Prevalence of Fast Rotators among small Near-Earth Asteroids: An ongoing survey from the Canary Islands Observatories

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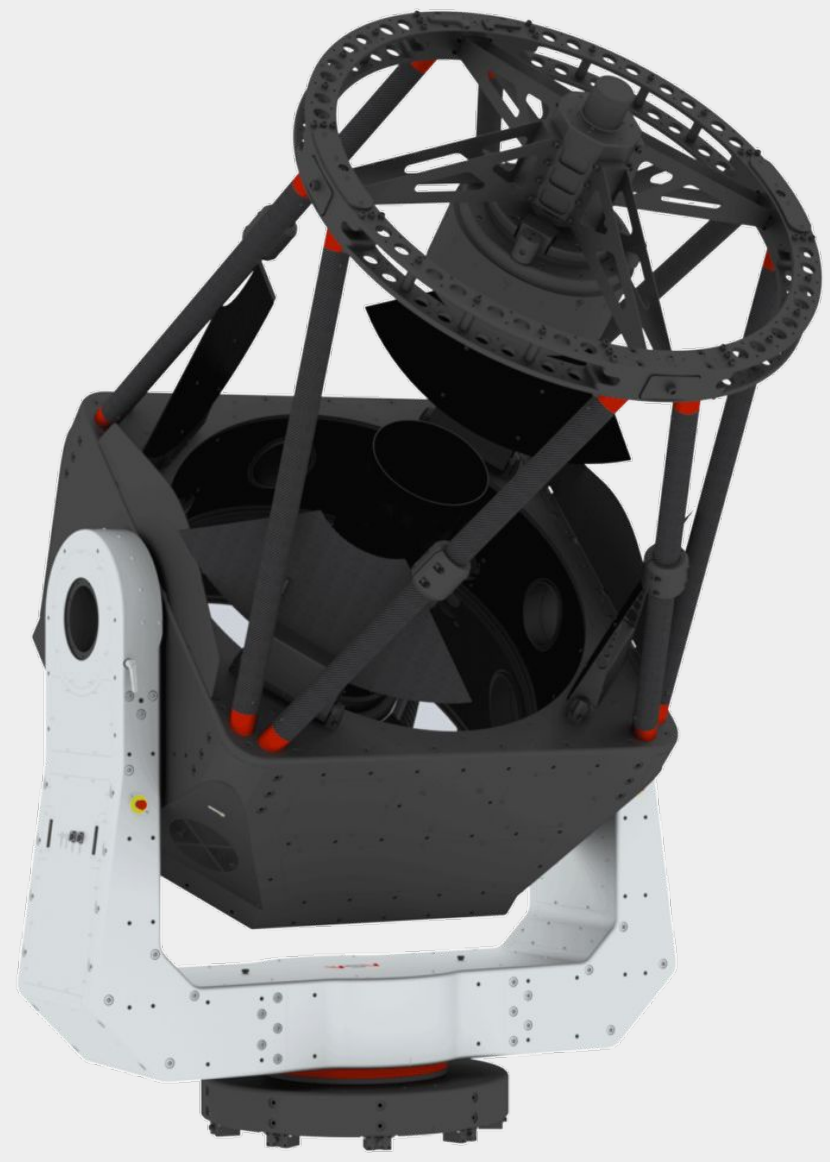
Near-Earth Asteroid (NEA) spin rates reveal fundamental aspects of their structure and evolution. Bodies larger than ~150 m typically rotate no faster than the ~2.2 h "cohesionless" spin barrier set by self-gravity (Pravec & Harris 2000). **Below ~100 m, however, surveys find that more than half of NEAs spin faster than this limit**, with some completing a rotation in under 10 min (Hergenrother & Whiteley 2011; Licandro et al. 2023). Such superfast rotators require internal strength—whether from monolithic rock or weak cohesive forces between grains—to withstand extreme centrifugal stress (Sánchez & Scheeres 2014, 2020). Moreover, many small fast rotators exhibit non-principal-axis tumbling, whose dual-frequency light curves probe internal energy dissipation and rigidity (Pravec et al. 2005). Together, these fast-spin phenomena define a size-dependent spin-rate distribution that remains sparsely sampled for the smallest NEAs.

Our ongoing survey addresses this gap by rapidly **following up newly discovered NEAs** with absolute magnitudes H > 22 using telescopes at the Teide Observatory (Tenerife, Canary Islands), taking sub-minute exposures to achieve **high-cadence light curves**. To date, we have observed 160 such objects and confirmed reliable rotation periods for 69; among these, **58 exceed the 2.2 h spin barrier**, and remarkably, **36 complete a full rotation in under 10 minutes**. This is an ongoing survey, and we will continue observing these objects to expand our dataset in the following months.

Target selection is performed automatically every day using predefined H-magnitude ranges and requiring SNR ≥ 15.

We use **sCMOS detectors** with near-zero readout time to capture continuous few-second exposures, and run our **custom GPU-accelerated algorithms** to obtain absolute photometry in near real time.



Telescope	∅ (m)	Instrument	FOV (′)	Scale (″/px)	Filter	H range	Observing block
TTT-1	0.80	QHY411	34 x 25	0.14	g'+r'	20 - 24	2 h
TTT-2	0.80	QHY411	34 x 25	0.14	g'+r'	20 - 24	2 h
TTT-3	2.0	QHY600	10 x 7	0.19	g'+r'	24 - 30	30 min

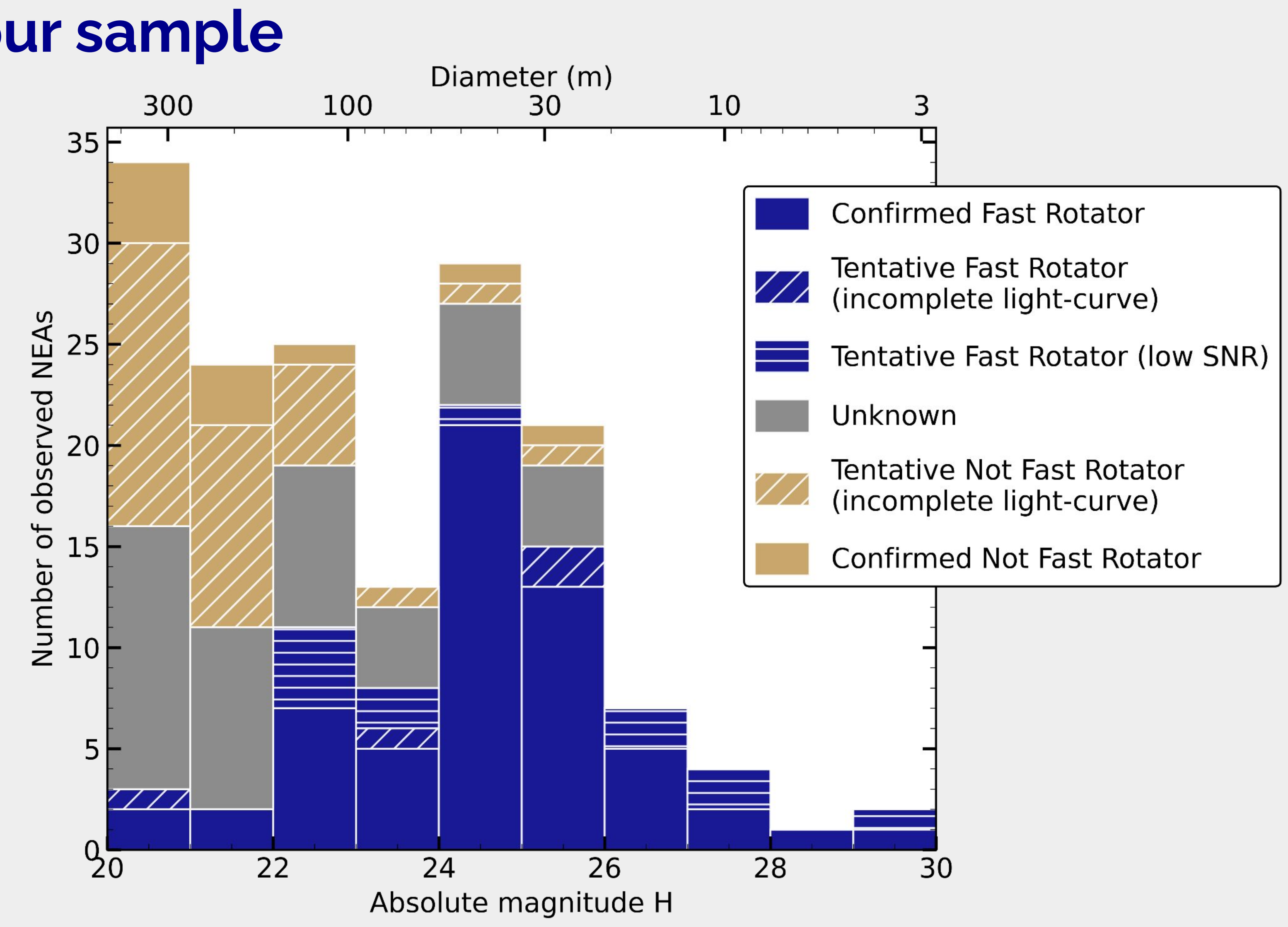
Spin-rate distribution in our sample

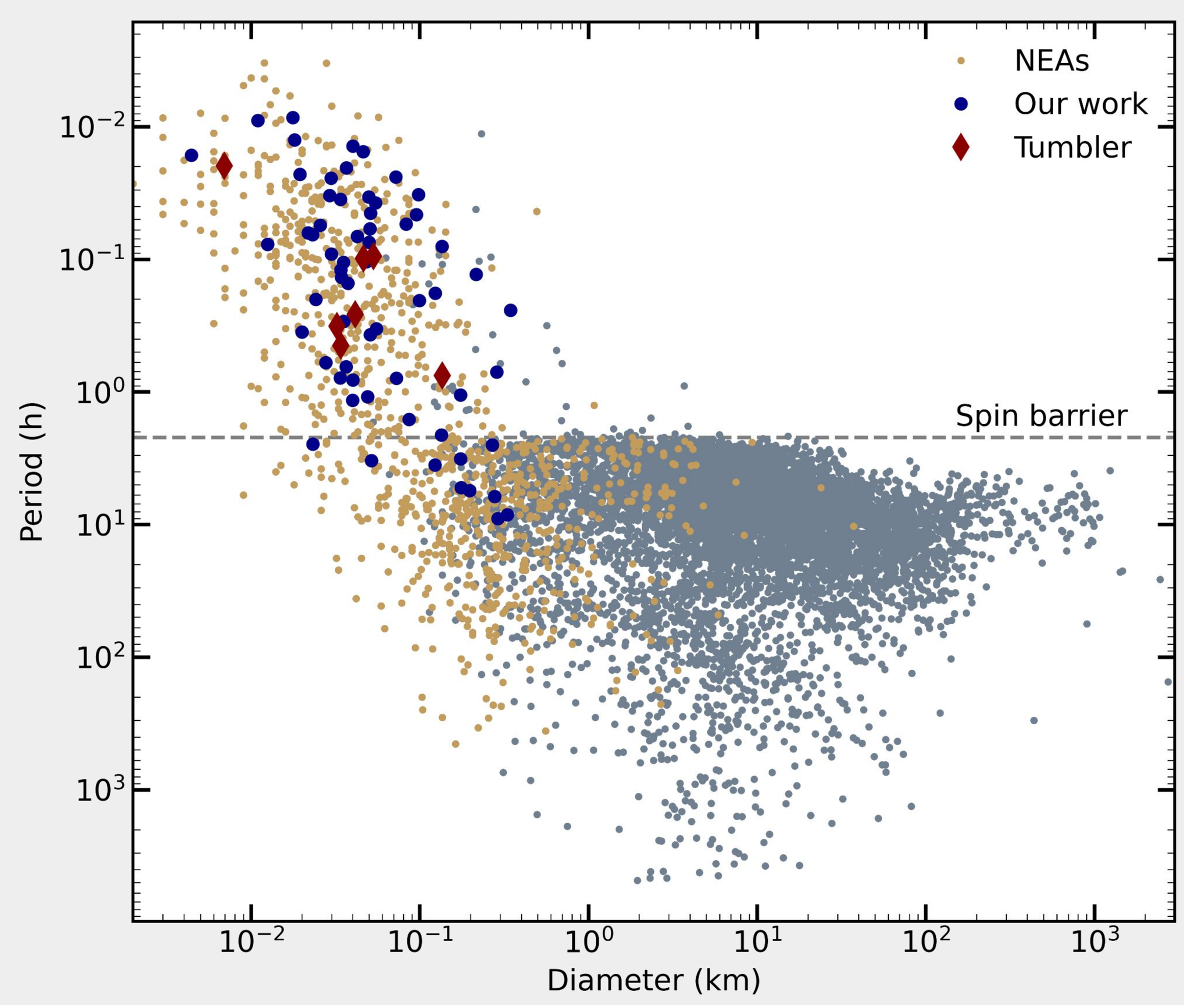
In our survey, we find that **91 %** of NEAs with **H > 24** are fast rotators, closely matching the 93 % fraction derived from the LCDB sample (U ≥ 2).

At the small end (**H > 26**), **all observed targets (14 in total) exhibit rapid rotation**, compared to 98 % in the LCDB.

This close agreement confirms that rapid rotation is nearly ubiquitous among the smallest NEAs, with only minor differences attributable to sample selection and completeness.

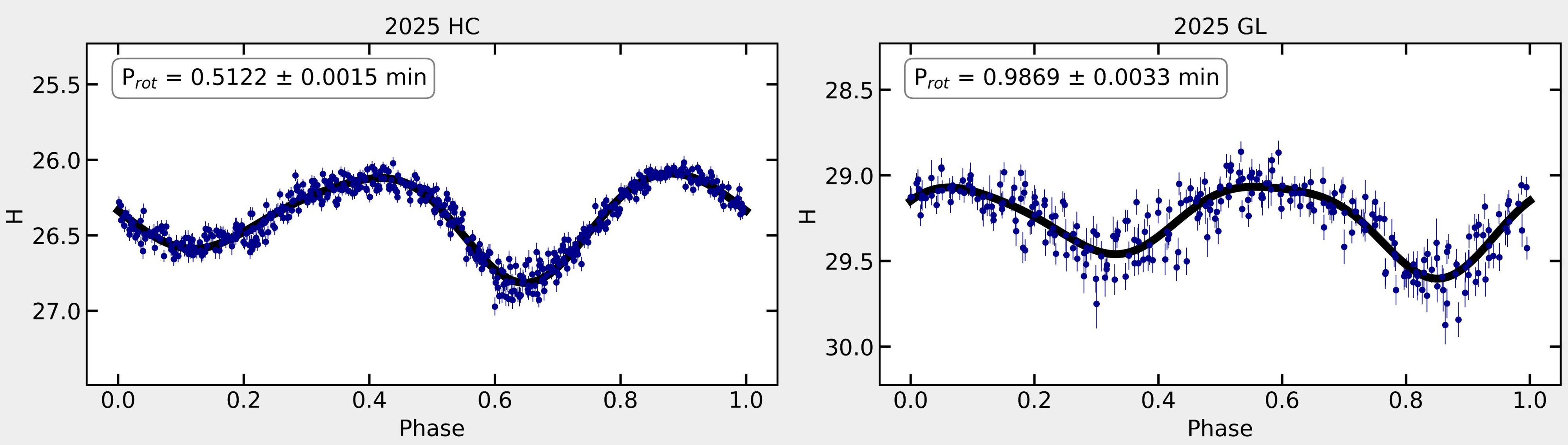
Among the fast rotators, **7** NEAs show evidence of **non-principal axis rotation** (tumbling).



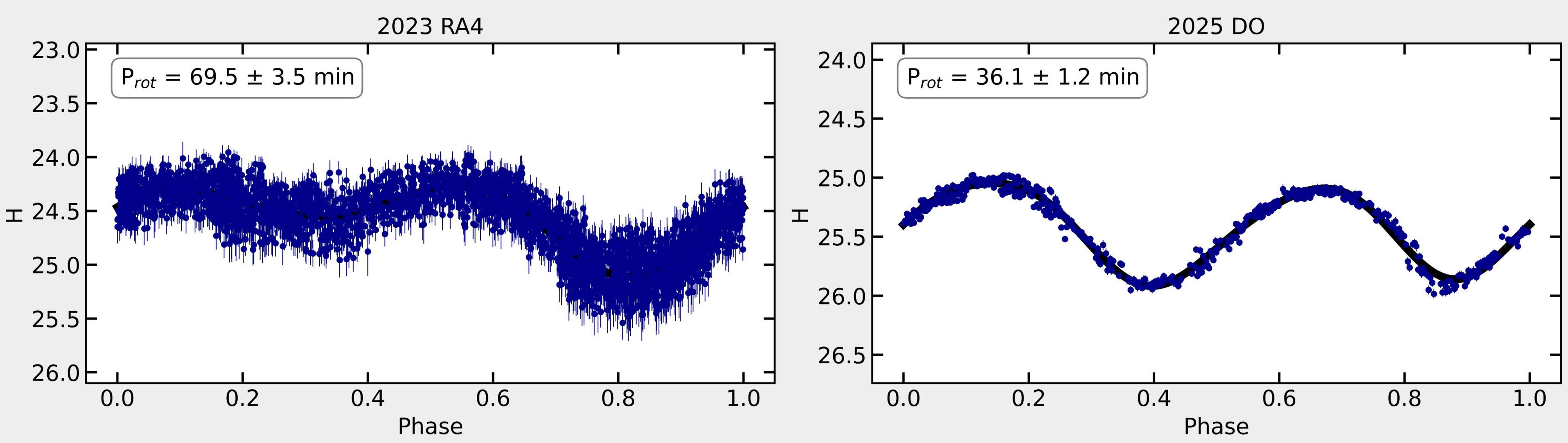


Light curves of some the targets

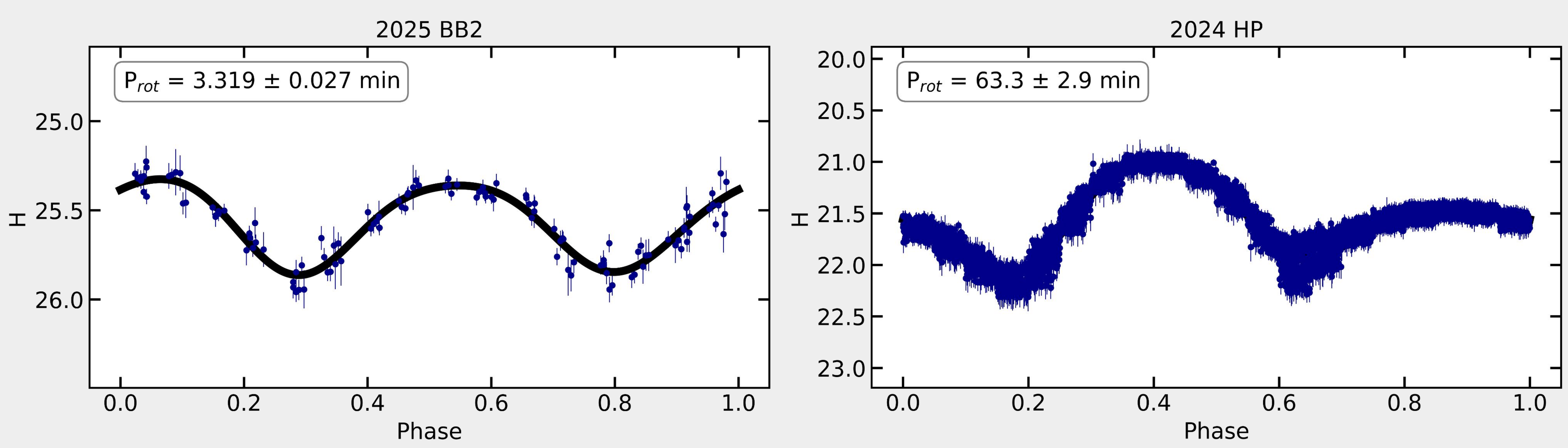
The fastest spinners: sub-minute rotation periods



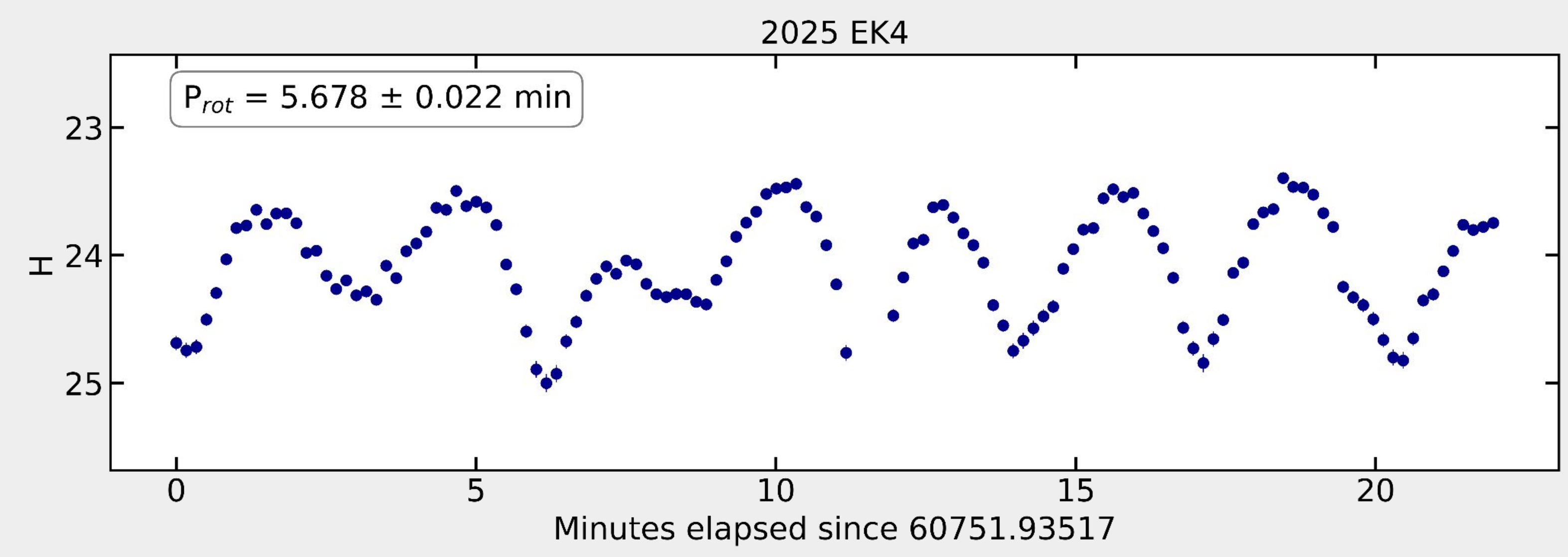
Potential mission targets (NHATS)

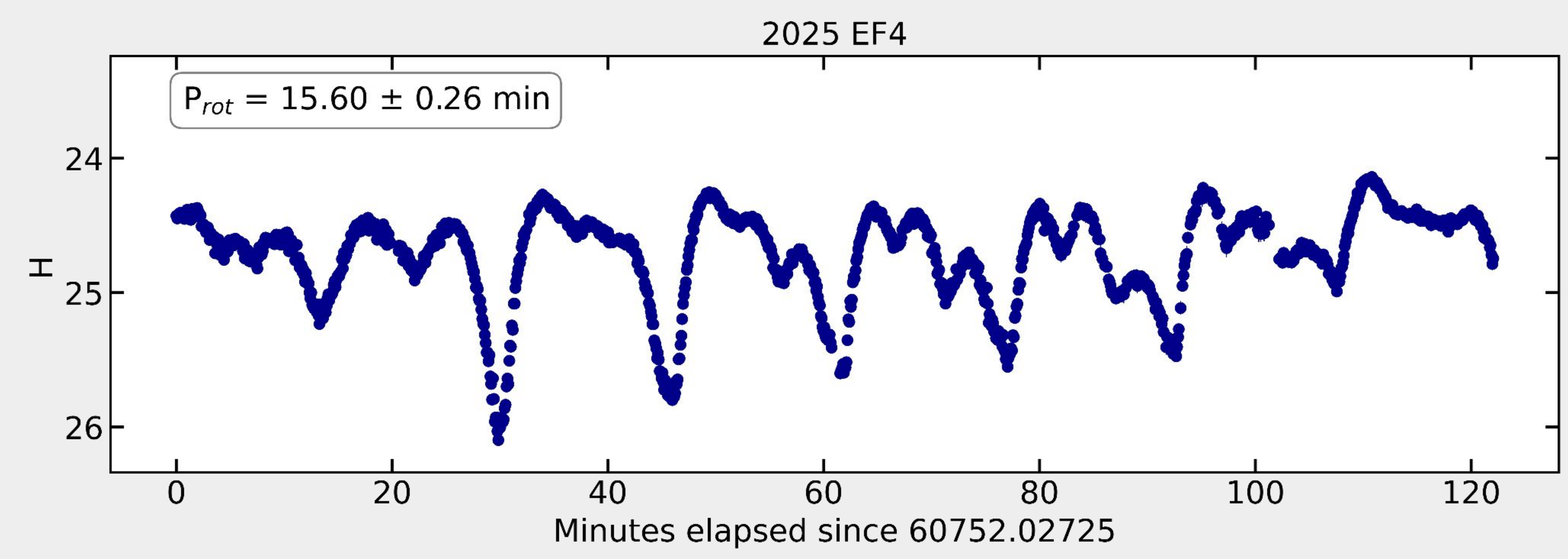


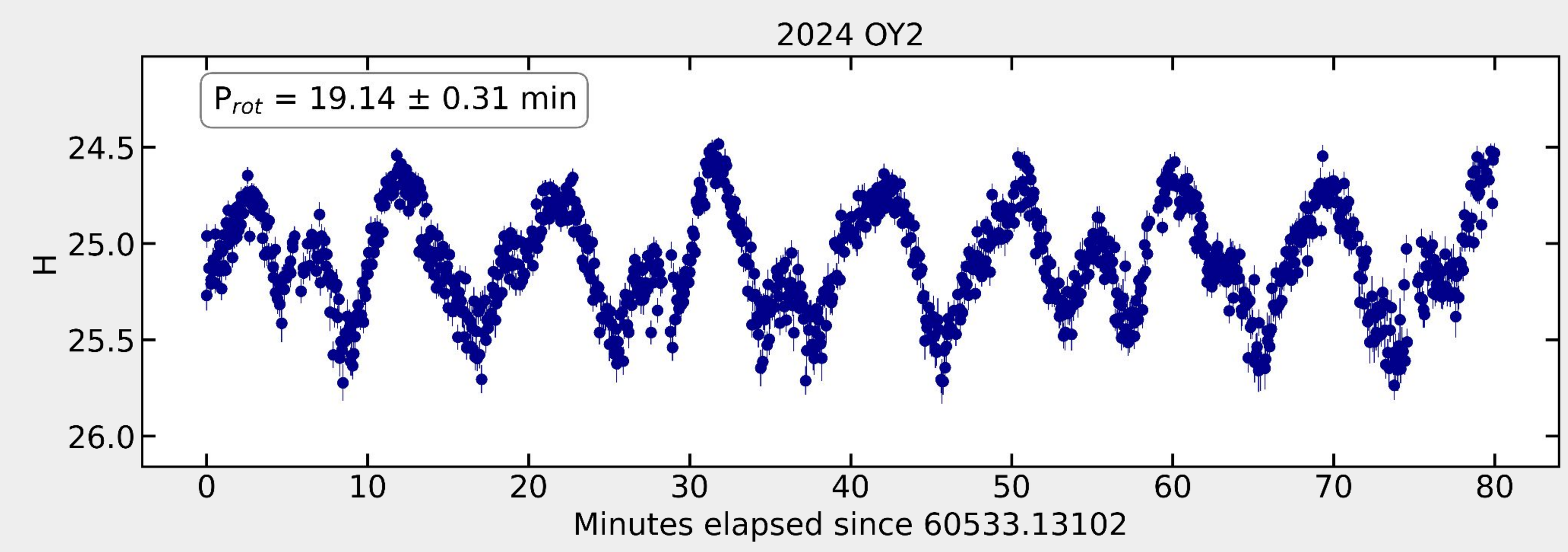
Observed Goldstone targets: Complementary to radar observations



Non-principal axis rotation







Hergenrother & Whiteley 2011, *A survey of small fast rotating asteroids among the near-Earth asteroid population*. Icar **214**, 194

Pravec and Harris 2000, *Fast and Slow Rotation of Asteroids*. Icar **148**, 12

Pravec et al. 2005, *Tumbling asteroids*. Icar **173**, 108

Licandro et al. 2023, *Observations of two superfast rotator NEAs: 2021 NY1 and 2022 AB*. MNRAS **521**, 3784

Sánchez & Scheeres 2014, *The strength of regolith and rubble pile asteroids*. M&PS **49**, 788

Sánchez & Scheeres 2020, *Cohesive regolith on fast rotating asteroids*. Icar **338**, 113443