Against the bias in physics of asteroids: Photometric survey of long-period and low-amplitude asteroids.

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Introduction: Spin and shape parameters of a large sample of asteroids are an important reference point for theories describing Solar System formation and evolution, with, e.g., thermal forces influencing orbital and physical properties of minor bodies. However, the available sample of well-studied asteroids is burdened with substantial selection effects. There exists a strong observational bias against small and/or low-albedo, and/or distant objects due to the limitations of instruments that are commonly used for photometric studies. But there are also other strong selection effects working against asteroids with long period of rotation (here: $P > 12$h) and low lightcurve amplitude (here: $a_{max} < 0.25$ mag). Each of these groups corresponds to almost half of the whole population of bright ($H < 11$ mag) main-belt asteroids, while spin and shape models have been determined for only 20 % of them (source: LCDB; Warner et al. 2009). On the other hand, the remaining populations (short-period and large-amplitude objects) have been each modeled with nearly 40 % completeness. Thus, asteroids modelled today are in majority quickly rotating and elongated in shape. This inevitably skews our knowledge, e.g., on their internal structure and density, on the frequency versus size distribution, and possibly also on the distribution of asteroid spin axes in space.

Observing campaign: We have recently started a large, long-term campaign aimed at reducing the observational bias that exist against long-period and low-amplitude asteroids, to obtain their spin and shape models. To do this we coordinated a few telescopes in Poland, Spain and in the US for efficient photometric observations of those asteroids that were usually avoided by the majority of previous studies. We designed a novel observing strategy that makes use of a robotic telescope ability to quickly switch between different targets. Since May 2013, we have been gathering data using, among others, the robotic 80-cm TJO telescope at the Montsec Observatory for asteroid photometric observations in a form of single data points spaced by equal intervals of time, e.g., half an hour. Repeating such observations enables unique period determinations for slowly rotating targets, while the usage of the observing time is greatly reduced. Other telescopes in our network perform carefully planned, optimised dense ligthcurve observations to get the full phase coverage, but also to record phase-angle effects in the lightcurve shape and amplitude.

Results: After 1.5 years, our observing campaign brought about a wealth of good-quality lightcurves for more than 30 objects under study. In at least five cases, the synodic periods that we found differ substantially from the ones accepted in LCDB at the time with codes 2, 2+, and 3. Initial results are presented in the table below.

Asteroid name	diameter [km]	amplitude [mag]	Period (LCDB) [h]	Period (this work) [h]
227 Philosophia	86.90	0.06–0.20	18.048	26.456 ± 0.005
329 Svea	77.83	0.09–0.26	15.201	22.778 ± 0.004
666 Desdemona	27.22	0.11–0.22	15.45	14.609 ± 0.005
806 Gyldenia	62.82	0.10–0.27	14.45	16.852 ± 0.002
995 Sternberga	31.70	0.12–0.20	14.612	22.404 or 11.201

Figure: Asteroid synodic periods and updated amplitudes found within this project.

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References: Warner, B. D., Harris, A. W., Pravec, P. (2009) Icarus, 202, 134.