BEST-FIT BIAXIAL ELLIPSOID SHAPE OF (1) CERES AND COMPARISON WITH CORRESPONDING SHAPE OF (4) VESTA. G. Salamunićar¹, Ivana Zajca 8, HR-47000 Karlovac, Croatia, gsc@ieee.org.

Summary: The best-fit biaxial ellipsoid of (1) Ceres was determined, including some accompanying topographical properties, using the recently available topography. It is compared with the best-fit biaxial ellipsoid of (4) Vesta.

Introduction: The catalogues with 132843 [1], 78287 [2], 9224 [3], 967 [4], 24 [5] and 6622 [6] craters, respectively, have been developed for Mars, the Moon, Phobos, Venus, Earth and Mercury. Thanks to the Dawn mission [7], Vestan topography has become available. Using it, the best-fit biaxial ellipsoid shape of Vesta was determined and the catalogue with 8749 craters was created [8]. Recently, Cererian topography has become available thanks to the same mission, at the beginning in lower resolution [9], and recently in considerably better resolution as well [10]. This topography can be used as an input for the topography-based crater detection algorithm (CDA) [11] in order to: (1) detect Cererian craters; (2) create the catalogue of these craters; and (3) compare their topographic-cross-profiles with Martian, Mercurian, Lunar and Vestan craters. As a first step, it is necessary to convert topography to a format and resolution acceptable by the CDA. This was an opportunity to compute the best-fit biaxial ellipsoid of Ceres and compare it with the corresponding shape of Vesta. Thanks to the high resolution and vertical accuracy of the new topography data, it is possible to compute it more accurately than previously possible.

Datasets and Methods: Datasets used and methods developed are as follows:

The initial topography of Ceres in low resolution. The currently highest available resolution of shape file with 1579014 vertices and 3145728 plate-vertex mappings has been used [9]. Based on that, the selected resolution for the resulting topography was 1/8° (2880x1440 pixels).

The latest topography of Ceres in high resolution. This topography is based on the Dawn High Altitude Mapping Orbit (HAMO) Framing Camera images and derived by using the stereo photogrammetry method [10]: (1) the values give the height in meters above a reference sphere of 470 km; (2) the topography has a lateral spacing of ~136.7 m/pixel (1/60° resolution) and a vertical accuracy of about 10 m. It was noticed that the last line in grid (10800) contained outliers (minimal value of 16-bit signed integer: -32768), so the values from the line before (10799) have been used instead. In order to prepare it for the CDA, it has been resampled to the first higher 1/2° resolution, the 1/64°.

Determination of a best-fit biaxial ellipsoid. A biaxial ellipsoid was chosen as a shape model, because in the case of Vesta [8], gravity and centrifugal force were one of the most dominant forces during planet formation. The iterative algorithm works as follows: it increases/decreases major/minor ellipsoid axis, in order to minimize the deviations between absolute elevations and the surface of the ellipsoid.

Results: The preliminary results are as follows:

The best-fit biaxial ellipsoid. For the given resolution of ±1 meter, the determined best-fit biaxial ellipsoid is 481.582 km (equatorial radius, r_e) · 444.662 km (polar radius, r_p), similarly to the results from [12] (r_p=482 km, r_e=446 km). The corresponding results for Vesta are r_e=278.624 km and r_p=220.872 km [8].

Processed initial topography of Ceres. The elevation values relative to the best-fit biaxial ellipsoid were computed for the initial topography in low resolution, shown in Fig. 1. This is an inferior Ceres-shaped model used for navigation purposes. For this reason, derived quantities are expected to be inaccurate. Therefore, this dataset has been used only for the initial insight into the topography. Once the latest topography in high resolution was available, all quantities were recomputed in order to utilize their considerable higher resolution and better vertical accuracy.

Processed latest topography of Ceres. The elevation values of the most recent topography in high resolution, relative to the sphere of 470 km, are shown in Fig. 2. The resulting elevation range of 45007 meters is from -27951 m to 17056 m. The elevation values relative to the best-fit biaxial ellipsoid were computed for latest topography in high resolution as well, shown in Fig. 3. The resulting elevation range of 18207 meters is from -7434 m to 10773 m. This is only ~40% of the elevation range relative to the sphere, due to the fact that biaxial ellipsoid better approximates the shape of Ceres.

General topographical properties of Ceres. The view of topography, as shown in Fig. 2, clearly shows that the Ceres is oblate ellipsoid. However, it is less usable when relationship between individual geological features wants to be determined. It outlines as low elevations all those close to poles, and as high elevations all those close to equator. The view of topography, as shown in Fig. 3, better shows relationships between different geological features, e.g. the highest and the lowest elevation.

The highest and the lowest elevation of Ceres. On Earth, the highest elevation is Mount Everest (8848 m),
and the lowest is Challenger Deep at the bottom of the Mariana Trench (-11034 m). These elevations are relative to the sea level. On Ceres it also makes sense to take these values as relative to the better approximation of its shape, the biaxial ellipsoid as shown in Fig. 3. The lowest elevation of -7434 m is inside one mid-latitude crater (-145.15°E, 24.51°S), which is closer to the equator than to the South Pole. The highest elevation of 10773 m is relatively close to the North Pole (11.95°E, 85.48°N), at the top of Yamor Mons.

**Conclusion:** The flattening \((1-r_p/r_e)\) and eccentricity \((1-(r_p/r_e)^2)\) of Ceres are \(-0.08\) and \(-0.38\), respectively. The corresponding values for Vesta [8] are \(-0.21\) and \(-0.61\), respectively, meaning that Vesta has a more irregular shape. Relative to the best-fit biaxial ellipsoid, difference between the lowest (-7434 m) and the highest (10773 m) elevation is 18207 m. Using the resulting topography and accompanying global image mosaics, the plan for the future work is: (1) to create the catalogue of Cererian craters; and (2) to compare them with Martian, Mercurian, Lunar and Vestan craters.


**Figure 1:** The processed initial topography of Ceres in low resolution, reconstructed from the shape file.

**Figure 2:** The most recent topography of Ceres in high resolution, where the values give the height in meters above a reference sphere of 470 km.

**Figure 3:** The processed most recent topography of Ceres in high resolution, where the values give the height in meters above the best-fit biaxial ellipsoid of 481.582 km (equatorial radius, \(r_e\)) \cdot 444.662 km (polar radius, \(r_p\)).