THE PREDICTED BYORP DRIVEN EVOLUTION OF 65803 DIDYMOS. J. W. McMahon[1], L. A. M. Benner[2], and S. P. Naidu[2], [1]Aerospace Engineering Sciences, University of Colorado Boulder, 431 UCB, Boulder, CO, 80309, [2]Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, Pasadena, CA 91109.

Introduction: The near-Earth asteroid 65803 Didymos is a small NEA binary. This system the target of the proposed Asteroid Impact & Deflection Assessment (AIDA) mission, which combines an orbiter [1] and a kinetic impactor experiment planned for fall 2022 [2]. The primary is estimated to be approximately 780 m in diameter, while the secondary is only 163 m in diameter. The separation between the components is estimated to be approximately 1.18 km, which leads to a binary orbit period of 11.92 hours. [3, 4]

Predicted evolution: Thermal re-radiation from the Didymos secondary will lead to the binary-YORP (BYORP) effect [5] which can cause a long-term secular change to the binary orbit size. The secondary is not currently modeled with a detailed shape model, however using the estimated ellipsoid size, density, and the orbit properties allows us to scale the BYORP rate from 1999 KW4 [6]. However, since in this we have an estimate of the secondary axes and density, we can update the scaling law to be

$$\dot{a}_D = \left(\frac{a_D c_D}{a_K c_K}\right)\left(\frac{T_D}{D^3_{D,s}\rho_D}\frac{D^3_{K,s}\rho_K}{T_K}\right)\left(\frac{a^2_{h,K}\sqrt{1-e^2_{h,K}}}{a^2_{h,D}\sqrt{1-e^2_{h,D}}}\right)\dot{a}_K$$

where the D subscript refers to Didymos, and the K subscript refers to 1999 KW4. The variables a and c represent the maximum and minimum semi-axes of the secondaries, T is the binary orbit period, D_S is the secondary mean diameter, ρ is the density, a_h and e_h are the heliocentric orbit semimajor axis and eccentricity.

This tells us that if the deviation in the shape of the Didymos secondary from a perfect ellipsoid is similar to that of the 1999 KW4 secondary, the Didymos orbit semimajor axis can be expanding/contracting at +/-1.66 cm/year. This semimajor axis rate translates to a quadratic mean anomaly drift rate of -/+2.8 deg/year^2, or a period drift of 0.91 s/year.

A second important dynamical consideration, however, is the strength of the tidal forces which will also work to expand the binary orbit. If in fact the BYORP effect is working to shrink the binary orbit, there can be an equilibrium between these two effects which will result in a constant orbit size [7] as is hypothesized for FG3 [8].

Finally, the tidal strength is also important for determining the possible libration amplitude of the secondary with respect to its radial direction [9]. If the tides are too weak, the libration will increase in the case where the orbit expands, causing the BYORP effect to be turned off when the secondary spin becomes asynchronous with the orbit period [10]. However, if the tides are strong enough, the librations are limited, and the orbit size can expand significantly [11]. Several different scenarios are presented.

References: [1] Michel P. et al. (2016), *ASR*, submitted. [2] Cheng, A. F. et al. (2016) *P&SS*, accepted. [3] Richardson, D. C. et al (2016) *LPS XLVII*, submitted. [4] Rivkin, A. S. et al (2016) *LPS XLVII*, submitted. [5] Ćuk, M., Burns, J., (2005). *Icarus,* 176, 418–431. [6] McMahon, J. and Scheeres, D. (2010) *Icarus,* 209, 494-509. [7] Jacobson, S. and Scheeres, D. (2011) *APJL*, 736, L19. [8] Scheirich, P. et al. (2015) *Icarus*, 245, 56-63 [9] McMahon, J. and Scheeres, D. (2013) *CMDA*, 115, 365-396. [10] Ćuk, M., Nesvorný, D. (2010) *Icarus* 207, 732-743 [11] McMaho, J. and Scheeres, D. (2014) *ACM*