Analysis of infrared spectra of a stellar occultation by the active Centaur (2060) Chiron

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Chiron, the first known Centaur, orbits primarily between Saturn and Uranus. It was originally thought to be an asteroid, but has since exhibited cometary-like behavior [e.g., 1,2]. This behavior is unusual given Chiron's relatively large distance from the Sun and its nucleus being larger than that of other comets. Previous stellar occultation data suggested that Chiron is greater than approximately 180 km in diameter and detected narrow jets as well as a gravitationally-bound dust coma [3,4]. More recent measurements from Herschel place the size at 218 ± 20 km [5].

On 29 November 2011, Chiron occulted a fairly bright star ($R = 14.8$) as seen from Hawai'i. We observed the event from the 3-m NASA Infrared Telescope Facility (IRTF) on Mauna Kea and the 2-m Faulkes Telescope North at Haleakala (run by the Las Cumbres Observatory Global Telescope network, LCOGT). Data were taken as visible wavelength images at the Faulkes, using an Andor iXon 888 camera, and at the IRTF, using the MIT Optical Rapid Imaging System (MORIS [6]). Simultaneously, low-resolution, near-infrared, 0.9–2.4 micron spectra were taken using SpeX [7] on the IRTF.

The MORIS lightcurve contains an occultation by Chiron's nucleus, with a chord corresponding to a minimum radius of 158 ± 14 km [8,9]. The Faulkes lightcurve, a station located 97 km to the north, contains deep, symmetric dips before and after the predicted midtime and no solid-body occultation. The extinction features are located roughly 300 km from Chiron's center, and are approximately 3 and 7 km in extent separated by 10–14 km [8,9]. The MORIS data were taken at ten times slower cadence (2 s) and show shallow dips at roughly the same distance from Chiron's center. These lightcurve features indicate optically thick material in a roughly circular distribution, suggesting the presence of a near-circular ring or shell of material.

Here, we present an analysis of the IRTF SpeX data of the occultation. Although the cadence was relatively slow (at 9.6 s), we investigate the flux versus wavelength dependence of the data in order to characterize the dust coma and shell/ring particles. This work is placed in context with other active Centaurs, given the recent discovery of rings around (10199) Chariklo [10] and the dust/gas coma observed on 174P/Echeclus [e.g. 11].

References: [1] Hartmann, W.K. et al. (1990), Icarus, 83, 1. [2] Meech, K.J. & M.J.S. Belton (1990), 100, 1323. [3] Bus, S.J. et al. (1996), Icarus, 123, 478. [4] Elliot, J.L. et al. (1995), Nature, 373, 46. [5] Fornasier, J. et al. (2013) A&A, 555, A15. [6] Gulbis, A.A.S. et al. (2011) PASP, 123, 461. [7] Rayner, J.T. et al. (2003) PASP, 115, 362. [8] Ruprecht, J.D. et al. (2014) Icarus, in prep. [9] Ruprecht, J.D. et al. (2013) AAS DPS meeting 45, 414.07. [10] Sicardy, B. et al. (2014) Nature, in press. [11] Bauer, J.M. et al. (2008), PASP, 120, 393.