

Near-Earth Asteroids and the Arecibo Observatory Radar

The Arecibo Observatory radar is the world's most powerful instrument for post-discovery characterization and orbital refinement of near-Earth asteroids.

Arecibo radar observations are critical for identifying asteroids that might be on collision course with Earth and, if necessary, preventing a collision.

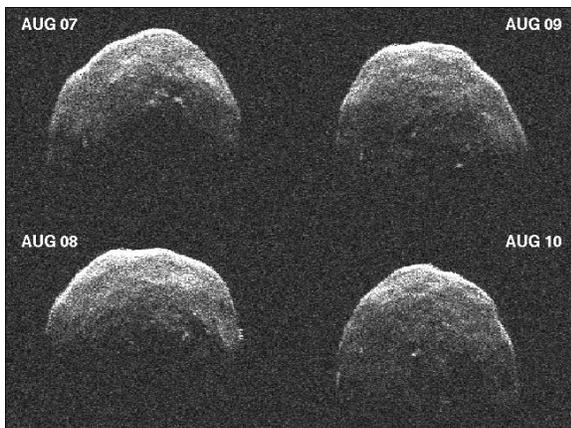


Near-Earth asteroids (NEAs) are critically important:

- They are derived mostly from the main asteroid belt but may include some extinct comet nuclei, and some might be the parent bodies of meteorites.
- They hold clues to the origin and evolution of the solar system.
- Their collisions with Earth brought much of the water and organics to the early Earth, allowing life to form, and since then have influenced the evolution of life.
- They include the most accessible objects for robotic or manned space missions – much easier targets than Mars or even the Moon.
- They could provide valuable raw materials for future interplanetary exploration
- They represent a low-probability but potentially very high-consequence natural hazard - one that we can prevent if given sufficient warning.

Radar can provide detailed physical characterizations of NEAs:

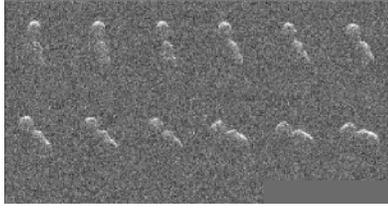
- If a small body is on course for an Earth collision in this century, Arecibo radar measurements could show this, and would dramatically reduce the difficulty and cost of any mitigation effort by defining the object's size, shape, mass, spin state, and orbit, and by revealing if it is one body or a two-body system.
- Radar investigations of many NEAs are roughly equivalent, in their science content, to space flyby missions, but have a much lower cost (five orders of magnitude).



Arecibo radar images of the 2-km diameter asteroid 1992 UY4 show surface features as small as 7.5 m.



Radar can detect binary objects, such as this Arecibo image of asteroid 1999 KW4's 1.5-km primary component and its orbiting moon.



A sequence of Arecibo images showing the rotation of the double-lobed asteroid 11066 Sigurd.

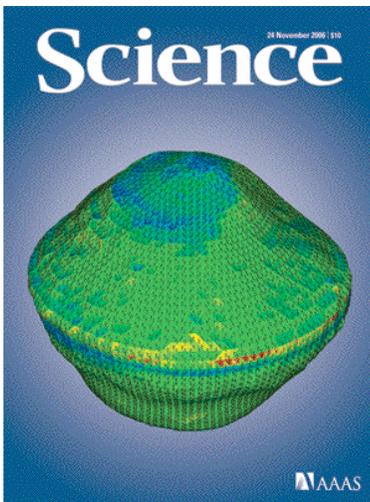


An Arecibo image of the 7-km asteroid 1999 JM8 taken with 15-m range resolution

Radar is invaluable in determining the orbits of potentially hazardous NEAs.

- Range-Doppler radar measurements complement optical observations by providing line-of-sight positional astrometry with precision as fine as 10 m in range and 1 mm/s in velocity, with a fractional precision 100 to 1000 times finer than that of typical optical measurements.
- Radar data increase the average interval of predictability (relative to optical-only orbit solutions) by up to 370 years and can provide warnings of impact during the initial discovery period, whereas two widely separated observations are needed for optical-only orbits.
- Radar data can quickly eliminate collision false alarms caused by optical-only data.

These unique capabilities of radar are critically important as we work towards the 2005 Congressional mandate of detecting and characterizing 90% of NEAs down to 140 m in size.



A model of the primary component of asteroid 1999 KW4, derived from radar data.

Funding for the Arecibo radar program is currently at risk, raising the possibility that we will lose a unique and valuable resource for tracking and characterizing NEAs.

- The National Science Foundation’s Senior Review report from Nov. 2006 recommended reducing Arecibo’s funding from the NSF Division of Astronomical Sciences by 25% initially and then by a further 50% in FY2011. If additional support cannot be found by early 2009 then the report recommended closure of the observatory.
- The reduced budget does not contain sufficient funds for the operation of the radar. Additional funding (~\$1 mil per year) is needed to maintain the radar system, which is currently funded only through FY08.
- There are no current plans to build a new facility capable of achieving the sensitivity and resolution of the Arecibo radar, so its loss would represent a long-term reduction in our ability to determine which NEAs might impact Earth.
- The Division for Planetary Sciences of the American Astronomical Society has issued a statement in support of the Arecibo radar system, with particular emphasis on its value for Near Earth Asteroid studies.