Detection of YORP spin-up for (101955) Bennu

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Spheroidal asteroids like the OSIRIS-REx target (101955) Bennu may form (or be formed from) binary systems through YORP spinup. On 17–18 September and 10–11 December 2012 we obtained HST photometry of Bennu in order to refine the rotation state and search for YORP effects. Nolan et al. (2013) determined the rotation rate based on lightcurve and radar observations in 1999 and 2005. The lightcurve data from four days in 2005 constrained absolute rotation rate to be 4.29764 ± 0.002 h. The radar and lightcurve data from 1999 additionally constrain the period to a comb of values spaced by 0.000352 h, which is one full rotation over the ~ 6 year interval. In sessions of 5 HST orbits each, we obtained nearly-complete lightcurves in September and December 2012. We then tested the relative lightcurve phases between the two session using each possible value of the comb, ± 26 rotations ($\pm 5\sigma$) The solutions with $+5$ and -20 rotations ($+1\sigma$ and -4σ) fit well. We reject the -4σ period as it visibly does not fit the 2005 data. The period of 4.296052 h has 5 additional full rotations between 1999 and 2005 compared to the original period reported by Nolan et al. (2013). Next we attempted to fit all three epochs, 1999, 2005, and 2012, with the same rotation period. Using a period that fits 1999 and 2005, the asteroid has rotated 15 degrees farther in 2012 than predicted. If we allow an angular acceleration, we can fit all of the data with a period of 4.296045 ± 0.000002 h on 2005 September 14 and an angular acceleration of $+2.5 \times 10^{-6}$deg/day^2, which we attribute to the YORP effect. We will be able to refine and confirm this detection of the YORP effect during the OSIRIS-REx encounter. Work is ongoing to re-fit the model using this period, and to refine the pole position, which is linked to the rotation rate when fitting the radar images, to confirm that there are no YORP-free solutions.