ASTEROID SHAPE RECONSTRUCTION FORM RADAR ECHO IMAGES

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Asteroids can be observed using many ground-based techniques, some of which allow for direct shape observations (e.g. stellar occultations, adaptive optics imaging). One interesting, information-rich technique is radar imaging. It provides insights about surface properties, sizes, pole orientations and shapes of asteroids [1]. Radar echo images can be used both for modeling asteroids and for testing results from other inversion methods.

Radar observation can be considered as an experiment as the observer controls the signal sent to the target body. Echo signal after bouncing of asteroid's surface returns to Earth shifted in frequency due to asteroid's rotation and distributed over time because of shape irregularities. It is possible to create 2D image of an asteroid by combining those two effects.

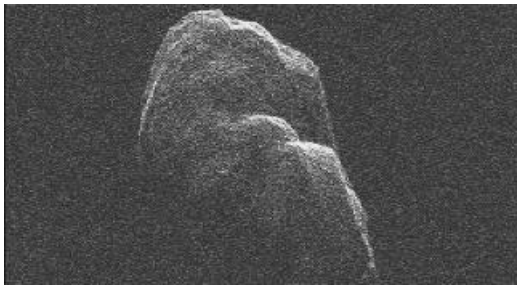
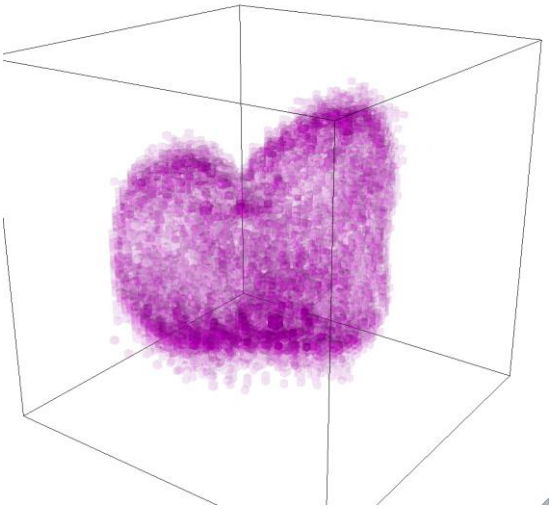


Figure 1. Example of reconstructed radar echo image of asteroid 4179 Toutais. Credit: JPL, NASA.

We propose a new method for asteroid shape reconstruction based on radar echo images. Given enough different geometries it is possible to disentangle 2D radar images into a 3D shape. The model is reconstructed in a form of three-dimensional probability density distribution. Then, surface detection algorithms are applied to arrive at the final model.

Figure 2. Example of probability density distribution of reconstructed model from radar images.



Surface uncertainty can be estimated based on the distribution of the reconstructed data.

We show results for numerical simulations and real radar observations.

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References:
[1] Ostro S. J. (2002) Asteroids III, 151