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The Gaia-based prediction of the 2019 May 1 occultation of elongated KBO (33128) 1998 BU_{48}

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Abstract

We report on the prediction and observation of the occultation by the elongated Kuiper Belt Object (KBO) (33128) 1998 BU_{48} on 2019 May 1 UT, in conjunction with concurrent lightcurve observations from Gemini North, designed to constrain its 3-dimensional size and shape. At this time (one week after the occultation) we have not had any reported positive detections of the event. This poster is therefore a case-study on the difficulties of predicting KBO occultations, even in the age of Gaia.

1. Introduction

The angular momentum of elongated KBOs or contact binaries is a clue to their formation environment [1]. The angular momentum depends on their periods, and their sizes and shapes, which can be probed by stellar occultation. We searched for occultations during 2018-2022 by 14 objects suspected to be elongated or contact binaries from lightcurves, from [1, 2] and elsewhere. The most promising was an occultation by an R=10.2 mag star by 1998 BU_{48}, a = 33.38 au, e = 0.385, i = 14.2°, classified as either a Centaur [Minor Planet Center] or a scattered disk object [1]. This is the first attempt to target a KBO specifically chosen from lists of potentially elongated or contact-binary targets.

2. Event prediction

We are in a golden age of occultations, where the error on the star is small, thanks to the Gaia catalog [3]. The challenge is now firmly on the target orbit. New observations in 2019 were taken with Lowell's Discovery Channel Telescope (DCT) (Wasserman), Magellan (Sheppard & Tholen), University of Hawaii 2.2-m telescope on Maunakea (Tholen), and existing measurements taken prior to PANSTARRS were refit for this prediction against a Gaia network (Tanga). A revised prediction was made 2019 March 26, and the final deployment prediction was made April 24 (Porter). The predicted centerline ran from San Diego CA to San Antonio TX, then recrossed land near Layton FL in the Florida Keys. Because our scientific motivation was to observe two or more chords to measure elongation, we used or deployed more than 60 telescopes in a relatively dense picket-fence, concentrated within 1-σ of the predicted northern and southern solid-body shadow path (Fig. 1).

3. Stellar Variability

The occulted star (UCAC4 507-052412) appears in the AAVSO catalog [4] as a "MISC" variable type with 48-day period and a range of 0.23 mag. We (Terrell) added this object to the observations of the automated SwRI David Slater telescope near Auberry CA. Initial results over 30 days (HJD 2458571-8602) show a variation in g' of 0.1 mag.

4. Rotational Lightcurves

Making a 3-D model of 1998 BU48 uses both occultations and lightcurves. In 2001, its lightcurve had a peak-to-peak 0.68±0.04 mag [1], strongly suggesting an elongated object with rotation period of 12.6 or 9.8 hours. The lightcurves measured in 2001 cannot be interpolated to the time of the occultation, especially given that both 12.6 or 9.8 hours matched observations. Furthermore, the shape of the lightcurve was expected to have changed, as the body moved 34° in true anomaly between 2001

and 2019. We (L. Young, Sheppard, Porter) were awarded Gemini Director's Discretionary time to measure the period and lightcurve of 1998 BU_{48}, and the rotational phase of the occultation. Observations were designed by Sheppard and Schwamb and analyzed by Thirouin. Three pairs of observations per night were taken on 2019 April 27 and May 2 (UT), and an additional five pairs of observations on May 8.

5. Occultation Observations

Occultation observers deployed included the RECON [5] network (Buie, Keller, Leiva), Texas Astronomical Society (Cobble), PHOT (Portable Highspeed Occultation Telescopes; Porter, Keeney, E. Young), UNAM (Reyes-Ruiz, Castro-Chacon, Silva), members of San Antonio-area astronomy groups (Bobick, Tobias), other IOTA observers (Dunham), and others (David DeColibus).

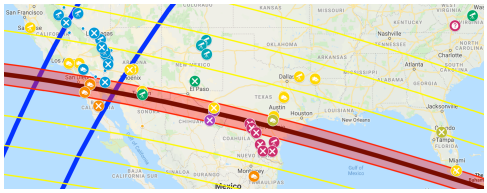

Figure 1. Predicted path (red) and 1, 2, and 3-σ offsets (yellow lines), with many of the reporting sites marked. Groups are marked by color: IOTA (yellow), RECON (blue and teal), UNAM (orange), PHOT (reddish), Texas Star Party (purple), and other (green and olive). Reported misses are "X" and reported clouds have a cloud icon.

At of the time of submission, we have heard from participating observers at over 50 sites, with data collected at over two dozen sites. There have been no positive detections, from reduced lightcurves or visual inspection. The occultation observers reporting so far are: Charles (Chaz) Havey, Dennis Harwell, Larry Spann, Dodie Reagan, Kevin Cobble, William Kloepping, Tong Liu, Joel Castro, Sergio Silva, Martin Herrera Endoqui, Bosco Hernandez, Julio Saucedo, Lorenzo Olguin, Salvador Aguirre, Eduardo Perez, Sergio Tamayo, Andres Aviles, Jose Enrique Perez Leon, Michael Skrutskie, Aart Olsen, Brian Keeney, Anne Verbiscer, Cathy Olkin, Leslie Young, Eliot Young, Rose J.C. Smith, Simon Porter, Raphael Marschall, Lawrence H. Wasserman, Robert R. Howell, Bill Hanna, Jason Mackie, Chris Anderson, Darrel Irwin, Richard Nolthenius, Dave Eisfeldt, Johnny Barton, Tony George, Dave Kenyon, Robert Jones, Gregory Lyzenga, Ted Blank, Mark Smith, Rick Wasson, Mike Smith, Michael Collins, John Moore, Paul Maley, Richard Nugent, Rick Frankenberger, Shawn Dvorak, Dick Bobick, Becky Bobick, Bryan Tobias, David DeColibus, Matt Nelson, Michael Daniel, Doug Thompson, Mari Echoes, Dorey & Ken Conway, Kaitlin McArdle, Angel Singleton, Robert Reaves, Jared White, Steve Larson, Charlene Wiesenborn, Glen Ryan, Nancy Ryan, Stephen Bock, RECON observers Brittani, Teralyn, Jeff, Russ, Chip, Joe Slovacek, John Keller, Rodrigo Leiva, & Marc Buie.

6. Summary and Conclusions

Astrometry from Gemini North from nights bracketing the event should give a post-event reconstruction of the actual shadow path. The results of this reconstruction may show us that 1998 BU_{48} is a possible binary, or that 1998 BU_{48} is small enough to slip through the pickets, or that the path was simply some offset from the predicted path and that we need to better understand systematics of some astrometric points. This will improve future occultation predictions, and allow us to take fuller advantage of the Gaia precision.

Acknowledgements

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