Thousand Asteroid Light Curve Survey: Preliminary Results

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Motivation

Does asteroid composition and location in the Main Belt affect rotation rate?

What is the binary fraction in the MB?

How does YORP drive the rotation distribution of 1km < D < 10 km bodies?

Are there any big, fast Tumblers???
Asteroid Spin Rate vs Diameter

Pravec et al., 2003 (Asteroids, III)
Survey Coverage

12 deg$^2$ of ecliptic with CFHT/MegaCam
- 3.6 m telescope, ~1 deg$^2$ camera

Phase angles from 10-4 degs

Astrometry initially vs USNO, then internal catalog
- 0.1" accuracy

Photometry accuracy to 0.01-0.02 mags (to $g' \sim$ 19 mag)

~1000 asteroids $g' < 22$ mag

Orbits, periods, amplitudes, $g'$-$r'$ colors, coarse light curves

~10 objects w/ period < 2 hours

~300 objects w/ 2 hours < period < 4 hours

~50 asteroids $D < 0.5$ km
Thousand Asteroid Light Curve Survey (TALCS) Observing Scheme

Exposure Times:

- 20 sec
- 30 sec
- 30 sec
- 40 sec (r′)

TTI:
- 2 min
- 7.5 min
- 15 min
- 17 min (r′)

Green: Superfast Rotator Survey
Blue: Fast Rotator Survey
Red: Wide Field Survey

20.4 hours, 1085 images
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<td>Orbit: 2 2-hour blocks</td>
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<td>Superfast: 1.5 hours</td>
<td>Wide: 3 hours</td>
<td>Long Period: 4 hours</td>
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Observing Timeline

- Orbit: 2 2-hour blocks
- Superfast: 1.5 hours
- Fast: 3.3 hours
- Wide: 3 hours
- Long Period: 4 hours
- Orbit: 1.6 hours
- r’ filter: 3 hours
Typical Results from a one-night survey with MegaCam
Sample TALCS lightcurve for H_v=14 object
One day lightcurve results

~6 hours
Sample TALCS lightcurve for H\_v=13.5 object
Sample TALCS lightcurve for H_v=12.5 object
Future Work:

• Full a-e-i determination for ~1000 objects
• Lightcurve fitting using multi-order sinusoids
• Static-sky subtraction
Follow-up Observations:

• UH 2.2m recovery and dense light curve samples
• Polarimetry with DBIP on UH 2.2m
• Pan-STARRS 1 recovery
Polarimetry
Polarization via Coherent Backscattering

Muinonen et al., 2003 (Asteroids III)
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Polarization-Phase Angle-Type relation

\[ \log (\text{albedo}) = -\log (h) - 1.78 \]

Zellner et al., 1974
Dual Beam Imaging Polarimeter

First Light: 3/22/07
Polarized Standard

![Diagram showing percent polarization vs. rotation stage angle with labeled curves Q, U, and P_tot.](image)
“Unpolarized” Standard

![Graph showing percent polarization vs. rotation stage angle with markers for Q, U, and P_tot.](image-url)
Polarized Measurements of asteroid 16 Psyche
Calibration Results

Halfwave mode:

- Single measurement noise on polarization: 0.03%
- Systematic error: ~0.06%
- Polarized standards confirmed to within 2.5-sigma
- Optical offset of 9.23 +/- 0.32 degrees

Full-Stokes Mode:

- Operational in August 2007