ARECIBO AND GOLDSTONE RADAR CHARACTERIZATION OF NEO MISSION TARGETS

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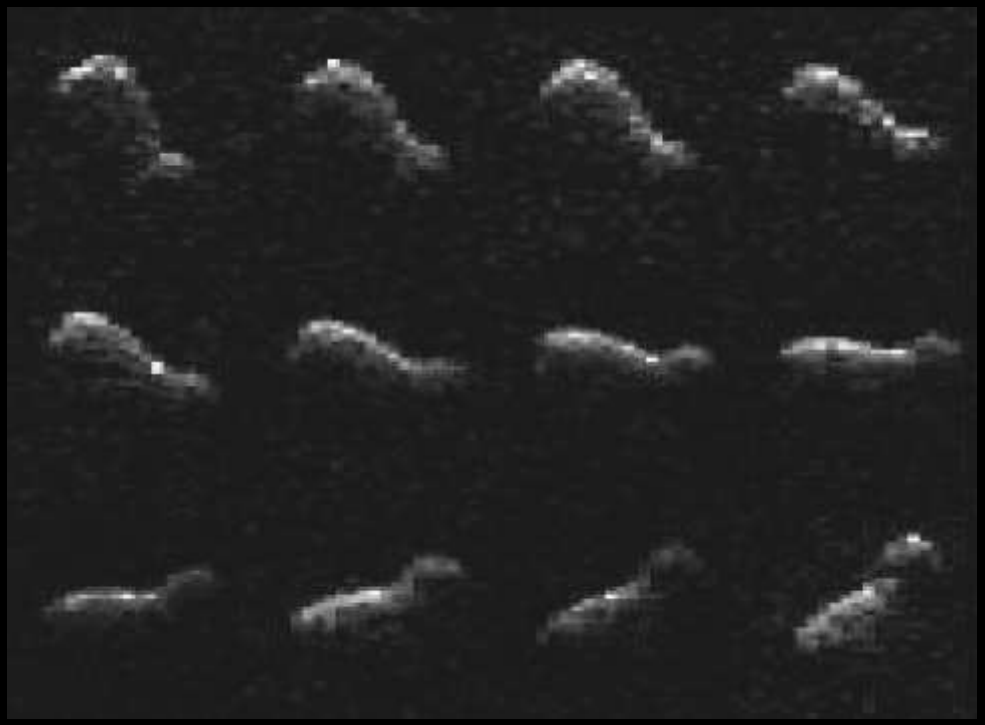
http://echo.jpl.nasa.gov/



Goldstone Radar Images of 25143 Itokawa

Why Use Radar?

Radar is a very powerful astronomical technique for characterizing near-Earth objects and for refining their orbits

What Can Radar Do?

Spatially resolve objects with 4-meter resolution: Greatly exceeds any ground-based or space-based optical telescope (even HST);
3-D shapes, sizes, surface features, spin states, surface roughness and density, regolith,
gravitational environments

Identify binary and ternary objects: orbital parameters, masses and bulk densities, orbit dynamics

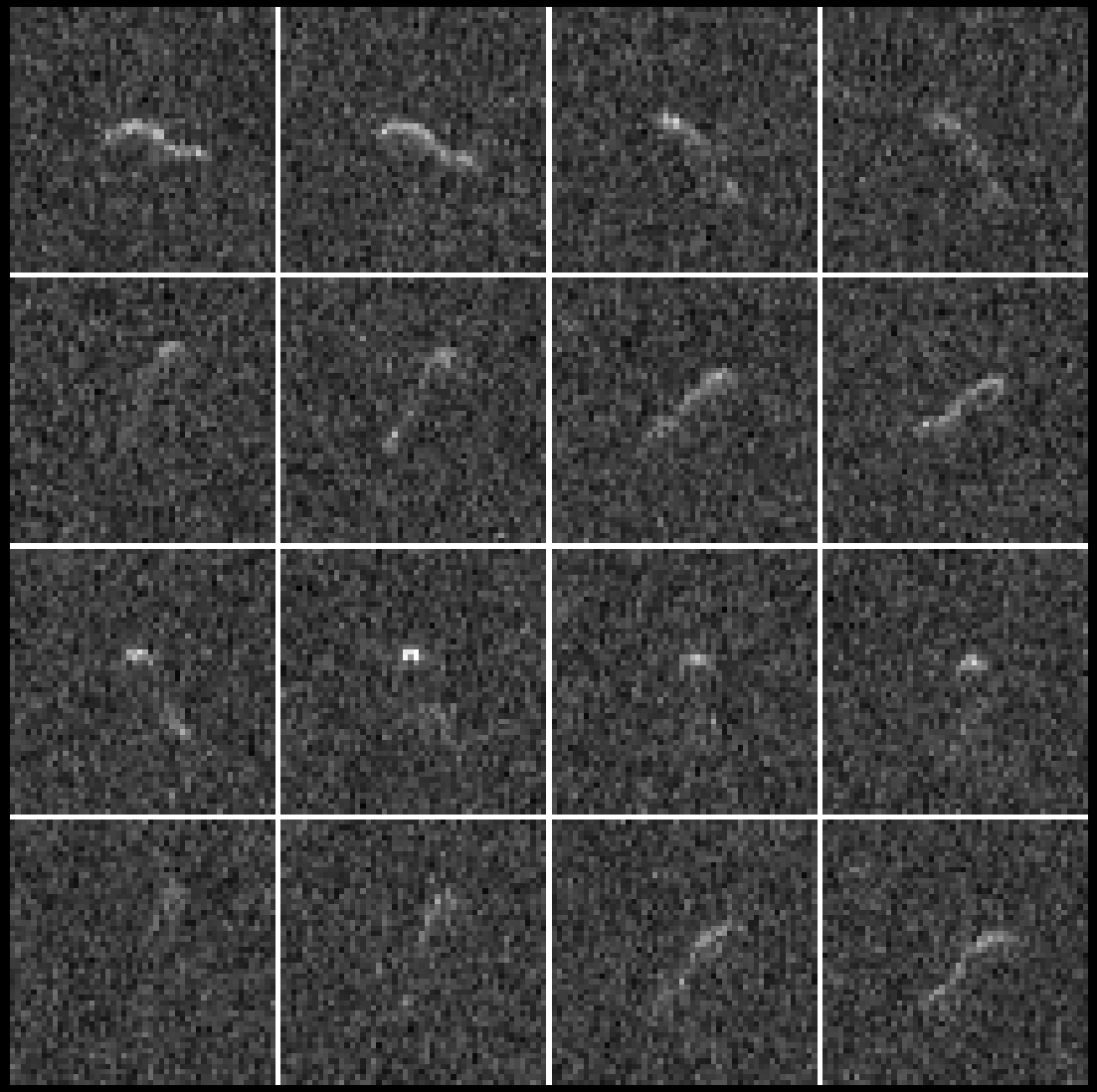
Improve orbits: Very accurate and precise. Shrink uncertainties drastically for newly-discovered NEOs. Predict motion for decades to centuries. Observations of previously-known NEOs can reduce uncertainties by several tens of percent.

Asteroid and Comet Missions Supported by Radar Observations

NEAR	433 Eros, 253 Mathilde
Hayabusa	25143 Itokawa, 4660 Nereus
Deep Impact	Comet Hartley 2
Clementine	1620 Geographos
Dawn	4 Vesta, 1 Ceres
Rosetta	21 Lutetia
Proposed Missions:	*OSIRIS-REx*, *BASiX*, *Deep Interior, Marco Polo*

EPOXI Mission Target: Comet Hartley 2

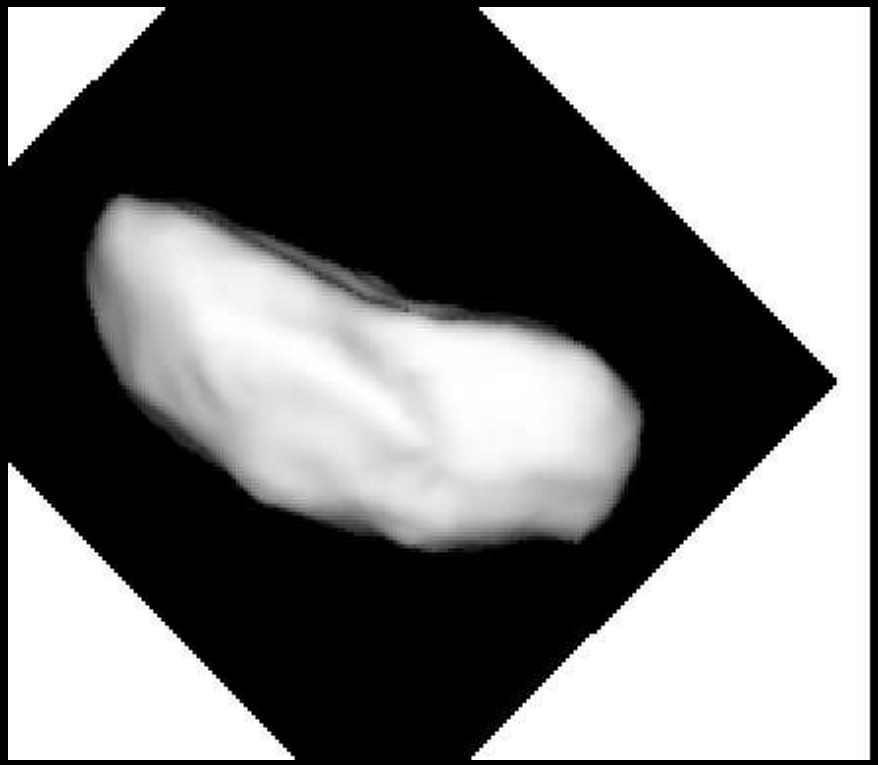
Arecibo Image



Harmon et al.

Epoxi image

Comparison with Hayabusa Spacecraft Images: 25143 Itokawa



Radar model image from inferior data

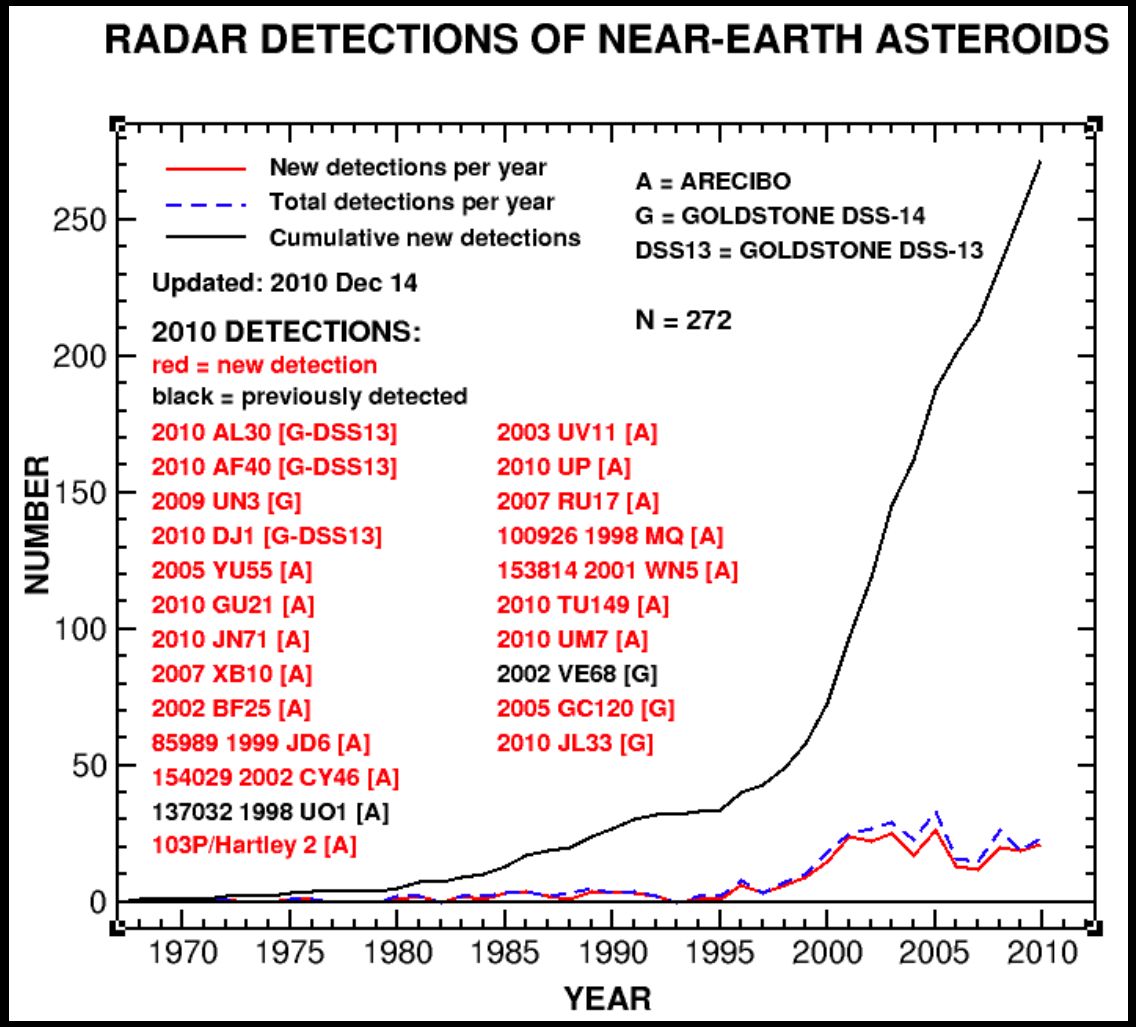
Hayabusa approach

Goldstone
70 m

Arecibo: 305 m

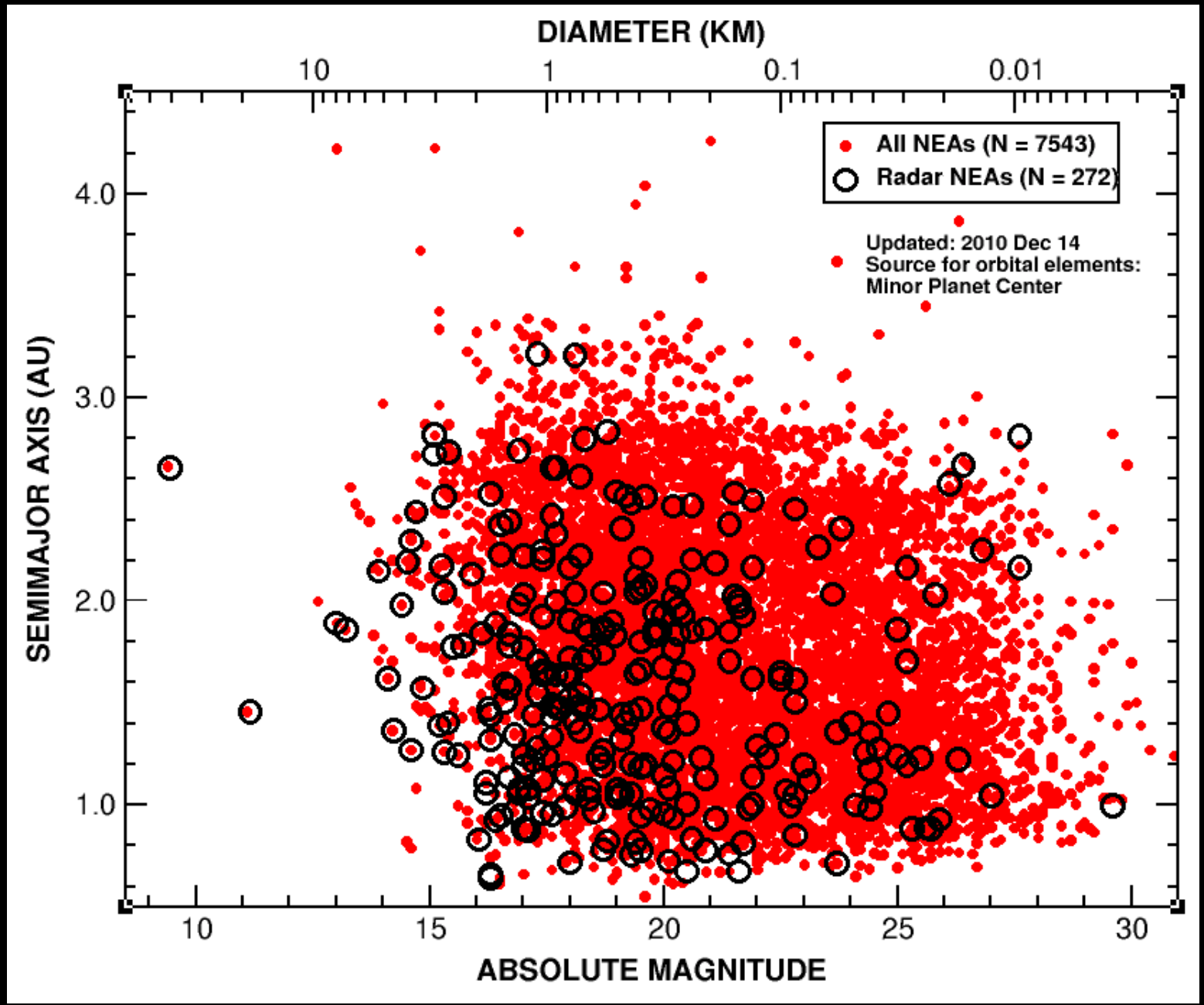
Capabilities are complementary

NEA Radar Detection History



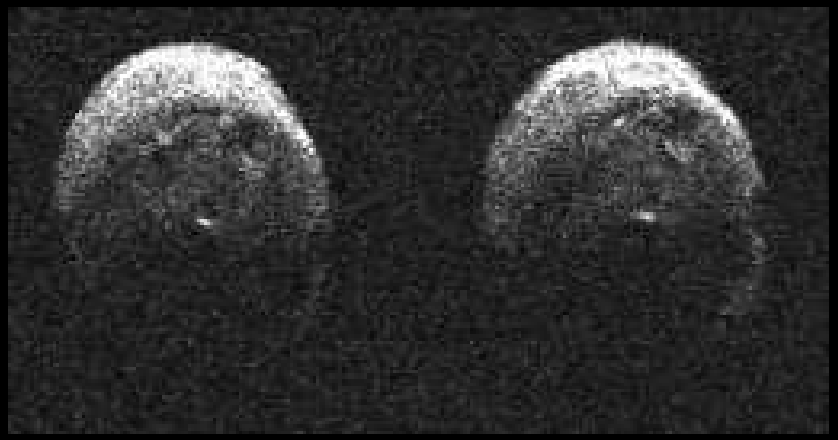
20-30 detections per year:
only ~5% of what could be done

Near-Earth Asteroids Observed by Radar

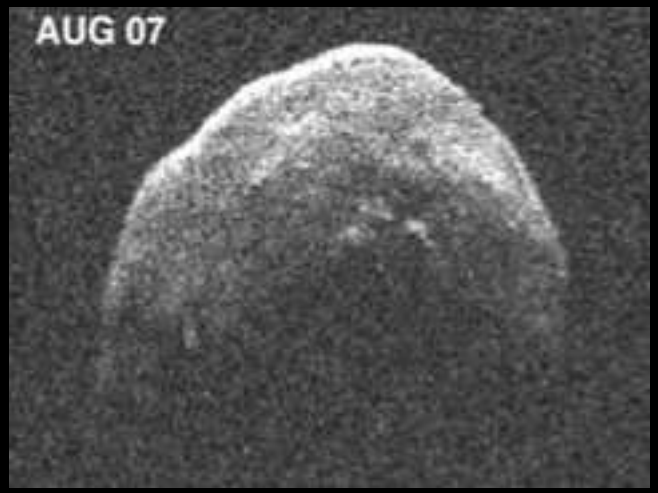


Sizes, Shapes, and Surface Features

1999 JM8



1998 CS1



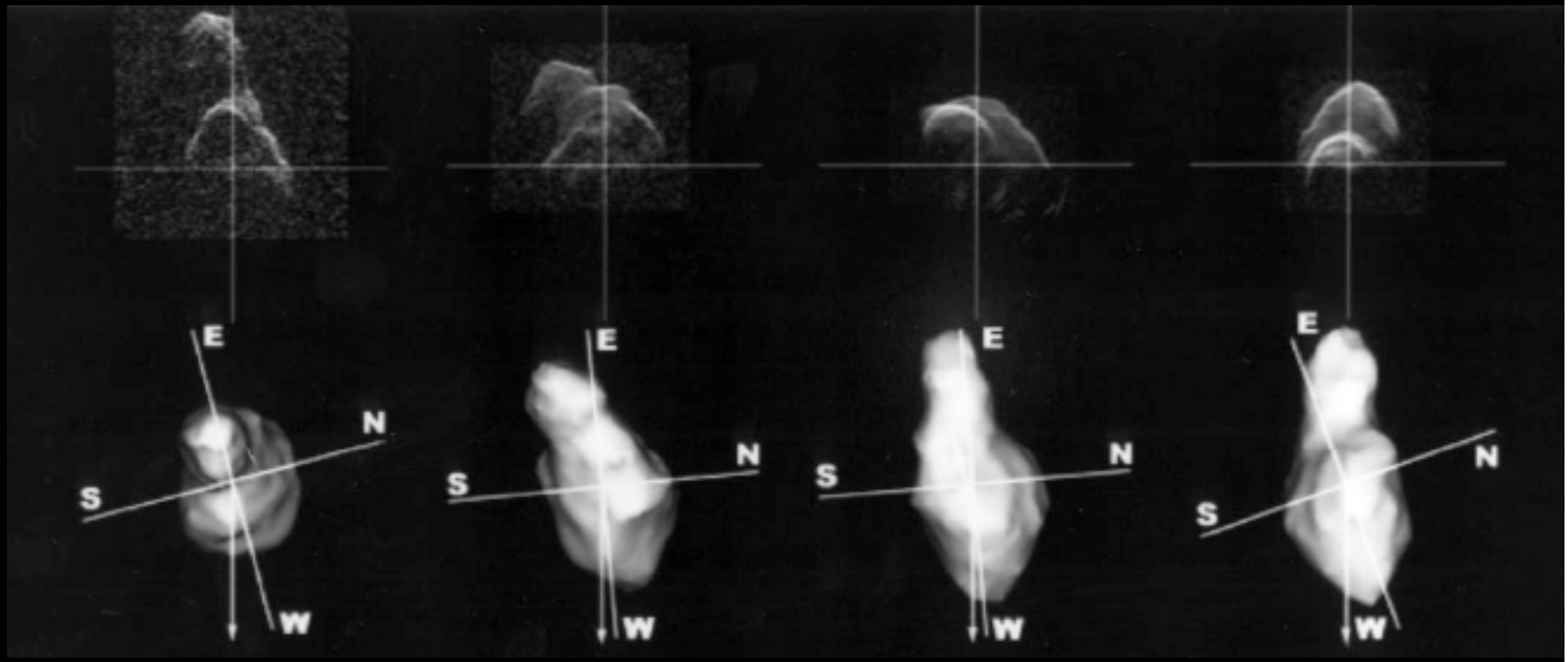
1992 UY4

2006 VV2

3-D Shapes and Non-Principal Axis Rotation: 4179 Toutatis

Data

odel

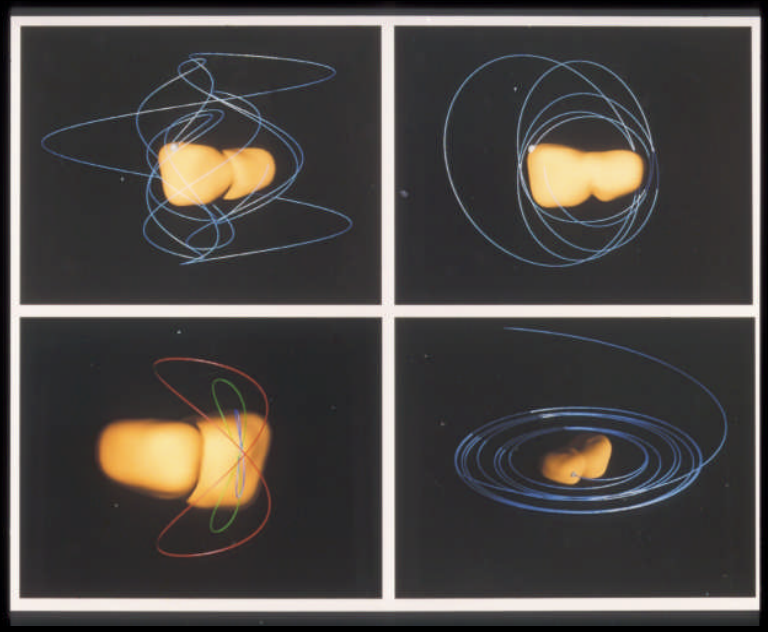


~32 shape models are available;
Several are under development

Hudson and Ostro 1995; Ostro et al. 1995, 1999

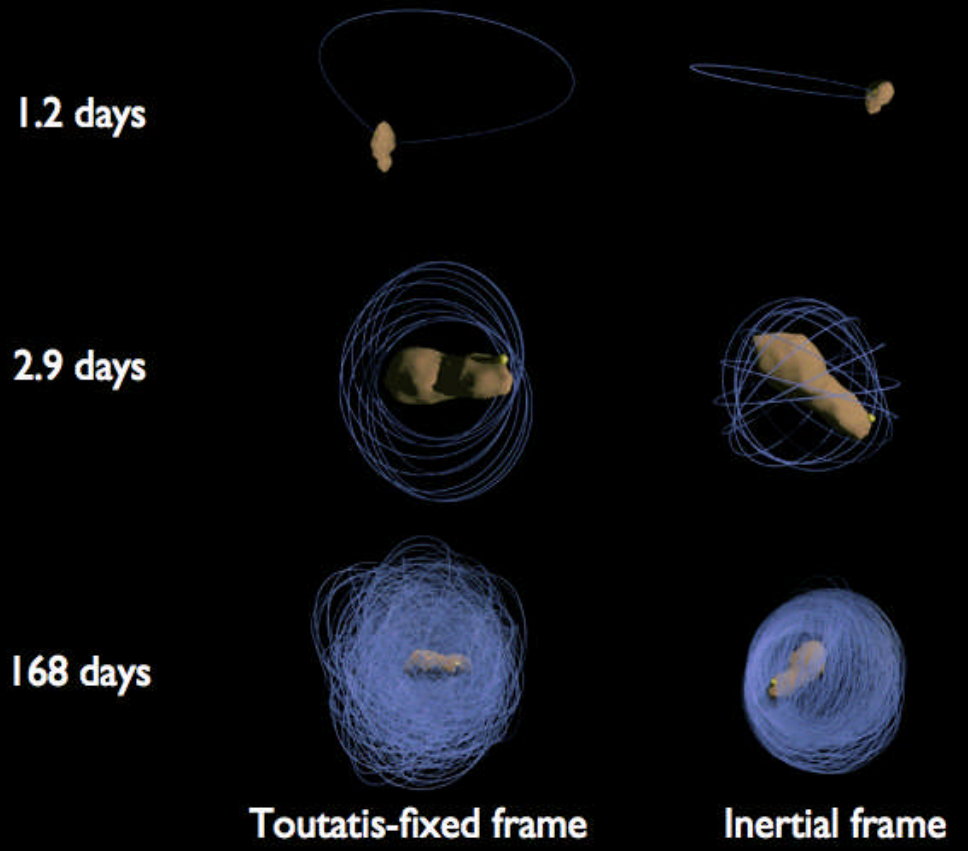
Close Orbits Using Shape Models

Castalia



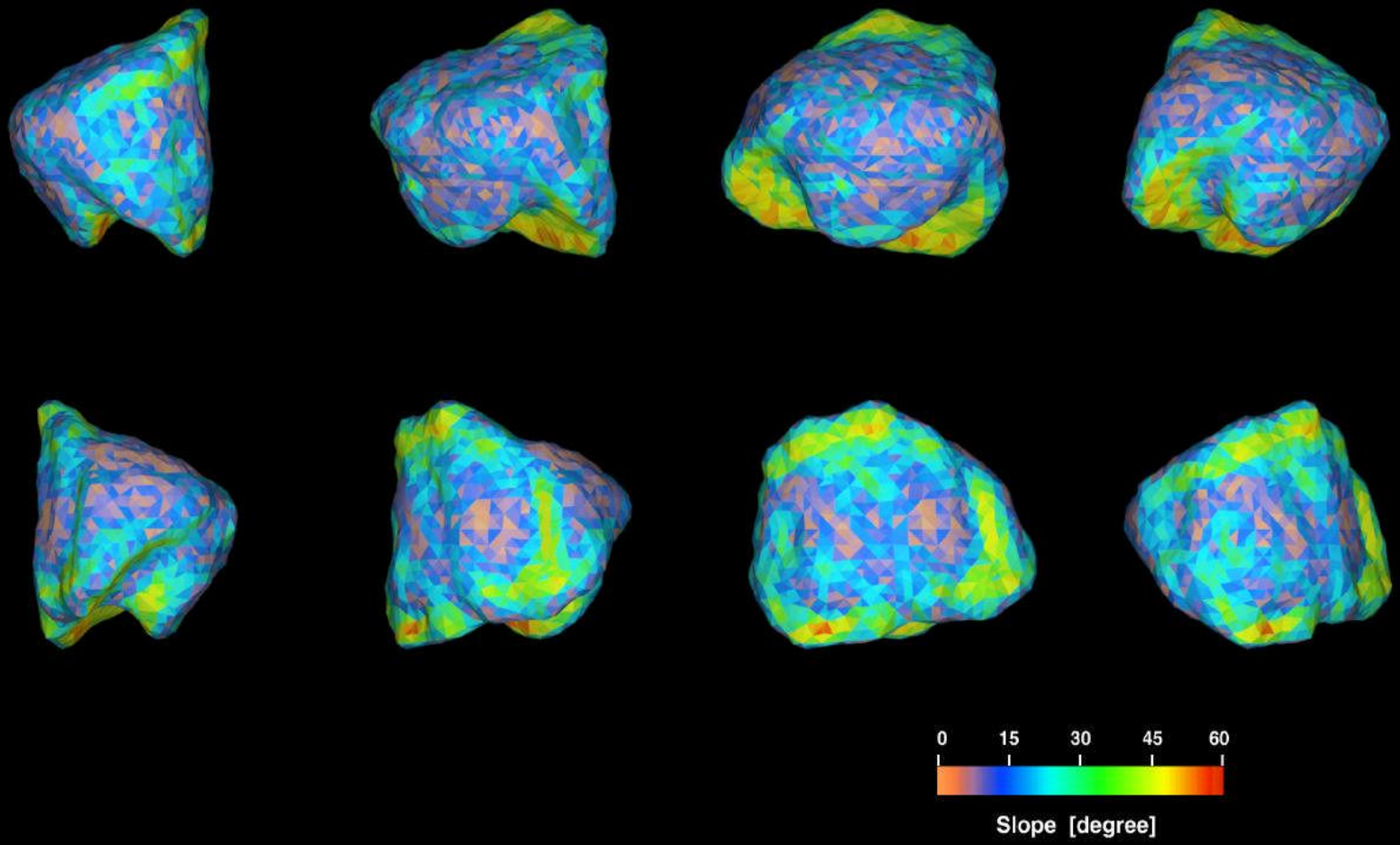
Scheeres et al. (1996)

Toutatis Return Orbits



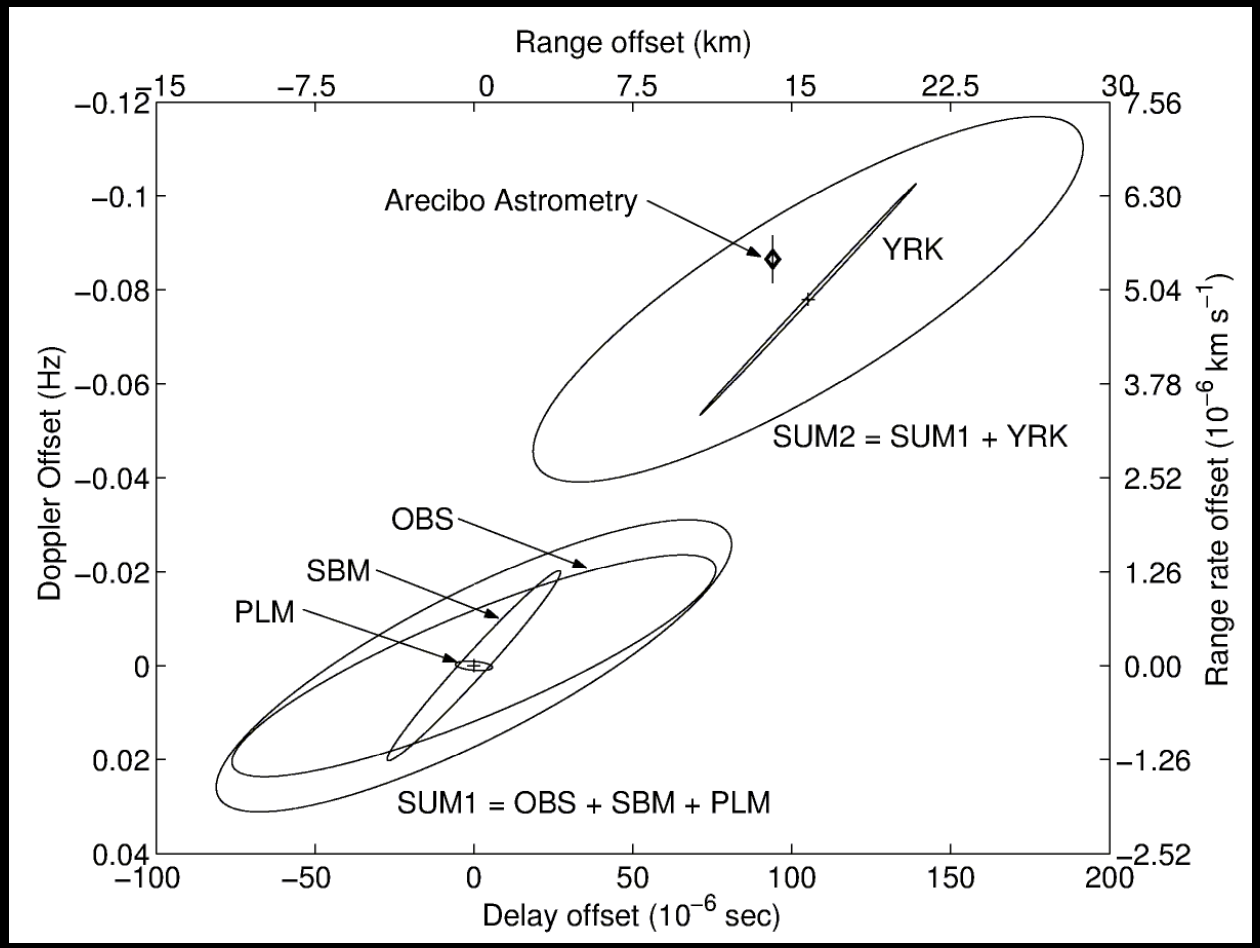
Scheeres et al. (1998), *Icarus* **132**, 53-79.

Gravitational Slopes: 6489 Golevka



Hudson et al. 2000

Detection of the Yarkovsky Effect by Radar Ranging: Estimate the Mass and Density of Golevka

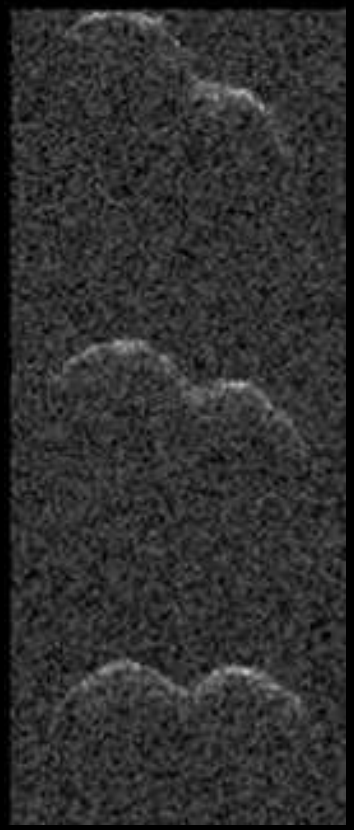


Chesley et al., *Science* **302** (2003).

Contact Binaries, Binaries, and Triples

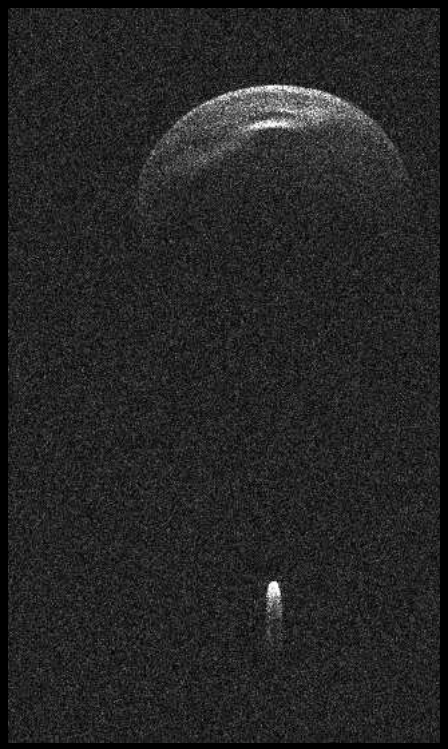
~25% of NEA population

Contact Binary



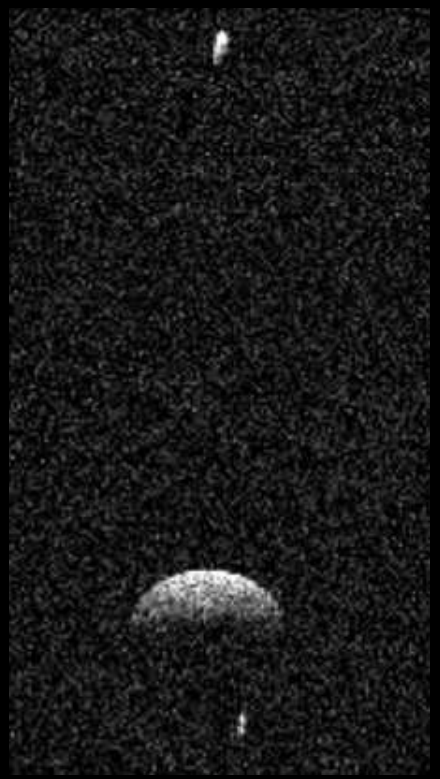
2005 CR37

Binary



1999 KW4

Triple

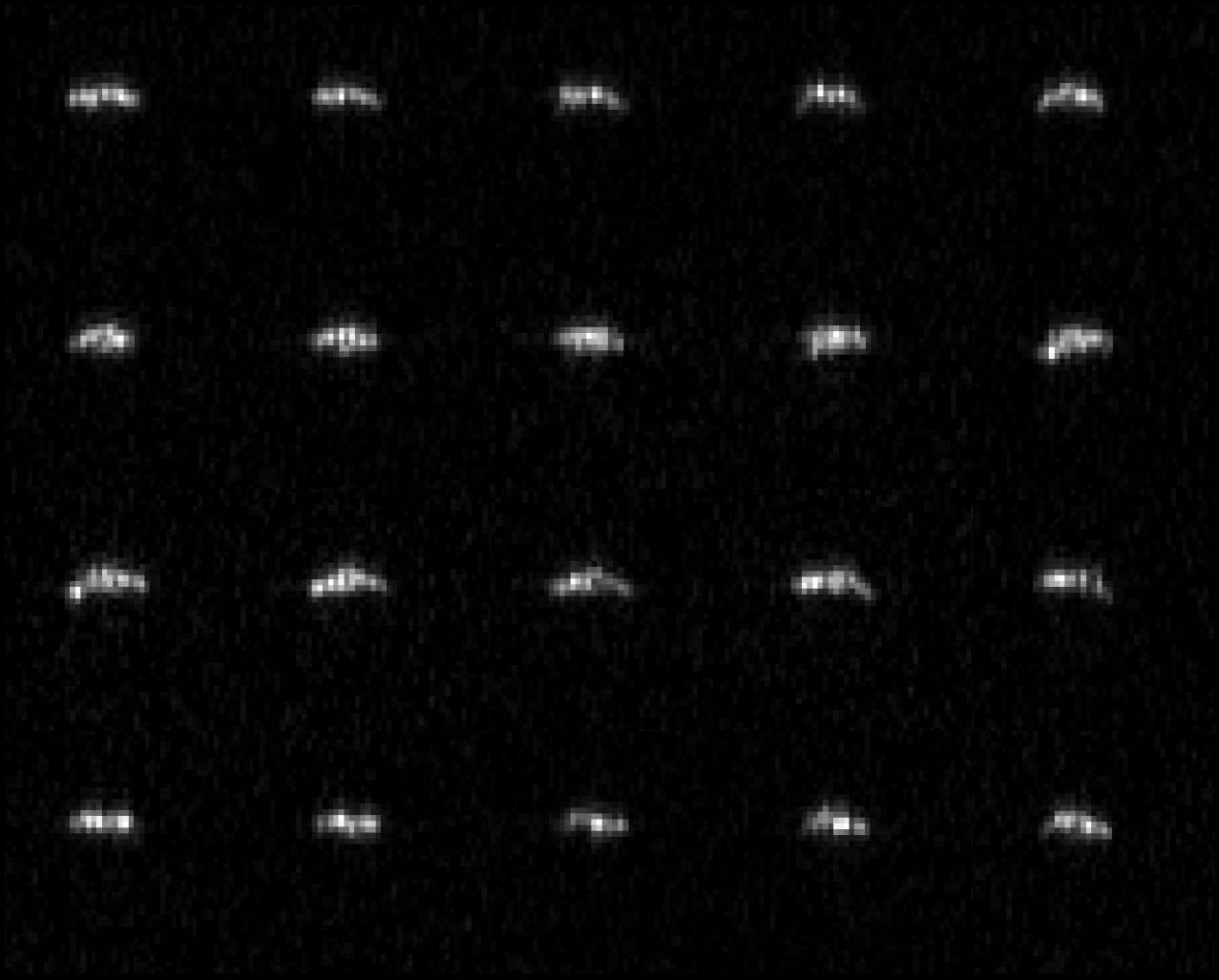


2001 SN263

Binaries and Triples Provide Masses and Densities

New Goldstone Hi-Resolution Imaging: 3.75 meters

2010 AL30: only ~30 m in diameter



Five-fold improvement in resolution!

Upcoming Asteroid Radar Targets

Mar	1999 TK12	May	2002 JB9	Nov	2005 YU55
Mar	2009 FY4	May	2009 BD	Nov	1996 FG3
Mar	2005 EY169	Jun	2002 JC	Nov	1994 CK1
Mar	2000 PN9	Jun	1973 NA	Nov	2000 WN10
Mar	2011 CY46	Jun	1998 KM3	Dec	2003 WM7
Mar	2005 ES70	Jun	1998 FH12	Dec	Heracles
Mar	Amun	Jun	2004 QY2	Dec	2003 AK18
Mar	Summanus	Jul	2003 YS117	Dec	2000 YA
Apr	2008 EY5	Jul	Eger	Dec	2000 VN2
Apr	2004 XN50	Aug	Comet HMP	Jan	1991 VK
Apr	1997 US9	Sep	2008 EK1	Jan	2001 YE4
Apr	2003 FF5	Sep	1999 RQ36	Jan	Eros
Apr	2001 AD2	Sep	2000 SP43	Jan	2009 KD5
Apr	2004 QT24	Sep	2003 QC10		
Apr	2008 FU6	Oct	1998 SC15		
May	2002 DB4	Oct	Ganymed		
May	2003 YT1	Oct	2002 AG29		
May	2007 TB23	Oct	2000 OJ8		
May	2003 AL73	Oct	2003 FH		
May	2002 CQ11	Oct	2004 JO2		

THREE-FOLD INCREASE IN OBSERVATION RATE!

More Information:

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Asteroid Radar Research Website:

http://echo.jpl.nasa.gov/