SHAPE UNCERTAINTY OF ASTEROID MODELS FROM INVERSION TECHNIQUES

P. Bartczak[1], G. Dudzinski[1]

[1]Astronomical Observatory Institute, Faculty of Physics, A. Mickiewicz University, Słoneczna 36, 60-286 Poznań, Poland, przebar@amu.edu.pl

In spite of growing number of adaptive optics observations, stellar occultations and radar echo images, photometry remains the main source of information about the shapes, rotational periods and spin states of asteroids.

Modern asteroid modeling techniques (e.g. convex light-curve inversion [1], KOALA method [2] or SAGE genetic algorithm [3]) produce asteroid's shape models, spin states and rotation periods.

We propose a method for calculating shape uncertainties of asteroid models based on the family of solutions produced by an inversion method, convex or non-convex. Given the family of solutions that reproduces observational data equally well (within a threshold) there is a need for a standard and robust numerical method of choosing the best model and calculating errors of the surface of the models.

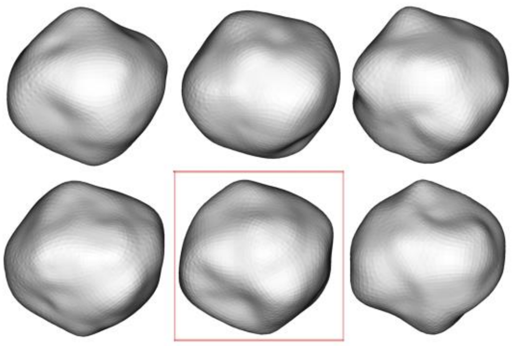

Figure 1. Example of the family of solutions for asteroid 159 Aemilia produced by SAGE modeling method [3].

Our method creates 2-element variation on the family of solutions to compare models with each other. This test selects the best model and computes uncertainty for each vertex of the model. Shape uncertainties can be shown directly on the surface of the model in a visualization.

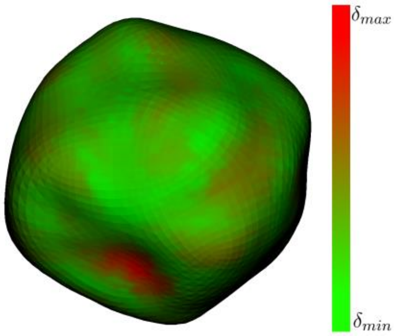

Figure 2. Visualization of shape uncertainties on the surface of the 159 Aemilia asteroid model.

Asteroid's shape models are defined as meshes of points in 3D space. Points serve as vertices of triangles – surface elements of the shape. Each model *k* in a family of solutions is compared with every other model creating a set of differences $\Delta_k = \{\delta_{kl}\}$, where δ_{kl} denotes a sum of differences between points in compared models *k* and *l*. Differences for *k*-th model are then summed $\sigma_k = \sum_l \delta_{kl}$ and a model with smallest sum σ is chosen as the best model. For every point in model *k* a closest point in model *l* is searched. The difference between points is a difference in the distance from the origin of the model (center of mass). To ensure the best fit possible of two compared models the orientation of the pole of the compared model is varying 10^o in α, β and rotation angle γ as well, with varying scaling factor. Comparing the best model with every other model in a family of solutions makes computation of average difference for each point possible. These values are used to create uncertainty maps.

Acknowledgement:

The research leading to these results has received funding from the European Union's Horizon 2020 Research and Innovation Programme, under Grant Agreement no 687378.

References:

[1] Kassalainen M., Troppa J. (2001) Icarus, 153, 24

[2] Durech J. (2011) Icarus, 214, 625

[3] Bartczak et al. (2014) MNRAS, 443, 1802