



UCLA



Recent Small Asteroid and Boulder Radar Observations

*Michael Busch,
for the Asteroid Radar Team*

Review of Radar Astronomy



Goldstone 70-m



Arecibo 305-m



Goldstone 34-m antenna

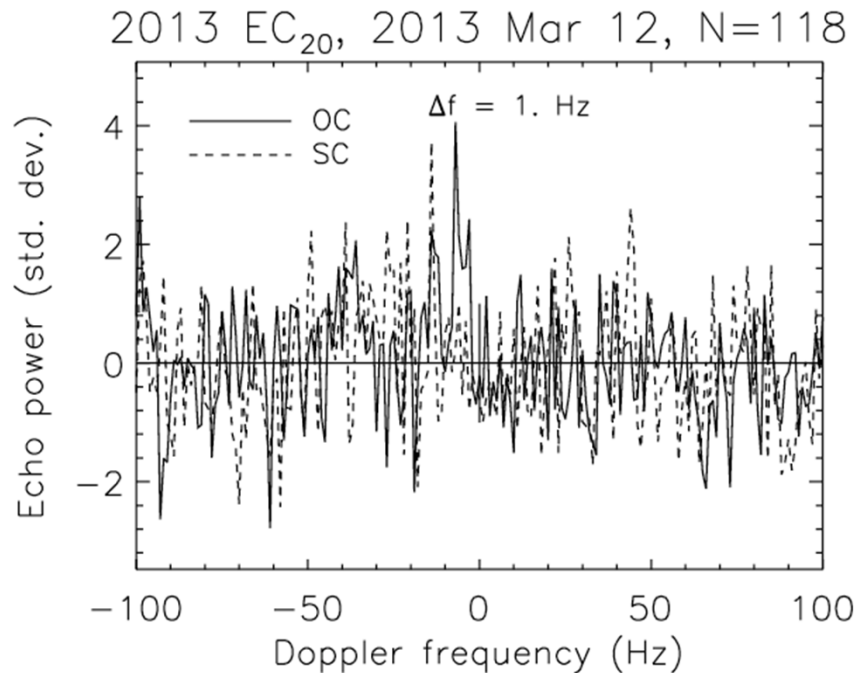


Klystron Tube; astronomer for scale

Small Objects

- ◎ Range resolution:
 - 7.5 m Arecibo.
 - 3.75 m Goldstone, upgrade to < 2 m pending.
- ◎ Can get equatorial dimensions to $< \pm 2$ m given spin period, pole constraint.
- ◎ Best results with several observations from multiple directions; requires rapid scheduling.
- ◎ Speckle tracking helpful only for strongest targets.

Small Objects



2013 EC20

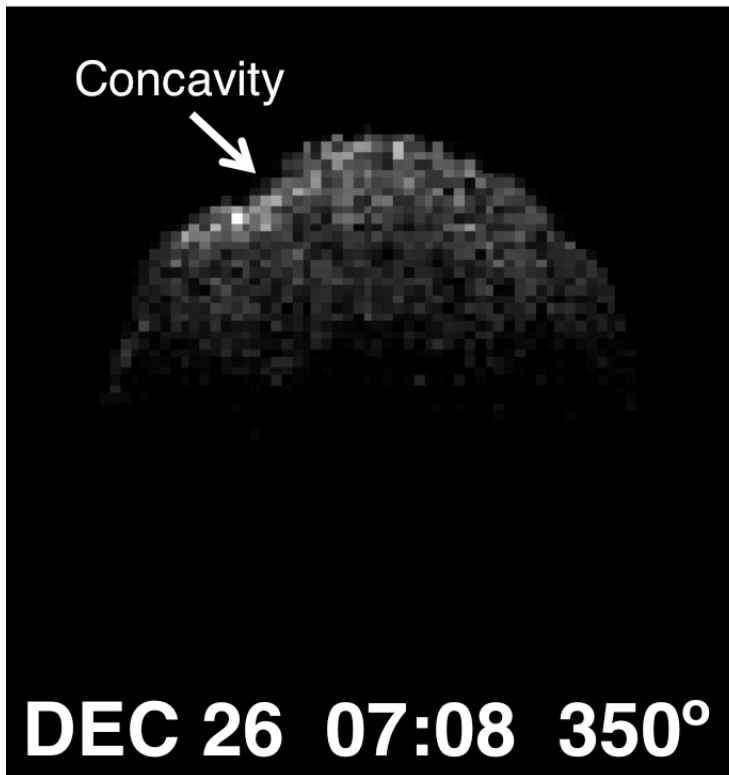
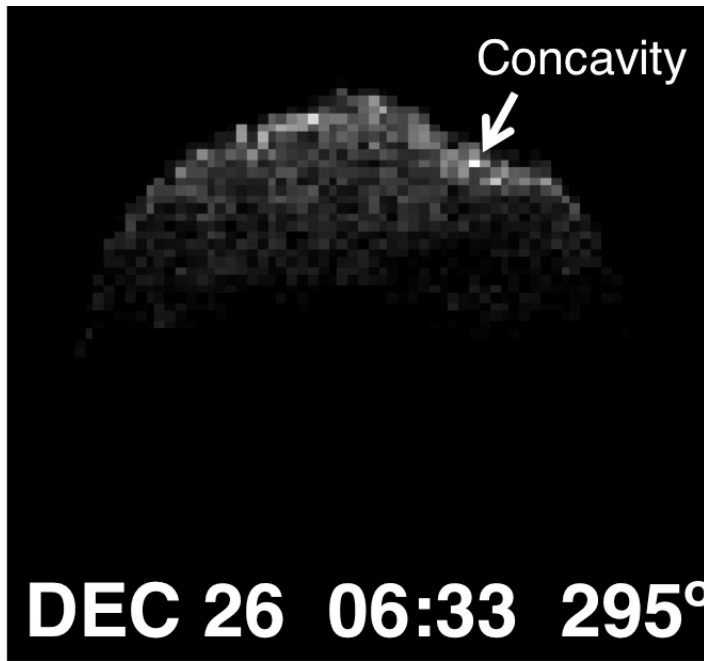
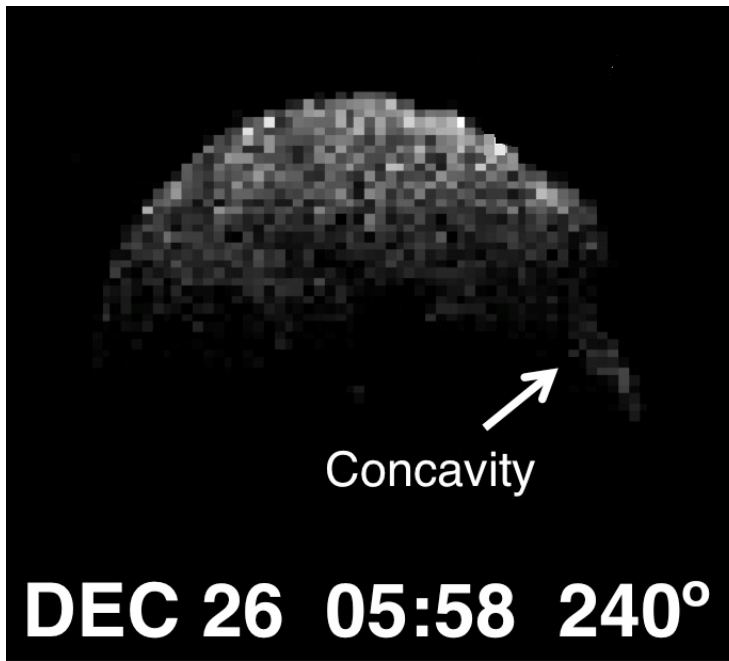
- Discovered 2013 March, observed with Arecibo while outbound.
- *2-3 m diameter, 10-30 ton mass.*
- High-albedo silicates.
- Too small to be worth retrieval?

2014 FO38

- Observed last week with Arecibo.
- Spin period ~ 5.4 min.
- $d = 10\text{-}15$ m, based on 1 day of observations.
- *Not a retrieval target.*

Boulders

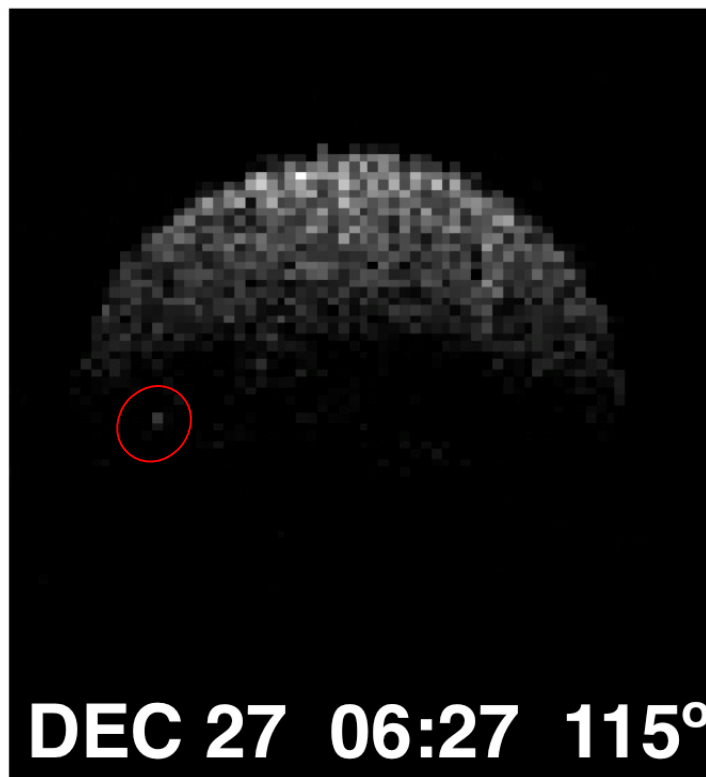
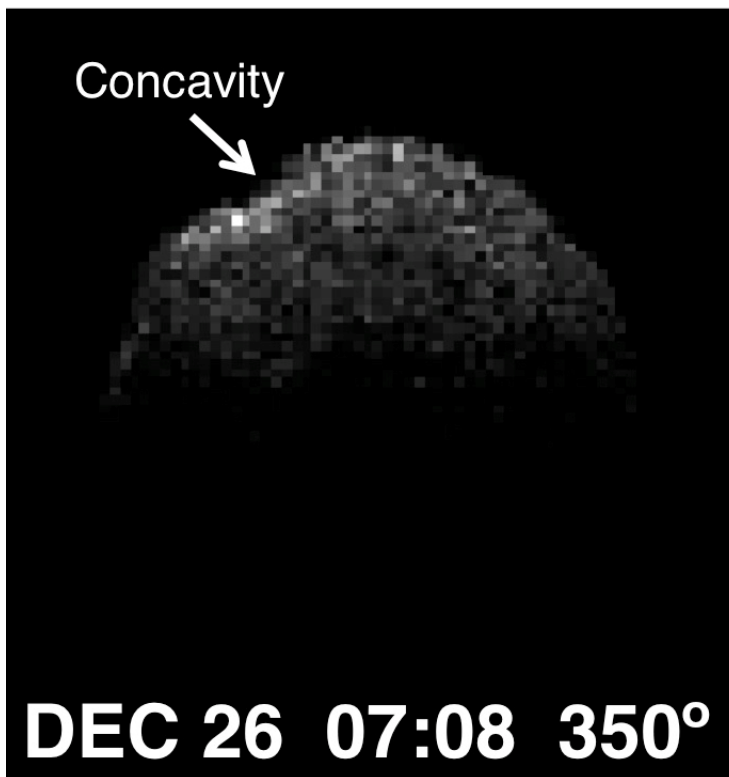
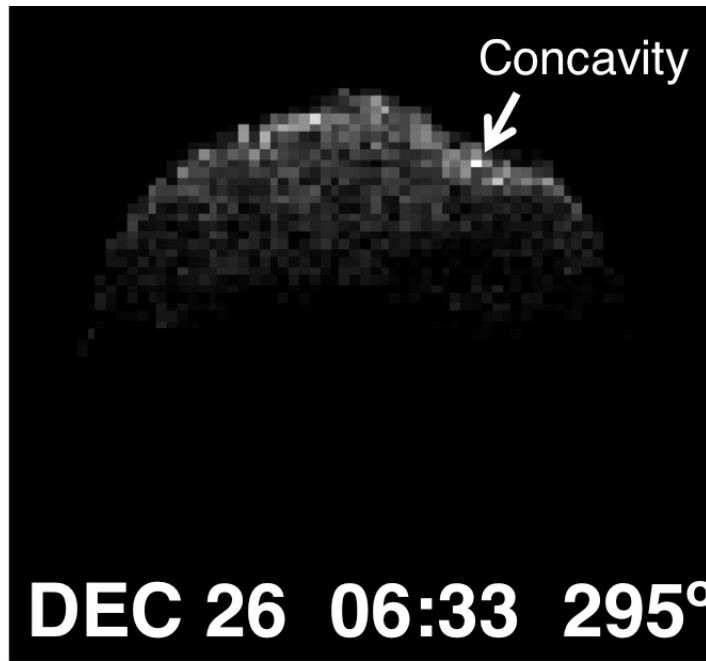
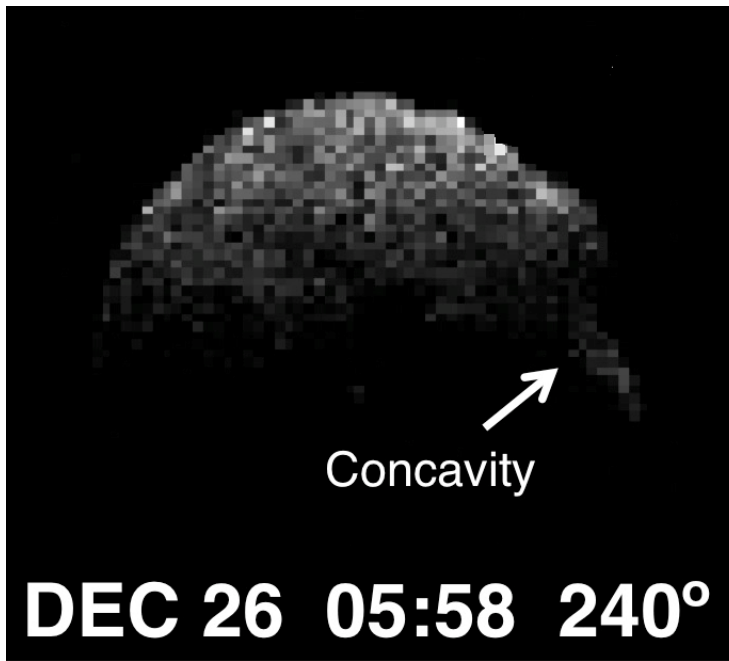
- Seen on ~10 asteroids observed with radar; on all visited with spacecraft.
- More visible in higher-resolution and higher-SNR images.
- Not identified on objects <80 m in diameter (may still be present).



2008 EV5

*Arecibo images;
2008 December.
Resolution 7.5 m in
range; the asteroid
is ~400 m in
diameter.*

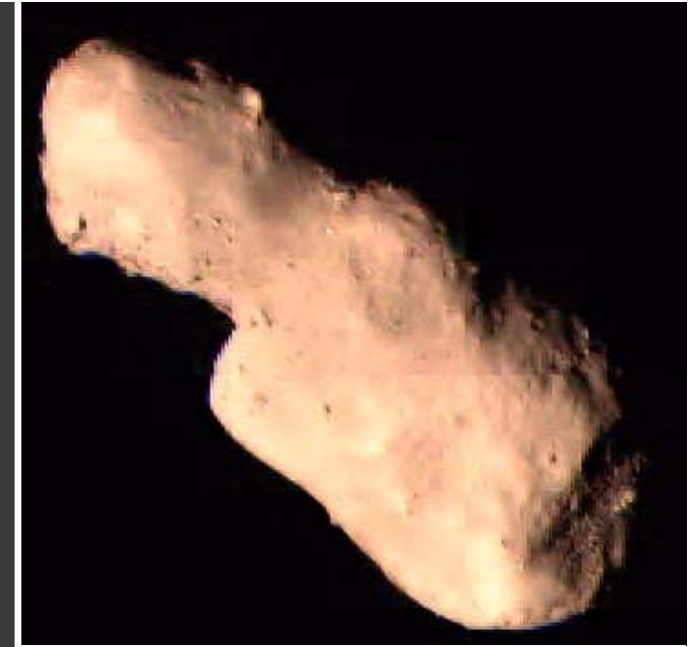
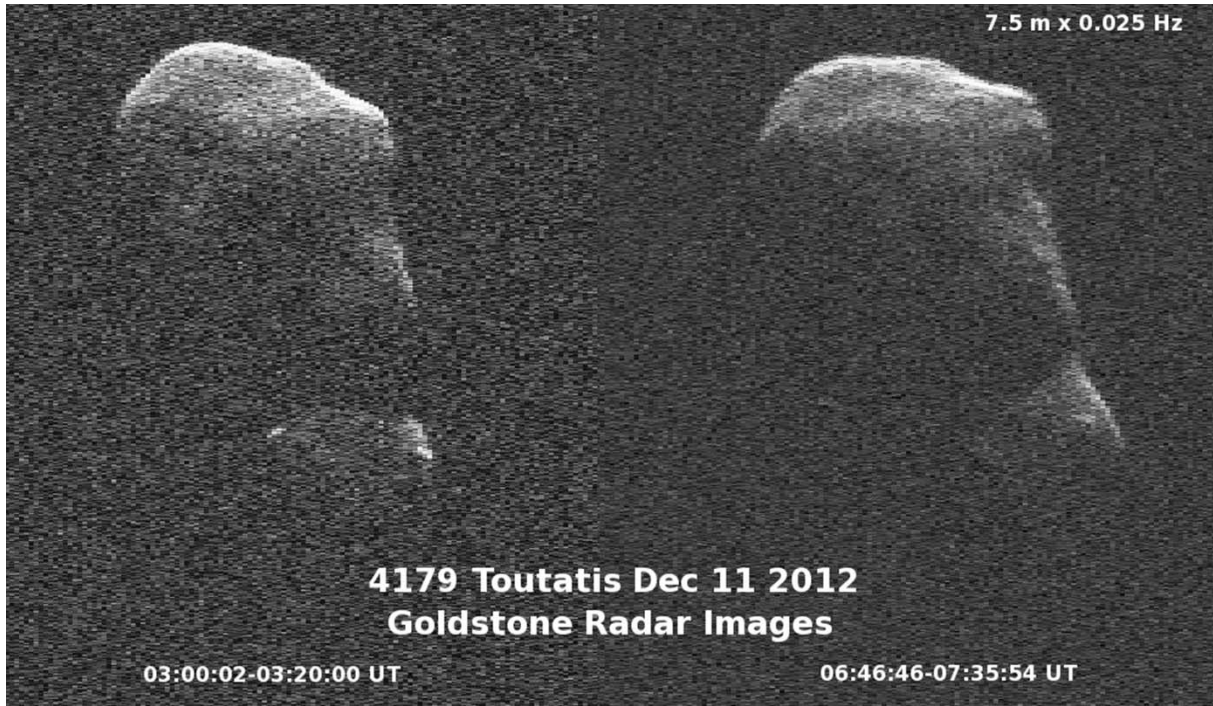
*Note the bright
pixels visible on the
limb, particularly on
December 27.*



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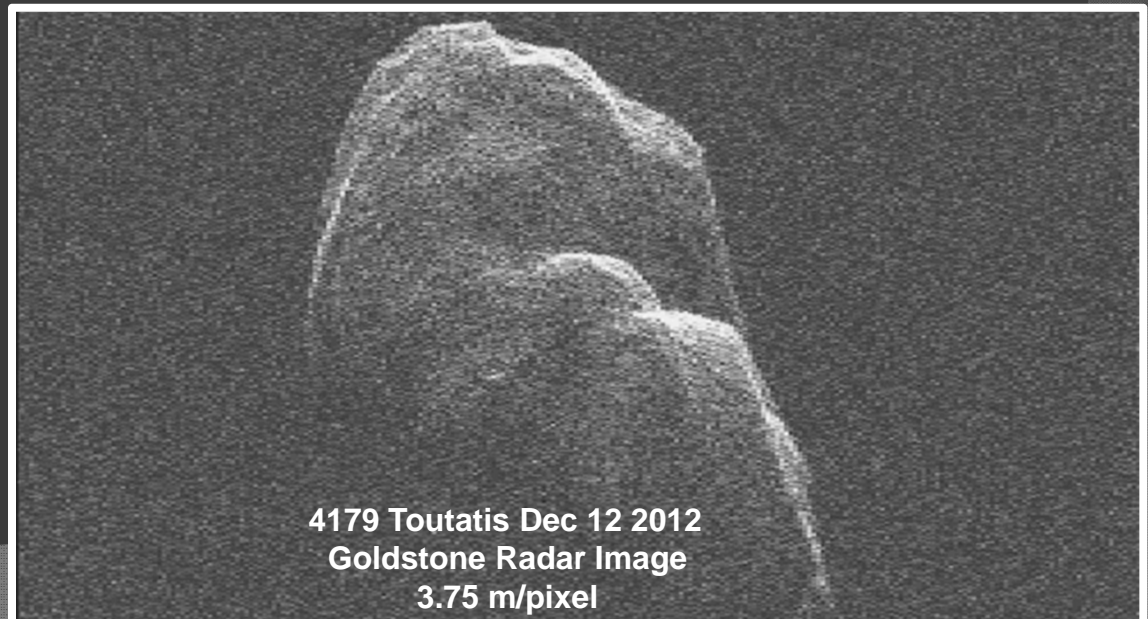


*Image from Chang'e 2
(Huang et al.)*

Toutatis

Images from Goldstone.

*Asteroid is 4.5 km long.
Some boulders visible here
also show up in Chang'e 2
pictures.*



A Thought On Cohesion

- ⦿ Objects appear to be gravity-dominated above ~200 m diameter. On 200 m object, $g \sim 0.03 \text{ mm/s}^2$. Gravitational force on blocks on surface: $\sim 0.03 \text{ N / ton}$.
- ⦿ Spin rates of some ~30 m objects are $\sim 300 \text{ s}$. $a \sim 5 \text{ mm/s}^2$. Cohesive force on the outside of such a pile: $\sim 5 \text{ N / ton}$. Larger objects fracture along weak zones.
- ⦿ Full shapes of blocks, actual cohesive forces, and fracture conditions unpredictable.

Picking up a block will require a lot more force than bagging one.