ASTROMETRIC AND PHOTOMETRIC OBSERVATIONS OF PHAs WITH 70cm TELESCOPE

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Introduction

A potentially hazardous asteroid (PHA) is a near Earth object (NEO) with an orbit that can make close approaches to the Earth and is large enough to cause significant regional damage in the event of impact. Currently, there are over 2300 objects classified as PHA. None of the PHAs present a threat to the Earth in the near future. However systematic observation of these objects can broaden our understanding of their orbital and physical properties.

AGO70 telescope is fully capable of tracking object with angular velocities up to 1.5deg/s, which enables long exposure observations even of fastest NEOs without trailing. The fastest PHAs have sky motion of up to 100s of degrees per day, which can be problematic for large and slow telescopes.

AGO70 is capable of astrometric and photometric image acquisition of these fast objects and could be a valuable tool for follow-up observations of NEAs of high interest and international observing campaigns. The acquired data could be used to update orbital precision, collect photometric colors and construct lightcurves.

AGO70 Telescope Specifications

- AGO70 instrument is a 0.7-m reflecting Newtonian telescope (see Figure 1) located at the Astronomical and Geophysical observatory in Modra, Slovakia operated by the Faculty of Mathematics, Physics and Informatics of the Comenius University in Bratislava.
- Telescope is registered under the MPC code M34.
- Telescope was initially developed for space debris research, but it is able to observe asteroids as well (Šilha et al., 2019).
- Mount is controlled by two separate motors, allowing tracking with high speed up to 1deg/sec in each direction (see Figure 2).
- Telescope is using FLI ProLinePL1001E Grade 1 CCD camera. Camera has a resolution of 1024x1024 pixels with a field of view 28.5’x28.5’, resulting in pixel resolution of 1.67’’x1.67’’.
- Telescope is equipped with filter wheel containing Johnson-Cousins BVRI filters, Sloan *g,r,i,z_s,y* filters and clear C filter.

Figure 1: Photo of AGO70 instrument.

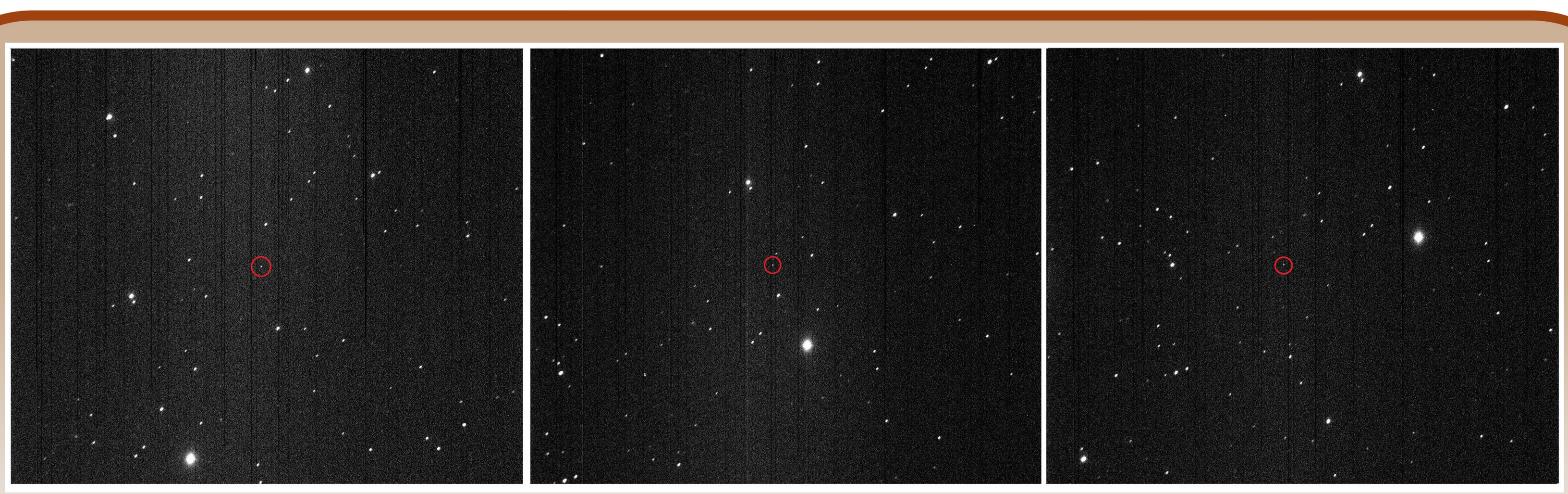

Figure 2: Example images of tracking of NEO 2023 EY during the night 2023-03-16. Images are taken with 5sec exposure in Johnson standard R filter. On this night object 2023 EY had sky motion of over 150arcsec/min and had a close approach to Earth of less than 1LD.

Observation planning

- Planning of the observation is performed using Python’s JPL Horizons library. Script retrieves objects, that satisfy observational parameters and creates the list of observable objects for each night. AGO70 telescope is able to observe objects with magnitudes 17.5 and brighter. Telescope has a horizon limit 25 degrees.
- Another approach for observation planning is NEO toolkit developed by European Space Agency (ESA) (Moreta et al., 2023). NEO toolkit is able to filter observable object for chosen site using predefined constraints. Users are able to obtain high accuracy ephemeris, precisely locating asteroids and simulating the close approach of those objects with Earth.

Photometric analysis

- Images are processed using standard photometric methods such as bias and dark subtraction and flat field correction. Target and stars are measured in AstroImageJ (Collins et al., 2017) software using Data Processing option with aperture photometry method. Photometric calibration to standard star system is performed using python libraries and all-sky ATLAS-REFCAT2 catalog (Tonry et al., 2018).
- Periods are usually retrieved from the publicly available light curve database (Warner et al., 2009). To verify whether our photometric methods are correct, we observed object 1627 Ivar and reconstructed its light curve (see Figure 3). Object has known period 4.796 hours (Warner and Stephens, 2020) therefor it was a good candidate to test our analysis.
- With target calibrated to standard magnitude system, it is possible to connect several different night of observation. This method helps with observation of objects with long rotation period and short observing window during each night. To test this method, we observed asteroid 98943 (2001 CC21) with known rotation period during 4 different nights and reconstructed the light curve of the object (see Figure 4).

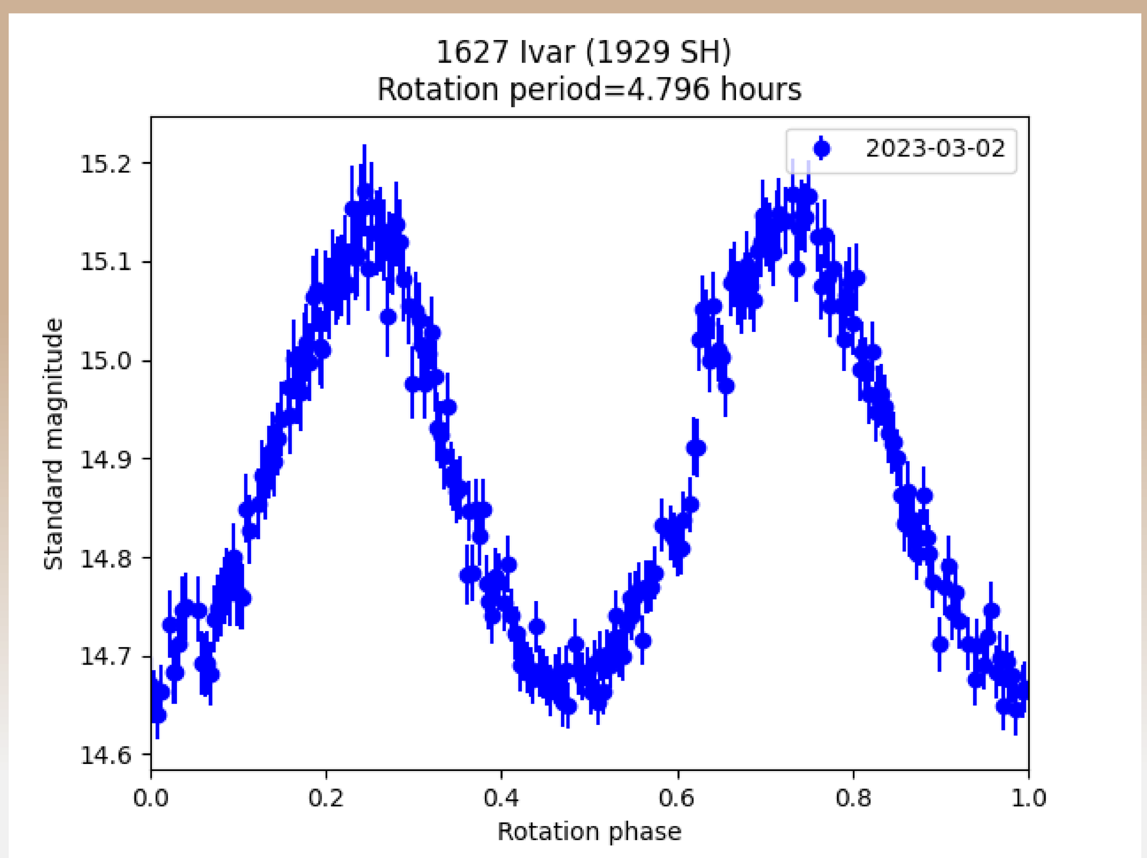

Figure 3: Light curve of NEO 1627 Ivar (1929 SH) observed by AGO70 telescope. Light curve consists of 5 hours of observation during the night 2023-03-02. Images have 60sec exposure using the clear C filter. Rotation period 4.796 hours (Warner and Stephens, 2020) was used for phase reconstruction.

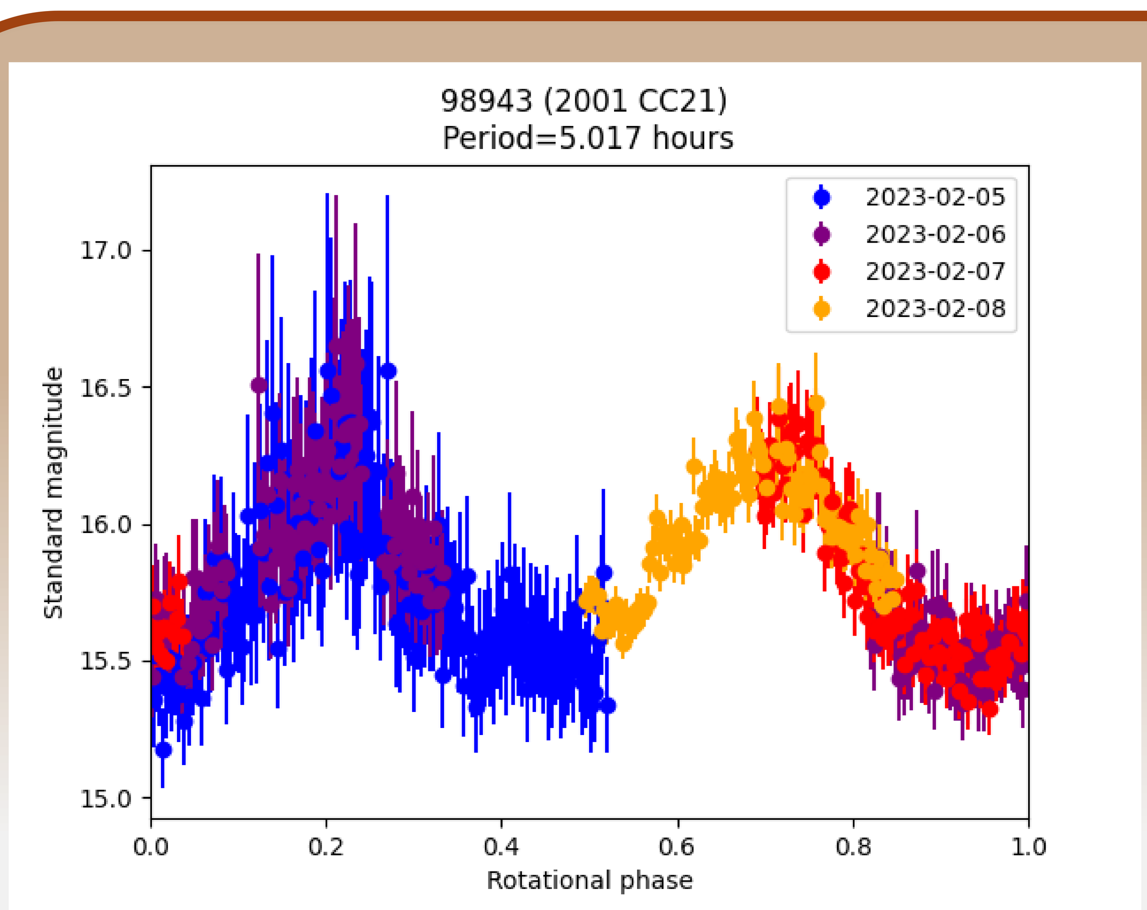

Figure 4: Light curve of NEO 98943 (2001 CC21) observed by AGO70 telescope. Light curve consists 4 different observation in consecutive nights from 2023-02-05 to 2023-02-08. Images have 15sec exposure using the Johnson-Cousins R filter. Rotation period 5.017 hours (Pravec et al., 2022) was used for phase reconstruction.

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