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# Estimating the Shapes and Spins of Asteroids from GAIA DR3 Photometry (online)

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Photometric inversion is a technique that has been used for several decades to infer the shape and spin properties of asteroids [1]. Inversion methods have extensively been applied to ground- based observations of asteroids [2], but the high- precision data provided by the Gaia mission has enabled more detailed studies of these objects.
Previous data releases have demonstrated the usefulness of Gaia photometry, which represent a sparse-in-time dataset. The recent Data Release 3 (DR3) of the Gaia space observatory contains photometric observations of 150,000 asteroids [3]. Here, we use the DR3 dataset to estimate shape and spin parameters for over 22,000 asteroids that have at least 25 Gaia photometric observations. We use ellipsoid and general convex shapes to estimate the rotational periods, spin axes, and photometric slopes of the asteroids in our sample. The results are used to assess trends in the general population.

We first fit triaxial ellipsoid shapes as described by the semimajor axes for which ≥ ≥. A Lommel- Seeliger surface scattering model is employed, for which the integrated brightness can be computed analytically [5]. Convex shapes are described by the Gaussian surface density. In this scheme, the proportion of surface areas are described by spherical harmonics coefficients. We characterize the probability distribution of each parameter by using a Markov chain Monte Carlo (MCMC) approach [6].

Comparing the shape parameters obtained from ellipsoids and convex shapes, we find an improvement in the uncertainty estimates when using the latter. Generally speaking, shapes are not well constrained along the c axis, arising from viewing aspects of the observations. We investigate the b/a distributions for different sizes (Figure 1) and rotation periods. Spin pole latitudes are more robustly constrained compared to longitudes, but both are susceptible to having erroneous mirror solutions. Interestingly, we find an excess of retrograde rotators in our sample which is dominated by asteroids in the Main Belt. We also find a small population of super- slow rotators (rotation periods exceeding 1000 hr) at small sizes (H ~ 14 mag, and smaller), which demand for further investigation. Further results and analyses will be presented at the conference and included in two manuscripts currently in preparation [7,8].

References:
[1] Kaasalainen, M., et al. (1992) A&A, 259, 333. [2] Durech, J., et al. (2015) In Asteroids IV, pp. 183–202. [3] Gaia Collaboration (2022) arXiv:2208.00211. [4] Cellino A., et al. (2015) P&SS, 118, 221-226. [5]Muinonen, et al. (2015) P&SS, 118, 227–241. [6] Muinonen, et al. (2020) A&A 642, A138. [7] Cellino, A., et al. (in prep). [8] MacLennan, E., et al. (in prep).

**Primary author:** MACLENNAN, Eric (University of Helsinki)

**Co-authors:** UVAROVA, Elizaveta (University of Helsinki); Dr PENTILLÄ, Antti (University of Helsinki); Dr MUINONEN, Karri (University of Helsinki); WILAWER, Emil (Astronomical Observatory Institute, A. Mickiewicz University); OSZKIEWICZ, Dagmara (Adam Mickiewicz University); CELLINO, Alberto (INAF, Observatorio Astrofisico di Torino); TANGA, Paolo (Université Côte d'Azur, Observatoire de la Côte d'Azur, CNRS, Laboratoire Lagrange); WANG, Xiaobin (Yunnan Observatories, Chinese Academy of Sciences); VIRKKI, Anne (University of Helsinki)

**Presenter:** MACLENNAN, Eric (University of Helsinki)

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