

Euclid: Asteroid rotation periods from the Euclid Ecliptic Survey[★]

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ABSTRACT

The Euclid Ecliptic Survey was conducted during the calibration phase of the mission, from 23 to 31 December 2023, as a campaign to study Solar System objects. We used data from this survey to analyse more than 23 000 appearances of 2321 known asteroids. Due to their high apparent angular motion relative to the background stars ($5\text{--}60''\text{ h}^{-1}$), these objects appear as streaks in VIS long-exposure images. We set out to estimate their spin periods, since only 7% of them have periods published in the literature. We used multiple apertures along each streak to increase the time resolution of our light curves. Our method combines a Lomb–Scargle approach with a Markov chain Monte Carlo (MCMC) algorithm to characterise the posterior distributions. Some asteroids show multimodality in the MCMC search, indicating period aliases; in these cases, we report all aliases and their likelihoods. We validate our pipeline by comparing our fitted periods with 48 published periods, including period harmonics. We find that 44% of our periods are within 1% of those published and 98% are within 15%, and we establish that with 98% confidence the best solution can be found among the first three aliases. All reliable periods reported are in agreement with our current understanding of the spin-period distribution for asteroids. We find 16 periods below the spin barrier of 2.2 h with absolute magnitudes below 19, and thus 16 candidate super-fast rotators. We provide light curves for all 2321 objects observed and 889 high-quality periods in an open-access catalogue. The asteroids with reported periods include five Mars crossers, four Cybeles, four Hildas, three Hungarias, and 877 asteroids in other regions of the main belt. Our results represent the first batch of spin periods extracted from light curves and include the first-ever period measurements for 93% of the objects.

Key words. astronomical databases: miscellaneous – surveys – minor planets, asteroids: general

1. Introduction

Time-resolved photometry can reveal key asteroid properties. For principal-axis rotators, rotation appears as a periodic

signature in the asteroid light curve that can be used to determine the rotation period, also known as the spin period. In turn, the spin period can help with the analysis of other physical characteristics. It can constrain asteroid surface features, since surface smoothness relates to faster spin rates (Persson & Biele 2022), as well as the internal structure, since fast rotators are thought to

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be monolithic, while rubble-pile asteroids with relatively short periods may suffer from rotational instabilities leading to failure modes (Pravec et al. 2002; Hirabayashi et al. 2015). The spin period can help us study the thermophysical properties and grain size of the observed asteroids (Spencer et al. 1989; Lagerros 1996; Müller & Lagerros 1998; Rozitis & Green 2011; Marciniak et al. 2019). This is relevant for interpreting the thermal infrared emissions using telescopes such as the Wide-field Infrared Survey Explorer (Wright et al. 2010) or the upcoming European Space Agency’s Near-Earth Object Mission in the Infra-Red (Conversi et al. 2024) and NASA’s Near-Earth Object Surveyor (Mainzer et al. 2023). The shape of an asteroid is influenced by its current and past spin rates (Barnouin et al. 2019), and through shape models we can connect the spin period to the mass distribution of the asteroid (Ostro et al. 1995) and to the features of any binary companions (Pravec et al. 2006; Scheeres et al. 2006). The sources of asteroid rotation, mainly past collisions and the Yarkovsky–O’Keefe–Radzievskii–Paddack (YORP) effect, can also be studied using spin-period analysis (Rubincam 2000; Pravec et al. 2002; Taylor et al. 2007; Marzari et al. 2020).

While these findings are informative at the individual level, collecting a statistically significant sample of asteroid spin periods can provide insights into the formation history of our Solar System. In particular, the asteroid main belt (MB), located between Mars and Jupiter, is relevant to understanding aspects such as the migration of the giant planets to the outer Solar System (Clement et al. 2020, and references cited therein) or the origin of near-Earth objects (Granvik et al. 2017). However, as of November 2025, periods have been published for fewer than 5% (around 50 000) of the known asteroids (Berthier et al. 2023). Of these, only about 20% of the periods that include reliability flags are considered to be of high quality. The light curve analysis required to determine the spin period often needs many high-quality data points, and the brightness variations, if subtle, can lie below the noise level of small telescopes.

In this work, we exploit the capabilities of the European Space Agency’s *Euclid* space telescope (Euclid Collaboration: Mellier et al. 2025) to expand our catalogue of asteroid spin periods. Although large astronomical surveys covering extensive portions of the sky have produced large amounts of asteroid data in the last decade, their observing strategies have typically yielded sparse photometry for these objects. This is the case for the Zwicky Transient Facility (Bellm et al. 2018), Pan-STARRS (Kaiser et al. 2002), and the Asteroid Terrestrial-impact Last Alert System (Tonry et al. 2018). Conversely, dense asteroid light curves that can be used to determine spin periods accurately remain relatively scarce in the literature and have never been gathered for the faintest apparent magnitudes in the range of the *Euclid* Visible Camera (VIS; Euclid Collaboration: Cropper et al. 2025), between 20 and 24. The observing strategy of *Euclid*, even if not primarily designed for asteroid science but for cosmological studies, nevertheless allows us to obtain dense photometry and to fill an unexplored gap in the asteroid population.

As is discussed by Carry (2018), during its nominal six-year mission *Euclid* will observe up to 150 000 Solar System objects (SSOs, which includes asteroids and comets) with extraordinary photometric stability. Since the mission will reach fainter magnitudes than previous surveys, many of these asteroids will have never been observed before. To test the potential of *Euclid* to find and characterise SSOs, a dedicated campaign, the *Euclid* Ecliptic Survey (EES), was conducted during the *Euclid* phase-diversity calibration (PDC) at the beginning of the mission, before the start of the *Euclid* Wide Survey

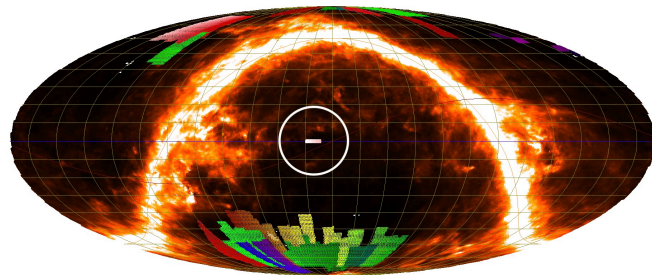


Fig. 1. Position in ecliptic co-ordinates of the EES (encircled in white) in the context of the DR1 (coloured tiles), projected using the *Euclid* Survey System (Gómez-Alvarez et al. 2018). The survey took place from 23 to 31 December 2023 and lay on the ecliptic plane, since it was designed to approximately follow the motion of the asteroids in the MB. A detail of the survey can be seen in Fig. 2.

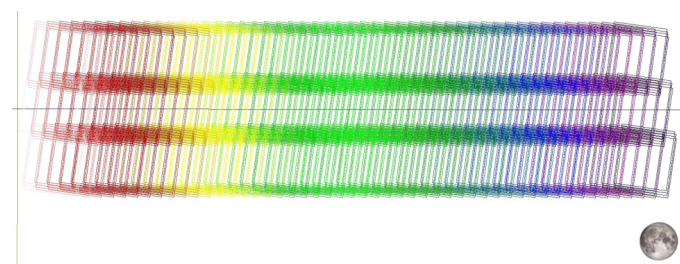


Fig. 2. Detail of the observing strategy of the EES, which starts on the rightmost squares on 23 December 2023 (black) and ends on the leftmost squares on 31 December 2023 (pink). Each square corresponds to a single exposure of 560.5 s (dither) and each observation is comprised by four dithers. Within each observation, the four dithers follow an S-shaped pattern. The observations had a high overlap to ensure that the asteroids observed would be seen in as many exposures as possible. In the figure, ecliptic longitude increases from right to left and the ecliptic latitude increases from bottom to top (ecliptic north is up). The Moon is displayed for a scale reference.

(Euclid Collaboration: Scaramella et al. 2022). The PDC observations require thermal stability and it was decided to use the thermal stabilisation periods for three sets of dedicated observing programmes, one of which was for SSOs. During this campaign, from 23 to 31 December 2023, VIS was pointed directly at the ecliptic plane and approximately followed the average motion of the MB. This strategy allows us to extract denser, longer light curves and observe more SSOs than the nominal *Euclid* Wide Survey mode, which generally avoids the ecliptic plane and hence produces sparser SSO photometry. The EES used both *Euclid* instruments, VIS and the Near Infrared Spectrometer and Photometer (NISP; Euclid Collaboration: Jahnke et al. 2025). For the purposes of this study, we only use data from VIS; the NISP analyses including thermal data are presented in a separate publication that will include a photometric analysis followed by taxonomic classification based on the multiband photometry (Pöntinen et al. 2025, Pöntinen et al., in prep.).

Figure 1 shows the EES in context, projected in ecliptic co-ordinates, and Fig. 2 presents a detail of the observing strategy. In this work, we use all 148 observations collected during the EES. We use trailed sources detected by Pöntinen et al. (2025) and search for periodicity in their signal. We build upon previous research that developed semi-automated pipelines to ingest the large volume of data produced by large surveys. The work pioneered by Polishook et al. (2012) and continued by Waszczak et al. (2015) and Chang et al. (2017) applied Fourier analysis to determine the spin periods of thousands of asteroids observed

by the Palomar Transient Factory. Later studies shifted towards the use of Lomb–Scargle algorithms, which are more robust to unevenly sampled time series, as is generally the case for asteroid light curves (e.g. Erasmus et al. 2021; Eglitis & Svincicka 2025). As is discussed in these papers, the survey cadences used to obtain many of the published light curves yielded sparse photometry that could not always fully constrain the period, leading to ambiguous solutions. The newest surveys, such as the Vera C. Rubin Observatory, and the more recent use of space telescopes that provide denser light curves due to their observing strategy, such as NASA’s TESS and K2, have been shown to significantly improve previous spin-period estimates; for instance, the studies of Szabó et al. (2022), Sergejev et al. (2025), Vavilov & Carry (2025), or Greenstreet et al. (2026). Our work complements these efforts and paves the way for future analyses during the Euclid Wide Survey.

The remainder of the paper is structured in five parts. Section 2 describes the data products that we used for our analysis. In Sect. 3, we develop the mathematical expressions and physical assumptions we made to construct the model for our asteroid light curves. In Sect. 4 we explain our methodology and justify any technical decisions. In Sect. 5, we present and discuss the results obtained during the validation of our pipeline and include tables with our fitted periods. Lastly, in Sect. 6, we lay out the main conclusions of our study and comment on future work.

2. Data

Our work focuses on asteroids moving fast relative to the background stars, with apparent motions of $5\text{--}60''\text{ h}^{-1}$. Our detection capabilities impose this dynamical constraint: we do not observe faster objects, which would be near-Earth objects and are much less frequent (about 1000 times), and slower objects cannot be detected by the detection pipeline (see Pöntinen et al. 2020). The slow objects will be detected by a separate pipeline (Nucita et al. 2025). Since the telescope did not explicitly track these asteroids, they appear as streaks of light spanning 10–100 pixels in the VIS long exposures of 560.5 s (the pixel size of VIS is $0''.1\text{ pixel}^{-1}$). This allows us to extract multiple data points from each exposure and construct dense light curves to determine the spin period accurately. For our analyses, we used calibrated (Level 2) images retrieved directly from the Euclid data products in the Euclid Science Archive System, Observation IDs 66202–66350, with a stable zero-point magnitude of around 24.4. The VIS observation range is in the optical band (550–900 nm) and the instrument does not use any filters. A thorough description of the calibration and processing of these images can be found in Euclid Collaboration: McCracken et al. (2026). All data products used will be published as part of the Euclid Data Release 1 (DR1; Euclid Data Release 1 2026).

We used the catalogue of approximately 23 000 streaks detected by Pöntinen et al. (2025), which provides the equatorial (RA, Dec) endpoint co-ordinates. The streaks were found using StreakDet, a streak-detection software originally developed by Virtanen et al. (2016) to find fast-moving objects in telescopic surveys of space debris. The StreakDet configuration parameters were optimised using simulated Euclid VIS images (Pöntinen et al. 2020). The software was first applied to all VIS individual long exposures, producing output streak catalogues with a high number of false positives, caused by other linear objects in the image, mainly diffraction spikes. The VIS short exposures were not used by the detection pipeline. A post-processing step using interdither linking was introduced to identify streaks moving consistently between exposures,

requiring them to appear in at least three exposures to be valid. This stage decreased the percentage of false positives to around 1%. According to the tests reported by Pöntinen et al. (2020), StreakDet was estimated to achieve its best recovery results when applied to streaks brighter than magnitude 23 in the optical band and faster than $8''\text{ h}^{-1}$. Following the interdither linking, we relate them to known objects using the tool of the Virtual Observatory service SkyBot (Berthier et al. 2006), with an allowed uncertainty of $1''$. This allows us to link the streaks further across observations and considerably extends the observation baseline, resulting in each of the 2321 objects being observed an average of 10 times. Without this step and given the length of the Euclid observations, the period determination would not be possible, except for very short periods (below 1 h). For this reason, in this paper we focus on analysing the streaks of known objects and we leave the streak-linking and analysis of unknown objects found by Pöntinen et al. (2025) for future work. For a detailed account of the streak catalogue, see Pöntinen et al. (2025).

3. Light curve model

The apparent brightness of a rotating asteroid is affected by its shape, solar phase angle, and the distances to the Sun and the observer. The variation due to rotation is dominated by the shape of the object; albedo variations can also contribute, but for objects much larger than our target population (Magnusson 1991; Wiktorowicz & Masiero 2017). We followed the approach laid out in Harris et al. (1989), but we treated the solar phase angle and viewing geometry of each object as constant, since, in our case, the observations only cover a time span of several hours or, at most, several days. We can fit a model of the asteroid flux $\Phi(t; \alpha)$ to the resultant light curve using a truncated Fourier series of n harmonics,

$$\Phi(t; \alpha) = \sum_{k=1}^n A_k \sin\left(\frac{2\pi kt}{P} + \phi_k\right) + C, \quad (1)$$

where P is the period, A_k and ϕ_k are the amplitude and phase of the k th harmonic, and C is the average brightness. The parameter vector α includes a term $\ln S$, the Gaussian intrinsic scatter (for a detailed discussion, see Kelly 2007), which is capped at the maximum photometric uncertainty and accounts for additional variability or other sources of uncertainty not modelled, such that $\alpha = (A, P, \phi, C, \ln S)$.

For simplicity, in our analysis we retain the single-harmonic representation ($n = 1$), which is proved to be sufficient later in our study. Even if the asteroids are not perfectly ellipsoidal, we assume that they present two maxima and two minima per rotation (double peak), so that we can fit a sine period and interpret it as half of a rotation period,

$$\Phi(t; \alpha) = A \sin\left(\frac{2\pi t}{P} + \phi\right) + C, \quad (2)$$

where the period of the asteroid, P_{ast} , is $P_{\text{ast}} = 2P$.

We denote the observation times as $T = \{t_j\}$ and the corresponding photometric uncertainties as $E = \{\sigma_j\}$, where we assume that the uncertainty of each measurement with respect to the model is independent and Gaussian. This allows us to express the likelihood over the entire light curve $Y = \{y_j\}$,

$$\mathcal{L}(Y | T, E, \alpha) = \prod_{j=1}^N \frac{1}{\sqrt{2\pi(\sigma_j^2 + S^2)}} \exp\left[-\frac{(y_j - \Phi_j)^2}{2(\sigma_j^2 + S^2)}\right], \quad (3)$$

where $\Phi_j = \Phi(t_j; \alpha)$ is the model at time t_j .

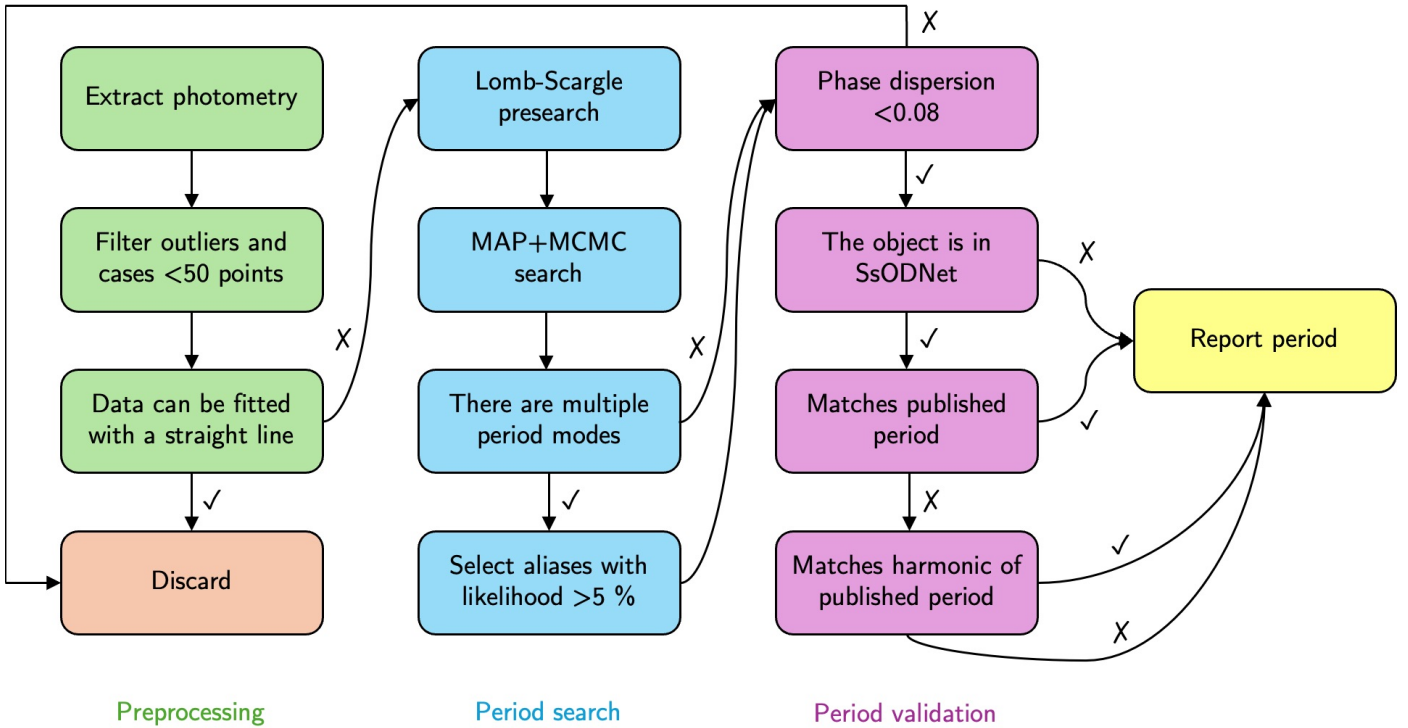


Fig. 3. Diagram summarising the general workflow of our pipeline. We first build our light curves, excluding the outliers and cases with insufficient signal. Then, we search the period using multiple algorithms and, after filtering, compare our results with those published in the catalogue.

To further constrain the parameters of our model, we adopted priors with hard parameter bounds. This ensured that all parameters remained within a physically meaningful range of values. We can note the prior distributions as $p(\alpha | \psi)$, where ψ conveys the set of prior bounds. Using Bayes’ theorem and Eq. (3), the posterior distribution is then given by

$$p(\alpha | T, Y, E, \psi) \propto \mathcal{L}(Y | T, E, \alpha) p(\alpha | \psi), \quad (4)$$

which serves as the basis for the optimisation and sampling methods that are described in the following section.

4. Methods

The methodology described in this section is summarised in Fig. 3. Our approach is divided into three parts: pre-processing, which includes extracting the photometry and filtering the outliers, period finding, which includes several search algorithms, and period validation, which uses two different tests to assess the validity of the results.

4.1. Photometry extraction

Traditionally, asteroid-tracking surveys have used circular aperture photometry on their targets, which appear as point sources amidst a background of trailed stars. On the contrary, in this work the stars are point sources, while the asteroids are streaked. This approach offers the advantage of a higher sampling rate than a point source but challenges conventional photometric approaches. To overcome this challenge, we highlight two existing solutions: TRIPPy, by Fraser et al. (2016), and the more recent method described in Devogèle et al. (2024). We chose

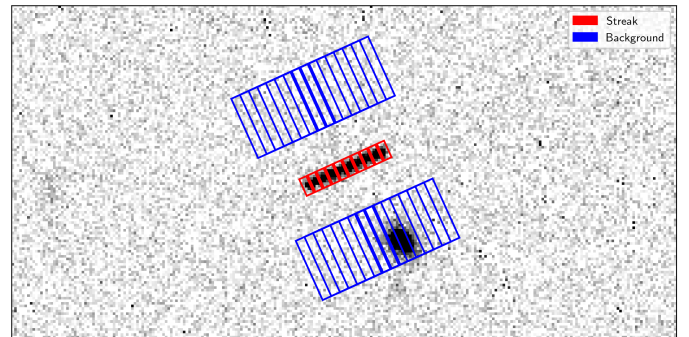


Fig. 4. Example streak with apertures placed along the direction of motion of the asteroid to increase the temporal resolution of the sampling. A bright galaxy falls on several of the background apertures; the approach to address it is described in Sect. 4.1.

the latter approach, since it is better optimised to extract the photometric information needed to constrain the spin period.

In this approach, we covered the streak with rectangular apertures instead of the conventional circular apertures used for point-source objects. This allowed us to align several apertures along the direction of the streak, each covering a small fraction of it, and to maximise the signal-to-noise ratio (S/N) collected by each aperture. We placed two additional larger apertures to compute the level of the sky background, one on each side of each streak aperture and at a sufficient distance (10 pixels) to avoid collecting any signal from it. The distribution of the apertures taken can be seen in Fig. 4.

The streak aperture size was determined by considering the following four conflicting objectives.

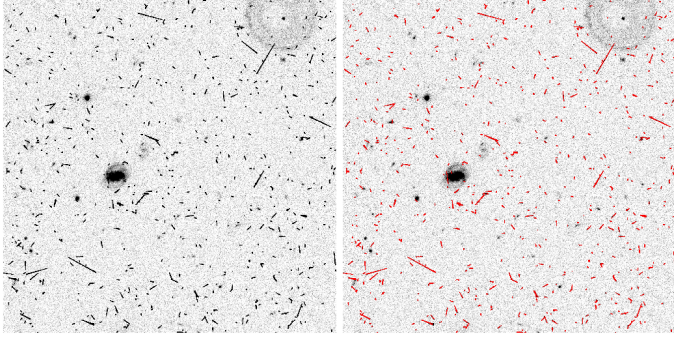


Fig. 5. Cut-out of VIS image comprising (left) and the same image with the overlaid mask of cosmic rays in red (right).

- Maximise the temporal resolution, which requires the direction along the streak (length) to be as short as possible.
- Maximise the S/N by increasing the aperture length.
- Minimise the flux loss, which requires the direction perpendicular to the streak (width) to be as large as possible to encompass the streak fully.
- Maximise the S/N, which requires the width not to exceed the streak bounds.

The four criteria are balanced empirically for the target *Euclid* asteroids. We find that an aperture size of 5 pixels along the streak \times 7 pixels perpendicular to it guarantees a high temporal resolution, even below 1 min, while optimising the S/N. This choice is conservative in width to account for bright asteroids, which extend over a larger number of pixels. For each aperture, the uncertainty in the measured flux is calculated using the CCD equation, which accounts for flux, background noise, and the aperture sizes of both the streak and the background. In this case, the dark current and readout noise are negligible. A more detailed discussion of these considerations can be found in Devogèle et al. (2024).

Since *Euclid* is located outside of Earth’s atmosphere, the images contain a large number of cosmic rays (10^5 per exposure during the EES, a level that can increase significantly during periods of intense solar activity). During the photometric reduction of the Level 2 data, the *Euclid* Consortium pipeline incorporated flags that recorded the exact positions of all cosmic rays in each exposure. However, we observe that these flags, which are designed for a more general cosmic-ray masking, search for isolated linear features and do not discriminate between the unwanted cosmic rays and our target asteroid streaks. For this reason, we used the cosmic-ray masks independently produced with Astro-SCRAPPY (McCully et al. 2018) as a part of the pipeline built by Nucita et al. (2025), specifically developed to avoid flagging asteroid streaks. We find the method to be successful at this task and highly effective at flagging cosmic rays. An example of a cosmic-ray mask that we used can be seen in Fig. 5.

Pixels flagged as cosmic rays that fall inside one of the apertures were handled differently depending on the aperture type. In the background apertures, we removed all pixels containing cosmic rays. This removal does not bias our calculation of the sky background, which is based on the median of each background aperture. For streak apertures, we attempted statistical inference and deep-learning algorithms, but they both produced artificial flux variations unrelated to the rotation of the asteroid. Since only removing the affected pixels would lower the flux extracted from that aperture, artificially creating an unphysical

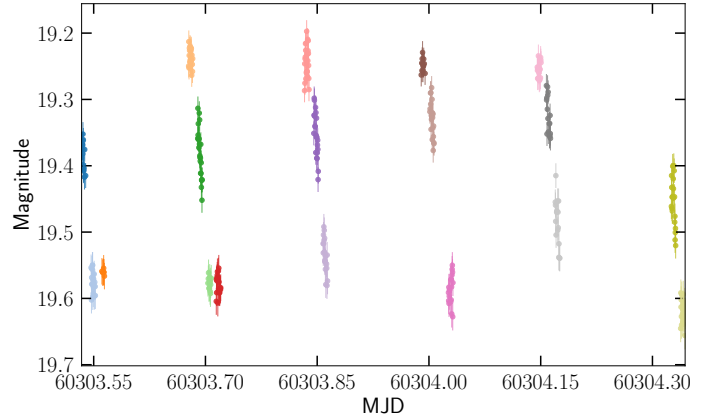


Fig. 6. Light curve of asteroid (18957) Mijacobsen. The time range covers several rotations; however, the sampling intervals are highly regular, which can potentially cause period aliases (a possibility discussed in Sect. 4.2.4). Each data cluster and colour corresponds to a different streak of origin.

drop in the light curve, we decided to remove the entire aperture in these cases. Beyond cosmic rays, apertures can also be contaminated by other objects such as stars or galaxies, as in the example in Fig. 4. Background apertures are least affected by this type of unwanted flux since we use sigma clipping and then take the median of the resultant values. Streak apertures affected are removed using a more complex outlier filtering at a later stage.

To build our light curves, we determine the timestamp of each aperture by mapping the endpoints of the streaks to the start and end times in the header (expressed in modified Julian date, MJD) and dividing the total exposure time by the number of apertures. We verified the direction of the streaks by confirming that the sign of the RA, Dec variation within each streak matched the sign of the RA, Dec variation between streaks. To improve the spin-period analysis, we post-processed the light curves, trimming the first and last points, which have shorter exposure times, and removing the outliers. This ensures that the period determination is not artificially affected by contaminating objects covering the streaks, such as galaxies, stars, or image artefacts. We flag outliers with a winsorised sigma-clipping algorithm that removes points more than 2σ away from the median of each streak or 2σ away from the median of each light curve. This routine is iterated until convergence and allows for the subsequent determination of the period. Our tests show that without the sigma clipping, the period fit is wrongly driven by the outliers. We show several examples of our light curves in Figs. 6–8.

4.2. Period determination

4.2.1. Preliminary vetting

In certain cases, either because the coverage is too short or because the amplitudes of the light curves are smaller than the measurement uncertainties, the light curves do not contain enough signal to constrain a period. As is shown in Fig. 9, we flag these cases by fitting a constant through each light curve; whenever the reduced chi-square, χ_r^2 , is 2 or below, we discard the light curve for period analysis. We also discarded light curves with temporal coverage below 1 h after observing that in these rare cases, the algorithm always fits the noise instead of the data. The discarded light curves are presented in Appendix B. We find that using this conservative threshold flags cases that lack enough

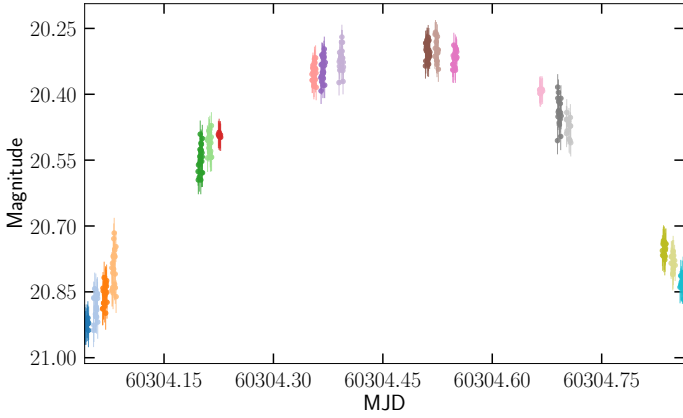


Fig. 7. Light curve of asteroid 2000 SQ₂₄. The time range covers less than one full rotation, which makes the spin-period determination highly suspect. Each data cluster and colour corresponds to a different streak of origin.

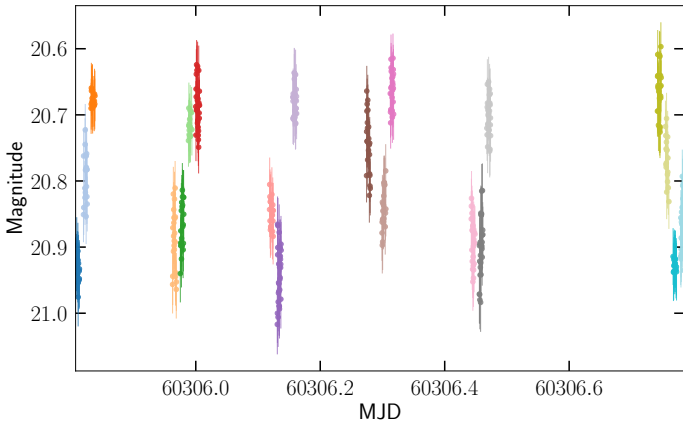


Fig. 8. Light curve of asteroid 2005 RE₂₉. The time range covers several rotations, which allows for reliable spin-period determination. Each data cluster and colour corresponds to a different streak of origin.

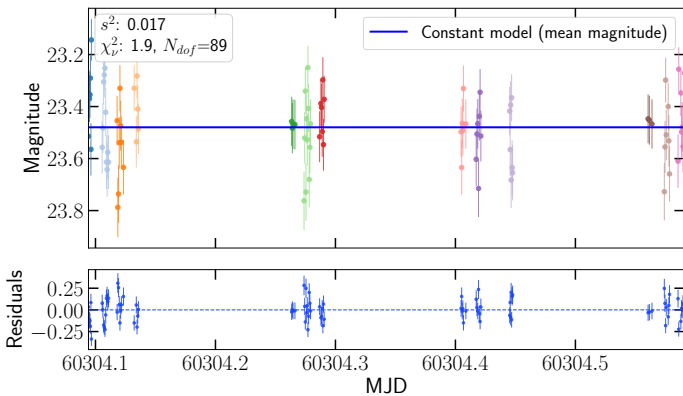


Fig. 9. Light curve of asteroid 2010 ES₈₉ fitted by a constant. The data are coloured by streak of origin. The fit is adequate, which implies that the data do not have enough signal to allow for a high-quality period search. We discarded this light curve.

variability for the period search. We then searched for rotation signatures in the light curves using a three-stage approach: Lomb–Scargle periodogram for initial period estimation, maximum a posteriori (MAP) optimisation to refine the estimate, and Bayesian inference with Markov chain Monte Carlo (MCMC) to find the best value.

4.2.2. Lomb–Scargle pre-search

As is discussed in Sect. 1, the Lomb–Scargle algorithm is more robust than simple Fourier analysis for unevenly sampled time series (VanderPlas 2018), which is generally the case for asteroid light curves. It is often applied to infer a period that is used as an initial guess when optimising the model or refined using other search methods, such as MCMC. In the case of the *Euclid* asteroids, the number of data points, the number of observations, and the data sparsity can vary from one object to another, which makes the use of the Lomb–Scargle method preferable. We used the `nifty-ls` method developed by Garrison et al. (2024), which is faster and more accurate than the default Astropy implementation. We used the power spectrum from the Lomb–Scargle estimation to set the bounds for the subsequent search, which ranges from 0.5–2.0 times the Lomb–Scargle period.

4.2.3. Bayesian inference via MCMC

Following the approach discussed in Foreman-Mackey et al. (2013), we improved the parameter estimates before the MCMC run by optimising the posterior in two stages. We first explored the parameter space with a global search using differential evolution within the bounds of the prior. Then, the best candidates were locally refined using an L-BFGS-B optimiser (Byrd et al. 1995). The result of this MAP estimate was used to initialise the MCMC walkers. This step does not impose any bounds on the search, but we observe it improves the convergence of the MCMC search.

After that preliminary optimisation had provided sensible starting values for the model parameters, we explored their full posterior distribution using Bayesian inference and the equations laid out in Sect. 3. This approach allowed us to quantify parameter uncertainties and correlations, and to assess the quality of the final model. To build our chains, we used the affine-invariant ensemble sampler implemented in the `emcee` package developed in Foreman-Mackey et al. (2013). In practice, each MCMC run was initialised near the parameter values found by the MAP optimiser, with small random perturbations to ensure there is diversity among the walkers. We followed the recommendations of the `emcee` documentation, which suggests using move mixtures to favour transitions between modes in multimodal posteriors. The lower bound for the period was 0.02 days (approximately 30 min) to include possible fast rotators. Faster periods are possible (see Greenstreet et al. 2026), but we expect them only very rarely in our target population, and we observe that reducing the lower bound causes the algorithm to fit the noise. The upper bound was set individually for each asteroid at twice the coverage of the observations; it should be noted that for periods found to be greater than the coverage, the result must be taken with caution and follow-up observations are required. We used 16 walkers, a number that exceeds twice the number of dimensions fitted, which is a requirement laid out in the `emcee` documentation. The samples of all jointly evaluated parameters represent the posterior distribution. We evolved the walkers for 100 000 steps, which is at least an order of magnitude greater than the estimated integrated autocorrelation time of the chains to ensure stable posterior estimates. We observe that increasing the number of steps beyond that value does not significantly affect the MCMC results, indicating that the chains converge well with the chosen value.

4.2.4. Best period and aliases

Particularly for light curves with large gaps or few data points, the spin-period solution can be degenerate, and the MCMC chain

can have multiple modes, known as aliases. This is illustrated in Fig. 11. In such multimodal cases, our data do not fully constrain the model, leaving multiple possible solutions for the period. To account for this, we take the median of the samples assigned to the most likely mode and report those parameters as the best fit. We also report all modes containing more than 5% of the samples as period aliases. The uncertainty of each mode, 1σ , is taken as the 16th–84th percentile range of the samples assigned to that mode.

4.3. Performance assessment

We first evaluated the quality of our estimates using a phase-dispersion metric. The phase dispersion can quantify whether the data cluster adequately when folded at a given period without assuming a specific model. We folded the light curves by the best period such that we map all points onto the phase interval $[0, 1)$. Grouping the points in bins of ten points, we computed the average of the variances inside each bin, σ^2 , and compared it to the overall variance of the folded light curve, s^2 . Considering that we use bins with equal number of points, our definition of the phase dispersion, Θ , is equivalent to that laid out in Stellingwerf (1978),

$$\Theta = \frac{\sigma^2}{s^2}. \quad (5)$$

A value of Θ close to 0 indicates an extraordinary good fit, whereas Θ close to 1 suggests a poor period estimate. We establish a threshold of $\Theta = 0.8$, above which we observe that the phase-folded light curves do not have a meaningful structure and discard them (although we still publish them in Appendix B). We report the Θ associated with the remaining periods to express, in each case, the reliability of our estimate. In addition, we report the phase coverage, ϕ_c , which quantifies what fraction of the rotation is sampled by our data. To calculate it, we divide the phase-folded light curve in ten equal bins and compute how many contain data points. In cases where ϕ_c is below 0.5, the fitted period should be interpreted with caution.

5. Results and discussion

5.1. Pipeline validation

We validated the performance of our pipeline by comparing our period estimates and their aliases with those published in the literature. We relied on real data to validate our method since there are no simulated datasets containing asteroid periods for *Euclid*. We chose to use the comprehensive Virtual Observatory web service Solar system Open Database Network (SsODNet) because it offers free access to a compilation of more than 3000 articles constantly being updated (see Appendix C), including millions of SSO parameters (Berthier et al. 2023). We accessed the server via the rocks Python client¹. Whenever an object has multiple peer-reviewed periods in SsODNet, we selected the closest match. Since the period quality flag is only available for a subset of the periods, we did not discard objects that had a low-quality flag. Only 60 of the periods in our final catalogue have been published by any of the sources in SsODNet, and we do not attempt a comparison with the periods that are more than twice our coverage using *Euclid*, which reduces the sample to 48 periods, all shown in Table A.1. We include the average magnitude, $\langle m \rangle$, which is calculated by converting C into magnitude,

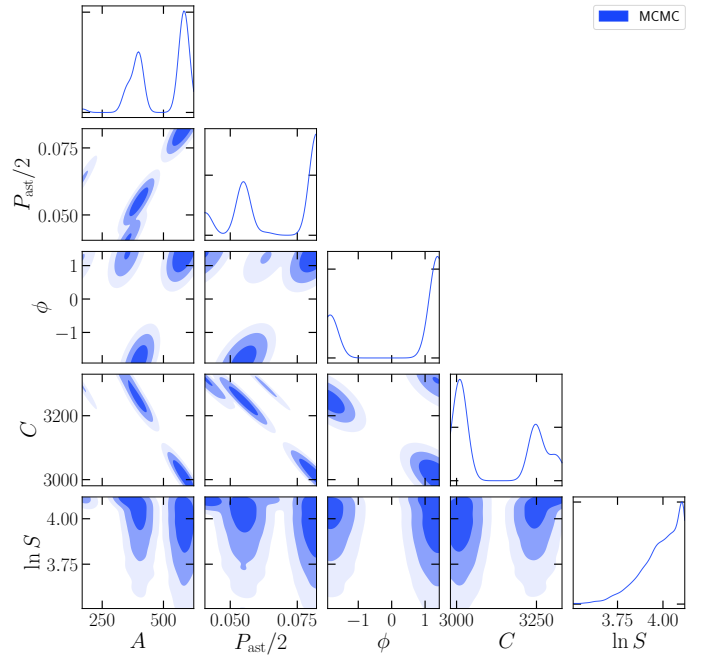


Fig. 10. Posterior distributions found during an MCMC search for asteroid (12776) Reynolds. The $P_{\text{ast}}/2$ panels show three clear modes for the period, which correspond to period aliases. In this case, the data have failed to constrain a unique solution. The range plotted is centred on the posterior and only a fraction of the searched space.

and the peak-to-peak amplitude, A_{p-p} , calculated using C and A . In cases in which our A is strongly overestimated and the calculation fails, we report a conservative A_{p-p} calculated as the difference in magnitude between the maximum and minimum flux. In these and other cases where the amplitude approaches 1 mag, the adopted light curve model does not reliably predict the amplitude, but this does not affect the validity of the period. None of the known periods had Θ above 0.8.

We compared our spin periods with all published periods in the database and the first few integer harmonics of the published periods: $2P_{\text{ast}}$, $3P_{\text{ast}}$, $4P_{\text{ast}}$, and their inverses $P_{\text{ast}}/2$, $P_{\text{ast}}/3$, and $P_{\text{ast}}/4$. Since harmonics convey physically equivalent descriptions of the same rotation state, the period can be reported in SsODNet with one of the harmonics, but represent an identical rotation. As opposed to aliases, which arise from sparse data, period harmonics are indistinguishable from each other; a rotation of period P_{ast} with a two-peak shape would present the same light curve as a rotation of period $P_{\text{ast}}/2$. Of the 48 matches with the database, a quarter (25.0%) of the periods have the closest match with a harmonic of the published period. For consistency, we report twice the fitted sine period, corresponding to a double-peaked light curve, although we note the harmonics and the fundamental period are mathematically equally valid solutions that cannot be distinguished solely from the photometry.

In cases in which our periods are multimodal, we compare the published period with all aliases. In this development, we confirm that none of the parameters can provide an unequivocal identification of a specific alias as the true value. For instance, the MCMC run performed on asteroid (12776) Reynolds can converge to three different modes, 0.16 days (the published value), 0.08 days (a harmonic of the published value), and 0.06 days. The resultant posterior distribution can be seen as a corner plot in Fig. 10, which shows distribution to three distinctive peaks in the period–period panel corresponding to the half period of the

¹ <https://github.com/maxmahlke/rocks>

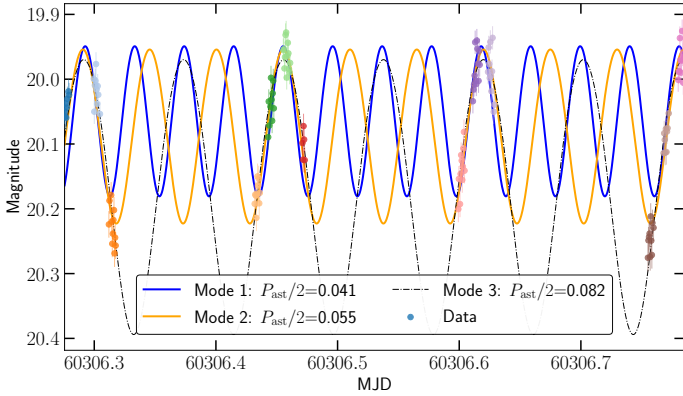


Fig. 11. Overlay of the three period aliases found in an MCMC run for asteroid (12776) Reynolds. Each data cluster and colour corresponds to a different streak of origin. Mode 3 is the most likely, followed by mode 2 and mode 1.

asteroid. Figure 11 illustrates why the three aliases cannot be unequivocally distinguished: the large and regular gaps between the different data clusters, corresponding to different observations, allow for the presence of multiple sine peaks. The first mode allows for three peaks in each data gap, the second allows for two, and the third allows for one. The third mode of 0.16 days, the published value, is the most likely fit in this case, but we observe that our best mode is not always the one closest to the published value.

More specifically, we note that in many of the cases, the mode closest to the published value is not necessarily the most likely or the one whose fit produced the best χ^2_v . However, using the full subset of published periods, we find a correlation between the likelihood of the reported modes and the distance to the published value: in 75% of the cases, the closest match is found with the most likely mode, and in 98% of the cases, with one of the three most likely modes; in other words, we establish a 98% confidence that the best solution can be found among the first three most likely modes.

Figure 12 shows the location of the fitted periods with respect to their published value. All modes found for a given period are connected by a line. The size of the points is proportional to their Θ , where a smaller size implies a better fit, while a darker shade of blue correlates with a brighter apparent magnitude. Figure 13 is a version of Fig. 12 with the modes collapsed to the mode closest to the published value or one of its harmonics.

After analysing the parameter distribution of the subsample, we find no clear correlation between the length of the fitted period and its divergence from the published value, as is shown in Fig. 14. We note that 1999 JA and 2001 RB₇₁, the only two cases with discrepancies greater than 20%, also have ϕ_c values below 0.5, which indicates that they are highly suspect.

We also inspect the relationship with Θ , shown in Fig. 15. Although the range of Θ values in this subset is not wide enough to extract strong conclusions, the plot shows a broad half-trumpet shape, indicating a possible correlation. The outlier to this trend in the top left corner of the figure is one of the objects with low ϕ_c , 1999 JA. The rest of the parameters, such as the number of data points, the relative amplitude of the data, the absolute and apparent magnitude of the asteroid, and the value of χ^2_v do not show consistent trends and we did not use them to predict the similarity with the published period.

Taking the published periods as the ground truth, we derived statistics on our accuracy. Looking at the central values, 44%

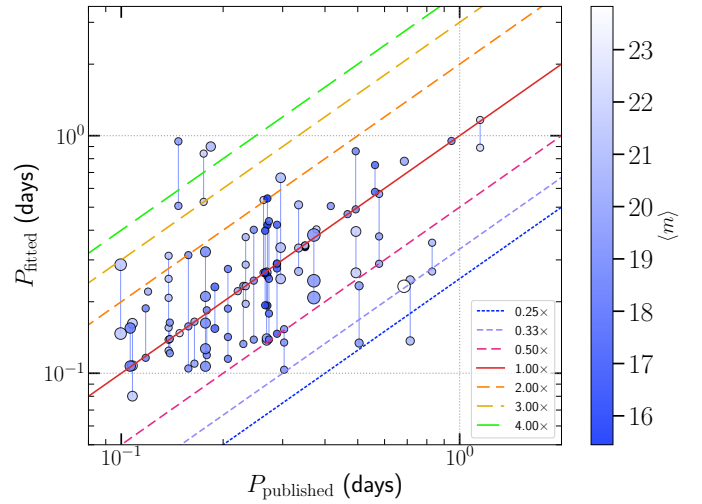


Fig. 12. Fitted P_{ast} , noted as P_{fitted} , against the published P_{ast} , noted as $P_{\text{published}}$, used for validating the pipeline. In cases presenting period aliases, the different modes are linked by a straight vertical line. The central, continuous red line indicates perfect agreement, while the dashed lines indicate agreement with a harmonic of the published period. The size of the points is proportional to their Θ , where a smaller size implies a better fit. The blue shading of the points indicates their average apparent magnitude, $\langle m \rangle$.

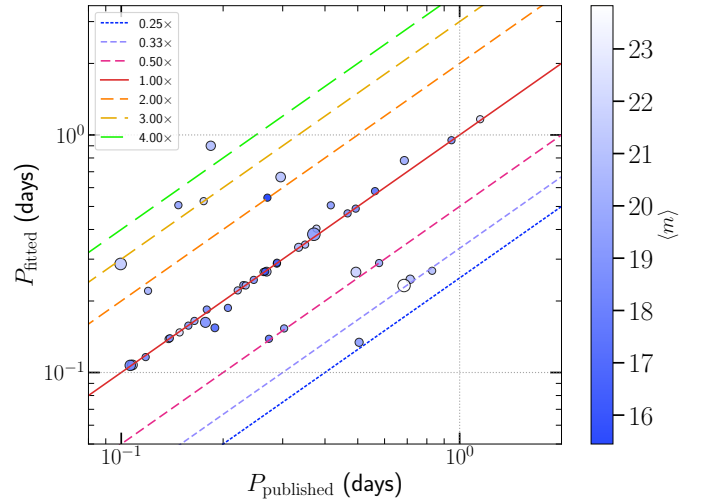


Fig. 13. Same as Fig. 12 but with the cases presenting aliases collapsed to the alias closest to the published period or its harmonics.

of our periods are within 1% of the published period (or one of its harmonics), 65% within 3%, 73% within 5%, and 94% within 15%. To compare our results with similar previous literature, Lam et al. (2023) tested their pipeline by using a dataset of 752 published periods and found that 88% of their periods were within 5% of the published ones. However, our dataset reaches much fainter magnitudes and our approach is sensitive to subtle variations (down to 0.1 mag), while their pipeline requires a magnitude variation of at least 0.3 mag to be detectable. The tests of Waszczak et al. (2015) on 927 periods showed that 67% of their periods were within 3% of the published, a comparable result to ours but for brighter magnitudes, centred around 19 mag. Although our validation sample size is smaller than that reported in the literature, we appear to achieve similar accuracy results for much fainter objects.

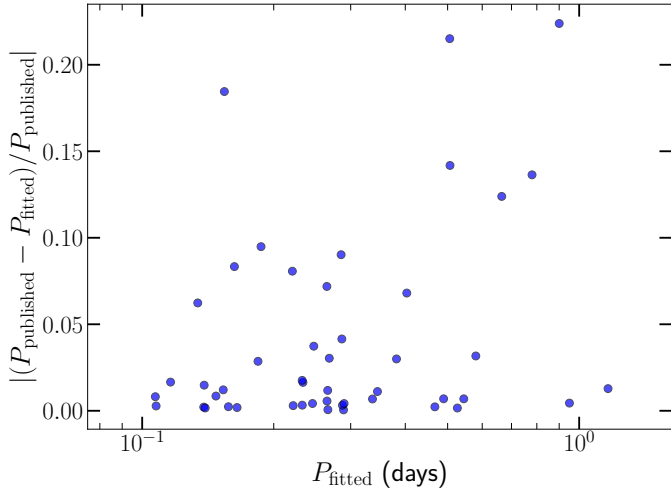


Fig. 14. Absolute fractional difference between $P_{\text{published}}$ (or, when applicable, the harmonic of the published period that was used for the comparison) and P_{fitted} as a function of P_{fitted} .

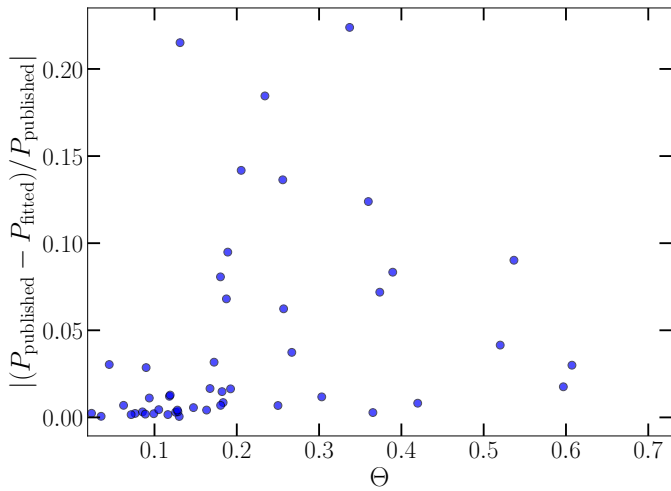


Fig. 15. Absolute fractional difference between $P_{\text{published}}$ and P_{fitted} as a function of Θ .

In addition, we should note that, even though we set the published periods as the ground truth, in some cases our data from the EES are more densely sampled and have better resolution than the published data using ground-based telescopes. Given that the *Euclid* telescope is not affected by atmospheric conditions, it is likely that some of our fitted periods are closer to the true value than those published. Whenever available, the quality code U illustrates the level of confidence of the value published in the literature: 3 and 3– do not allow for other solutions; although unlikely, 2+ might be in error; 2 may be wrong by 30%, and 2– indicates that the coverage was not enough to derive an accurate period.

Lastly, we rerun our fitting algorithm by adding a second term to the light curve model in Eq. (2) to assess whether the sinusoidal assumption held. We find that with the additional term, the MCMC routine struggles to converge to reasonable solutions and often overfits the data. This test confirms that in the particular case of our EES data, the simpler single-term model is sufficient.

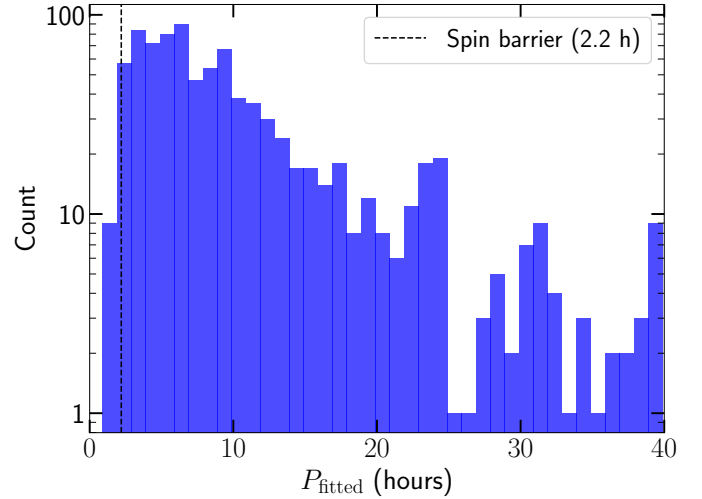


Fig. 16. Distribution of all 889 fitted periods in bins of 1 h. The distribution is denser for periods shorter than 1 day and shows an artificial peak in values near 2 days, resulting from the upper bound of the period search. In cases of multimodality, we plot the most likely period. The dashed black line shows the spin barrier at 0.092 days.

5.2. Period determination for known objects with unknown periods

After validating the performance of our pipeline, we use it to analyse the full dataset of 2321 known objects identified in the EES. Following the criteria described in Sect. 4, we discard 1125 of them because they are unsuited for our period analysis, and 202 after the period finding because they have Θ above 0.8. Given their size, we expect only a minority of our target asteroids to have periods below the spin barrier of 2.2 h, which implies that periods found in this range are more likely to be mistaken. We observe that in short periods for which the value of Θ is high, the algorithm has often fitted the noise. For this reason, we apply an additional filter and discard periods below the spin barrier that have Θ above 0.5 (see Appendix B). This further removes 105 asteroids from the sample, resulting in a dataset of 889 objects: in this subset, five are Mars crossers, four Cybele, four Hilda, three Hungaria, and 877 are located in other regions of the MB. We present a preview of the results in Table A.2; the remaining results are available as an electronic table at the Strasbourg Astronomical Data Center (CDS).

We observe that most of our periods (76%) present aliases, likely due to insufficient phase coverage caused by the cadence of our exposures. Even though the sampling pattern of the EES is dense, it is highly regular, which may lead to repeated gaps that can result in aliasing. We analyse the phase coverage in our sample and find that the average ϕ_c is 0.64, with a standard deviation of 0.19. Only a small fraction (9%) of the periods have full phase coverage, while 15% of the periods have ϕ_c below 0.5, which makes them highly suspect. To inform the reader, we include ϕ_c in Table A.2.

The filtered period distribution in hours is shown in Fig. 16, where we can observe that most periods are concentrated in the range below 1 day. The distribution presents a peak in its tail in longer values, artificially caused by the imposed upper bound on the period search, although the underlying periods could be longer. As such, periods near that value are likely longer in reality. We compared our period distribution with the published database using the Kolmogorov–Smirnov (K–S) test

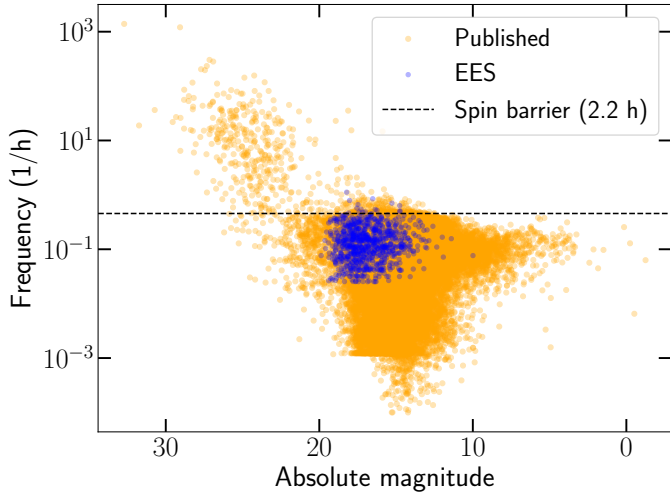


Fig. 17. Distribution of all 889 fitted periods in the context of the known distribution, from the literature. The dashed black line shows the spin barrier at 0.092 days.

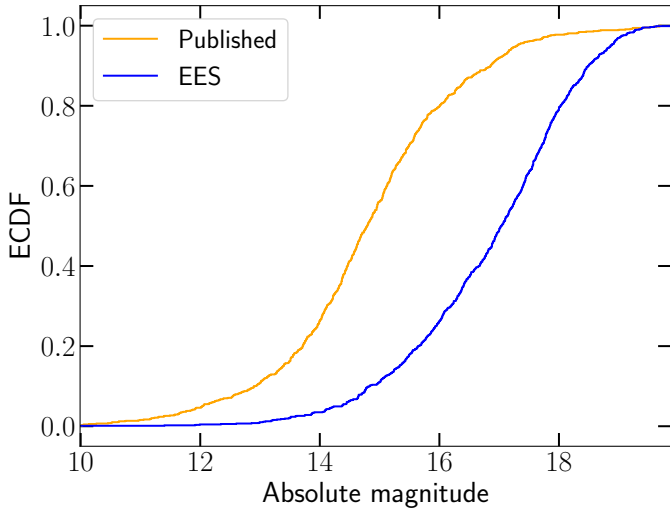


Fig. 18. One-dimensional K–S test comparing the empirical cumulative distribution functions (ECDFs) of our magnitude distribution and the published over the same period–magnitude range. The two distributions diverge, with cumulative differences of up to 55%. As expected, the EES objects are fainter.

(Massey 1951) and found that the two distributions are compatible, differing by at most 6% in cumulative fraction, as can be seen in Fig. 19. These subtle differences are expected and likely due to selection effects.

We then inspected the distribution of the fitted frequency in our sample as a function of the reported absolute magnitude. We plot the full catalogue of spins in the database in Fig. 17. Similarly to the case of Fig. 16, we observe an overly dense region in the band corresponding to the upper bound. Most of our asteroids have an absolute magnitude 15–19, which corresponds to a diameter size of approximately 1–5 km, assuming typical MB distances and albedo. We performed another K–S test to compare our frequency–magnitude distribution to that of the catalogue, and find that the two distributions differ, even after applying the cuts. As can be seen in Fig. 18, although the distribution of the EES is contained within the bounds of the published distribution, their shapes differ. On average, the objects of the EES

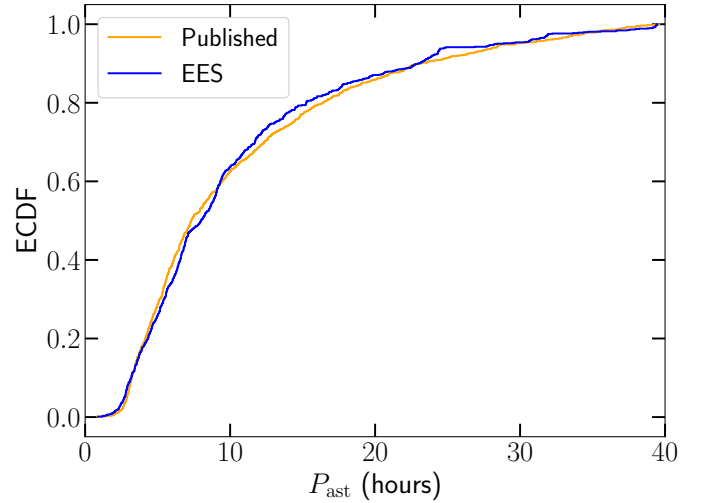


Fig. 19. One-dimensional K–S test comparing the empirical cumulative distribution functions (ECDFs) of our period distribution and the published one. The two distributions are found to be broadly consistent, with a maximum difference between the two cumulative distributions of 6%.

are significantly fainter than those published in the catalogue, with cumulative differences of up to 55%. Given that the *Euclid* mission reaches fainter magnitudes than most dedicated asteroid surveys, this behaviour is expected.

The second quality test we performed was to assess the reliability of the Θ indicator. We visually confirm that whenever Θ is above 0.8, the fit is almost random and we cannot reliably constrain the period of the asteroid. Figure 20 displays several cases of periods with high Θ . The first example shows some structure following the model; however, half of the data points are not aligned with it. The second and fourth examples show signs of variability, but the solutions are clearly not constrained by the data. In the third example, the data are highly dispersed and do not follow the model. We also establish that there is a correlation between low Θ values and higher-quality periods. In contrast to Fig. 20, Fig. 21 shows four examples with low Θ , all visually accurate. Two thirds (64%) of the fitted periods have Θ below 0.5.

Within the filtered periods, we find 16 that are below the spin barrier of 2.2 h. We observe that the light curves in this sample deviate from the first-order sinusoidal shape. This behaviour is expected from the increased rotation speed, which can lead to the presence of binary companions or rotation about an axis other than the principal axis (tumbling). We note that these objects are candidates for being fast rotators since they are below the spin barrier and, given their large size (all below absolute magnitude 19), they are considered candidate super-fast rotators. The rate found of approximately 0.5% (16/2321) is consistent with the literature (Strauss et al. 2024). The full list of candidates can be found in Table A.3, and four example phase-folded light curves are depicted in Fig. 22. The case of 1992 RC₄, 1999 XN₂₆ and 2000 GP₆₀ is particularly rare for their large size: 3.0 km (absolute magnitude 14.8). Since the *Euclid* sampling for these asteroids is sparse for such short periods, we will require follow-up observations to further constrain their rotation periods and confirm their status as super-fast rotators.

We built an open database containing the light curves of all 2321 objects studied, all period results, including the 889 high-quality periods, and their most relevant physical parameters. This

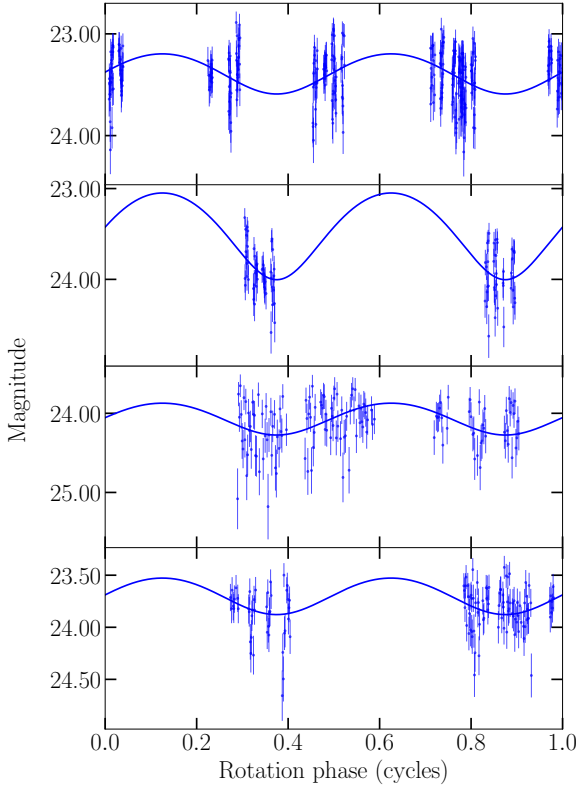


Fig. 20. Examples of phase-folded light curves using periods with Θ above 0.8, indicating a poor solution. All cases with Θ above 0.8 are discarded from the results. From top to bottom: 1996 RC₁₇, 2000 KW₈₄, 2001 MR₃, and 2002 GP₁₉₃.

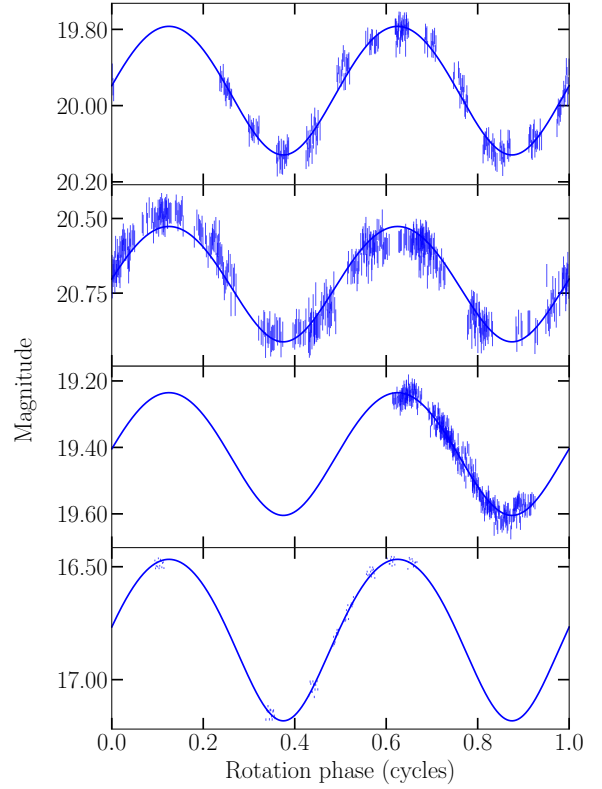


Fig. 21. Examples of phase-folded light curves using periods with Θ below 0.1, indicating an excellent solution. From top to bottom: 2000 VW₃₁, 2006 WG₁₀₈, (18957) Mijacobsen, and (2165) Young.

information will allow all users of our catalogue to interpret and use our data appropriately.

6. Conclusions and future work

We present a catalogue of spin periods for 889 MB asteroids observed during the EES, which took place at the beginning of the *Euclid* mission. This is the first set of spin periods extracted from *Euclid* light curves. The photometric precision and long exposures of the VIS images have allowed us to build dense light curves for many objects for which only sparse photometry was available before. Out of the 889 spin periods, 93% (829) had never been reported before. We validate the performance of our pipeline by comparing our fitted periods with the values published in the SsODNet database for the 48 cases with sufficient *Euclid* coverage. We find that in 44% of the cases, our fitted period is within 1% of the value published in the literature or one of its harmonics, and that 98% of our periods are within 15% of the published value. For the cases analysed, the largest driver of divergence from the published period is the phase coverage, and other parameters, such as goodness of fit, magnitude, or amplitude, have only a marginal effect.

With this work, we have aimed to expand our knowledge of the spin-period distribution in the MB and to complement, and even improve, the efforts of ground-based telescopes. Future work will focus on extracting the rotation periods of unknown objects observed during the EES by first linking their streaks across multiple observations. To strengthen our findings, we will incorporate data taken with other surveys. We will also work

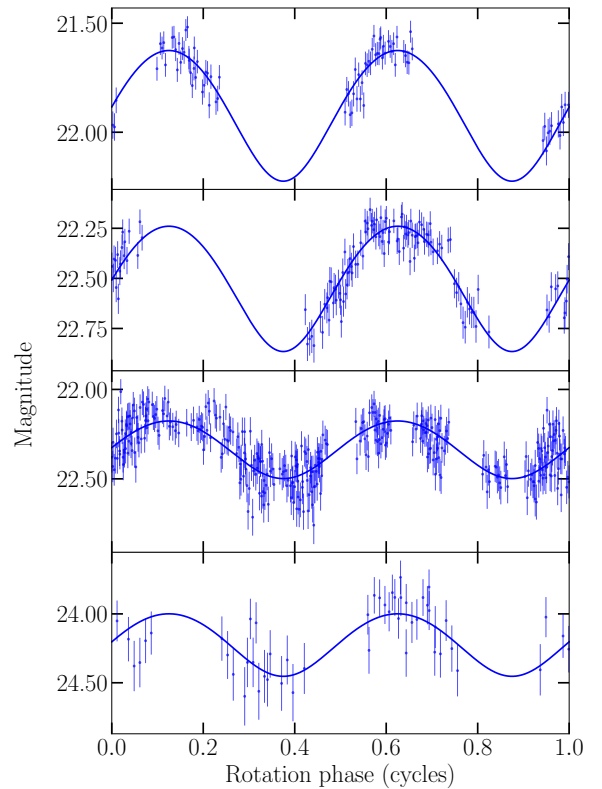


Fig. 22. Candidate super-fast rotators, with periods below 2.2 h. From top to bottom: 2005 SS₄₄, 2013 SG₆₄, 2015 XS₂₉₀, and 2023 TC₁₉₂.

on upcoming detections from the Euclid Wide Survey, which will provide sparser data but a higher likelihood of encountering near-Earth asteroids. This new dataset will enable us to test our pipeline on a different asteroid population and potentially shorter rotation periods. As the Euclid Wide Survey unfolds during the nominal six-year mission, we will expand our catalogue of asteroid rotational properties in future data releases.

Data availability

The data used for this study will become available in November 2026 with the DR1 (Euclid Data Release 1 2026). The full Tables A.2, B.1, and B.2 are available at the CDS via <https://cdsarc.cds.unistra.fr/viz-bin/cat/J/A+A/710/A27>.

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Appendix A: Tables

We present in Table A.1 a comparison between our fitted periods and those reported in the SSODNet catalogue; in Table A.2, a preview of the fitted periods from the EES, and in Table A.3, the candidate super-fast rotators in the EES. For a detailed discussion, see Sect. 5.1 and Sect. 5.2.

Table A.1. Comparison between our fitted periods and those reported in the SSODNet catalogue.

Name	P_{fitted} [h]	$P_{\text{published}}$ or harmonic [h]	$P_{\text{published}}$ [h]	Harmonic factor	Quality code	Fractional difference	$\langle m \rangle$ [mag]	ϕ_c
1993 FD ₂₂	6.93 ^{+0.02} _{-0.02}	6.94 ^{+0.01} _{-0.01}	13.88 ^{+0.02} _{-0.02}	1/2	U=2	0.001	20.04 ^{+0.01} _{-0.01}	0.3
1995 CD	4.49 ^{+0.01} _{-0.01}	4.960 ^{+0.003} _{-0.003}	4.960 ^{+0.003} _{-0.003}	1	U=2	0.095	18.67 ^{+0.01} _{-0.01}	0.4
1997 BQ ₆	6.35 ^{+0.03} _{-0.02}	5.92 ^{+0.14} _{-0.14}	11.85 ^{+0.29} _{-0.29}	1/2	U=2	0.072	21.824 ^{+0.008} _{-0.008}	0.8
1998 BB ₃₄	3.679 ^{+0.008} _{-0.007}	3.64	7.27	1/2		0.012	19.530 ^{+0.002} _{-0.002}	0.5
1998 FB ₆₁	5.889 ^{+0.004} _{-0.004}	5.9136 ^{+0.0001} _{-0.0001}	5.9136 ^{+0.0001} _{-0.0001}	1	U=2	0.004	19.192 ^{+0.002} _{-0.002}	0.8
1998 SU ₁₃₄	8.29 ^{+0.04} _{-0.03}	8.39	8.39	1	U=2	0.011	20.69 ^{+0.03} _{-0.03}	0.4
1999 JA	12.134 ^{+0.008} _{-0.003}	9.99 ^{+0.08} _{-0.08}	9.99 ^{+0.08} _{-0.08}	1		0.215	19.54 ^{+0.01} _{-0.01}	0.3
2000 AY ₂₃₉	5.30 ^{+0.03} _{-0.02}	5.76 ^{+0.06} _{-0.06}	2.88 ^{+0.03} _{-0.03}	2	U=2-	0.081	20.488 ^{+0.003} _{-0.003}	1.0
2000 CZ ₄₅	11.22 ^{+0.04} _{-0.04}	11.1948 ^{+0.0001} _{-0.0001}	11.1948 ^{+0.0001} _{-0.0001}	1		0.002	19.191 ^{+0.002} _{-0.002}	0.6
2000 GX ₇₅	5.93 ^{+0.16} _{-0.11}	5.71	17.14	1/3		0.037	21.075 ^{+0.007} _{-0.005}	0.9
2000 KY ₈	6.87 ^{+0.09} _{-0.09}	7.17 ^{+0.06} _{-0.06}	2.39 ^{+0.02} _{-0.02}	3	U=2	0.040	21.51 ^{+0.03} _{-0.03}	0.6
2000 QG ₁₂₀	5.60 ^{+0.01} _{-0.01}	5.51	5.51	1		0.016	19.478 ^{+0.002} _{-0.002}	0.8
2001 FQ ₇₇	6.38 ^{+0.07} _{-0.07}	6.4548 ^{+0.0001} _{-0.0001}	6.4548 ^{+0.0001} _{-0.0001}	1		0.012	20.57 ^{+0.02} _{-0.02}	0.4
2001 OF ₈	3.216 ^{+0.005} _{-0.005}	3.03	12.11	1/4		0.062	19.697 ^{+0.002} _{-0.002}	1.0
2001 QB ₉₃	18.72 ^{+0.40} _{-0.37}	16.47	16.47	1		0.136	20.255 ^{+0.005} _{-0.005}	0.3
2001 RB ₇₁	21.61 ^{+0.12} _{-0.21}	17.65348 ^{+0.00004} _{-0.00004}	4.41337 ^{+0.00001} _{-0.00001}	4		0.224	20.92 ^{+0.03} _{-0.03}	0.4
2001 VJ ₆	15.96 ^{+0.05} _{-3.40}	14.20 ^{+0.40} _{-0.40}	7.10 ^{+0.20} _{-0.20}	2	U=2+	0.124	21.14 ^{+0.01} _{-0.01}	0.6
2002 JJ ₇₄	6.85 ^{+0.07} _{-0.03}	6.28 ^{+0.24} _{-0.24}	1.57 ^{+0.06} _{-0.06}	4	U=2-	0.090	21.16 ^{+0.02} _{-0.02}	0.4
2002 WP ₁₄	5.32 ^{+0.03} _{-0.02}	5.30	5.30	1		0.003	20.676 ^{+0.006} _{-0.006}	0.6
2003 AE ₃₁	5.579 ^{+0.004} _{-0.004}	5.60 ^{+0.01} _{-0.01}	5.60 ^{+0.01} _{-0.01}	1	U=2	0.003	20.905 ^{+0.005} _{-0.005}	0.4
2003 BD ₇₆	3.319 ^{+0.002} _{-0.002}	3.31	3.31	1		0.002	21.284 ^{+0.008} _{-0.007}	0.4
2004 FT ₁₁₀	3.54 ^{+0.01} _{-0.01}	3.57 ^{+0.02} _{-0.02}	3.57 ^{+0.02} _{-0.02}	1	U=2	0.009	22.452 ^{+0.006} _{-0.006}	0.6
2004 LF ₄	6.43 ^{+0.01} _{-0.02}	6.63	19.90	1/3		0.030	21.079 ^{+0.005} _{-0.007}	0.8
2005 GV ₁₂₇	12.63 ^{+0.05} _{-0.06}	12.61	4.20	3		0.002	21.869 ^{+0.005} _{-0.005}	0.8
2005 WD ₁₀	6.36 ^{+0.01} _{-0.01}	6.32 ^{+0.08} _{-0.08}	6.32 ^{+0.08} _{-0.08}	1	U=2	0.006	21.852 ^{+0.007} _{-0.008}	0.7
2006 TV ₇₄	9.68 ^{+0.06} _{-0.06}	9.06 ^{+0.17} _{-0.17}	9.06 ^{+0.17} _{-0.17}	1	U=2	0.068	21.852 ^{+0.007} _{-0.007}	0.8
2014 AH ₇	27.94 ^{+0.38} _{-0.37}	27.59 ^{+0.47} _{-0.47}	27.59 ^{+0.47} _{-0.47}	1	U=2	0.013	22.38 ^{+0.01} _{-0.01}	0.6

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Table A.1 – Continued from previous page

Name	P_{fitted} [h]	$P_{\text{published}}$ or harmonic [h]	$P_{\text{published}}$ [h]	Harmonic factor	Quality code	Fractional difference	$\langle m \rangle$ [mag]	ϕ_c
2016 UR ₁₀₀	5.58 ^{+0.07} _{-0.07}	5.48 ^{+0.18} _{-0.18}	16.44 ^{+0.54} _{-0.54}	1/3	U=2	0.018	23.83 ^{+0.02} _{-0.02}	0.6
Ashkinazi	6.895 ^{+0.004} _{-0.003}	6.92	6.92	1		0.003	18.515 ^{+0.001} _{-0.002}	0.9
Bowenyueli	8.08 ^{+0.01} _{-0.01}	8.022 ^{+0.003} _{-0.003}	8.022 ^{+0.003} _{-0.003}	1	U=2	0.007	20.76 ^{+0.01} _{-0.02}	0.5
Cornaa	12.15 ^{+0.17} _{-0.17}	14.16 ^{+0.16} _{-0.16}	3.54 ^{+0.04} _{-0.04}	4	U=2	0.142	19.819 ^{+0.003} _{-0.003}	0.6
Corradolam.	22.80 ^{+0.14} _{-0.13}	22.702 ^{+0.001} _{-0.001}	22.702 ^{+0.001} _{-0.001}	1		0.004	18.959 ^{+0.002} _{-0.002}	0.5
Gismonda	13.07 ^{+11.40} _{-0.05}	12.98 ^{+0.01} _{-0.01}	6.488 ^{+0.005} _{-0.005}	2	U=3	0.007	15.447 ^{+0.001} _{-0.002}	0.7
Handley	13.92 ^{+0.03} _{-0.03}	13.49 ^{+0.84} _{-0.84}	13.49 ^{+0.84} _{-0.84}	1		0.032	17.895 ^{+0.001} _{-0.001}	0.6
Haydn	2.787 ^{+0.006} _{-0.006}	2.83	2.83	1		0.017	18.895 ^{+0.001} _{-0.002}	0.7
Hiraimasa	6.95 ^{+0.01} _{-0.01}	6.93	6.93	1		0.004	17.508 ^{+0.003} _{-0.003}	0.6
Jayaranjan	11.750 ^{+0.009} _{-0.009}	11.83	11.83	1		0.007	18.964 ^{+0.002} _{-0.002}	0.6
McCauley	3.701 ^{+0.008} _{-0.008}	4.54	4.54	1		0.185	17.588 ^{+0.001} _{-0.001}	0.7
Medkeff	2.58 ^{+0.01} _{-0.01}	2.59 ^{+0.01} _{-0.01}	2.59 ^{+0.01} _{-0.01}	1	U=2	0.003	21.697 ^{+0.005} _{-0.005}	0.8
Mijacobsen	3.780 ^{+0.002} _{-0.002}	3.7890 ^{+0.0007} _{-0.0007}	3.7890 ^{+0.0007} _{-0.0007}	1	U=2	0.002	19.404 ^{+0.002} _{-0.002}	0.4
Noctua	4.42 ^{+4.08} _{-0.03}	4.2953 ^{+0.0002} _{-0.0002}	4.2953 ^{+0.0002} _{-0.0002}	1		0.029	19.00 ^{+0.14} _{-0.00}	0.4
Okabayashi	2.57 ^{+0.01} _{-0.01}	2.5515 ^{+0.0005} _{-0.0005}	2.5515 ^{+0.0005} _{-0.0005}	1	U=3–	0.008	18.651 ^{+0.002} _{-0.002}	0.9
Oliver	3.327 ^{+0.001} _{-0.001}	3.28 ^{+0.05} _{-0.05}	6.56 ^{+0.10} _{-0.10}	1/2		0.015	17.994 ^{+0.001} _{-0.001}	0.7
Pecorelli	3.345 ^{+0.002} _{-0.002}	3.34	3.34	1	U=3–	0.002	19.369 ^{+0.003} _{-0.003}	0.6
Reynolds	3.957 ^{+0.006} _{-0.006}	3.94923 ^{+0.00001} _{-0.00001}	3.94923 ^{+0.00001} _{-0.00001}	1		0.002	20.156 ^{+0.004} _{-0.004}	0.5
Vespucci	9.17 ^{+0.21} _{-0.18}	8.90	8.90	1		0.030	19.616 ^{+0.007} _{-0.007}	0.6
Young	6.385 ^{+0.003} _{-0.003}	6.389 ^{+0.003} _{-0.003}	6.389 ^{+0.003} _{-0.003}	1		0.001	16.7670 ^{+0.0009} _{-0.0009}	0.6
Yuuko	3.90 ^{+0.01} _{-0.01}	4.26 ^{+0.14} _{-0.14}	4.26 ^{+0.14} _{-0.14}	1		0.083	19.122 ^{+0.002} _{-0.002}	0.5

Notes. Due to space constraints, we do not include the numbers of named asteroids.

Table A.2. Fitted periods from the EES (preview).

Name	P_1 [h]	$(A_{p-p})_1$ [mag]	P_2 [h]	P_3 [h]	$\langle m \rangle$ [mag]	$N_{\text{datapoints}}$	χ^2_{ν}	ϕ_c	Θ
(39418) 1204 T-2	2.885 ^{+0.008} _{-0.008}	0.17	4.72 ^{+0.02} _{-0.03}	2.083 ^{+0.003} _{-0.004}	20.565 ^{+0.003} _{-0.004}	154	2.78	1.0	0.34
1981 EL ₄₃	3.017 ^{+0.007} _{-0.007}	0.13	4.99 ^{+0.03} _{-0.02}		20.863 ^{+0.002} _{-0.002}	177	1.02	1.0	0.24
1981 EO ₁₂	2.910 ^{+0.006} _{-0.006}	0.24	4.67 ^{+0.02} _{-0.02}		21.146 ^{+0.003} _{-0.003}	161	1.04	1.0	0.17

Notes. The first three aliases, P_1 , P_2 , and P_3 , are presented in order of likelihood. The full table is available at the CDS.

Table A.3. Candidate super-fast rotators in the EES.

Name	P_1 [h]	$(A_{p-p})_1$ [mag]	P_2 [h]	P_3 [h]	$\langle m \rangle$ [mag]	$N_{\text{datapoints}}$	χ_v^2	ϕ_c	Θ	H
1992 RC ₄	1.97 ^{+0.02} _{-0.01}	0.12	2.239 ^{+0.009} _{-0.008}	1.746 ^{+0.009} _{-0.009}	19.914 ^{+0.003} _{-0.003}	50	0.86	0.5	0.30	14.75
1999 XN ₂₆	1.577 ^{+0.004} _{-0.004}	0.19	1.97 ^{+1.14} _{-0.01}	1.300 ^{+0.003} _{-0.004}	20.385 ^{+0.004} _{-0.004}	64	1.96	1.0	0.24	14.76
2000 EZ ₄₆	1.422 ^{+0.006} _{-0.006}	0.06	1.57 ^{+0.01} _{-0.01}	1.113 ^{+0.004} _{-0.005}	20.071 ^{+0.003} _{-0.002}	142	1.05	1.0	0.47	15.27
2000 GP ₆₀	2.04 ^{+0.00} _{-0.01}	0.13			19.443 ^{+0.003} _{-0.003}	67	1.86	0.6	0.26	14.75
2001 SL ₁₉₇	2.093 ^{+0.009} _{-0.008}	0.30	1.420 ^{+0.004} _{-0.004}	1.111 ^{+0.004} _{-0.005}	22.43 ^{+0.01} _{-0.01}	70	1.10	0.8	0.39	17.17
2003 VN ₇	1.179 ^{+0.003} _{-0.002}	0.13	1.023 ^{+0.002} _{-0.002}		21.491 ^{+0.005} _{-0.005}	134	1.05	1.0	0.45	16.52
2005 GF ₁₆₉	2.06 ^{+0.69} _{-0.01}	0.25	1.80 ^{+0.02} _{-0.02}		22.49 ^{+0.01} _{-0.01}	89	1.01	0.8	0.34	17.41
2005 SS ₄₄	1.750 ^{+0.002} _{-0.002}	0.60	1.895 ^{+0.003} _{-0.003}	2.065 ^{+0.002} _{-0.003}	21.88 ^{+0.02} _{-0.02}	85	1.13	0.6	0.44	17.55
2006 FW ₃₉	1.510 ^{+0.008} _{-0.007}	0.19	1.91 ^{+0.01} _{-0.01}	1.273 ^{+0.003} _{-0.003}	22.287 ^{+0.007} _{-0.008}	165	1.11	0.9	0.42	17.48
2012 OD ₄	2.052 ^{+0.003} _{-0.003}	0.36	1.88 ^{+0.03} _{-0.05}	2.043 ^{+0.003} _{-0.003}	21.902 ^{+0.008} _{-0.007}	80	1.09	0.6	0.27	17.01
2012 TV ₉₆	1.854 ^{+0.006} _{-0.007}	0.26	3.69 ^{+0.02} _{-0.02}	2.44 ^{+0.02} _{-0.02}	22.58 ^{+0.01} _{-0.01}	70	1.13	0.6	0.38	16.36
2013 SG ₆₄	1.83 ^{+1.62} _{-0.00}	0.63	1.221 ^{+0.002} _{-0.002}		22.51 ^{+0.04} _{-0.01}	133	1.03	0.7	0.22	17.28
2014 WR ₁₅₄	1.269 ^{+0.002} _{-0.002}	0.38	1.080 ^{+0.002} _{-0.002}		23.24 ^{+0.01} _{-0.01}	111	1.02	1.0	0.45	18.03
2015 XS ₂₉₀	2.156 ^{+0.003} _{-0.003}	0.32	2.995 ^{+0.005} _{-0.005}		22.326 ^{+0.005} _{-0.005}	359	1.01	1.0	0.37	18.09
2023 TC ₁₉₂	0.893 ^{+0.003} _{-0.003}	0.45	0.843 ^{+0.003} _{-0.002}	0.799 ^{+0.003} _{-0.003}	24.20 ^{+0.02} _{-0.03}	51	1.06	0.8	0.48	18.22
(41450) Medkeff	1.922 ^{+0.008} _{-0.008}	0.12	3.90 ^{+0.03} _{-0.03}	2.58 ^{+0.01} _{-0.01}	21.697 ^{+0.005} _{-0.005}	111	1.04	0.8	0.37	16.24

Notes. The first three aliases, P_1 , P_2 , and P_3 , are presented in order of likelihood. The absolute magnitude, H , is taken from SsODNet and can be used as a size proxy.

Appendix B: Discarded light curves

We present in Table B.1 a preview of the light curves that did not show enough variability in the observed time range to allow for period determination. A description of the methods used for this filtering can be found in Sect. 4.2. We present in Table B.2 period fits that we considered low quality and excluded from the sample of 889 high-quality periods, as is discussed in Sect. 4.3.

Table B.1. Light curves from the EES that did not show variability (preview).

Name	$\langle m \rangle$ [mag]	σ_m [mag]	$N_{\text{datapoints}}$	Range [h]	χ_v^2
1992 BT ₅	20.76	0.04	112	8.21	1.92
1993 BR ₁₁	23.03	0.11	166	15.69	1.97
1993 FZ ₅₂	21.95	0.06	211	19.73	1.61

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Table B.1 – Continued from previous page

Name	$\langle m \rangle$ [mag]	σ_m [mag]	$N_{\text{datapoints}}$	Range [h]	χ^2_{ν}
1994 SE ₇	21.77	0.04	63	12.14	1.47
1994 FJ ₉	20.18	0.02	157	15.98	1.02

Notes. The value of the fitted constant is displayed as $\langle m \rangle$. The full table is available at the CDS.

Table B.2. Periods from the EES that were considered low-quality fits (preview).

Name	$\langle m \rangle$ [mag]	σ_m [mag]	$N_{\text{datapoints}}$	Range [h]	Θ
1996 RC ₁₇	$23.38^{+0.01}_{-0.01}$	0.24	309	19.74	0.85
2000 KW ₈₄	$23.4^{+0.2}_{-0.2}$	0.27	92	8.51	0.85
2001 MR ₃	$24.05^{+0.02}_{-0.02}$	0.30	139	4.77	0.89
2002 GP ₁₉₃	$23.69^{+0.04}_{-0.04}$	0.22	131	15.90	0.85
2002 TP ₃₃₀	$23.42^{+0.05}_{-0.07}$	0.16	89	4.78	0.92

Notes. The full table is available at the CDS.

Appendix C: Sources of known periods used

We present the sources of the periods used for comparison with our results in Sect. 5.

Stephens (2012); Chang et al. (2015); Waszczak et al. (2015); Chang et al. (2016); Āurech et al. (2018); Chang et al. (2019); Erasmus et al. (2020); Pál et al. (2020); Yeh et al. (2020); Podlewska-Gaca et al. (2021); Āurech et al. (2022); Āurech & Hanuš (2023); Lam et al. (2023); McNeill et al. (2023); Cellino et al. (2024).