POST-IMPACT MUTUAL ORBIT OF THE DIDYMOS BINARY SYSTEM DERIVED FROM PHOTOMETRY. P. Scheirich[1]*, P. Pravec[1], and the DART Observations Working Group. [1]Astronomical Institute of the Czech Academy of Sciences, Ondřejov, Czech Republic, *Email: petr.scheirich@gmail.com

Introduction: On September 26, 2022, NASA's Double Asteroid Redirection Test (DART) spacecraft impacted the satellite, called Dimorphos, of the binary near-Earth asteroid (65803) Didymos. Thorough ground-based photometric observations of the Didymos system were scheduled from the impact through March 2023 in order to detect the orbit period change, its eccentricity and apsidal precession rate, as well as possible libration-induced orbit period variations [1].

We present results of our modeling of the data. The model of the Didymos binary system was constructed by adapting the technique described in [2]. The components were assumed to have ellipsoidal shapes and to be on Keplerian orbit, allowing for apsidal precession. Didymos and Dimorphos are assumed to be in a principal rotation state, with their pole orientations equal to the orbital pole. We fixed the orbital pole coordinates at their nominal values obtained for the pre-impact orbit by [2], and ellipsoid axes, size ratios of the components and the semimajor axis at the values from [3].

The results presented here are based on an incomplete dataset of post-impact observations. We will present the final results at the ACM conference.

Post-impact photometry data: The data used in our analysis cover a time span from 2022-09-28 to 2023-01-29 and were obtained using the following instruments:

Telescope / Observatory / Observers & Reducers (*No. of nights*)

Danish 1.54m / La Silla / P. Pravec & coll., C. Snodgrass (*39*); LCOGT 1-m network / T. Lister (*28*); Lowell 1.1-m / Lowell / N. Moskovitz, T. Polakis, B. Skiff & coll.(*20*); Swope 1-m / Las Campanas / D. Osip & coll. (*8*); Spacewatch 0.9-m / Kitt Peak / J. Scotti, J. Larsen, M. Knight, A. Tubbiolo, M. Brucker, R. Mastaler & coll. (*7*); Ondřejov 0.65-m / Ondřejov / P. Pravec & coll. (*4*); MRO 2.4-m / Magdalena Ridge / B. Ryan & E. Ryan (*4*); TRAPPIST-N 0.6-m / E. Jehin & M. Ferrais (*3*); Sugarloaf Mt. 0.64-m / Sugarloaf Mt. / D. Pray (*3*); LDT 4.3-m / Happy Jack / N. Moskovitz, C. Thomas, M. Knight (*2*); VATT 1.8-m / Mt. Graham / J.-B. Kikwaya & C. Hergenrother (*1*); Maidanak 1.5-m / Maidanak / O. Burkhonov, P. Pravec & coll. (*1*); Stará Lesná 0.6-m / High Tatras / M. Husárik (*1*); BOAO 1.8-m / BOAO / H.-J. Lee & coll. (*1*).

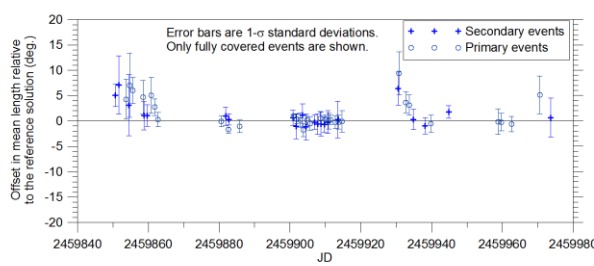
Fixed parameters of the model: Didymos and Dimorphos axes and size ratios and semimajor axis to Didymos size ratio were taken from [3]. The components are assumed to be in a principal rotation state, with their pole orientations equal to the orbital pole. The mutual orbital pole is taken from [2].

Varied parameters of the model: ω_0 – argument of periapsis at t_{imp}; $P_{orb} = 2\pi/(n + d\varpi/dt)$ – mean orbital period in an inertial frame; e – eccentricity; $d\varpi/dt$ – apsidal precession rate; $L_0 = \omega_0 + M_0$ – argument of mean length at t_{imp}.

Best-fit solution: $P_{orb} = 11.3676 \pm 0.0014$ h; $e = 0.021 \pm 0.014$; $d\varpi/dt = 7.5 \pm 1.0$ °/day; $\omega_0 = 324 \pm 50°$; $L_0 = 178 \pm 5°$; $M_0 = 214 \pm 45°$ (all uncertainties are formal 3σ).

Possible eccentricity reduction: We also experimented with fitting two blocks of data separately: the first one with the data from L0 to L2 lunation and the second one with the data from L3 to L4 lunation, with the following results, suggesting that the eccentricity decreased in the post-impact data: $e = 0.024 \pm 0.014$ using a dataset from 2022-09-28 to 2022-12-02; $e = 0.014^{+0.020}_{-0.014}$ using a dataset from 2022-12-17 to 2023-01-29 (uncertainties are 3σ).

Hint on the orbit period oscillations: In order to check for possible orbit period oscillations, we constructed the following figure, showing offsets in mean length (i.e., the amount Dimorphos is ahead (+) or behind (–) in time wrt. to an ephemeris from the nominal solution of the orbit. Expressed in degrees of the orbital phase; 1° ~ 1.9 min.) for every observed mutual event with respect to the best-fit solution. As is apparent from the figure, we see some trends in the offset, but the results are not conclusive.



References: [1] Meyer, A. J. et al. (2021) *PSJ* 2:242 [2] Scheirich and Pravec (2022) *PSJ* 3:163 [3] Daly, R. T. et al. (2023) *Nat.* in press.