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First Small-Body Occultation Attempts from the Stratospheric Observatory for Infrared Astronomy

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Abstract

Here we report the first attempts to observe a stellar occultation from the Stratospheric Observatory for Infrared Astronomy. We predicted and will attempt to observe the stellar occultations by Pluto and Charon on 23 June 2011 UT and by Pluto and Hydra on 27 June 2011 UT. We shall provide details on the predictions, preparation, and any successful observations and initial results and implications for the Pluto system.

1. Introduction

Airborne astronomy platforms are particularly helpful for observing small-body stellar occultations, as they are highly mobile and can be placed precisely within the predicted shadow paths of these events, including normally inaccessible areas of the Earth, such as over the oceans.

During its years of operation, the Gerard P. Kuiper Airborne Observatory (KAO) was generally acknowledged as the premiere airborne platform for earth-based stellar occultation research. The 0.9-m telescope on the KAO was used to discover the rings of Uranus [1] as well as the atmosphere of Pluto [2] with stellar occultation observations. The KAO was heavily involved in various occultation observation efforts from its first decade right through its final year of operation.

Here we report on the first stellar occultation observations attempted from the KAO's successor aircraft, the Stratospheric Observatory for Infrared Astronomy (SOFIA), using the High-speed Imaging Photometer for Occultations (HIPO) [3].

With a 2.5-m dish, HIPO, and the ability of this Boeing 747SP wide-body aircraft to be placed in the center of the predicted shadow path and above most weather issues, this platform is expected to provide outstanding occultation data.

2. Ephemeris Correction Models

Our group has spent the last several years collecting astrometric data to improve the ephemerides of the Pluto system as well as other KBO's specifically for predicting stellar occultations. The MIT ephemeris correction models (ECMs) include data from the du Pont 2.5-m, USNO 61-inch, and Lowell Astrograph telescopes over the span of 6 years. These data were reduced with respect to stars in the UCAC2 catalog [4] and used to create a model to eliminate first-order residuals between the observations and the Pluto system JPL ephemeris. This model is then extrapolated into the future to make occultation predictions.

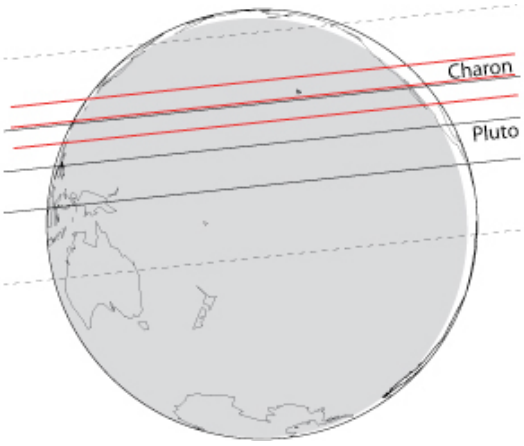

Figure 1: The 23 June 2011 Occultations by Pluto and Charon. We show the globe as seen from the occultation star and overplot the shadow predicted shadow paths of Pluto (black) and Charon (red). Each shadow path consists of a centerline and two lines on either side for the limb. The dotted lines are

three sigma error bars for the location of the Pluto limbs. Notice the area near the northern limb of Pluto where both shadows may be observed from the same locations.

3. Pluto Occultations

Stellar occultations by Pluto provide a means of monitoring the changes in Pluto's atmosphere, as well as allowing us to search for signs of a tenuous atmosphere on Charon and establish the sizes of the smaller moons. Our predictions [5] for 2011 include two opportunities which are accessible to the SOFIA platform.

3.1 Pluto/Charon Event on 23 June 2011

The first opportunity includes possible occultations of the same star by both (134340) Pluto and its largest moon, Charon. In fact, a portion of the shadow paths of both objects overlap allowing a rare opportunity to observe the occultations by both objects from the same location on the same evening. Observations of both Pluto and Charon occultations from the same telescope could greatly reduce the remaining uncertainties in the mutual ephemerides of these bodies.

Figure 2: The 27 June 2011 Occultations by Pluto and Hydra. We show the globe as seen from the occultation star and overplot the predicted shadow paths of Pluto (light) and Hydra (dark). The Pluto shadow path consists of a centerline and two lines on either side for the limb, while Hydra includes only two estimated limb lines. The dotted lines are three sigma error bars for the location of the Pluto limbs. Note that the location of the Hydra path is extremely uncertain due to the uncertainties in the Hydra ephemeris.

3.2 Pluto/Hydra Event on 27 June 2011

Similarly, the 27 June 2011 event provides for opportunities to observe occultations by both Pluto and its outermost moon, Hydra. The Hydra occultation is very difficult to observe due to its small size. In addition, its location with respect to Pluto at the time of its occultation is uncertain by approximately a Pluto radius.

4. Summary and Conclusions

We shall attempt to observe these two events from the SOFIA platform using the HIPO camera during the last weeks of June 2011. The observations have the promise of providing an exacting look at both Pluto's atmosphere and the organization and sizes of its moons. We shall present the preliminary results of any observations obtained.

Acknowledgements

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[5] For current predictions, see our website: http://occult.mit.edu/research/occultationPredictions.php