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Spin, 3-D shape, and Size of (10199) Chariklo

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(10199) Chariklo is the largest Centaur, and one that has presented puzzling changes in brightness and observed water ice signature[1]. The recent discovery of a system of rings around this minor body[2] solved this puzzle, while presenting many new questions. The presence of rings around a small body was completely unexpected, and it is not immediately clear how or when these must have formed, although a massive collision while Chariklo was still in the Kuiper Belt region is a likely explanation.

In order to shed more light on these questions, we set out to better constrain the bulk properties of Chariklo itself. One of the key observable properties for any small body is its rotation rate, as this can constrain the more fundamental (but difficult to measure) property of bulk density. The spin rate can also place constraints on the elongation of the body. Surprisingly, for a relatively bright outer solar system object, no clear rotation period had been determined prior to the discovery of the rings. We obtained new lightcurves using the Danish 1.54m and Max Planck Group 2.2m telescopes at the European Southern Observatory's La Silla site in 2013 and 2014, and combined this data with new photometry from archival images taken at the 3.6m ESO New Technology Telescope, also at La Silla, in 2010 and 2011. We also use newly acquired lightcurve for an independent project taken in 2013, coincidentally only a week after the ring discovery observations, using the 4m SOAR telescope in Chile [3].

With multiple lightcurves over a number of years it is also possible to find a shape model for a small body, using the technique of lightcurve inversion[4]. The bulk shape, and pole position, which is also provided by this method, are particularly important parameters to determine for Chariklo, given the discovery of its ring system. The rotation pole is assumed to be defined by the ring plane (under the assumption that the rings circle Chariklo's equator), which in turn allowed the use of icy rings to solve the puzzle of the changing brightness and ice signature. Use of lightcurve inversion techniques places an independent constraint on this assumption, which is the basis of many of the derived ring properties. Furthermore, the shape of Chariklo is particularly interesting, as this is the first known ring system around a potentially irregularly shaped body (other known rings being found only around giant planets), meaning that it has to be stable in a more complex gravitational field. Reasonable constraints on the complex shape are needed before any modelling of ring stability, for example, can be performed.

Finally, the shape and spin can be combined with direct information on the size of Chariklo from the occultation measurements that revealed the rings. Together, these parameters allow a more refined thermophysical model to be fitted to infrared observations, updating the recently published fit to Herschel, Spitzer and WISE data [5] with better assumptions.

We will present results from our lightcurve measurements and pole, shape and thermal property modelling. Preliminary analysis available at the time of abstract submission suggest that the pole from lightcurve inversion is in agreement with the preferred ring plane pole solution, and that the rotation period is not unusual for an outer solar system body, with solutions around 7, 8.4 and 10 hours. Final results will be available by the time of the EPSC.

References

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