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Observations of Chariklo's rings in 2015

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Abstract

We are organizing several campaigns in 2015 to observe stellar occultations by Chariklo and its rings from the ground. In parallel, three *Hubble Space Telescope* (HST)/WFC3 visits are planned in June and August 2015 to image the system in the near UV and visible, as well as four visits on the *Very large Telescope* (VLT)/SPHERE instrument of the European Southern Observatory (ESO), in the near IR in April and July. Results derived from those observations will be presented.

1. Introduction

A stellar occultation observed on 3 June 2013 revealed the surprising presence of two dense rings around (10199) Chariklo [1], the largest Centaur object known to date with a radius of 119 ± 5 km [2]. This is the first ring system ever detected in the solar system around a body that is not a giant planet.

The two rings (called respectively C1R and C2R) have orbital radii $a_{\rm C1R} = 390.6 \pm 3.3$ km and $a_{\rm C2R} = 404.8 \pm 3.3$ km (1-σ limits), and typical average optical depths of $\tau_{\rm C1R} \sim 0.4$ and $\tau_{\rm C2R} \sim 0.06$. They are separated by a gap of about 9 km that is empty to within an upper limit of $\tau \sim 0.004$.

The rings' changing geometry explains the long term variations of Chariklo's absolute magnitude and the spectral changes observed between 1997 and 2013. They imply a reflectance I/F of about 0.07 for C1R, and show that it contains about 20% of water ice, the latter remaining undetected on Chariklo's surface [3].

An occultation observed in 2014 reveals a W-shaped structure for C1R ring, with the densest parts reaching an apparent optical depth of about 2. The width of C1R may exhibit a m=1 mode, with a width W varying between ∼5.5 and ∼7.1 km over the full 360 degrees longitude range, see Fig. 1 and [4]. The width of C2R is less constrained and lies between 2 and 4 km.

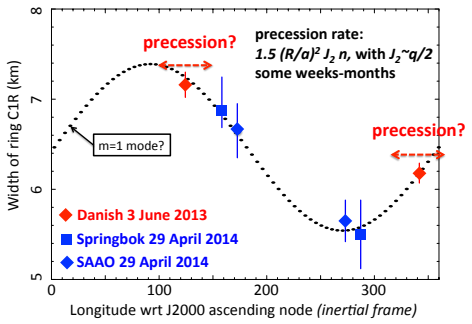

Figure 1: The width of ring C1R as a function of longitude in an inertial reference frame. As the ring precession rate is not known, one cannot conclude at present time if a m=1 mode is present in that ring. From [4].

2. Observations in 2015

Several ground-based stellar occultations by Chariklo are planned for 2015. The main goals of occultations are (1) improve the ring orbital elements, (2) confirm the azimuthal width variation, (3) derive Chariklo's shape (presently unknown) and its orientation relative to the rings, and (4) attempt multi-wavelength observations to detect possible dependence of the optical

depth vs. wavelength, a way to constrain dust particle size distribution, if present.

Similarly, direct imaging of Chariklo and its rings will be performed using HST and VLT.

Three HST visits are planned in 2015 (two in June and one in August), using the WFC3/UVIS camera with filters F300X ($\sim$250-350 nm), F475X ($\sim$400-650 nm) and F350LP ($\sim$300-1000 nm). Dither mode will be applied, resulting in a typical PSF size of about 30 milli-arcsec (mas), corresponding to about 300 km at Chariklo.

Meanwhile, four visits are planned (one in April, three in July) using the new SPHERE high contrast instrument of the VLT/ESO in the near IR (Y, J and H bands), with typical expected PSF sizes of 30-40 mas (300-400 km at Chariklo)

The aims of the HST and VLT imaging campaigns are: (1) obtain direct images of the rings, confirming their existence and their orientation, (2) derive multi-wavelength photometry, thus constraining their composition (concerning in particular the presence of water ice), (3) perform a deep search of small satellites (down to a few km in diameter) and (4) faint dusty rings around Chariklo (down to about $\tau \sim 10^{-5}$-10^{-6}), and (5) search possible cometary jets or coma, akin to what is observed around another Centaur, Chiron.

First results will be presented at the meeting, as observations have not yet been performed at the moment of writing this abstract.

Acknowledgements

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