Interpreting the Stellar Occultations of (15094) Polymele – a *Lucy* Target. H. F. Levison[1,2], M. W. Buie[1], B. A. Keeney[1], S. Mottola[3], and the *Lucy* team. [1] Solar System Science & Exploration Division, Southwest Research Institute, 1050 Walnut St., Suite 300, Boulder, CO, 80302, USA; [2]hal.levison@swri.org; [3]Institute of Planetary Research, DLR, Rutherfordstr. 2, D-12489 Berlin, Germany.

Introduction: NASA's *Lucy* mission is the first reconnaissance of the Jovian Trojan asteroids [1,2]. It will visit a total of eight of these mysterious objects between Aug. 2027 and Mar. 2033. In order to prepare for these encounters, the *Lucy* team is performing an extensive set of Earth-based observations intended to both determine the size and shape of its targets, and search for satellites [3-10].

Here we report on a preliminary analysis of a series of six stellar occultations of (15094) Polymele. This dataset is described in a companion abstract in this conference [11]. Understanding the shape of Polymele is particularly important because it is the smallest of the *Lucy* targets and thus is the most challenging for the spacecraft to observe. In addition to supplying limb profiles for Polymele at six different epochs, a satellite was serendipitously discovered during these observations. We have observed this satellite twice as of the writing of this abstract.

Methods: We performed two separate Monte Carlo fits to the available data. The first uses the available limb profiles to determine the shape and rotational pole position of Polymele itself. The second uses the projected relative position of the satellite with respect to Polymele to determine the orbital radius and pole position of the satellite, under the reasonable assumption that it is a circular orbit about the primary. Finally, by assuming that the satellite is sitting in Polymele's equatorial plane (i.e. that the orbital and rotational poles are the same), we constrain the shape of Polymele and orbital radius of the satellite.

Results: Ellipses were fit to the six available occultation profiles. In particular, we estimated the length of the major and minor axes and the position angle of the ellipse in the sky. Uncertainties in these parameters were estimated from the uncertainties in the length of individual chords as well as the variation of the length of adjacent chords. Polymele itself is assumed to be a triaxial ellipsoid. The resulting positions of Polymele's rotational pole in ecliptic J2000 coordinates are shown as the white dots in Figure 1.

The colored symbols in the figure show the orbital pole position of the satellite as determined by our calculations. The color of a data point corresponds to the orbital radius of the solution. These calculations use the projected separation between the primary and secondary at each of the two observed epochs. Uncertainties in these values include both the uncertainties in the position of the satellite and the center of Polymele as determined from elliptical fits of the occultation limb profiles.

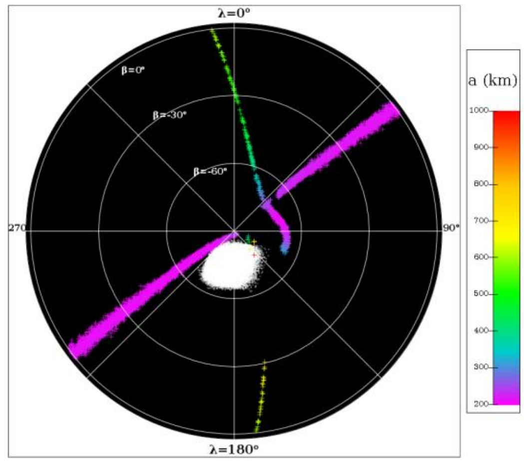

Figure 1: The location of the rotational pole of Polymele (white) and the orbital pole of the satellite (color) as determined by our Monte Carlo fits. The color corresponds to the orbital radius of the satellite, a. Our methods cannot distinguish between retrograde and prograde solutions. However, long-term light curves show that the system is retrograde (Mottola, personal comm.), and so only that pole is shown.

If we assume that the satellite's orbit is tidally relaxed, then it should lie in Polymele's equatorial plane. This implies that the two poles should be the same and the true solution should lie in the region of overlap in the figure. In this case we find that the pole is at $\lambda = 231.8^\circ \pm 4.5^\circ$, $\beta = -80.9^\circ \pm 2.1^\circ$. Polymele's shape is $A = 13.5 \pm 1.0$ km, $B = 12.2 \pm 0.8$ km, and $C = 5.2 \pm 0.8$ km. The satellite's orbital radius is $a = 204.4 \pm 2.6$ km. Assuming that the density of Polymele is between 0.7 and 1 g cm^{-3}, the satellite's orbital period is between 16.6 and 14.4 days.

References: [1] Levison H. F. et al. (2021) *PSJ*, 2, 171. [2] Olkin C. B. et al. (2021) *PSJ*, 2, 172. [3] Buie, M. et al. (2019) *EPSC-DPS Joint Meeting 2019*, 13, EPSC-DPS2019-863-1. [4] Noll, K. S. et al. (2020) *PSJ* 1, 44. [5] Mottola, S. et al. (2020) *PSJ* 1, 73. [6] Buie, M. et al. (2021) *AGU Fall Meeting Abstracts*, id. P32B-02. [7] Keeney, B. et al. (2022) *AAS DPS #54*, id. 512.03. [8] Buie, M. et al. (2022) *AAS DPS #54*, id. 512.04. [9] Mottola, S. et al. (2023) *PSJ*, 4, 18. [10] Noll, K. et al. (2018) *AAS DPS #50*, id. 217.04. [11] Buie, M. et al. (2023) *This conference.*