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DETERMINATION OF DIMORPHOS'S CHANGE IN VELOCITY RESULTING FROM THE DART KINETIC IMPACT

Harrison F. Agrusa[1,2], Andrew F. Cheng[3], Brent W. Barbee[4], Alex J. Meyer[5], Tony L. Farnham[2], Sabina D. Raducan[6], Derek C. Richardson[2], Elisabetta Dotto[7], Angelo Zinzi[8], Vincenzo Della Corte[9], Thomas S. Statler[10], Steven Chesley[11], Shantanu P. Naidu[11], Masatoshi Hirabayashi[12], Jian-Yang Li[13], Siegfried Eggl[14], and the DART and LICIACube Teams

[1] *Université Côte d'Azur, Observatoire de la Côte d'Azur, CNRS, Laboratoire Lagrange, Nice, France*
[2] *University of Maryland, College Park, MD, USA, hagrusa@astro.umd.edu*
[3] *Johns Hopkins University Applied Physics Laboratory, 11100 Johns Hopkins Road, Laurel, MD, USA*
[4] *NASA/Goddard Space Flight Center, Greenbelt, MD, USA*
[5] *Smead Department of Aerospace Engineering Sciences, University of Colorado Boulder, CO, USA*
[6] *Space Research and Planetary Sciences, Physikalisches Institut, University of Bern, Switzerland*
[7] *INAF-Osservatorio Astronomico di Roma, Italy*
[8] *ASI-Space Science Data Center, Roma, Italy*
[9] *INAF-Istituto di Astrofisica e Planetologia Spaziali, Roma, Italy*
[10] *Planetary Defense Coordination Office and Planetary Science Division, NASA Headquarters, 300 Hidden Figures Way SW, Washington DC 20546, USA*
[11] *Jet Propulsion Laboratory, California Institute of Technology*
[12] *Auburn University, Auburn, AL, USA*
[13] *Planetary Science Institute, Tucson, AZ, USA*
[14] *Department of Aerospace Engineering, University of Illinois at Urbana-Champaign, IL, USA*

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ABSTRACT

On September 26, 2022, NASA's Double Asteroid Redirection Test (DART) mission successfully impacted the asteroid Dimorphos, the secondary component of the (65803) Didymos binary system [1]. With ground-based radar and photometric observations, it was determined that the kinetic impact reduced the binary orbit period by approximately 33 minutes [2]. From our analysis of the orbit period change and other system parameters, we find that Dimorphos's along-track orbital velocity component changed by $\Delta v_T = -2.7 \pm 0.1$ mm/s [3]. This result was achieved using a Monte Carlo technique to sample over a range of plausible pre- and post-impact states of the Didymos system. The Monte Carlo routine was coupled to a Full Two-Body Problem (F2BP) code [4] to account for spin-orbit coupling resulting from the non-spherical shapes and close separation of the two binary components. Each Monte Carlo sample draws a pre-impact semimajor axis, pre-impact orbit period, and post-impact orbit period based on the orbital solution presented in [2]. It also samples over the shapes of Didymos and Dimorphos given in [1]. The F2BP code is used to numerically determine the Δv_T required to connect the pre- and post-impact orbital solution. We verify the numerical Δv_T with analytic models such as a simplified Keplerian approximation with a correction for Didymos's oblateness. The dominant sources of uncertainty in Δv_T are the post-impact orbit period and the pre-impact semimajor axis. The uncertainty in the post-impact orbit period will decrease as ground-based observations continue. We discuss prospects for refining the pre-impact semimajor axis based on a measurement of the post-impact semimajor axis following the arrival of the Hera spacecraft in late 2026 [5].

[1] Daly et al., 2022 *submitted*
[2] Thomas et al., 2022 *submitted*
[3] Cheng et al., 2022 *submitted*
[4] Davis & Scheeres 2022 *Icarus* **341** 113439
[5] Michel *et al.,* 2022 *Planet. Sci. J.* **3** 160

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Comments:

Oral, please schedule this talk immediately before the abstract submitted by A.F. Cheng. His talk will be based on the results of this one.