

Campaign plan

* required items

1. Name of Campaign *

[Mysterious circumplanetary environment of trans-Neptunian objects revealed by stellar occultation]

2. Principal Investigator

[Ko Arimatsu (Kyoto University)] *

3. Phenomena *

2023-09-30 27:38 JST

Gaia DR3: 12460425975997824 (Gaia RP mag = 11.1) occulted by 2004UX10

2023-10-24 22:01 JST

Gaia DR3: 6897437174926043008 (Gaia RP mag = 15.5) occulted by 2015MQ204

2023-11-09 26:41 JST

Gaia DR3: 941676497387966208 (Gaia RP mag = 12.8) occulted by 2002XW93

2023-12-20 24:15 JST

Gaia DR3: 224719633892722688 (Gaia RP mag = 14.1) occulted by 1995SM55

4. Importance of observation *

We propose to monitor stellar occultations of several 100 km-sized trans-Neptunian objects (TNOs) to search for their circumplanetary ring(s).

These rings (e.g., Braga-Ribas et al. 2014, Nature, 508, 72) are thought to be ubiquitous around larger TNOs (with diameters of approximately > several 100 km) and represent the formation and dynamical evolution history of the outer Solar System, as well as the physical properties of TNO bodies.

However, for most TNOs occultation observations with sufficient photometric accuracy to probe for the rings have never been made.

We propose observations of 4 occultation events by the known 100 km sized TNOs (2004UX10, 2015MQ204, 2002XW93, and 1995SM55), which have never been studied in detail.

5. Occult area [Japan] *

6. Special note regarding party scale

Since the uncertainties of the occultation is larger (~ 1000 km or larger in projected distances),

we request observation positions should be distributed as much as possible.

7. Special note regarding observation

Since the Hill radius of a 100-km sized TNO with a typical comet nucleus volume density of about 0.5 g cm⁻³ in the Kuiper Belt region is about 10⁵ km, so we will search for possible flux drops by rings within about 1/10 of the Hill radius (~ 10⁴ km) where they can stably exist.

For this purpose, we plan to conduct continuous photometric observations for about 10 minutes before and after the expected occultation time.

In this campaign, we plan to obtain occultation of possible ring(s) and planet body with corresponding spatial resolutions smaller than ~30 km (required, corresponds to half width of the Haumea's ring) or ~3 km (optimal, corresponds to half width of the Quaoar's ring).

Since the present observations require higher SNs of the light curves and the target stars are relatively faint for the 2015MQ204 and 1995SM55 occultation events, we request the exposure time of each frame to be relatively longer.

We thus request exposure times for each frame to be shorter than 0.18, 3.8, 0.18, and 1.3 seconds for the 2023-09-30, 2023-10-24, 2023-11-09, and 2023-12-20 events, respectively.

8. Special note regarding target body

9. Reference of papers, books and documents

- Arimatsu, Hashimoto, et al., Evidence for a rapid decrease of Pluto's atmospheric pressure revealed by a stellar occultation in 2019, *Astronomy & Astrophysics*, 638, L5, 2020
- Arimatsu, Hashimoto, et al., New Constraint on the Atmosphere of (50000) Quaoar from a Stellar Occultation, *The Astronomical Journal*, 158, 236, 2019
- Arimatsu, et al., A kilometre-sized Kuiper belt object discovered by stellar occultation using amateur telescopes, *Nature Astronomy*, 3, 301, 2019
- Arimatsu, et al., Detectability of Optical Transients with Timescales of Subseconds, *The Astronomical Journal*, 161, 135, 2021
- Arimatsu, et al., Organized Autotelescopes for Serendipitous Event Survey (OASES): Design and performance, *Publ. Astron. Soc. Japan*, 69, 4, 201

10. Necessity for cooperation with other regions

11. Restrictions on publication of observation results *

Yes:

Two years after the last observation or on the date the paper is published, whichever comes first.

12. extra documents

- https://www.asteroidoccultation.com/2023_09/0930_144897_82124.htm
- http://hal-astro-lab.com/asteroid/2023_10_24%200%202015%20MQ204.png
- https://www.bedekkingen.vvs.be/predictions/asteroids2023/PDF/B23_11002.pdf
- http://hal-astro-lab.com/asteroid/2023_12_20%2024835%201995%20SM55.png