New Stereophotoclinometry (SPC) Shape Models for Irregularly Shaped Saturnian Satellites

Come see us at poster 536

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Saturn's irregularly shaped moons contain clues to the history of the Saturn system.

Cassini acquired moderate- to high-resolution images of many such satellites (Fig. 1). Analysis of these images could reveal, for example, similarities and differences between moons with similar orbits (e.g., Epimetheus & Janus) that could be clues to their origins, migration, or exogenic contamination [e.g., 1,2].

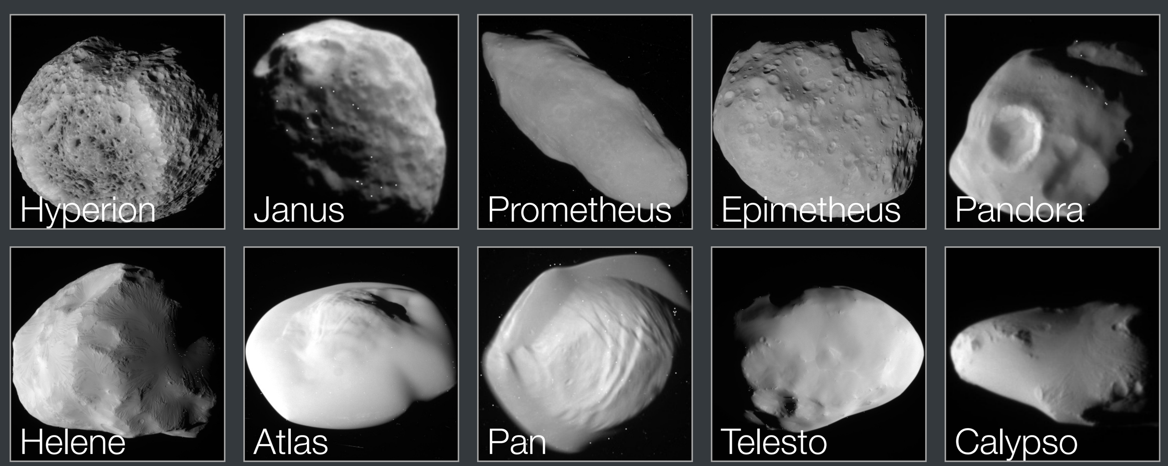

FIGURE 1. Cassini ISS images of irregularly shaped saturnian moons. Not to scale, but approximately listed by decreasing size (top to bottom, left to right. Hyperion's longest dimension is 360 km. Calypso's is 30 km.

However, visualizing data and mapping features on irregularly shaped bodies is difficult: 2D map projections distort spatial relationships and sizes. Yet, this information is critical for deciphering the histories of small bodies. Varied imaging conditions (image resolution, illumination, etc.) create additional challenges.

Accurate shape models help overcome these challenges.

Draping registered images onto accurate shape models reveals the spatial relationships key to geologic analysis. Interpretations of some small body datasets may be erroneous if not coupled to a good shape model (Fig. 2).

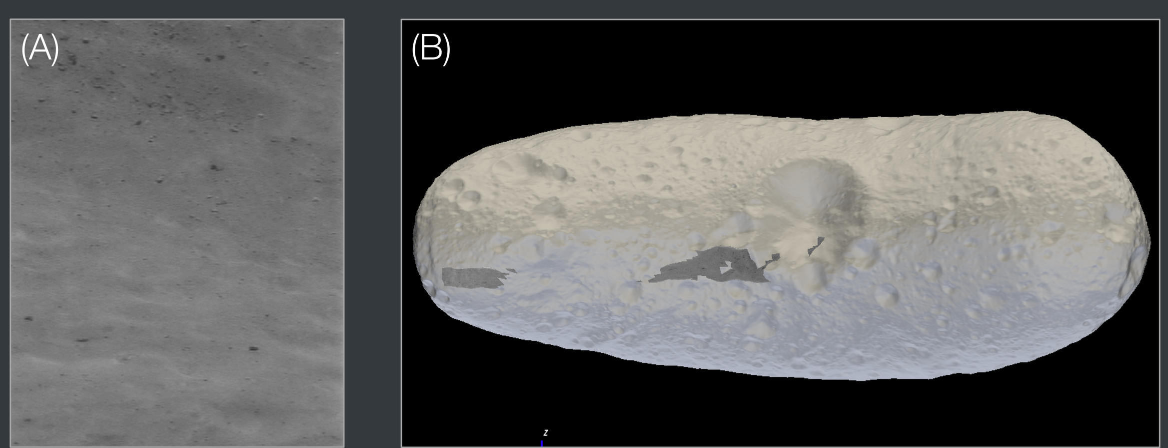

FIGURE 2. (A) Boulders and depression on Eros imaged by the NEAR multispectral imager. (B) Draping this image onto an Eros shape model reveals that image actually captures disparate parts of Eros' surface.

We are using stereophotoclinometry (SPC) to develop shape models for irregularly shaped saturnian moons.

SPC uses images obtained across a range of viewing geometries, combined with knowledge of the spacecraft's location and camera pointing, to generate a detailed shape model of the object of interest [e.g., 3].

We are using Cassini ISS images acquired from 2004 through the end of mission. Although coverage varies, many moons have near-global coverage for images in which the body is 20 pixels or more across the moon's smallest dimension (Fig. 3).

FIGURE 3. Simple cylindrical maps showing coverage of moon surfaces by images in which the moon is ≥20 pixels across. Many moons have near-global coverage, although some (e.g., Atlas, Calypso, Pan) have only regional coverage. Areas that appear brighter were covered by multiple imaging passes.

Our SPC workflow has four key steps.

1 Register all useful Cassini ISS images to a low-degree, limb-based shape model (Fig. 4).

FIGURE 4. Images of Pandora registered to a limb-based shape model. Thin white lines around each image show shape model extent. Once all useful images have been registered to this coarse shape, the moon is ready for step 2.

2 Tile the limb-based shape with 15° x 15° maplets (Fig. 5).

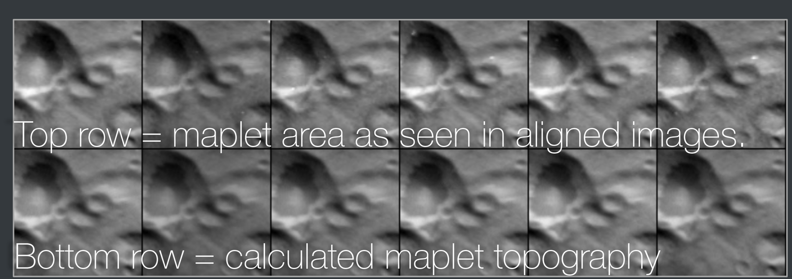

FIGURE 5. Excerpt of a maplet on Epimetheus. Each maplet is populated with images (e.g., top row) that cover the associated part of the shape model. Image positions are shifted to align landmarks (features) in the images. SPC then calculates maplet topography (e.g., bottom row).

3 Combine maplets & limbs to create an initial global shape model (Fig. 6); update camera position and pointing.

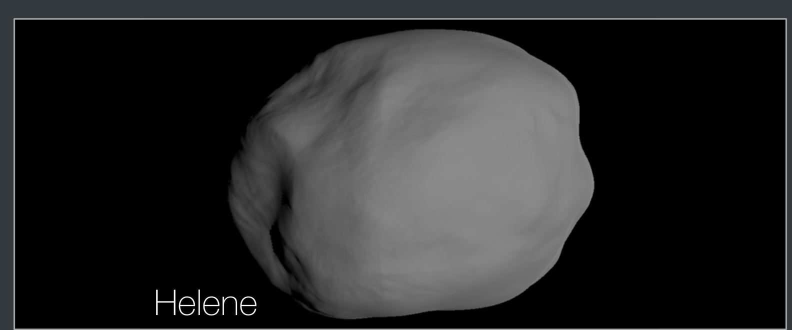

FIGURE 6. Preliminary, low-resolution global shape model for Helene (7.2-km-wide maplets, 120-m ground sample distance). The model will improve significantly as we add higher-resolution maplets. Helene should support maplets with a ground sample distance of ~15 m in areas covered by the highest resolution images.

4 Improve the shape (Fig. 7): Add higher-res. maplets, update camera pointing/position, and refine outliers.

The Small Body Mapping Tool (SBMT) will contain the new models & registered images.

The SBMT is a simple and easy way to search, access, and in 3D analyze shape models and spacecraft data for small bodies [4]. The public version of the SBMT contains shape models and co-registered spacecraft datasets for Ceres, Vesta, Eros, Itokawa, Phobos, Deimos, Mimas, Phoebe, and Tethys (Fig. 7).

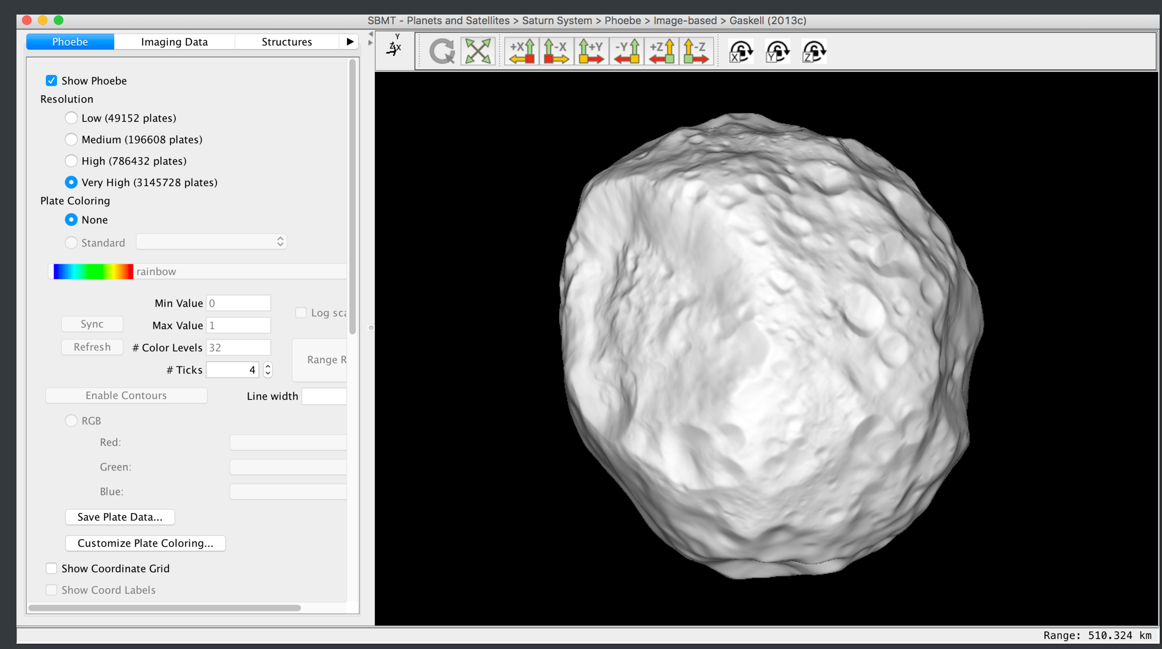

FIGURE 7. A step #4 shape model of Phoebe displayed in the SBMT. The SBMT has a control panel (left) and a rendering panel (at right). The control panel has various tabs for manipulating shape models, searching for data, and doing scientific analysis. (The "Phoebe", "Imaging Data", and "Structures" tabs can be seen in this view).

Completed shape models of irregularly shaped saturnian moons, along with registered Cassini images and geophysical data products, will be publically available in the SBMT (Fig. 8).

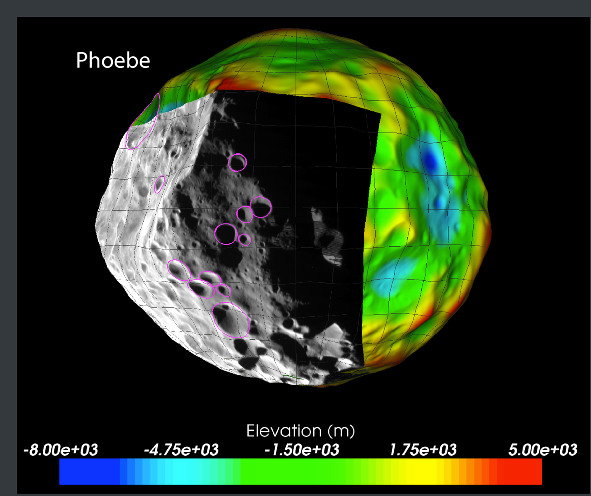

FIGURE 8. Example of Cassini-specific SBMT functionality. Here, an image of Phoebe has been draped onto the existing Gaskell Phoebe shape model [5], which has been colored by elevation. A few craters have been mapped using the "structures" tab in the SBMT. Structures data can be exported as human-readable ASCII or XML files.

To find out more, stop by the SBMT poster on Tues. (#536) or visit sbmt.jhuapl.edu.

References

[1] Filacchione et al. (2010) *Icarus,* 206, 507 – 523. [2] Filacchione et al. (2012) *Icarus,* 220, 1064 – 1096. [3] Gaskell et al. (2008) *MAPS,* 43, 1049 – 1061. [4] Ernst et al. (2018), this meeting, abstract no. 1043. [5] Gaskell (2011) Phoebe Shape Model V1.0, PDS.