for NEO detections from Caltech’s Zwicky Transient Facility

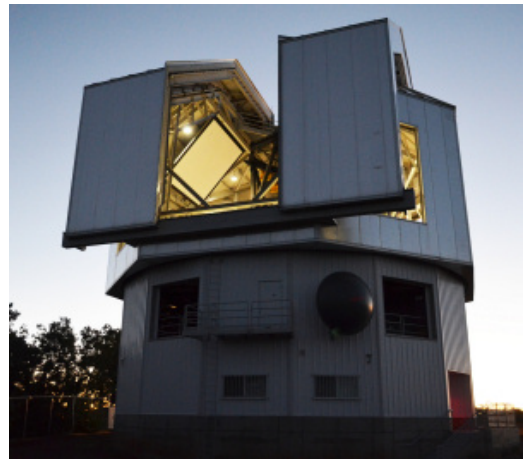
Ground-based Assets We “Rent:” For NEO Astrometric Follow Up

NEO astrometric follow-up – For precise orbit determination. Current competed awardees are primarily utilizing:

Spacewatch (U of AZ)

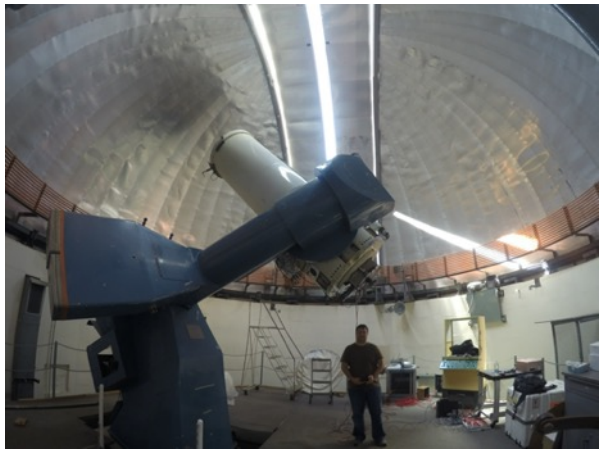
Magdalena Ridge Observatory (NM Tech)

Catalina (U of AZ)



Lowell Discovery Telescope

U of Hawai’i 2.2m



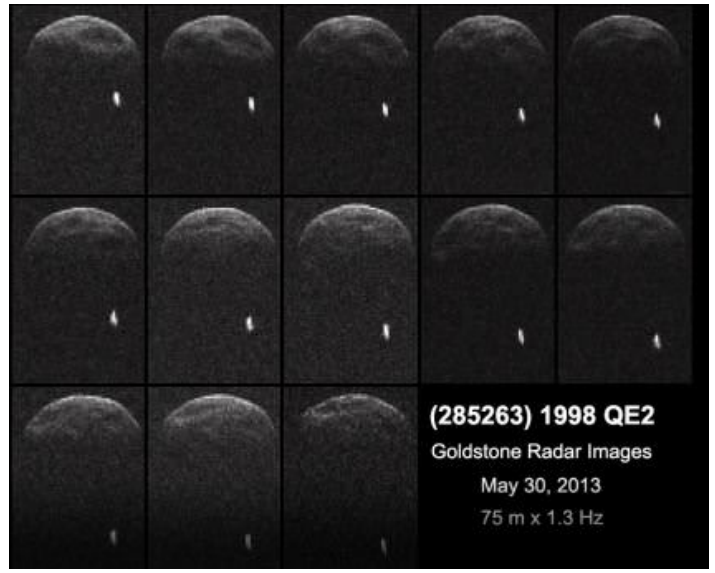
Astronomical Research Institute (Illinois and Chile)

Table Mountain Obs. (JPL)

Ground-based Assets We “Rent:” Planetary Radar

Planetary radar observations – Small bodies, planets, satellites, the Moon

- For NEOs that pass close enough to Earth, precise orbit determination and also surface characteristic determination and radar imaging.
- Goldstone Solar System Radar on the Deep Space Network’s Goldstone 70-meter dish
- Associated planetary radar data processing and analysis (*e.g.,* Arecibo planetary radar data analysis and archiving)



Planetary R&A Grants for Astronomy Investigations

Planetary science from observations obtained by requesting time on a variety of telescopes worldwide

NEO physical characterization

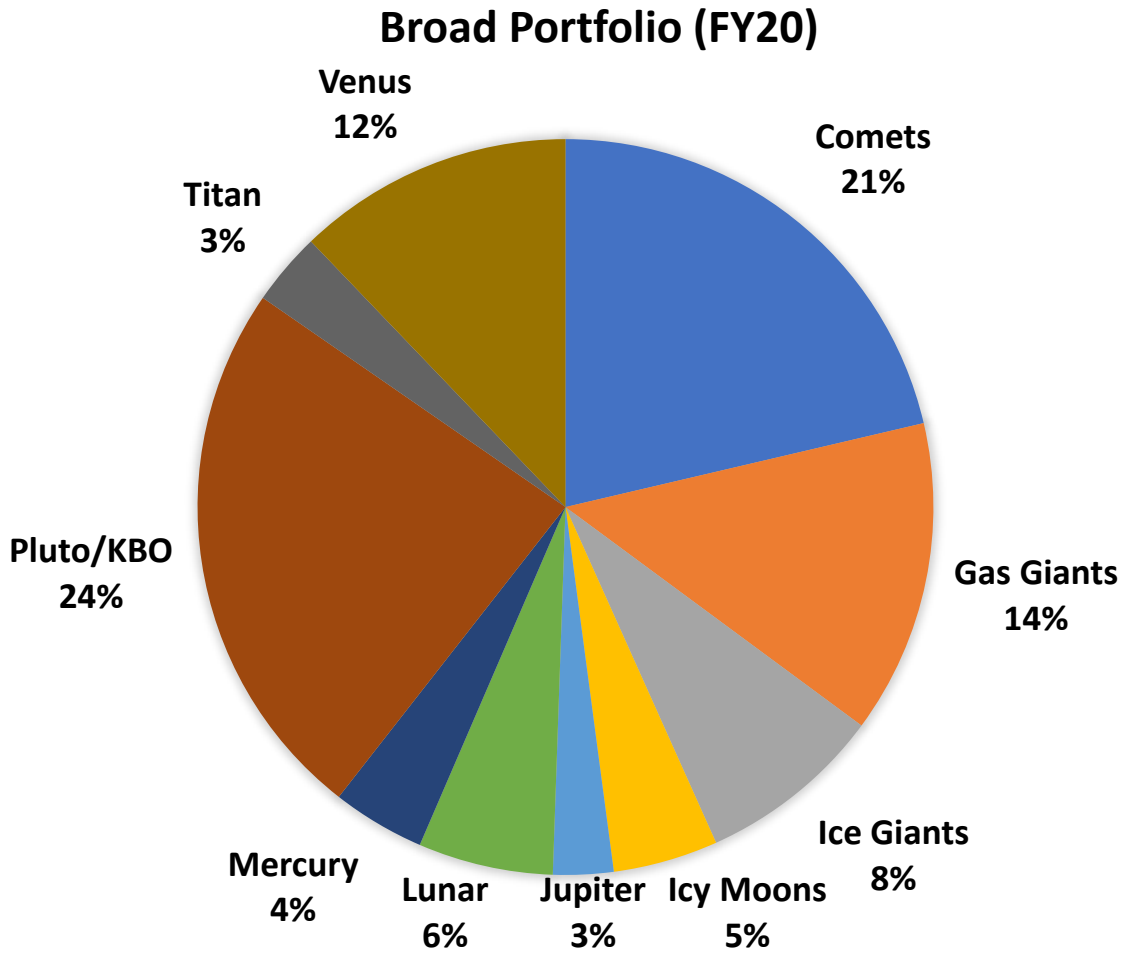
- Photometric, spectral, and other characterization of individual NEOs is a continuing requirement for determining properties of catalogued NEOs for planetary defense
- Solicited via Yearly Opportunities for Research in Planetary Defense (YORPD) and funded by the Near-Earth Object Observations Program

Planetary R&A Grants for Astronomy Investigations

Planetary science from observations obtained by requesting time on a variety of telescopes worldwide

Solar System Observations (SSO) Program

- Planetary Science Division core research program for relevant astronomy
- Astronomical investigations of planets, moons, small bodies in the Solar System
- **Enhance, complement, or otherwise expand on the science of NASA missions**, either in development or in operation, and science objectives



Synthesizing worldwide ground-based and space-based position data for small body science and exploration:

Planetary Data System's Small Bodies Node

NEO and small body position measurements from observatories

- Identification
- Designation
- Initial orbit computation

High precision NEO orbits
- Short-term: new discoveries
- Long-term: future orbits of hazardous asteroids

Time, location and geometry in the event of a predicted impact

Future Planetary Science Division Astronomy

- Solar system astronomy in support of NASA missions and objectives will continue utilizing IRTF and other ground-based facilities
- NASA-funded ground-based NEO survey could decrease as other capabilities are matured and significantly surpass the discovery rates of current systems (*e.g.,* NEO Surveyor mission, NSF's Vera Rubin Observatory)
- Some ground-based systems will be continued to fill significant geographic and short-warning capability gaps for NEOs, and to follow up NEO discoveries, though some systems will lack the sensitivity to continue viable follow up for future surveys
- Support for radar capability will continue, but may be directed to different capabilities as new technologies, such as phased dish radar, mature
- Relevant astronomical research opportunities utilizing ground-based facilities will continue to be competed through ROSES (*e.g.,* SSO, YORPD)