You Spin Me Round: Finding Fast Rotations of Near-Earth Asteroid Candidates

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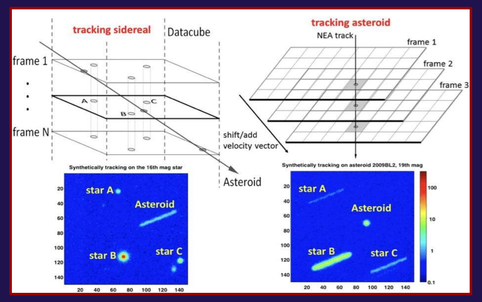
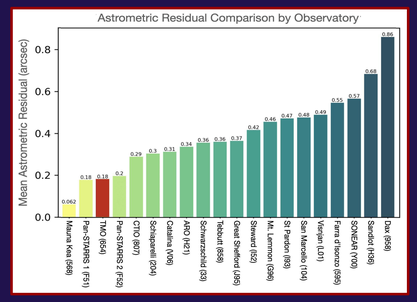
Synthetic Tracking @ TMO

- Since 2020, we have used Synthetic Tracking to observe over 1500 Near-Earth Asteroids (NEA) with the 1-m Table Mountain Observatory (TMO).
- Synthetic Tracking utilizes a series of short exposures that are software-aligned on our NEAs to avoid streaking.
- This technique enables high-precision astrometry (~10 mas), as well as high-cadence (1-sec) photometry of our targets.



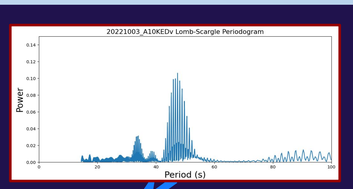


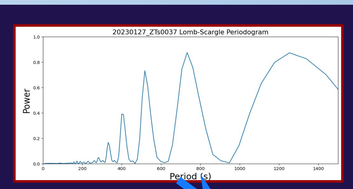
Left: A visualization of synthetic tracking and the resulting stacked images.

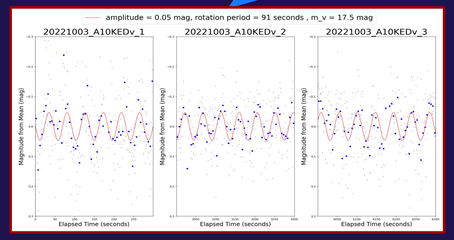
Right: A histogram showing the mean astrometric residuals by observatory in the follow-up program.

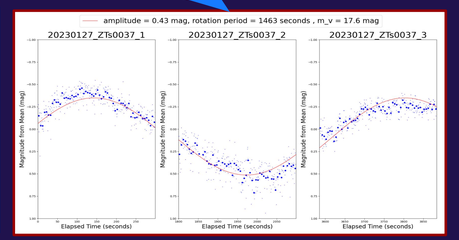
Determining Spin Rates of NEAs

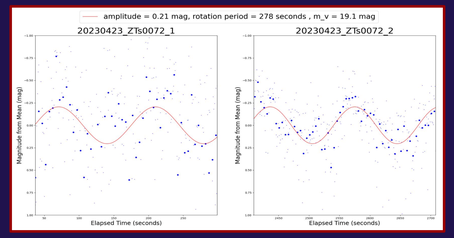
- We perform periodogram analysis on our photometric data to determine rotation rates of a preliminary subsample of 50 bright (m_g<19.5) NEAs observed from Sept 2022 - July 2023.
- From that subsample we present eight candidates that show photometric variability consistent with rotation.
- Sizes, estimated based on H-mag values and an assumed mean albedo=0.15 (range=0.03-0.3) are combined with our period fits to place objects in the context of known NEAs.

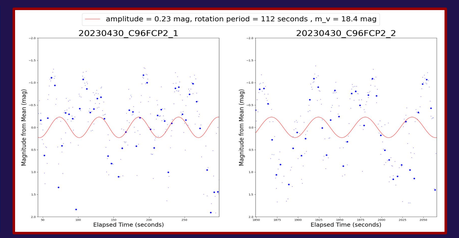


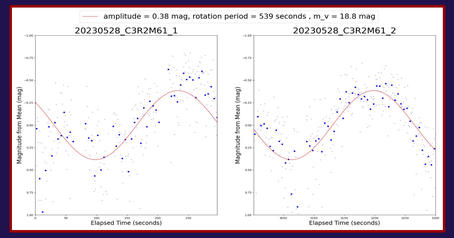


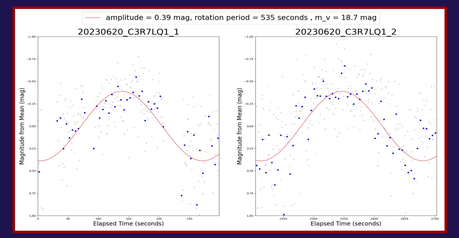


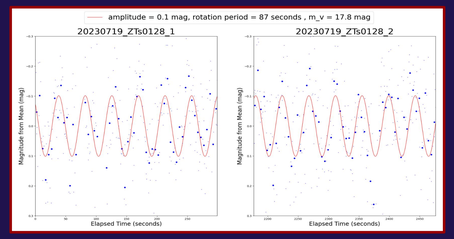


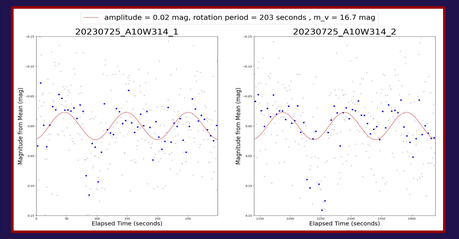




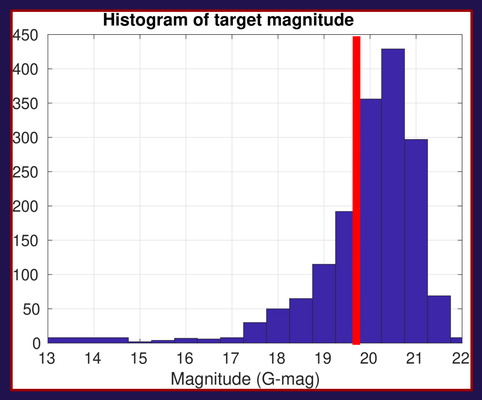




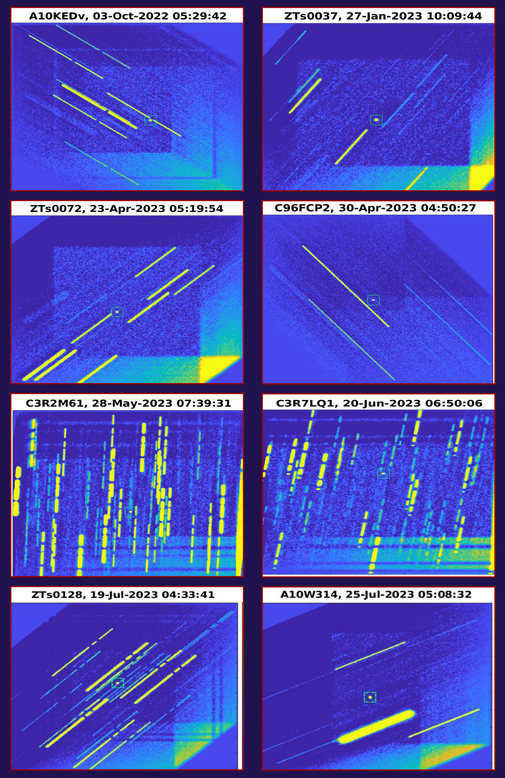


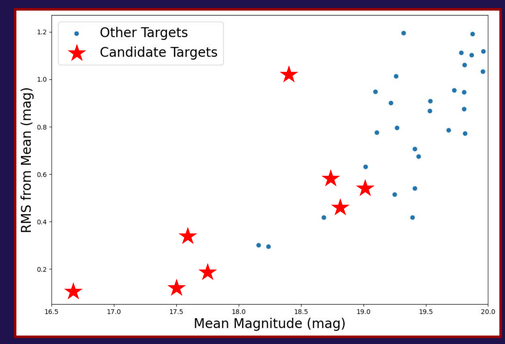


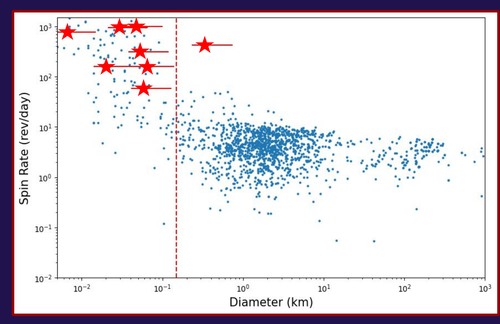
Top: Example Lomb-Scargle periodograms for the candidates in the first row.
Bottom: Multi-epoch light curves of our candidates with best-fit sine functions overlaid.



Left: A histogram by brightness of observed NEO targets.
Right: Mosaic of candidates with measurable rotation.







Top: RMS vs. m_v, with best candidates highlighted.
Bottom: Spin rate vs. diameter overplotted on existing asteroid data.

Acknowledgements

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References

- C. Zhai, M. Shao, N. Saini, P. Choi, N. Evans, R. Trahan, K. Nazli, and M. Zhan, arXiv preprint arXiv:2401.03255 (2024).
- B. D. Warner, A. W. Harris, and P. Pravec, 202, 134 (2009).
- Asteroid size estimator, URL https://cneos.jpl.nasa.gov/tools/ast_size_est.html.