NASA's Near-Earth Object Program (Spaceguard)

Don Yeomans
Manager, NASA Near-Earth Object Program Office

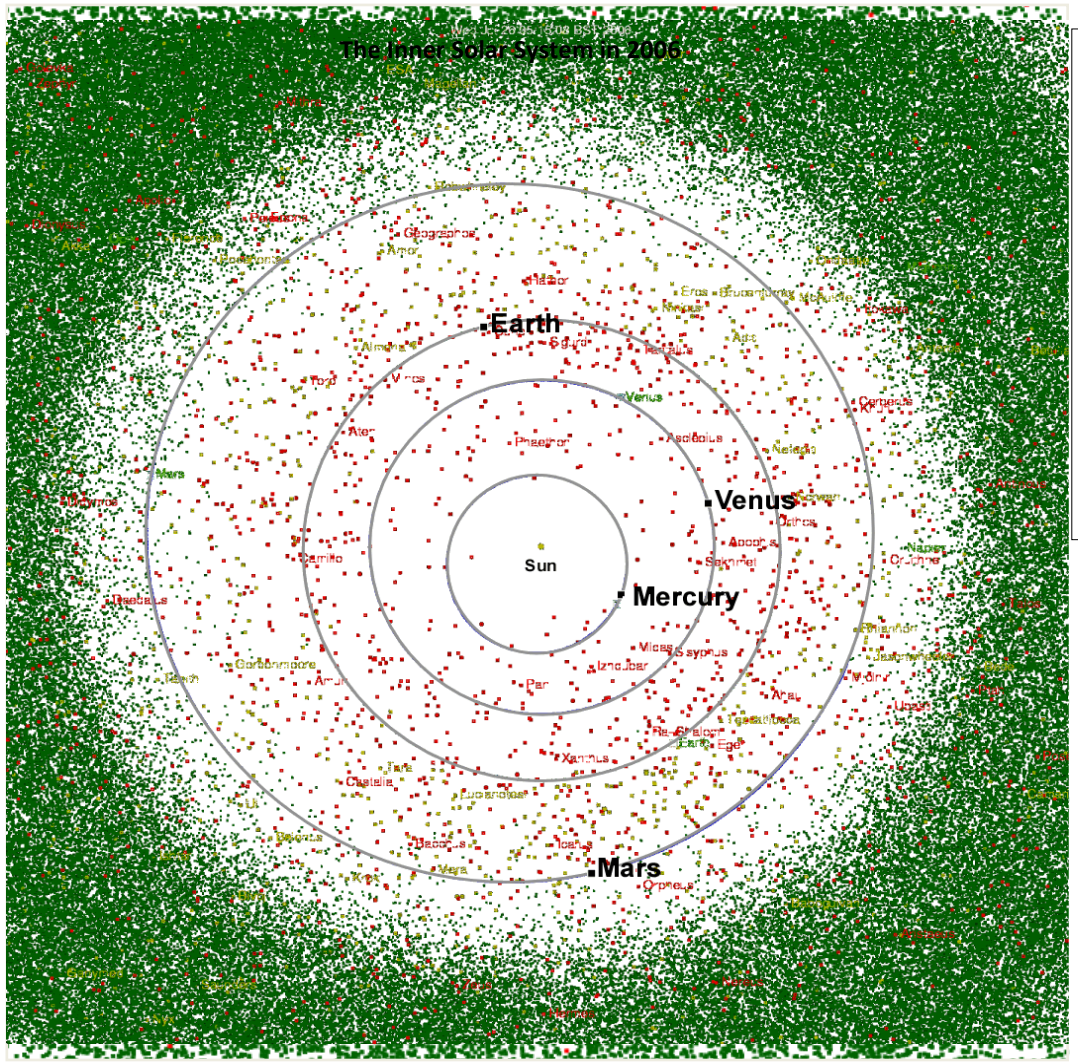
Meteor Crater
Arizona

History of Known NEO Population

2011

Earth Crossing

Outside Earth's Orbit



Known

- 500,000 minor planets
- 7750 NEOs
- 1200 PHAs

Scott Manley

Armagh Observatory

NASA's NEO Search Program

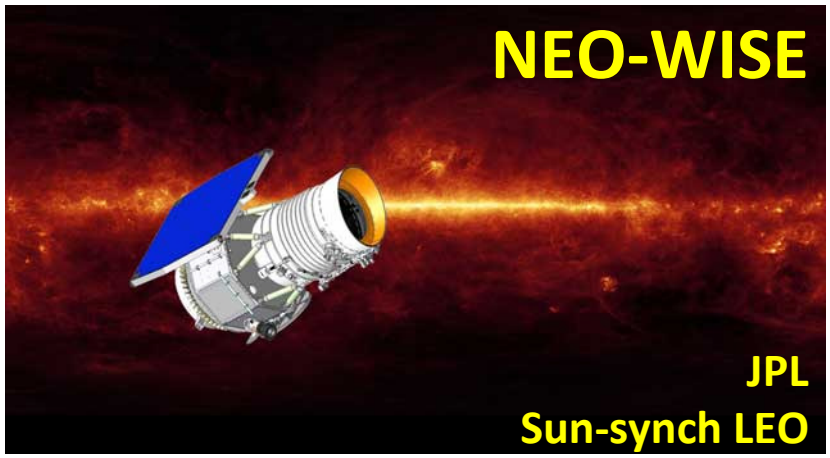
(Current Systems)

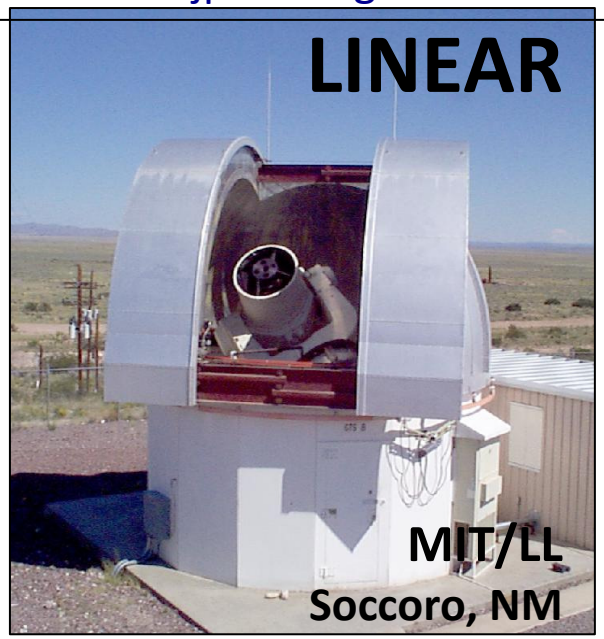
Minor Planet Center (MPC)
- IAU sanctioned
- Int'l observation database
- Initial orbit determination

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

NEO Program Office @ JPL
- Program coordination
- Precision orbit determination
- Automated SENTRY

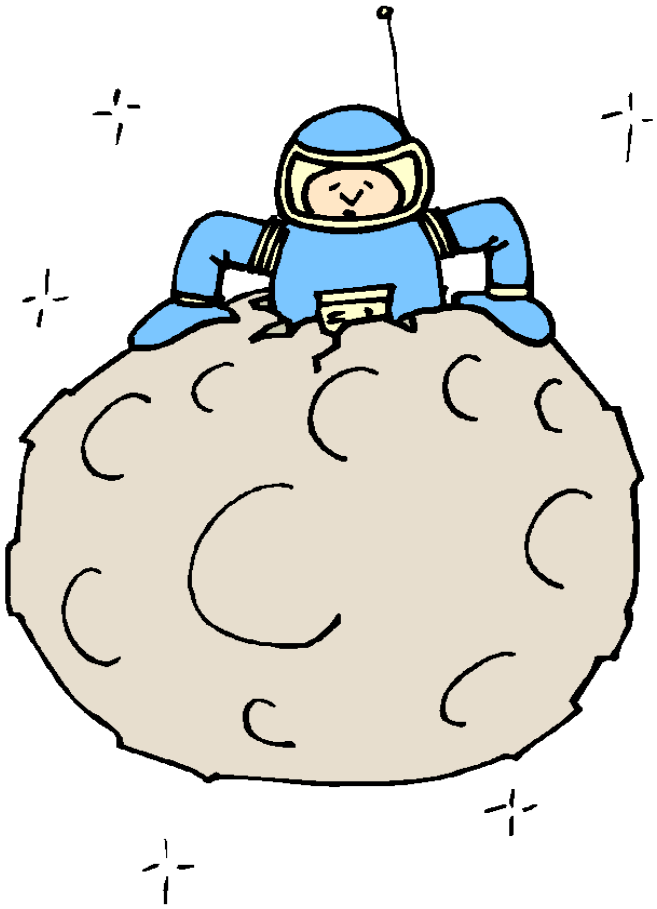
www.neo.jpl.nasa.gov





The Importance of Near-Earth Objects

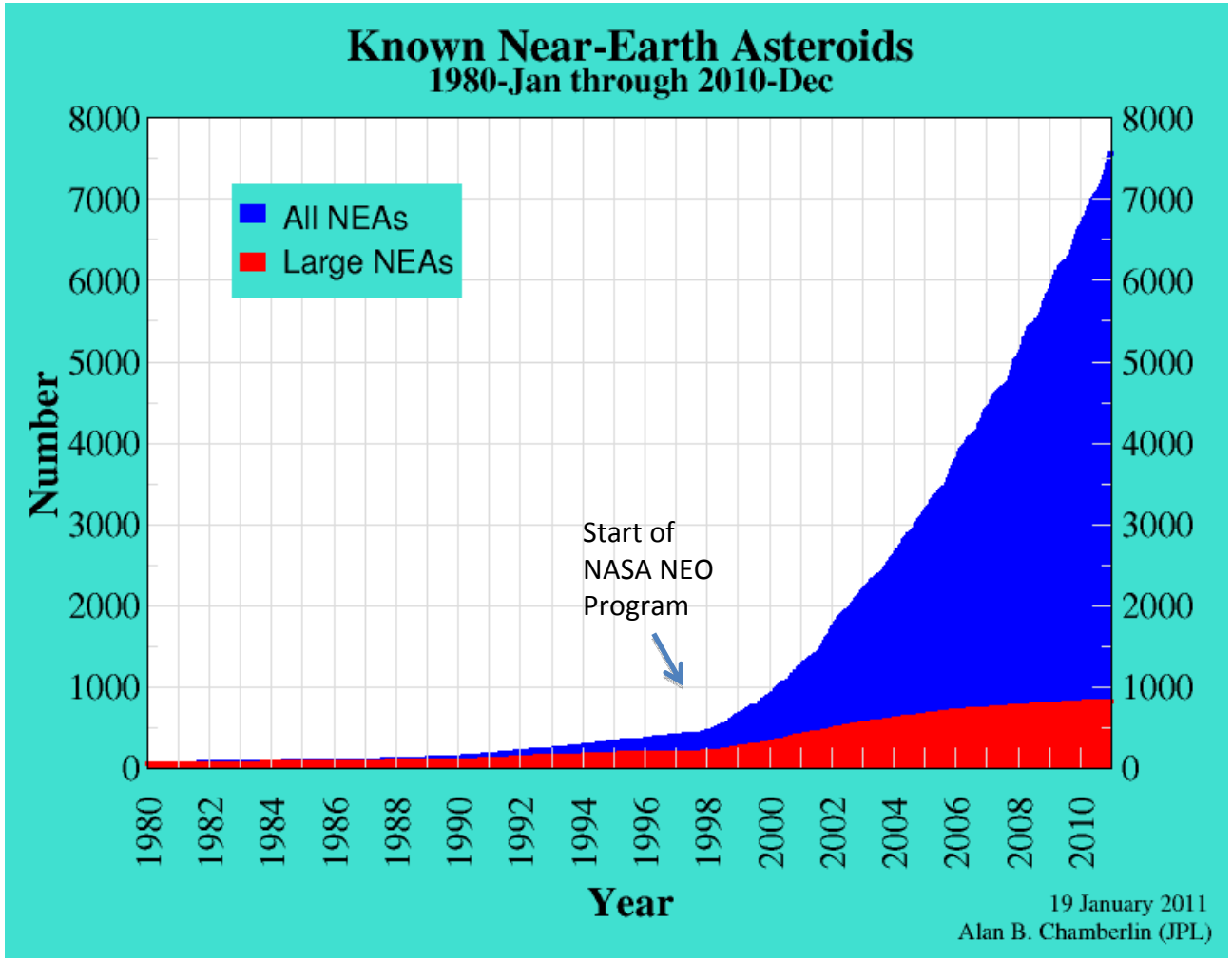
- Science
- Future Space Resources
- Planetary Defense
- Exploration



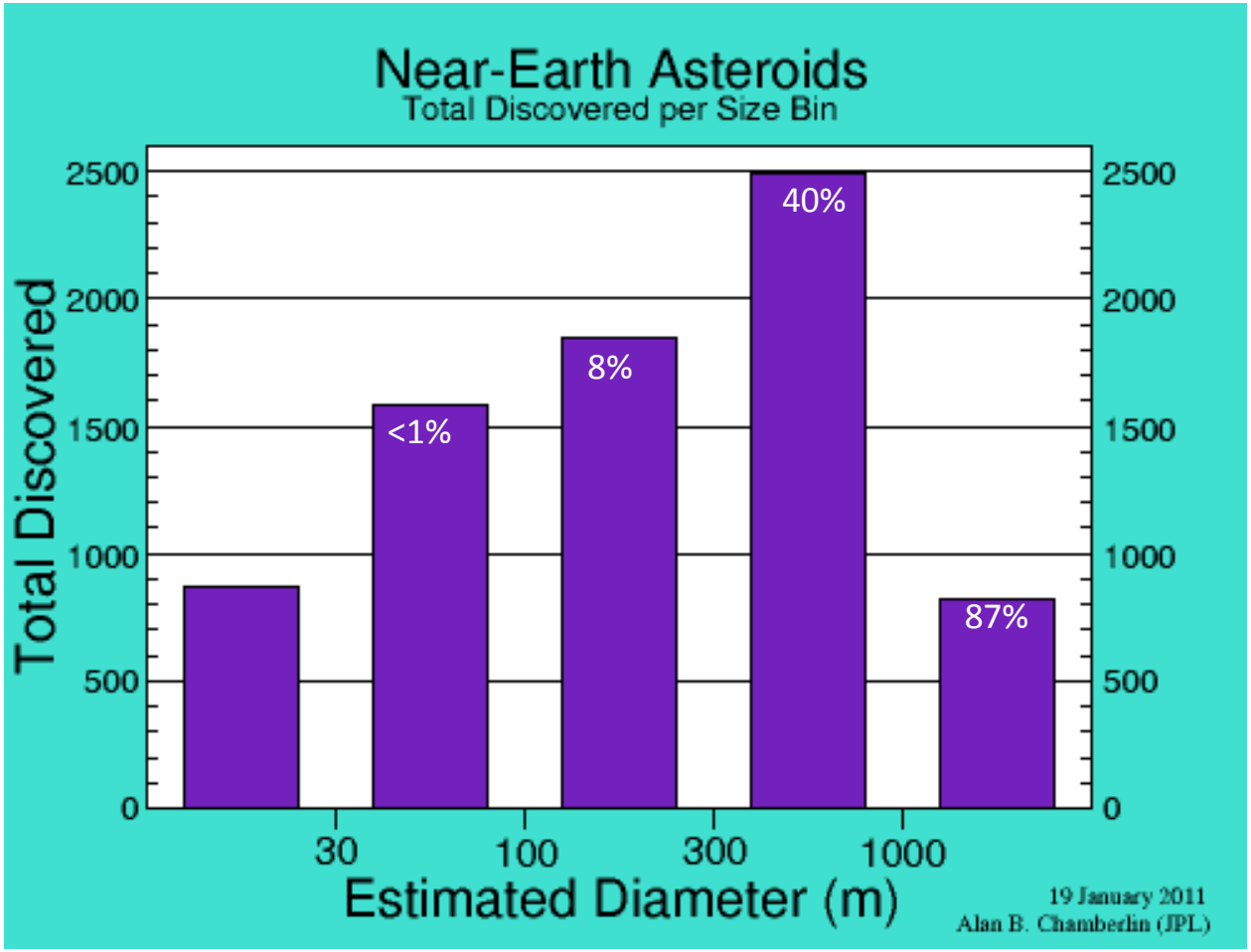
NASA's NEO Program Office at JPL

- Coordination and Metrics
- Automatic orbit updates as new data arrive
- SENTRY system
- Relational database for NEO orbits & characteristics
- Conduct research on:
  - Discovery efficiency
  - Improving observational data
  - Modeling dynamics
  - Optimal mitigation processes
- Impact warnings & outreach
  - http://www.jpl.nasa.gov/asteroidwatch/
  - NEO Program Office: http://neo.jpl.nasa.gov/

Near-Earth Asteroid Discoveries

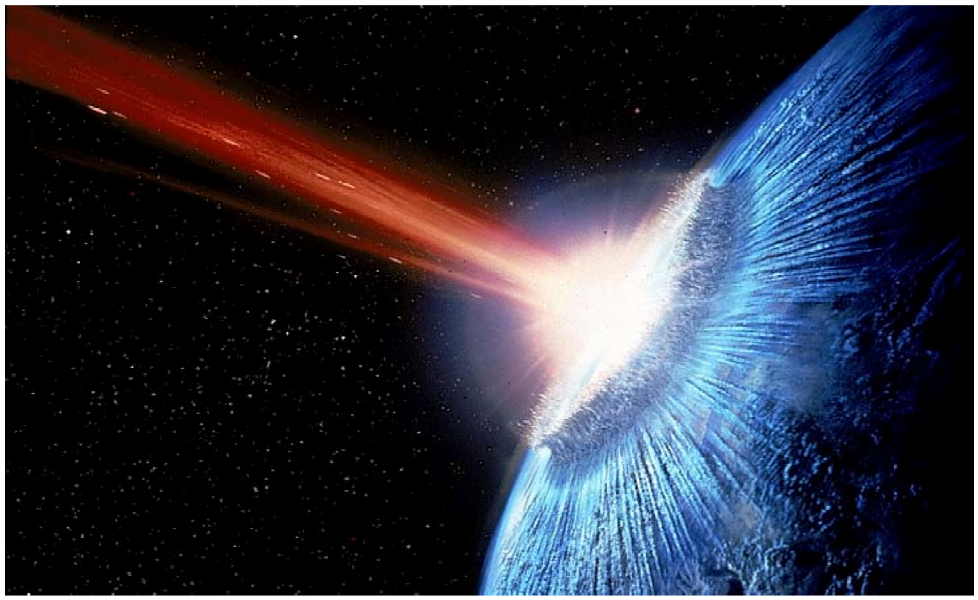


Discovery Completion Within Size Intervals



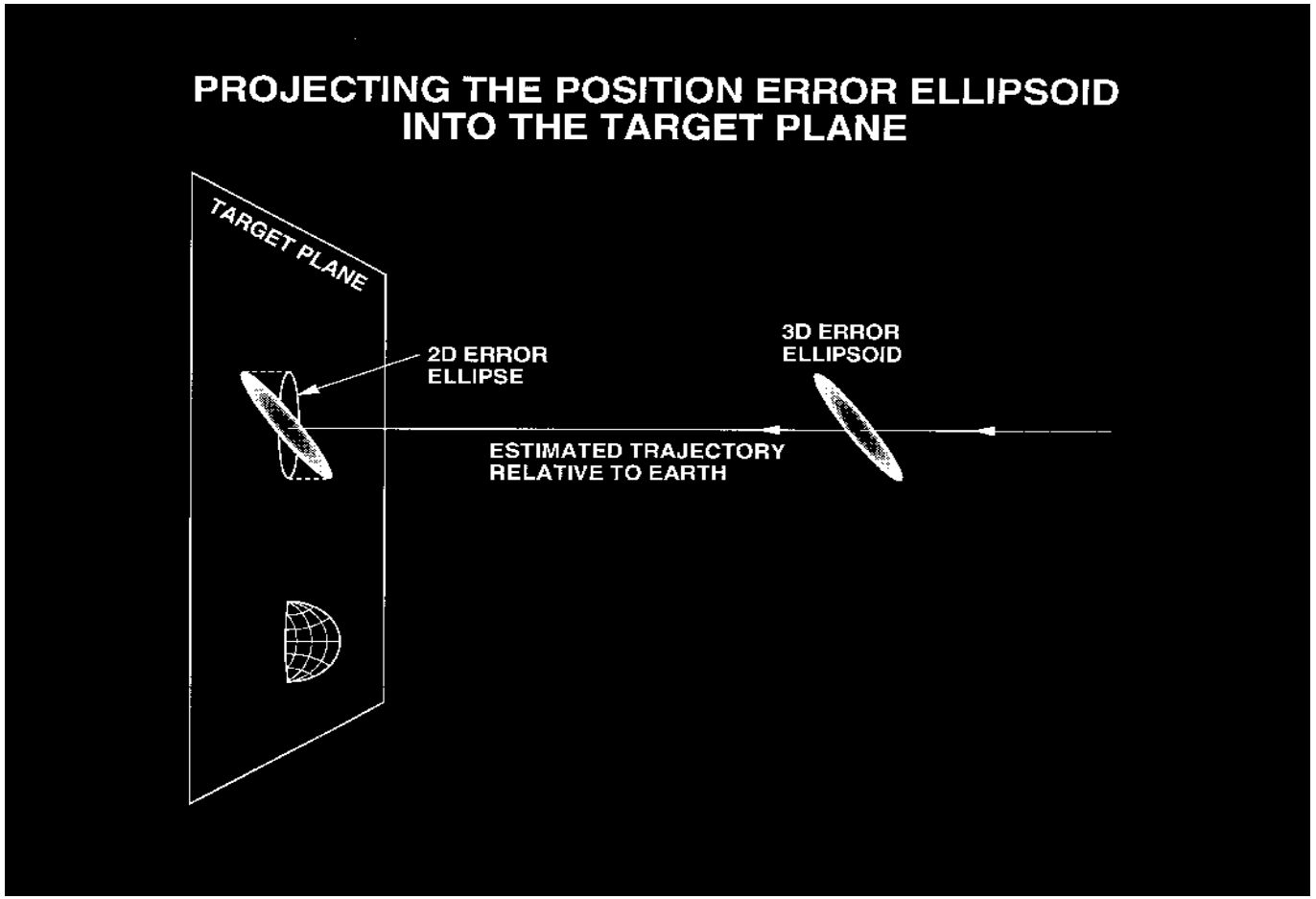
JPL's SENTY NEO Risk Page

http://neo.jpl.nasa.gov/risk/

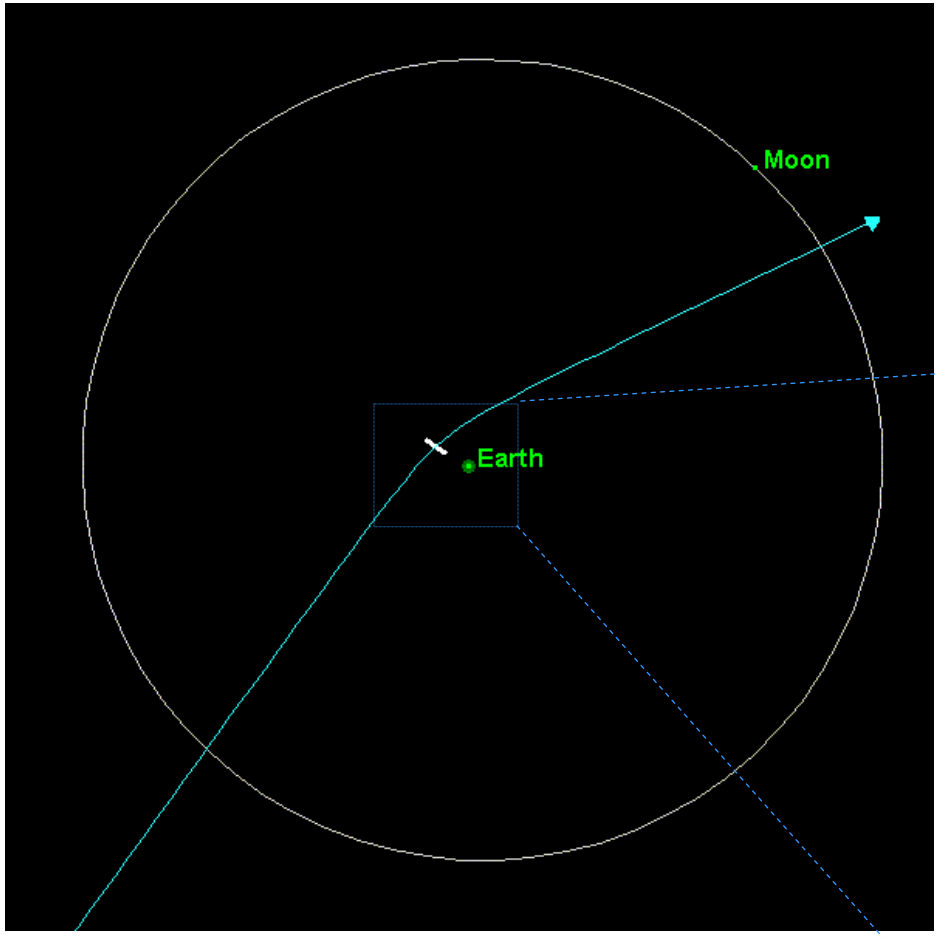


Object Designation	Year Range	Potential Impacts	Impact Prob.	Velocity (km/s)	H (mag.)	Estimated Diameter (km)	Palermo Scale	Torino Scale
1999 RQ36	2169-2199	8	7.1×10^{-4}	6.36	20.7	0.560	-1.68	N/A
2007 VK184	2048-2057	4	3.4×10^{-4}	15.63	22.0	0.130	-1.80	1
Apophis	2036-2103	6	7.4×10^{-6}	5.87	19.7	0.270	-3.08	0

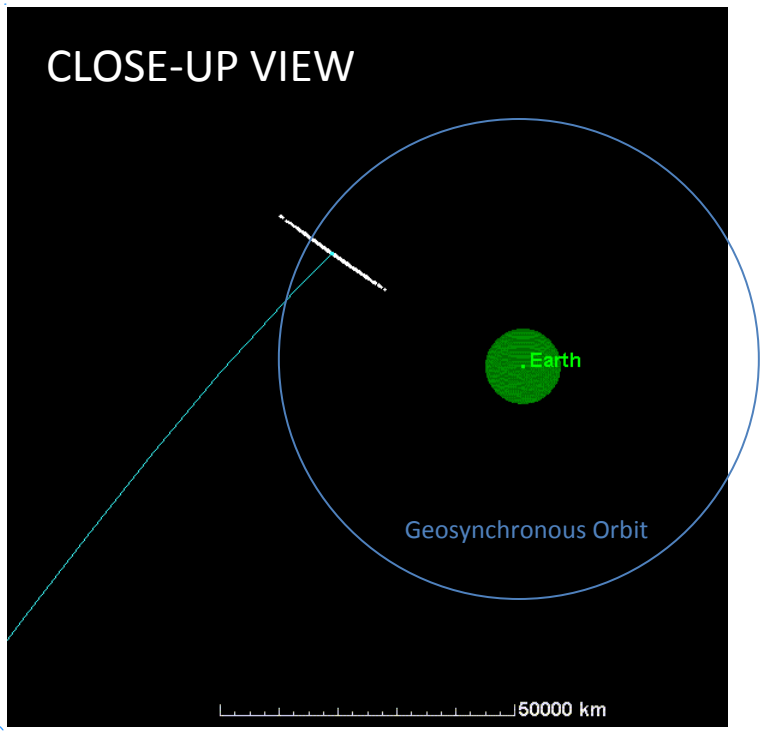
Computing and Verifying Impact Probabilities
(Working with our Italian Colleagues)



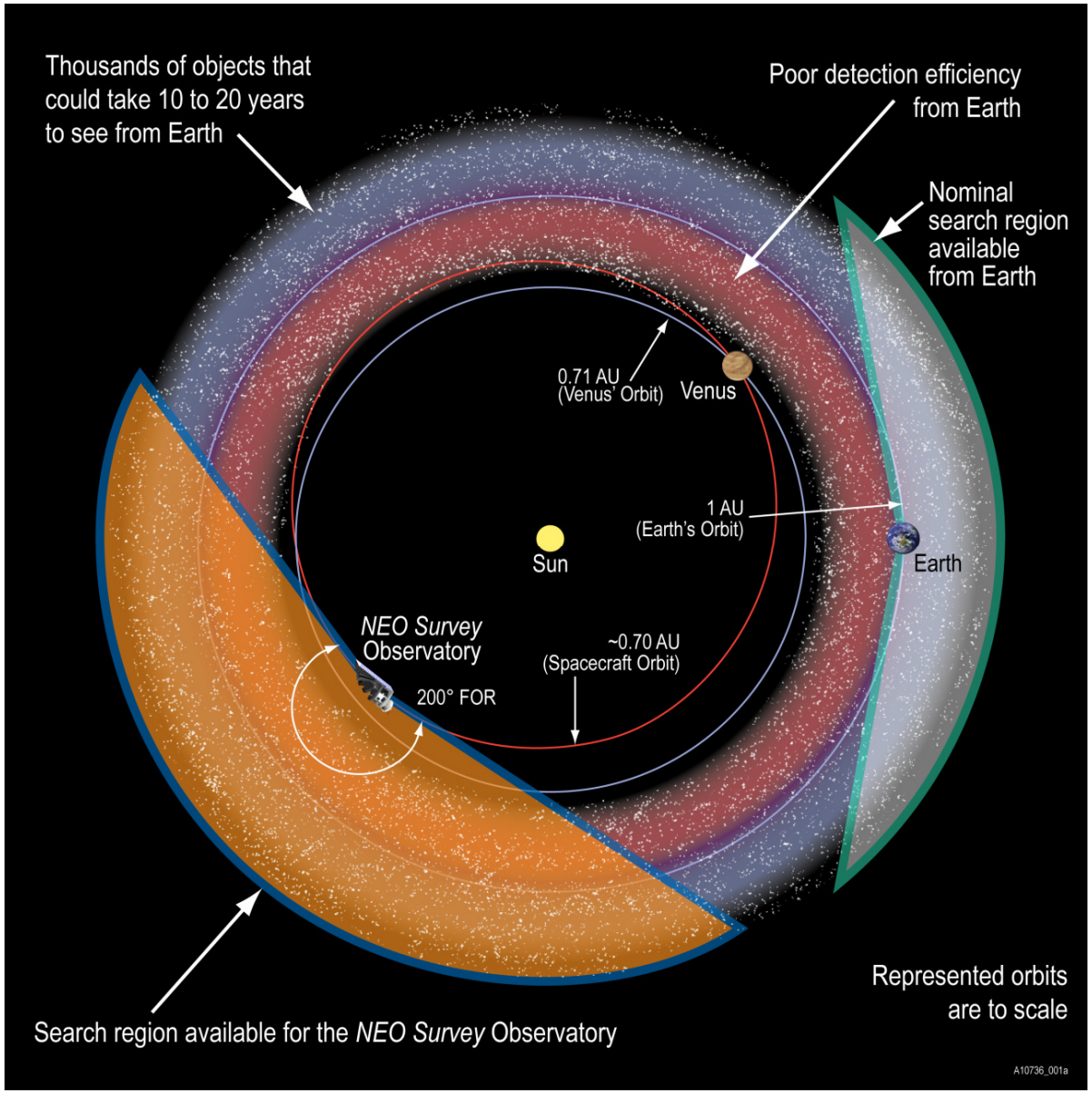
Near-Earth Asteroid Apophis



Predicted Close Approach of Apophis (~270m Object) on April 13, 2029



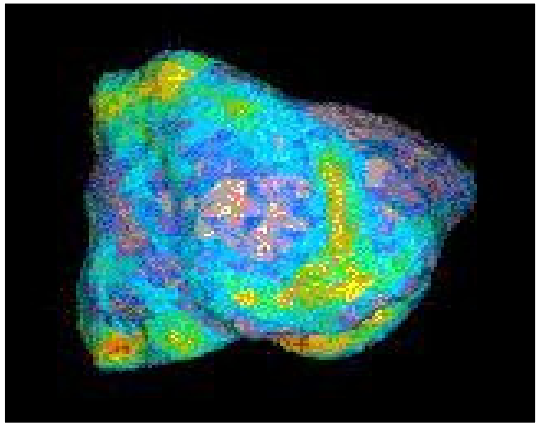
Discovering NEOs Using a Space IR Telescope



Radar Studies

Goldstone, CA

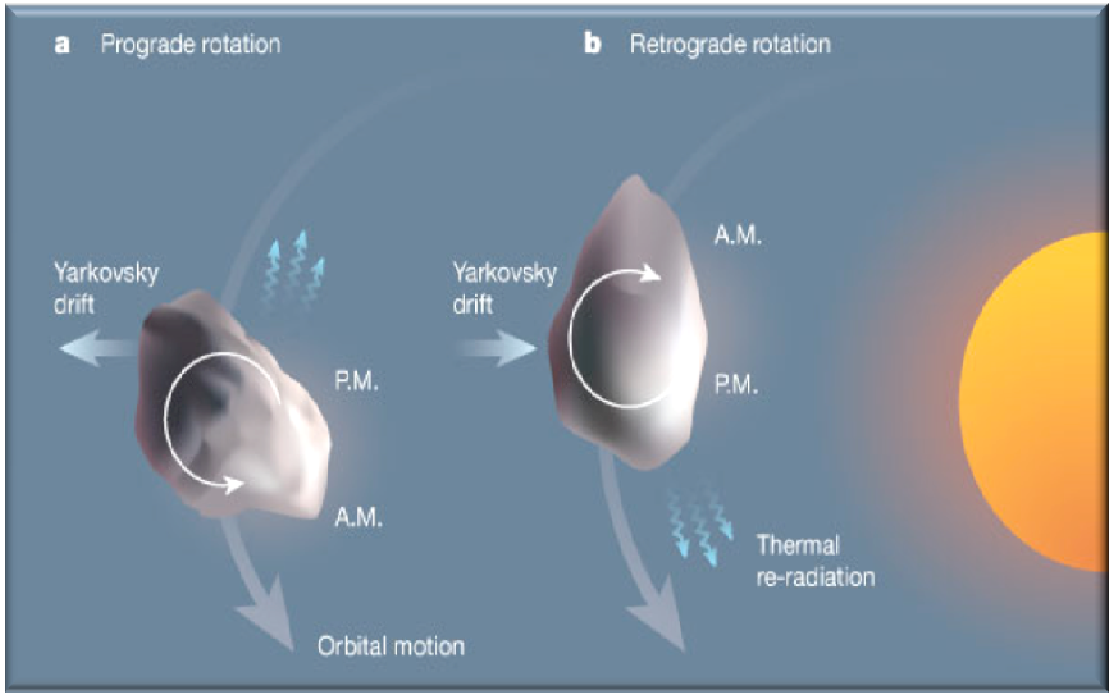
Arecibo, Puerto Rico



Shape, Size of 6489 Golevka

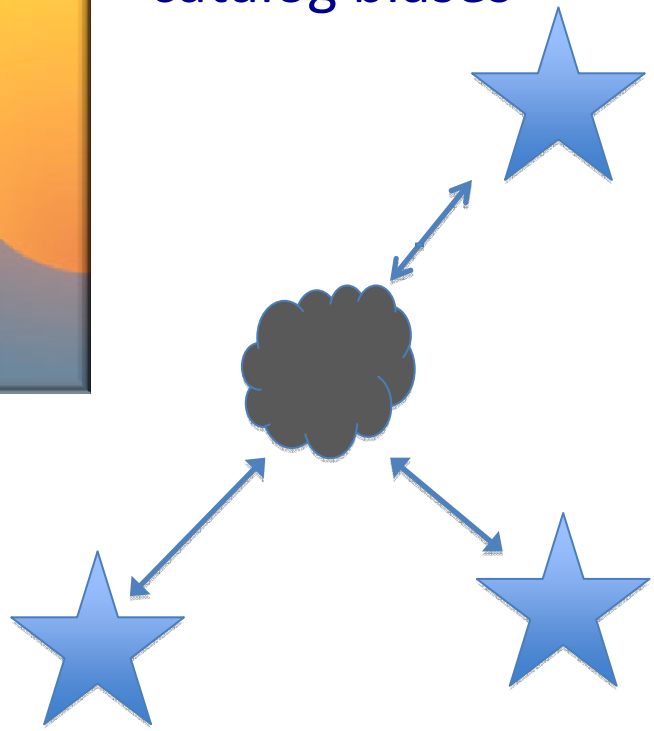
Study of Shape, Size, Motion and mass of near-Earth object 66391 (1999 KW4)

Improving Our Accuracy



Improving dynamic models - Yarkovsky Effect

Improving data accuracy by removing star catalog biases



Nucleus of Comet Hartley 2 as Seen by the Deep Impact Spacecraft on 2010 Nov. 4

Deep Impact Spacecraft Collides with Nucleus of Comet Tempel 1 on July 4, 2005

Comet Tempel 1 Seen by Stardust-NExT Spacecraft on Feb. 14, 2011

Future Near-Earth Object Program Office Activities

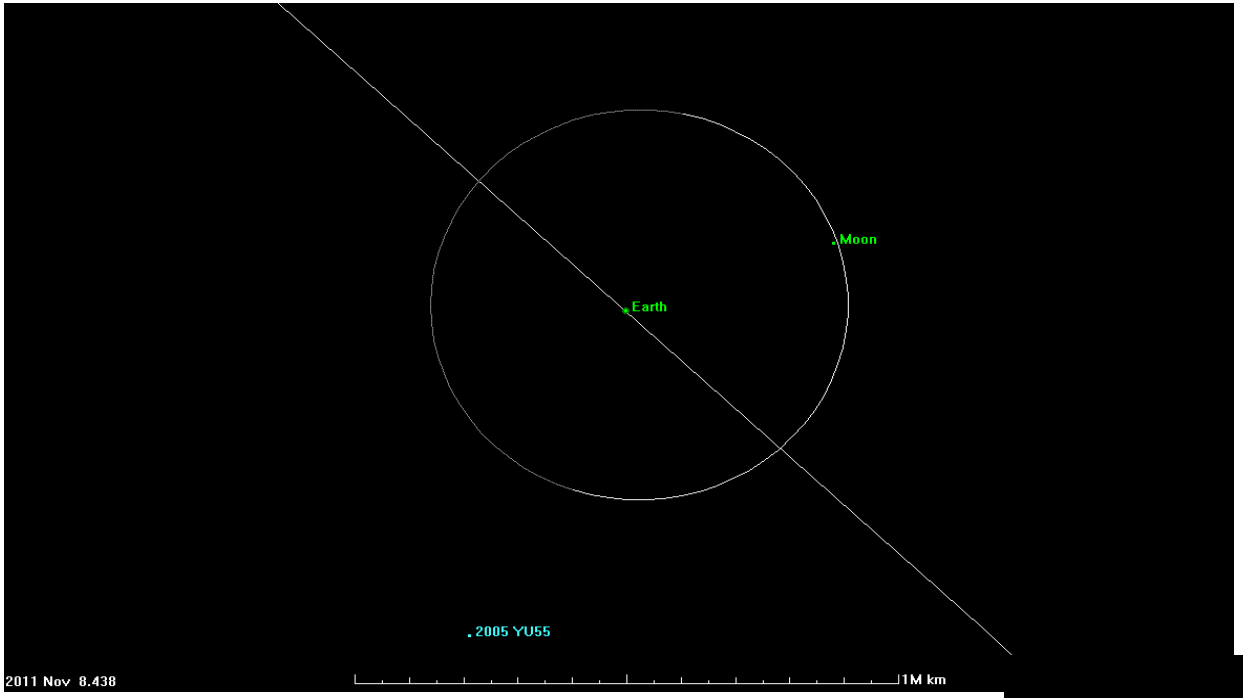
- Improve existing processes.
- Provide precise NEO orbits for 100 yrs.
- Identify close Earth approaches and compute Earth impact probabilities.
- Improve modeling of asteroid and comet motions.
- Additions and improvements to relational database of orbits & NEO characteristics.
- Correct star catalogs & update orbits.
- Study viable mitigation options.

- Inform NASA HQ, public and media of significant events.

http://neo.jpl.nasa.gov

http://www.jpl.nasa.gov/asteroidwatch

2005 YU55 to Approach Earth Nov. 8, 2011



C-type asteroid
Diameter ~400 m

Earth & moon close approaches

Extensive radar, visual and infrared observations are being planned.