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Hydra stellar occulatation of 2011 June 27

M. W. Buie (1), D. J. Tholen (2), L. H. Wasserman (3), B. Sicardy (4), L. A. Young (1), E. F. Young (1), W. Ryan (5), E. Ryan (5), K. Walsh (1), T. Widemann (4), F. Vachier (6), W. Beisker (7), T. Hall (8), J. Dire (9), C. K. Erickson (10), C. Nance (11), M. Person (12)

(1) Southwest Research Institute, Colorado, USA (buie@boulder.swri.edu), (2) University of Hawaii, USA, (3) Lowell Observatory, Arizona, USA, (4) LESIA, Paris Observatory, France, (5) New Mexico Tech, USA, (6) IMCCE, Paris Observatory, France, (7) IOTA European Section, Hannover, Germany, (8) KEASA, Kauai, Hawaii, USA, (9) University of Hawaii-Kauai Community College, USA, (10) Summit Kinetics, Hawaii, USA, (11) Keck Observatory, Hawaii, USA, (12) Massachusetts Institute of Technology, USA

Abstract

We will present details regarding the deployment strategies, prediction efforts, and final results of a stellar occultation by Pluto's outermost satellite, Hydra, that is predicted to occur on 2011 June 27.

1. Introduction

Occultations have proven to be a very effective tool for the study of the Pluto system. We can get atmospheric properties over time for Pluto as well as sizes of the bodies and relative positions. The newly discovered satellites, Nix and Hydra, are thus compelling targets for occultation studies so that we can measure their sizes and shapes directly. At present we have more knowledge of the masses of these objects than we do their sizes and yet we need both for the all-important determination of their bulk densities.

A fortuitous pair of stars will gives us our first, and perhaps only, opportunity to measure the size of Hydra until the New Horizons flyby. First, Pluto and Charon will occult a star on 2011 June 23 UT. This event will be visible from Baja Mexico, the Hawaiian islands, and much of the pacific region. We are making special plans to cover this event on Kauai and the Isle of Hawaii to support the prediction (described below). The second event is on 2011 June 27 UT and will involve Pluto and Hydra with Pluto being observable in nearly the same region as for the first event. Hydra will be most easily observable from Australia.

These two events promise a wealth of information on relative astrometry of Pluto-Charon and Pluto-Hydra, atmospheric monitoring over long and short timescales, and a size and shape for Hydra.

2. Prediction

Hydra is a very challenging target for an occultation observation. For planning purposes we assume a 100km diameter which at the distance of the Pluto system subtends 4.4 milli-arcseconds (mas). To see an event, the ground stations must thus be targeted within the 100km shadow track. For this event there are three primary sources of error that needs to be reduced collectively to below 4.4 mas: 1) Pluto system barycenter position in the International Celestial Reference Frame (ICRF), 2) star position in the same reference frame, and 3) position of Hydra with respect to the system barycenter.

2.1. Pluto system barycenter

Recent successful occulations indicate that the nominal uncertainty in the Pluto position is roughly 500 km (22 mas). Reaching even this level requires de-trending the current JPL ephemeris for the Pluto barycenter. The post-fit position of Pluto with respect to an occulted star is 12 km depending on the number of chords and the data quality[1]. The atmospheric structure limits the accuracy on Pluto but Charon may be significantly better with enough chords.

2.2. Star position

The absolute position of a star is limited by the current state of astrometric catalogs and are generally good only to 100 mas. Differential astrometry can be considerably better with values in the range of 1-10 mas being readily achievable. There is often a small systematic error component between an absolute star position and an ephemeris position. Total absolute position errors can be reduced to the range of 10-30 mas[1] with sufficient additional targeted astrometric observations.

2.3. Hydra orbit

The most recently published orbit for Hydra is only good to ~1000 km.[2] This level of uncertainty makes it very unlikely to get a successful occultation. Buie and Tholen are working on new data collected with the *Hubble Space Telescope* (HST). The data are from 2007 and 2009 and extend the astrometric constraint from 4 to 8 years. With this extension, the extrapolation from the constrained orbit to the occultation is reduced from 5 years down to 1 year thus yielding a much better position.

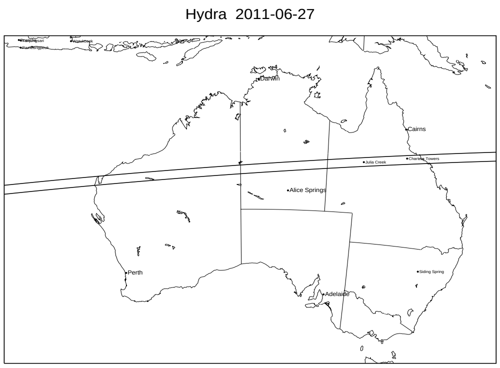

Figure 1: Prediction for the Hydra track as of April 2011. The uncertainty of this prediction is estimated to be about 5-6 track widths.

3. Deployment

The prediction strategy is built on a set of linked data. First, we will get many observations of the two occultation stars. Since they can be observed on the same FOV they can be differentially calibrated to a level that will not contribute significantly to the final prediction uncertainty. Second, we must get a successful two-chord observation of either Pluto or Charon from the first occultation. More chords and both objects will only make the uncertainty better. At this stage the dominant error will be from the ephemeris of Hydra. Estimates of our current data indicate that a 100km uncertainty is reasonable with the possibility of an even better outcome. We expect that 48 hours before the second event the uncertainty will less than or equal to one track width. From the final prediction we will have 48 hours in which to coordinate observers in Australia and place our mobile telescopes in the path.

4. Results

The final presentation at the meeting will either be a complete discussion of the prediction effort or a presentation of the occultation results depending on the outcome of the observational effort. This event demonstrates a new technique to use closely spaced occultations by the Pluto system to help target small features such as the small satellites or the central flash zone. As long as Pluto is in the rich star fields of Sagitarius we can take advantage of this technique.

Acknowledgements

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References

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