Near-Earth Asteroid Lightcurves Program at the Center for Solar System Studies

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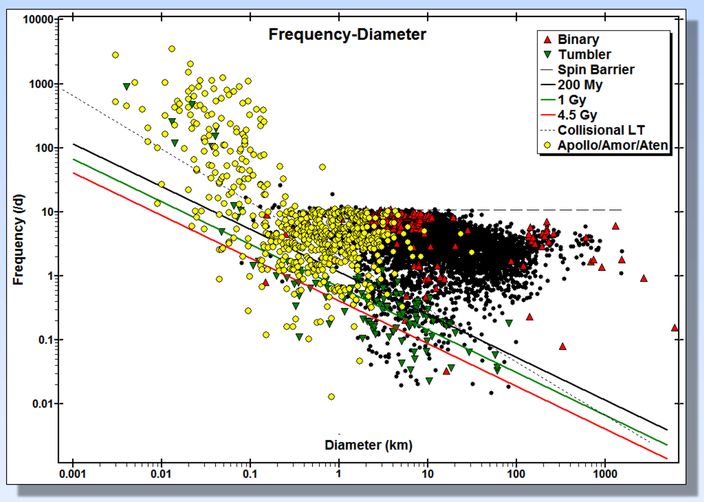
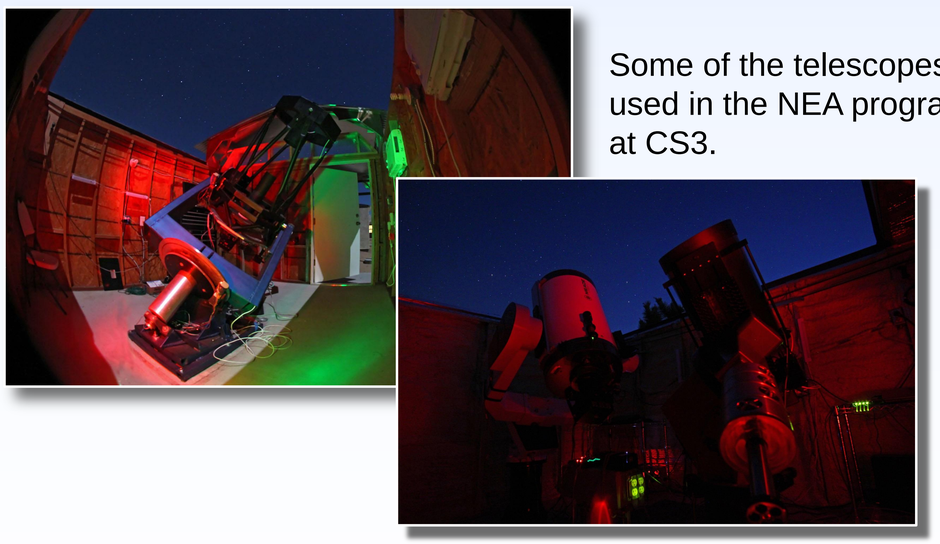
Abstract

As of October 2014, the asteroid lightcurve database (LCDB; Warner et al., 2009) contains 775 near-Earth asteroids with statistically useful rotation rates, about 7% of all known NEAs. The LCDB also contains 54 NEAs that are known or suspected binary or multiple systems, 47 with spin orientations, and 47 tumblers. 172 NEAs have a rotation period of $P \leq 2$ h, and 148 with $P \leq 1$ h. While these counts are sufficient to make reasonable inferences about NEA rotation rate statistics, the significantly smaller sampling of binaries, tumblers, and known spin orientations in both the NEA and the general populations often leads to more questions than answers.

Background



The plot above shows the frequency-diameter distribution of objects in the LCDB (Warner *et. al*, 2009; 2014 October 1). The near-Earth objects are highlighted in yellow.



Some of the telescopes used in the NEA program at CS3.

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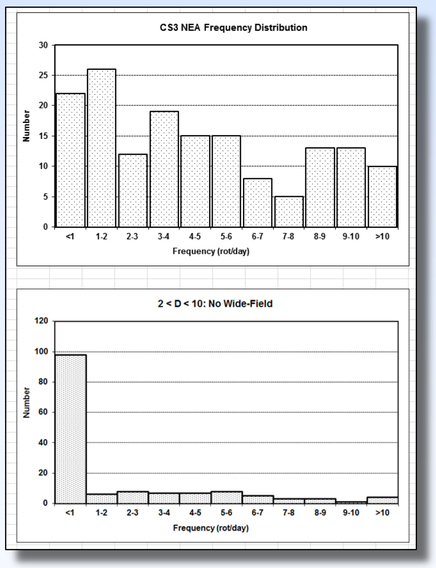
Center for Solar System Studies

The Center for Solar Systems Studies (CS3) is located in the California high desert north of Yucca Valley. Nine telescopes were used for this project. The facility is fully robotic with local computers running the telescope/camera software as well opening and closing the roofs via Internet-accessible power strips. The computers are accessed via the Internet using remote desktop software so that we can monitor operations and change scripts to work new targets when needed. Otherwise, the scripts can run for several days without intervention.

We started our campaign in mid-2013 to find reliable rotation periods for as many NEAs as possible. When conditions allowed, we try to obtain dense lightcurves spread over weeks for lightcurve inversion modeling.

We are working closely with the radar teams at Arecibo and Goldstone in order to supplement their radar observations with dense lightcurves.

From 2013 May 23 to 2014 October 1, the Center for Solar System Studies did 82% of all NEA lightcurves published.



A plot of the Frequency of all NEAs observed at CS3 vs. all NEAs in the size range of 2 to 10 km.

The six observatories at CS3.

Results

CS3 Statistics	Count
Nights (2013 May 23– 2014 October 1)	
Available (calendar days)	496
Observed (82%)	406
Total Lightcurves	483
NEA	196
Hungarias	125
Others	162
NEA - Total	196
Binary (known or suspected)	15
Tumblers (known or suspected)	13
Super-fast ($P < 2$ h)	5
Slow ($P \geq 24$ h)	9
Ordinary	154

NEA Lightcurves from CS3. Clockwise from top left: super-fast rotator, slow rotator, binary with eclipse event, and tumbler.

"Normal" asteroids usually take from 3 to 5 observing sessions to get a complete and satisfactory lightcurve. Slow rotators and tumblers (*e.g.*, above, upper right and lower left) can require data from 10 or more nights before a solution is found, if at all.

References

Stephens, R.D., Warner, B.D., Harris, A.W. (2010). *Minor Planet Bulletin* **38**, 172-174.
Statler, T.S., Cotto-Figueroa, D., Riethmiller, D.A., Sweeney, K.A. (2013). *Icarus* **225**, 141-155.
Warner, B. D., Harris, A. W., Pravec, P. (2009). *Icarus* **202**, 134-146.
Updates available at:
http://www.minorplanet.info/lightcurvedatabase.html

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Center for Solar System Studies: *http://www.planetarysciences.org* **Minor Planet Info Gateway: *http://www.MinorPlanet.info***