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Asteroid photometric and spectroscopic studies with Gaia DR3 data

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The Gaia Data Release 3 (DR3) contains high-precision sparse-in-time photometric data of more than 150 000 asteroids and spectroscopy of more than 60 000 asteroids (Tanga et al., A&A, 674, A12, 2023). We have fitted simple triaxial and general convex shapes to estimate the rotational periods, spin axes, and linear photometric slopes of the asteroids with the lightcurve inversion algorithm developed by Muinonen et al. (A&A, 642, A138, 2020). Sample selection of the asteroids follows Cellino et al. (A&A, in press, 2024), and we use the ellipsoid results from their genetic evolution algorithm to initiate our ellipsoid and convex shape inversion solutions.

In total, we have modelled linear photometric slopes for 8660 asteroids, which have at least 25 Gaia observations (MacLennan et al., in preparation). The slopes are used to compute H,G_1,G_2 phase functions (Muinonen et al., Icarus, 209, 542, 2010) to derive absolute magnitudes for the asteroids. As the absolute magnitudes have been calculated using Gaia's G-band, they account for a larger portion of the incident solar spectrum compared to e.g. V-band. This is particularly useful for estimating the amount of absorbed sunlight for thermal infrared studies of asteroids via calculation of the Bond albedo.

Selecting the asteroids for which there are spectroscopic data as well, gives us 2381 asteroids to analyse further. We have kept the data from the Gaia red and blue photometers (RP and BP) separate due to problems merging them. The wavelength range of both ends have also been cut to eliminate unreliable behaviour in the spectra. We are left with the following wavelengths: 418, 462, 506, 550, 594 nm (in the BP), and 638, 682, 726, 770 nm (in the RP).

We have taken asteroid diameters from NASA's NEOWISE survey (Mainzer et al., NEOWISE Diameters and Albedos V2.0, 2019) and the absolute magnitudes derived from the lightcurve inversion to calculate geometric albedos for the asteroids. Bond albedos are calculated from the

geometric albedo and using the phase integral, $q(G_1,G_2)$, from Muinonen et al. (Icarus, 209, 542, 2010). Traditionally, geometric albedos have been used to examine the inclusion of asteroids in asteroid families (Masiero et al., ApJ, 770, 7, 2013). Yet, taken together with the mean photometric slope of the families there seems to be a steep inverse linear trend with slopes smaller than 2 mag/rad at $\alpha = 20^{\circ}$.

We now investigate the parameters further by creating bins of the photometric slope and geometric albedo pair using Principal Component Analysis (PCA) on the data of individual asteroids. The asteroid spectra within the bins are examined in order to evaluate how well the parameter pair aids in the classification of asteroids.