



Finding Near Earth Objects

Before They Find Us!

Lindley Johnson

Near Earth Object Observations

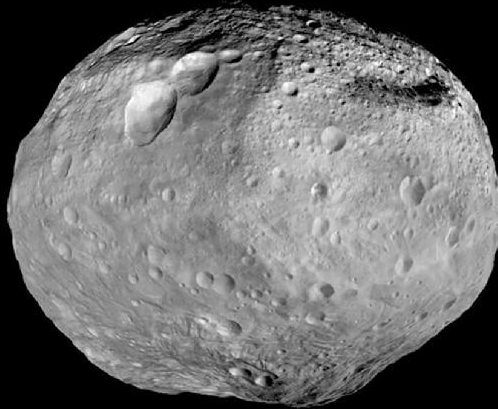
Program Executive

NASA HQ

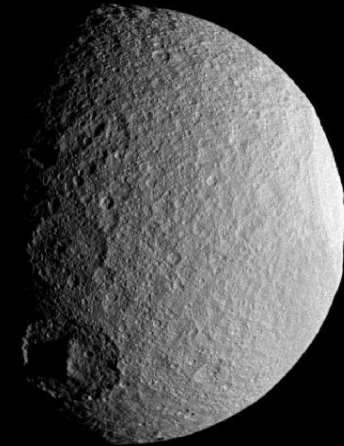
July 8, 2013



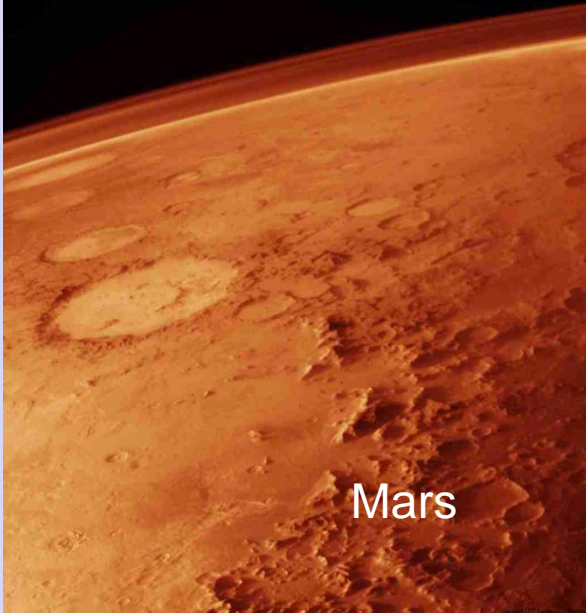
Impact is a Planetary Process



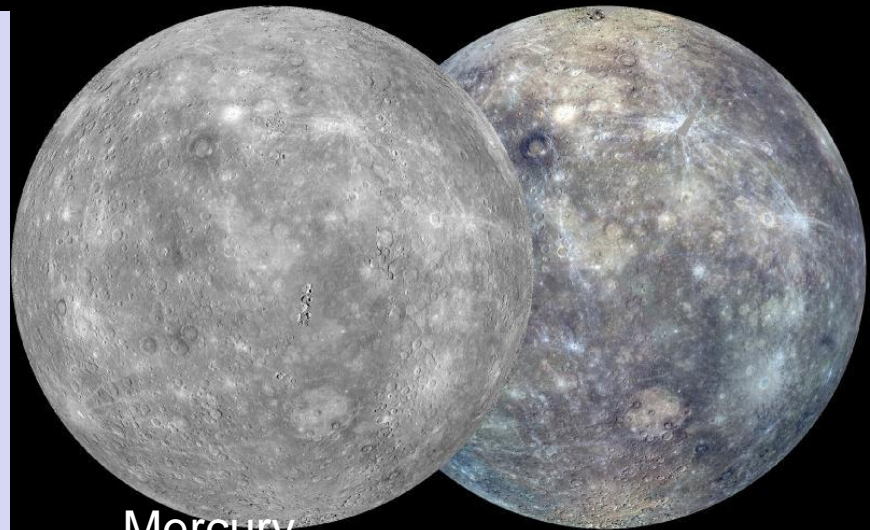
Vesta



Saturn moon Tethys



Mars



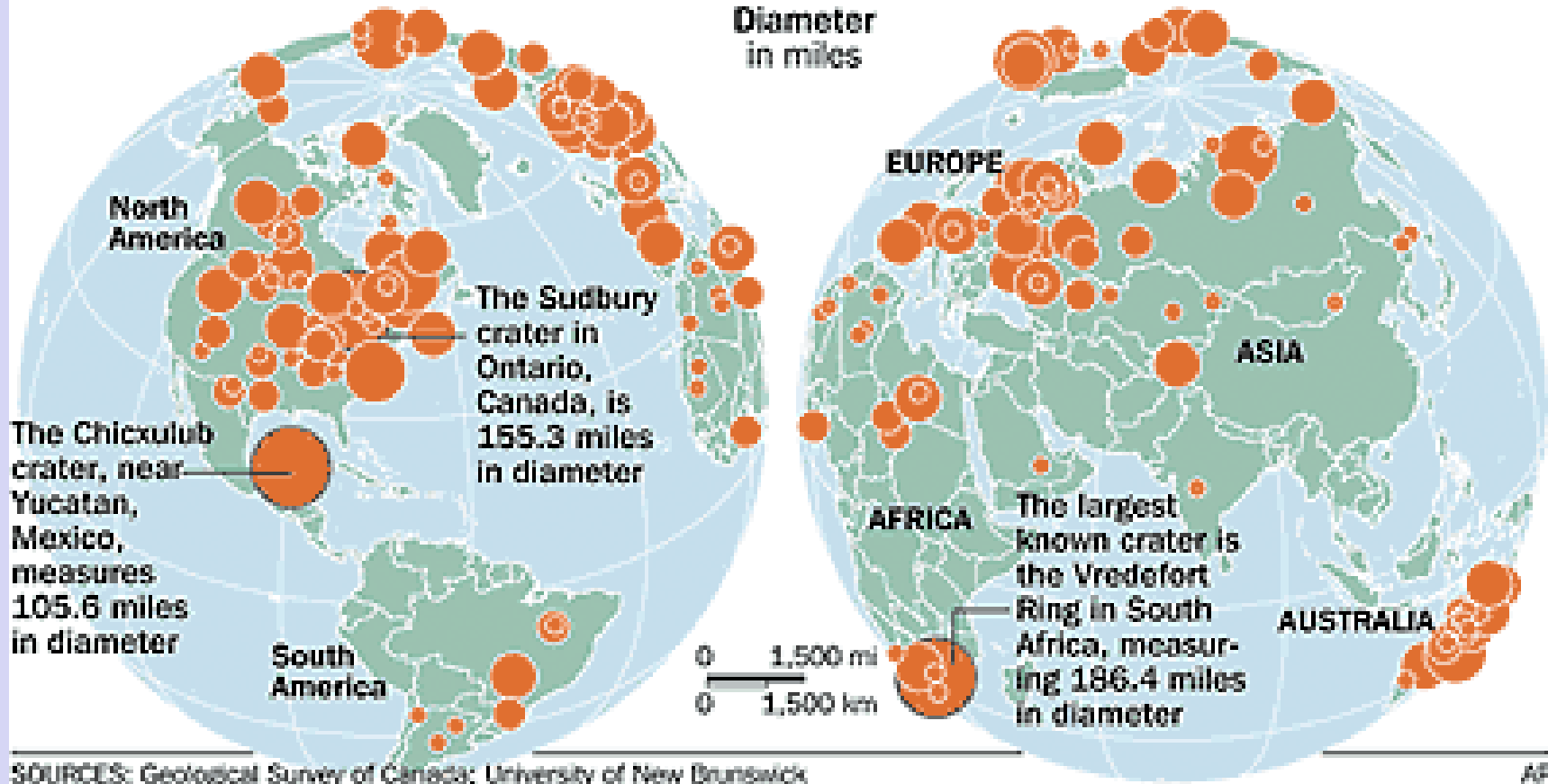
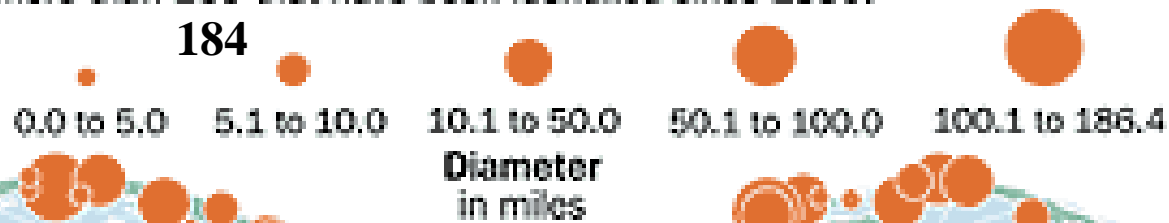
Mercury

Earth's Cratered Past

Impacting Earth

Scientists hypothesize that impacts from comets or asteroids have caused a wide range of effects – from carving craters on the moon to triggering periodic mass extinction on Earth. While most craters on Earth have eroded with time, there are more than ~~100~~ **184** that have been identified since 1950.

Identified crater
on the planet





Why this is Important





Why this is Important



**Barringer Crater
Winslow, Arizona**

**Diameter – 1.2 km
Age – 50,000 yrs**

**Impactor size - ~50m
Energy released - ~10Mt**



Impact Frequencies and Consequences



Type of Event	Diameter of Impact Object	Impact Energy(MT)	Average Impact Interval (years)
High altitude break-up	< 30 m	<5	10 - 50
Tunguska-like event	> 30 m	>5	250 - 500
Regional event	> 140 m	~150	5,000
Large sub-global event	> 300 m	~2,000	25,000
Low global effect	> 600 m	~30,000	70,000
Medium global effect	> 1 km	>100K	1 million
High global effect	> 5 km	> 10M	6 million
Extinction-class Event	> 10 km	>100M	100 million



Effects of TUNGUSKA EVENT



June 1908 – 100 years ago





CHELYABINSK EVENT



February 15, 2013
17-20 meter object
~400-450 kilotons TNT



CHELYABINSK EVENT



February 15, 2013
1613 citizens injured
~\$30 million damages



NEO Observation Program



US component to International Spaceguard Survey effort
Has provided 98% of new detections of NEOs since 1998

Began with NASA commitment to House Committee on Science in May, 1998 to find at least 90% of 1 km and larger NEOs

- Averaged ~\$4M/year Research funding 2002-2010
- That goal reached by end of 2010

NASA Authorization Act of 2005 provided additional direction:

“ . . .plan, develop, and implement a Near-Earth Object Survey program to detect, track, catalogue, and characterize the physical characteristics of near-Earth objects equal to or greater than **140 meters** in diameter in order to assess the threat of such near-Earth objects to the Earth. It shall be the goal of the Survey program to achieve **90 percent completion** of its near-Earth object catalogue **within 15 years** [by 2020].

New Program Objective: Discover $\geq 90\%$ of NEOs larger than 140 meters in size as soon as is feasible

- Starting with FY2012, now has \$20.5 M/year



NASA's NEO Search Program

(Current Systems)



Minor Planet Center (MPC)

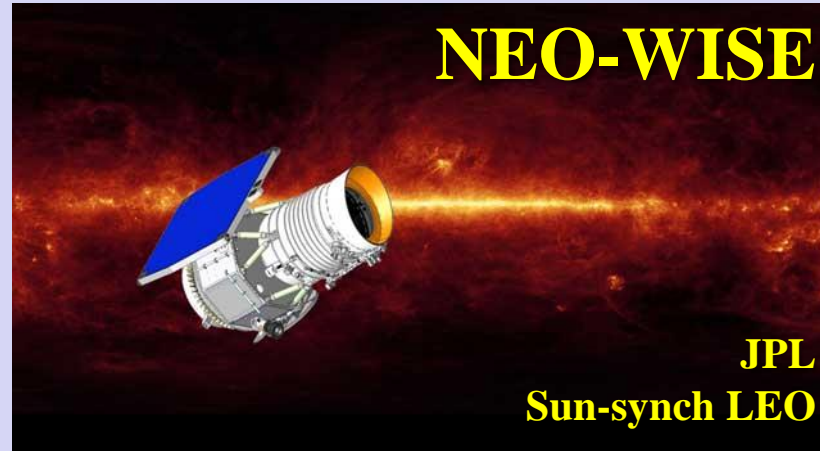
- IAU sanctioned
- Int'l observation database
- Initial orbit determination

www.cfa.harvard.edu/iau/mpc.html

NEO Program Office @ JPL

- Program coordination
- Precision orbit determination
- Automated SENTRY

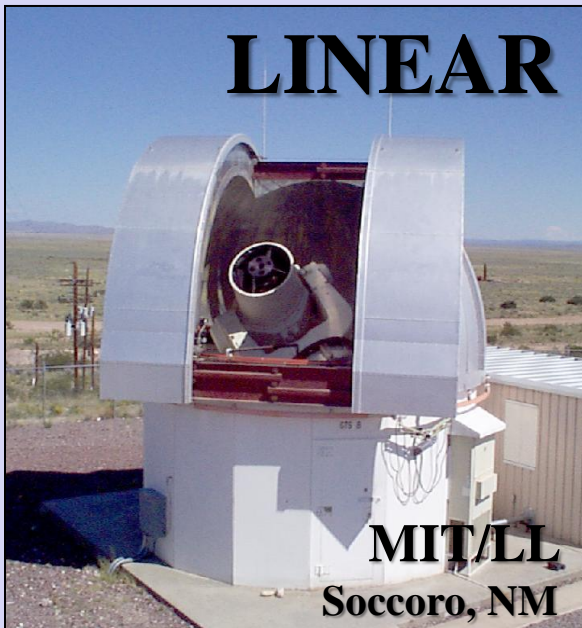
<http://neo.jpl.nasa.gov/>



NEO-WISE

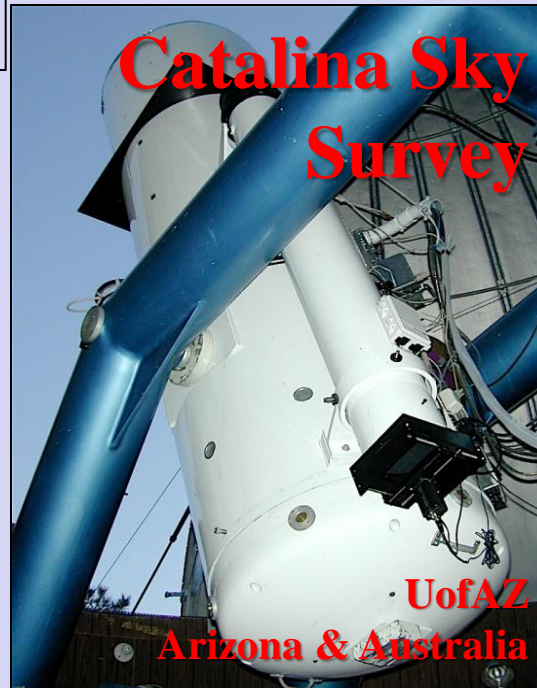
JPL
Sun-synch LEO

End of
Operations
Feb 2011,
129 NEAs found,
Analysis
of IR Data
continues



LINEAR

MIT/LL
Socorro, NM



Catalina Sky Survey

UofAZ
Arizona & Australia

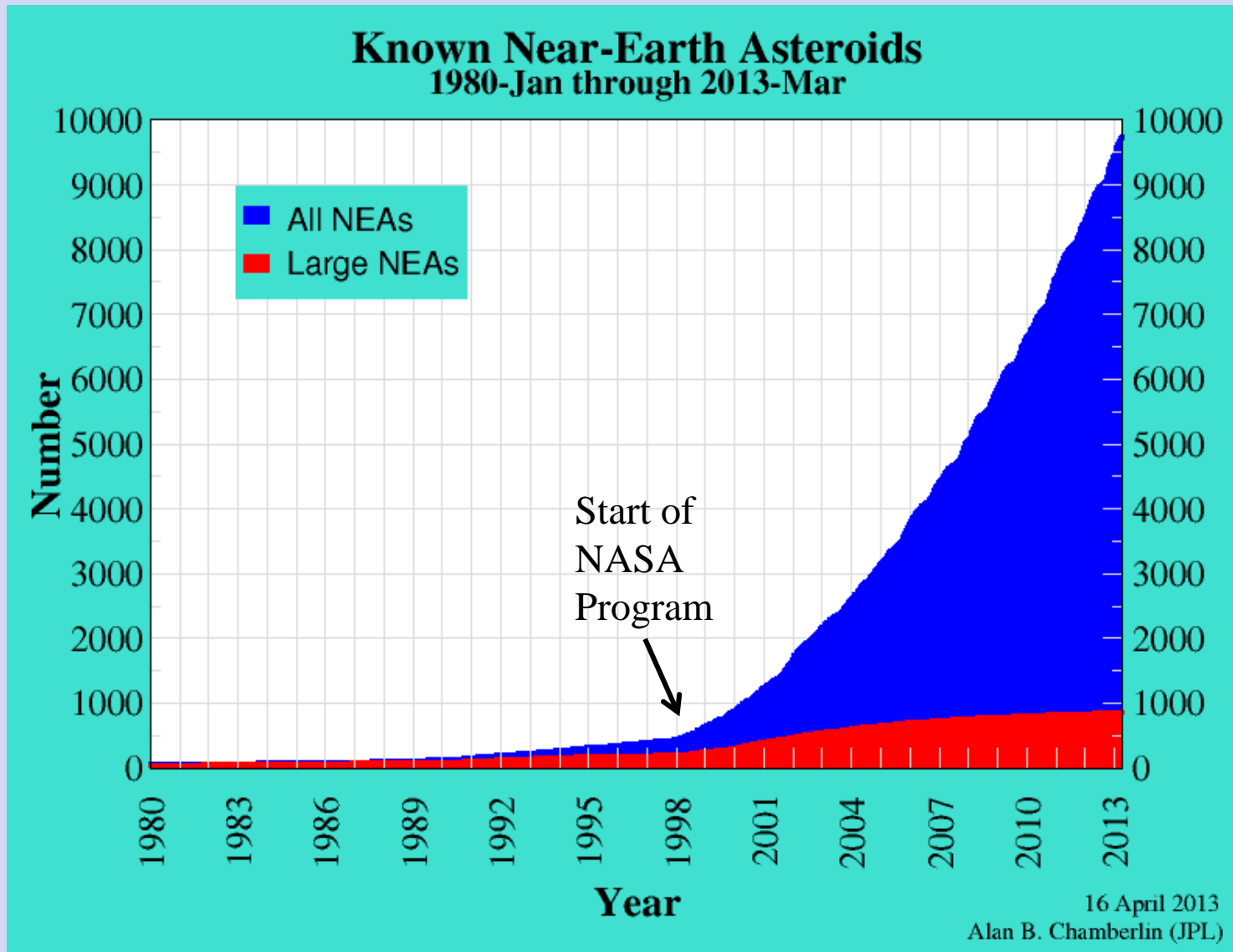


Pan-STARRS

Uof HI
Haleakula, Maui



Known Near Earth Asteroid Population



10,006
7/01/13

Includes
94 comets

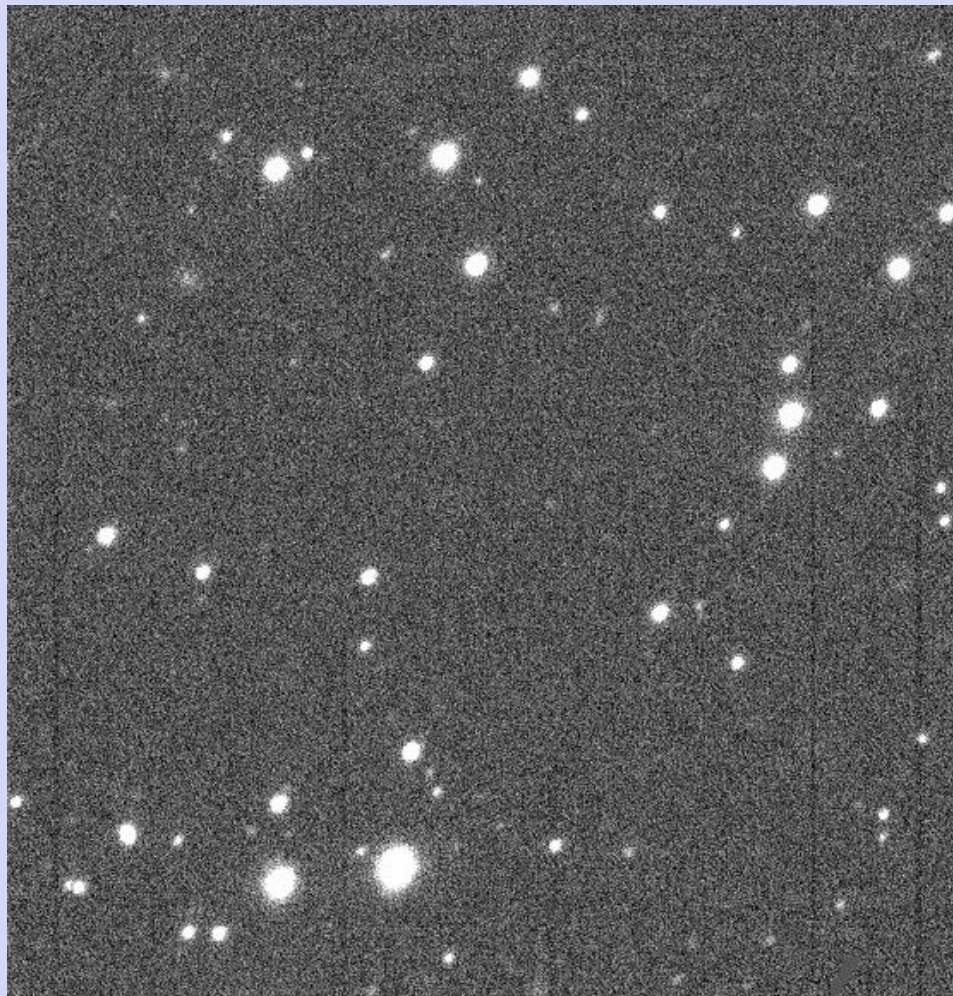
861
7/01/13



Discovery Images of Asteroid 2013 MZ5



Do you see it?



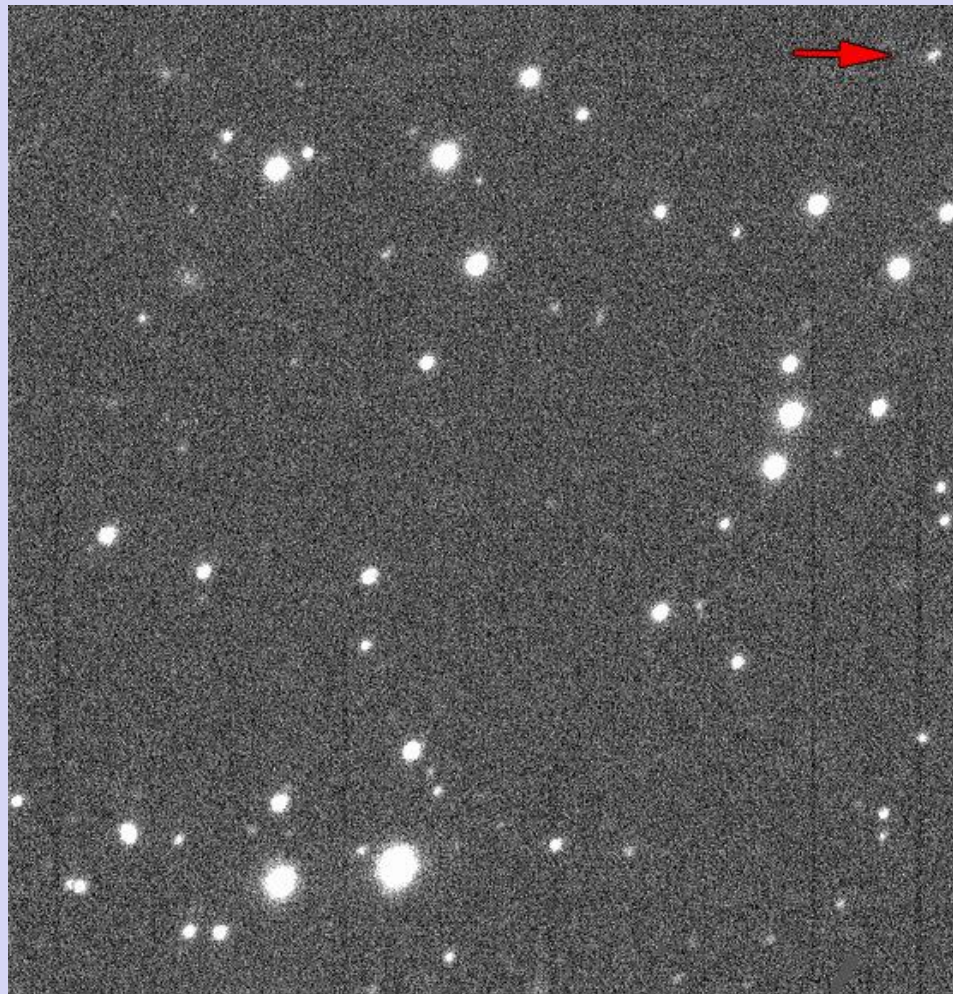
Courtesy of Pan-STARRS



Discovery Images of Asteroid 2013 MZ5



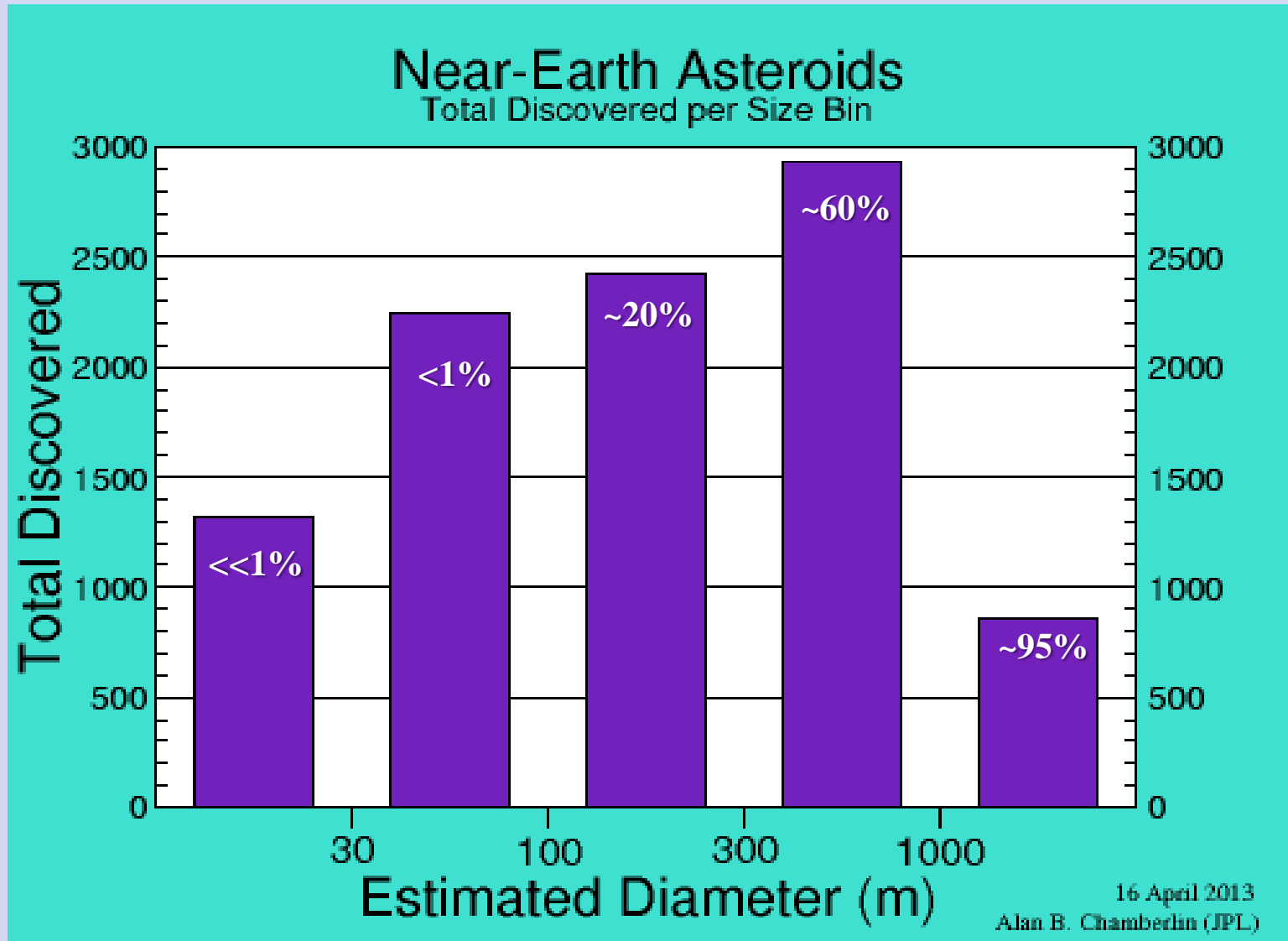
Did you find it?



Courtesy of Pan-STARRS



Known Near Earth Asteroid Population



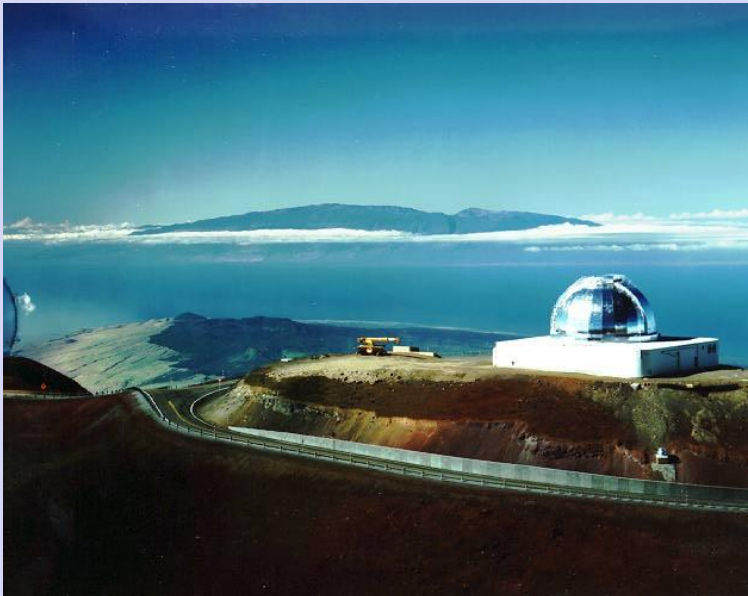


NEA Characterization



Spitzer Infra-Red Space Telescope

- In extended Warm-phase mission
- Characterization of Comets and Asteroids
- Thermal Signatures for Albedo/Sizes
- Longer time needed for scheduling



NASA Infra-Red Telescope Facility (IRTF)

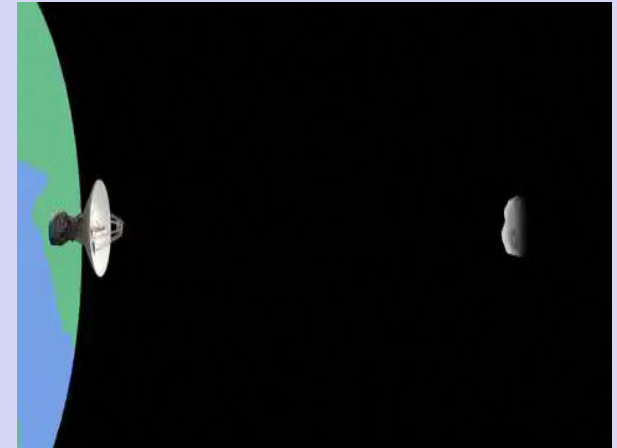
- Dedicated Planetary Science Observatory
- Characterization of Comets and Asteroids
- Spectroscopy and Thermal Signatures
- On-call for Rapid Response on Discoveries



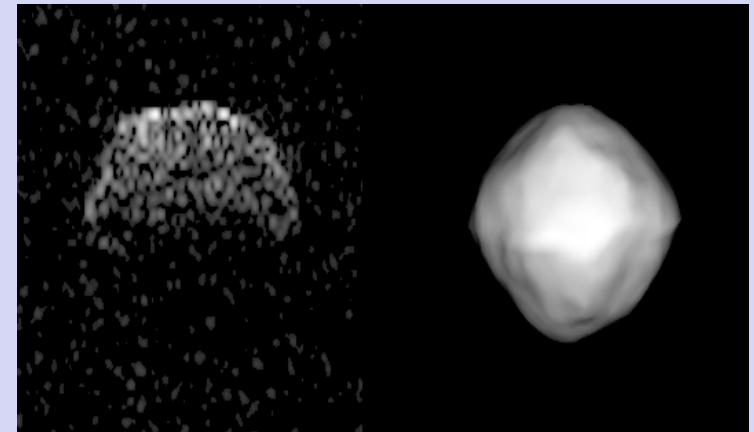
Arecibo Observatory



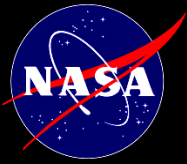
Goldstone Radar



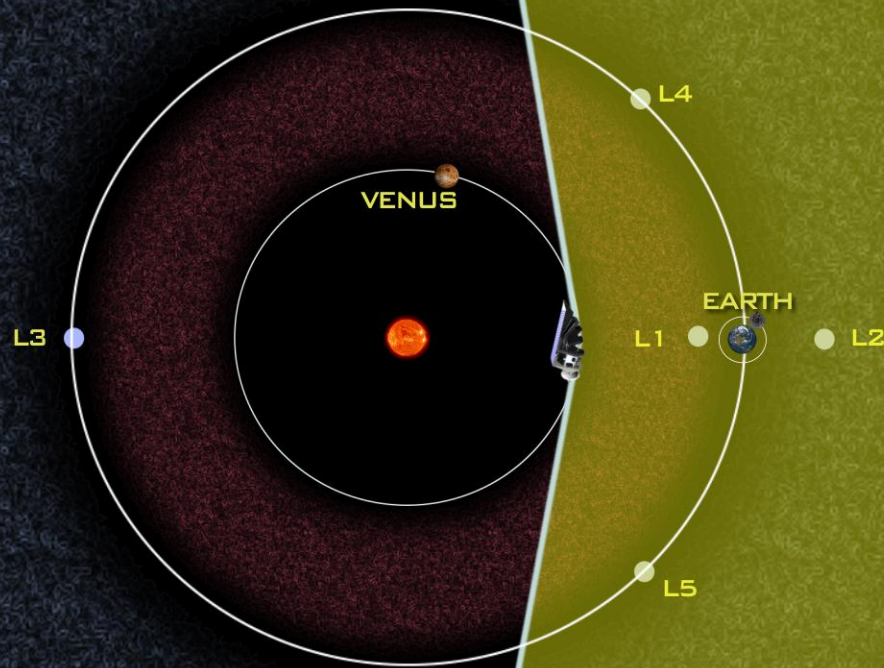
- Observations on limited number of accessible objects, but next best thing to a flyby
- Observations each year has doubled
 - Required for timely precision orbit determination
 - Characterization with sufficient signal strength
 - Shape, spin-state, surface structure
 - Detection of moons (and then derived mass)



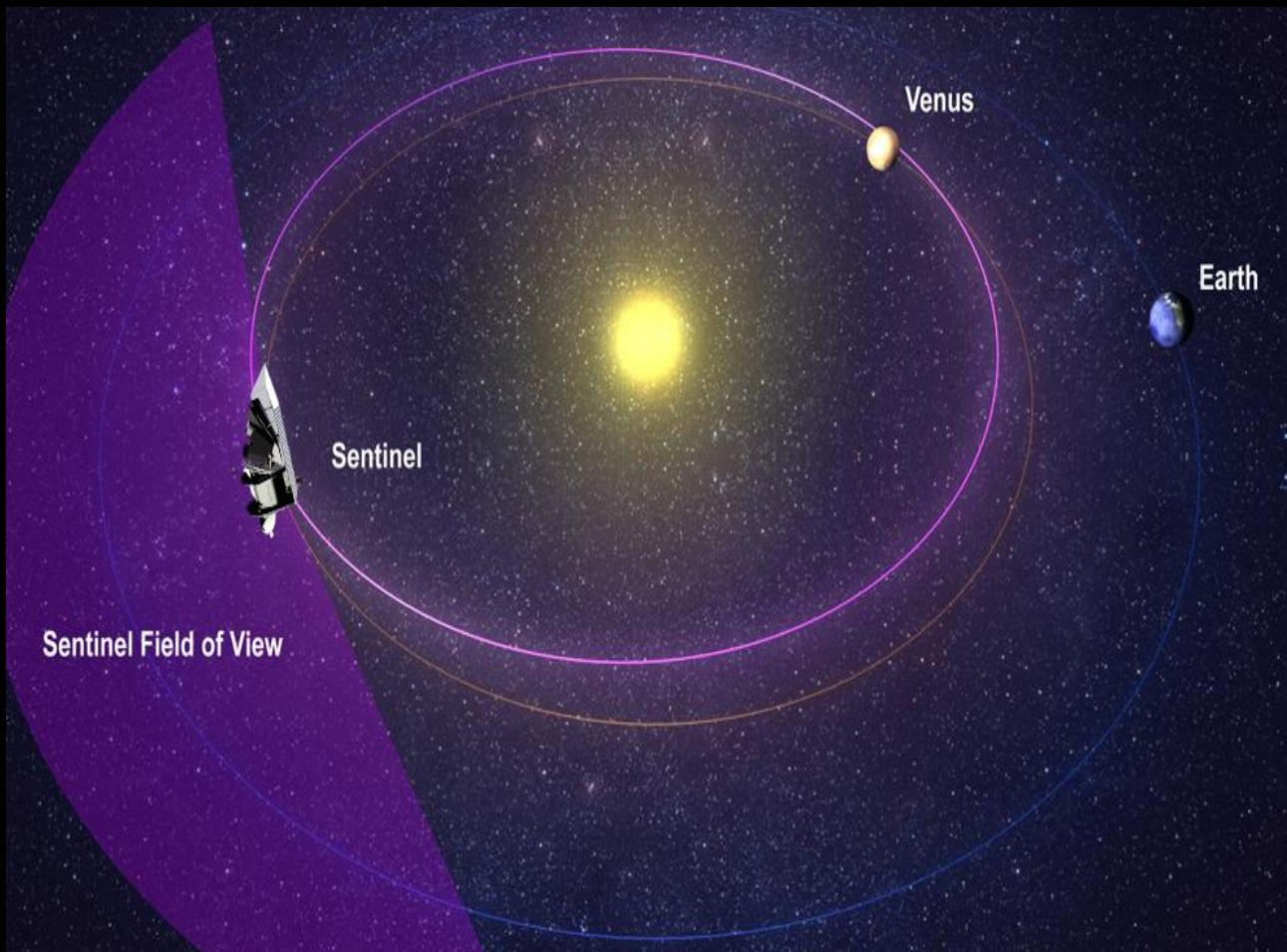
Bennu (1999 RQ36)



Space-based NEO Surveys



Public Private Partnership- Space Act Agreement with B612





Grand Challenge Statement*

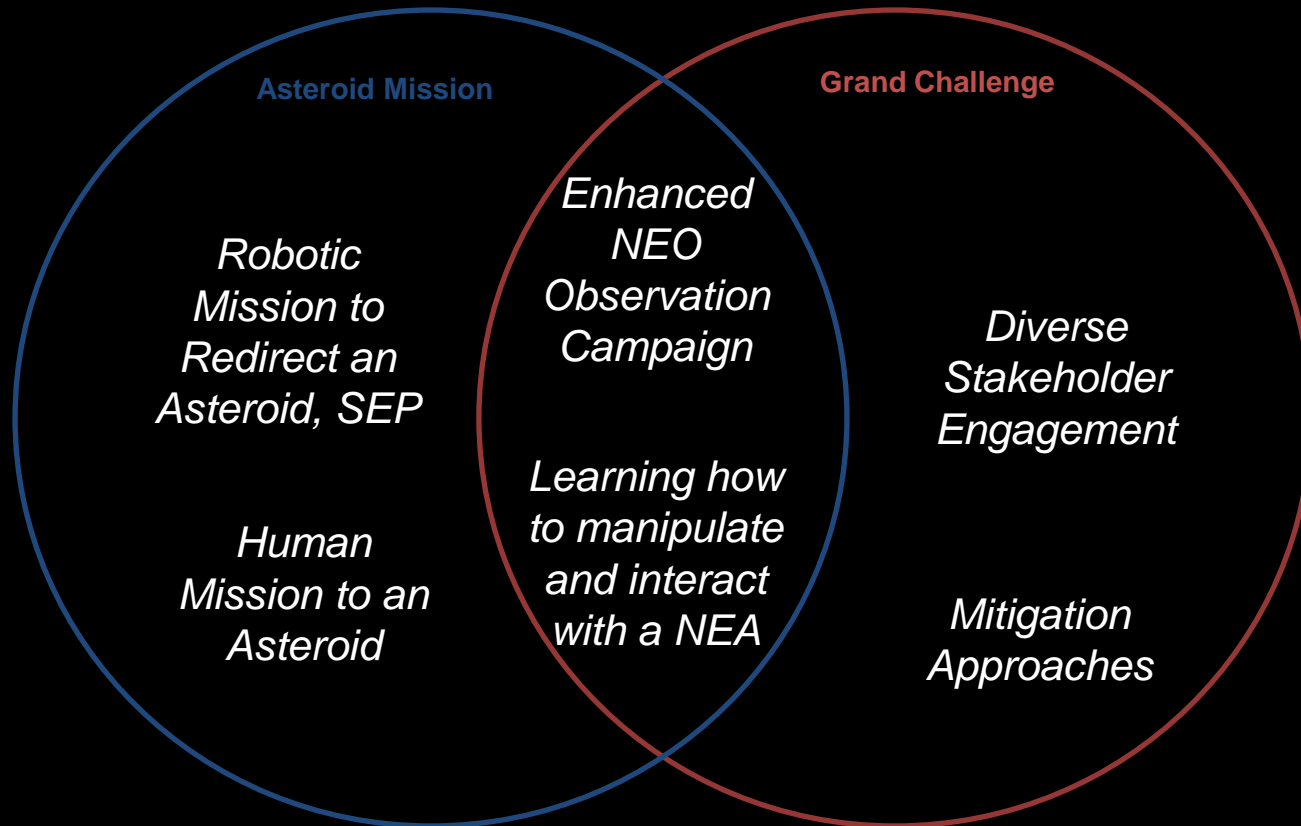
Find all asteroid threats to human populations and know what to do about them



*Announced 18 June, 2013 20

FY14 Asteroid Initiative: What and How

Asteroid Initiative



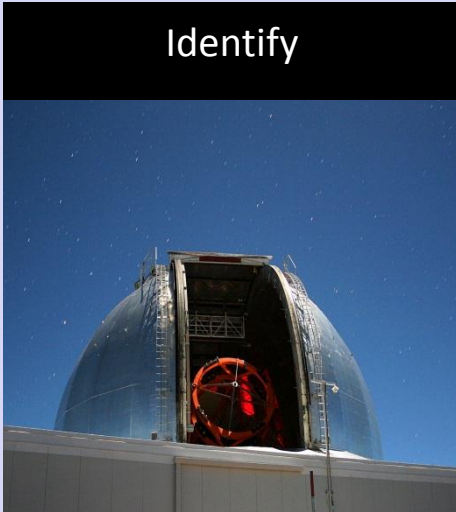
Both sets of activities leverage existing NASA work while amplifying participatory engagement to accomplish their individual objectives and synergize for a greater collective purpose.



Asteroid Redirect Mission Consists of Three Main Segments



Identify



Asteroid Identification Segment:

Ground and space based NEA target detection, characterization and selection

Tasked to NEOO

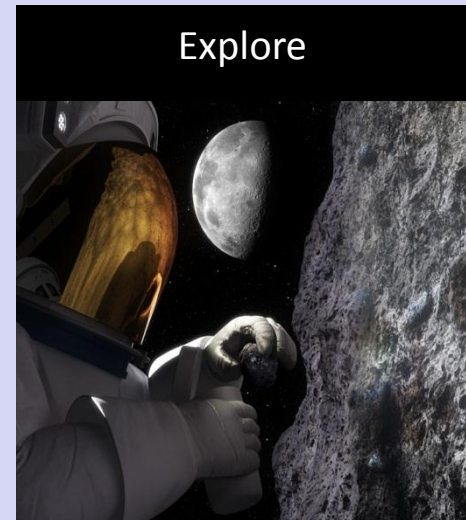
Redirect



Asteroid Redirection Segment:

Solar electric propulsion (SEP) based robotic asteroid redirect to trans-lunar space

Explore



Asteroid Crewed Exploration Segment:

Orion and SLS based crewed rendezvous and sampling mission to the relocated asteroid

See A/AC.105/C.1/L.329
21 Dec 2012

