Asteroid lightcurve phase shift due to the photometric properties of the surface

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We have simulated asteroid lightcurves for simple shape models using a realistic surface scattering law, which includes a shadowing function computed with numerical ray tracing.

We have computed lightcurves in a variety of illumination geometries for both the traditional Lommel-Seeliger law and our semi-numerical law, and observed a shift in the rotational phase of the lightcurves, depending on the illumination geometry and the direction of the spin axis of the asteroid. This phase shift is always zero at opposition, and can be as large as 10° (3 % of the rotational period) for illumination geometries typical for main-belt asteroids.

The figure shows the amount of phase shift (the phase difference between the Lommel-Seeliger model and our model), as a function of photometric phase angle in the situation where the asteroid's spin axis is perpendicular to the Sun-asteroid-observer plane.

The phase shift has implications on the accuracy of other results which are based on asteroid lightcurve analysis, such as spin-state or shape determination. We are currently performing an analysis of observed asteroid lightcurves to find observational evidence for the phase shift.

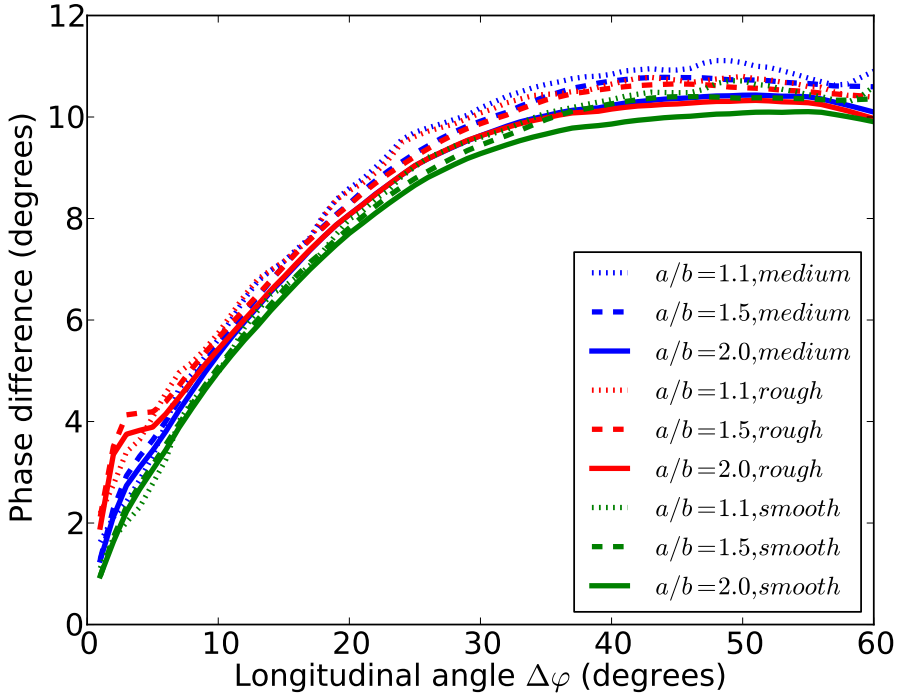

Figure: Phase shift as a function of photometric phase angle (here equal to what we call the longitudinal angle).

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References: Wilkman, O. and Muinonen, K. (2014) Asteroid lightcurve phase shift from rough-surface shadowing, Meteoritics and Planetary Science 49 1–7.