

# Public Relations and Training

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## **Distribution of Observing Manual:**

This year, an observation manual supervised by IOTA/EA will be added to the publication list.

## **Data analysis training:**

Data analysis will be the main lecture content of this year's occultation observation workshop.

# Distribute Observing Manual

## English version

Observation manual for stellar occultation by asteroids

Edited by IOTA/EA

February 2024

2. is related to the observation camera commonly used in Japan. Most of the occultation observers in Japan use QHY174M-GPS (made by QHY) or ASI290MM (from ZWO). QHY174M-GPS, which was developed for occultation observations, became popular as a standard camera for occultation observations around 2017 after the observation of stellar occultation by the Kuiper Belt object (486958) Arrokoth, which is the flyby target of NASA's New Horizons spacecraft. On the other hand, since the QHY174M-GPS is quite expensive, it was not widely used by Japanese amateurs. Instead, the ASI290MM, which was developed as a popular planetary imaging camera, became popular among Japanese amateurs. However, the ASI290MM camera does not have a built-in GPS function. This camera does not have a built-in GPS function, so it requires a unique observation method (see Chapter 4).



図 4: (a) QHY174M-GPS (made by QHY) is a mainstream camera among overseas occultation observers. (b) ASI290MM (made by ZWO) is popular among Japanese occultation observers because of its low price. But this ASI290MM has no GPS function. To compensate for the lack of GPS function, it is necessary to use a GPS module at the same time (see text for details).

The aforementioned occultation observations of (486958) Arrokoth were supported by the New Horizons mission and were a great success. The occultation observations predicted that (486958) Arrokoth is a contact binary before the spacecraft flyby. In Japan, occultation observations of the Apollo-type asteroid (3200) Phaethon, the flyby target of the DESTINY+ mission, were systematically performed in 2019, 2021, and 2022. The 2021 observations were performed from 35 different sites, and then the positive detections were reported from 18 sites. These observations helped to determine the exact size and shape of Phaethon. The observation of the occultation by Phaethon was also a great success in 2022 (see chapter ?? for details). The size and shape of asteroids obtained from occultation observations leave little room for error. As these examples show, occultation observations have recently attracted the attention of professional researchers as a tool for solar system exploration missions.

of the time between the start of exposure of the  $n$ th frame and the frame output. Based on this principle, Limovie creates a model of the phenomenon, including light diffraction, and compares it with the photometric results of the observation, then obtains the most accurate time of the phenomenon. The light curves obtained from the observation and the time of the phenomenon calculated from the model fit are shown in Figure 8.

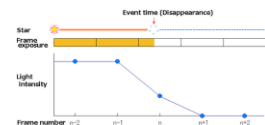


図 7: When occultation (dimming) occurs in the middle of the exposure of the frame.



図 8: We analyzed the video shown in Figure 6, and then fit the diffraction simulation model to the light curve of the star occulted by the asteroid to obtain the most likely value of the event time. As a result, we found that 17h43m 22.785  $\pm$  0.021s was the most likely value of the event time. This means that the event occurred 0.081s before the timestamp of 17h43m 22.866s, which is the timestamp of the frame in which the faint star image was seen.

### 2.3.3 推定時刻誤差

まず、数項のような求め方をすると誤差要因となるのは、ライトカーブ上に載っているノイズである。これらは、観測素子上の読み取りノイズや、大気の影響によるノイズ

[https://drive.google.com/file/d/1nA3Dqac3Syzp9lr36ly5pWM1vahI1zur/view?usp=share\\_link](https://drive.google.com/file/d/1nA3Dqac3Syzp9lr36ly5pWM1vahI1zur/view?usp=share_link)

The English version is a translation of the Japanese version. Some figures in the English version still have Japanese explanations in the figures.

We welcome your comments and feedback on both the Japanese and English versions. We hope to have all revisions completed and ready for posting on the IOTA/EA website by the end of IOTA/EA 2024/25.

小惑星による掩蔽観測マニュアル

早水, 宮下, 渡辺, 山村, 吉田  
IOTA-EA 掩蔽観測チーム編

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### 2.3.2 測光結果から現象時刻の最確値を求める

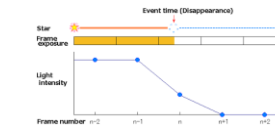


図 7: フレーム露光期間の途中で掩蔽(減光)が起きた場合。

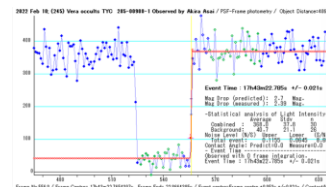


図 8: 図 7 のシミュレーションモデルにフィットさせて現象時刻最確値を求める図 3 のビデオの解析を行い、現象時刻として 17h43m 22.785  $\pm$  0.021s が得られた。薄い直線が与えられたフレームのタイムスタンプの 17h43m 22.866s よりも 0.081s 前に現象が起きたことになる。

ビデオのコマ送り(フレーム画像の目録)では、フレームの出力間隔が時間分解能であった。ビデオに映る画像を、静止画カメラと同じように光度測定することができれば、光度変化曲線(light curve)が得られ、それを用いて、更に時刻精度を向上させることができる。この測定は、Limovie や PyMovie をはじめとするビデオファイル用の光度変化測定ソフトウェアを用いることで可能となる。

図 7 は、第  $n$  フレームの露光期間の約 3 分の 1 の時点で減光が起きた場合を示している。後継現象により星像が画面上に現れると、第  $n$  フレームにはそれ以前の 3 分の 1 の明るさの星像が写っていることになる。逆に、星像が導入前の 3 分の 1 の明るさであれば、第  $n$  フレームの露光開始から、フレーム出力間隔の 3 分の 1 の時間後に現象が起きたことがわかる。これにより、フレーム出力間隔よりさらに精密な現象時刻を求

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図 29: 微小光学系構成例



図 30: レデューサー組み合わせ例。左: $\times 0.63 + \times 0.5$  レデューサーの組合せ。右: $\times 0.63 + \times 0.33$  レデューサーの組合せ

# Occultation Observation Workshop

The occultation observation workshop will provide training in data analysis. So that each observer can correctly analyze and quickly report his/her observation data.

An IOTA/EA-sponsored workshop will be held once a year.

**Date:**

**2024 Nov. 16-17** (with the Phaethon's observation campaign)

**Main topic:**

**Analysis of occultation observation data**

**Venue:** Kobe University (Rokkodai 1st Campus)

**Lecturers:** (TBD)

Methods for analyzing AVI data and FITS data

