

Hubble Space Telescope Observations of the Evolution of Dimorphos's Ejecta Created by the DART Impact

Jian-Yang Li¹, Masatoshi Hirabayashi², Tony L. Farnham³, Jessica M. Sunshine³, Matthew M. Knight⁴, Gonzalo Tancredi⁵, Fernando Moreno⁶, Brian Murphy⁷, Cyrielle Opitom⁷, Steven Chesley⁸, Daniel J. Scheeres⁹, Cristina A. Thomas¹⁰, Eugene G. Fahnestock⁸, Andrew F. Cheng¹¹, Andrew S. Rivkin¹¹, and the DART Investigation Team

Hubble Space Telescope observed the DART impact ejecta in 18 orbits post-impact from T + 20 min to T + 18.5 days at a geometry shown in Fig. 1 to the right. The sequence of images is shown in Fig. 2 for the evolution of the ejecta, and in Fig. 3 for the formation and evolution of the tail. The ejecta in the first 8 hours (Fig. 1a – 1f) is dominated by particles ejected at speeds > 1 m/s that directly leave the binary system at their initial velocities, forming an overall cone-shape viewed from the side. Between about T + 1 day and T + 3 days (Fig. 1g - 1j), the dust particles in the base of the cone move at speeds up to a few times the escape

speed of the binary system, and their trajectories are appreciably curved by Didymos (Ferrari et al. 2022), forming the curved ejecta streams (s1 and s2). After T + 4 days (Fig. 1l – 1q), solar radiation pressure dominates the ejecta evolution and pushes the dust towards the antisolar direction. The different orientations of s1 and s2 relative to the direction of the Sun result in different morphologies in the north and south of Didymos. Small particles in s1 is accelerated faster and catch up with the large particles in s2, forming the streaks overlapping the northern wing-like feature (best view in Fig. 1n).

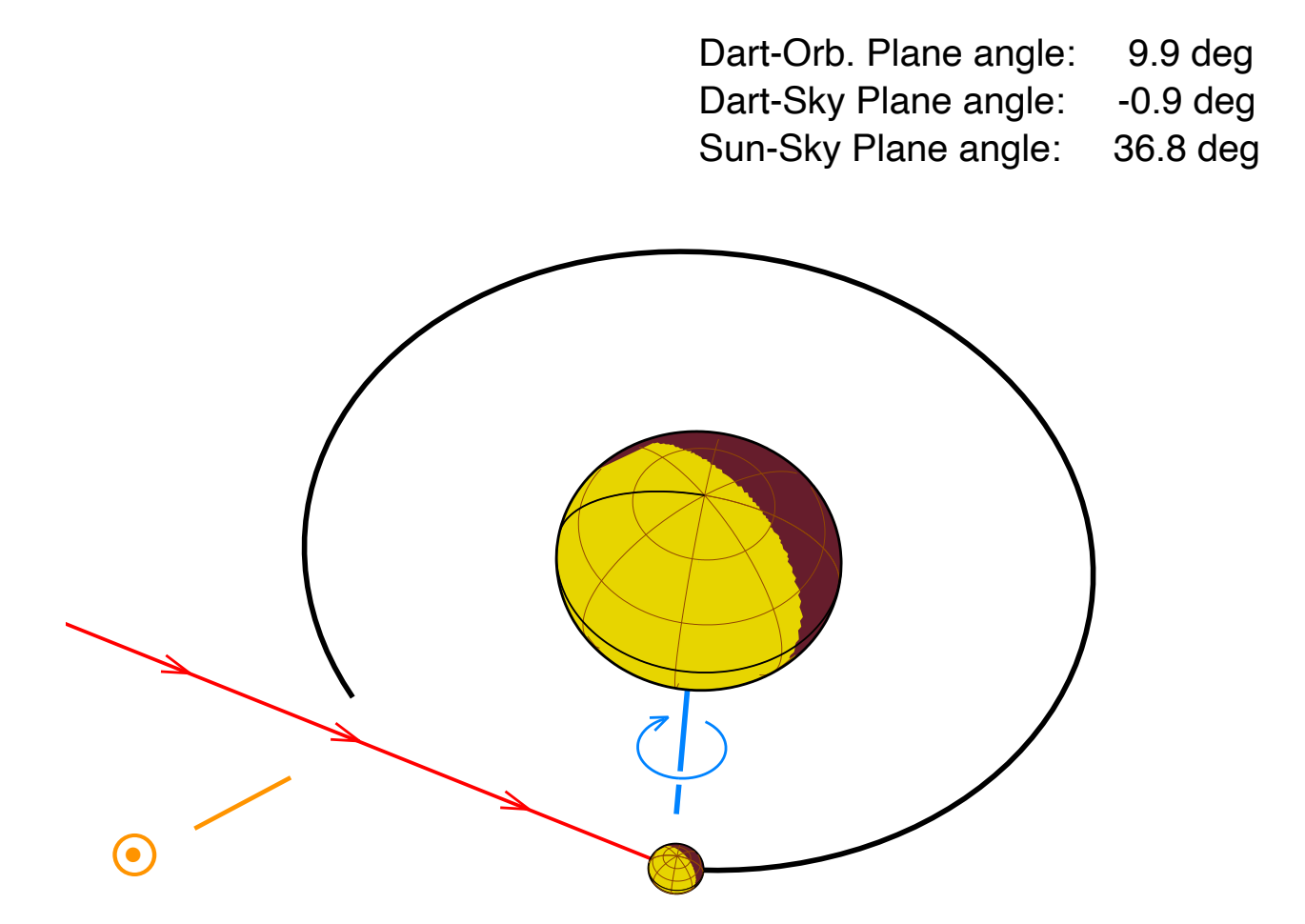


Figure 1. Earth observing geometry of the Didymos system at DART impact.

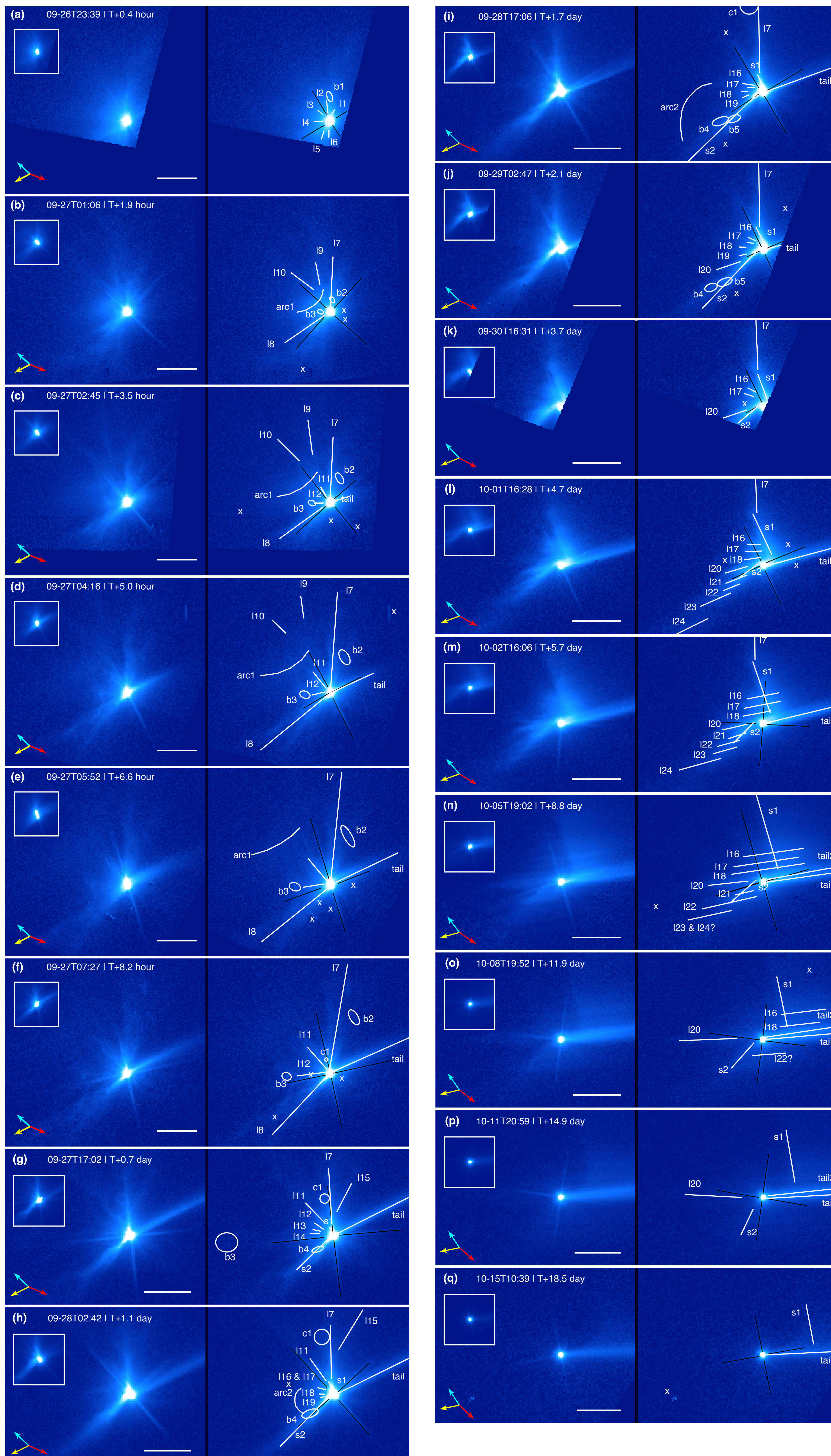


Figure 2. Evolution of the ejecta created by the DART impact. Each panel shows a pair of duplicated image, with the features annotated on the right. The inset is the 100 pixels square in the center of the same image, stretched differently to show the bright core of the ejecta. North is up and east to the left. The “x” marks image artifacts. The red, cyan, and yellow arrows mark the projected directions of DART velocity at impact, the orbital velocity of Didymos, and the Sun. The scale bars are 200 km.

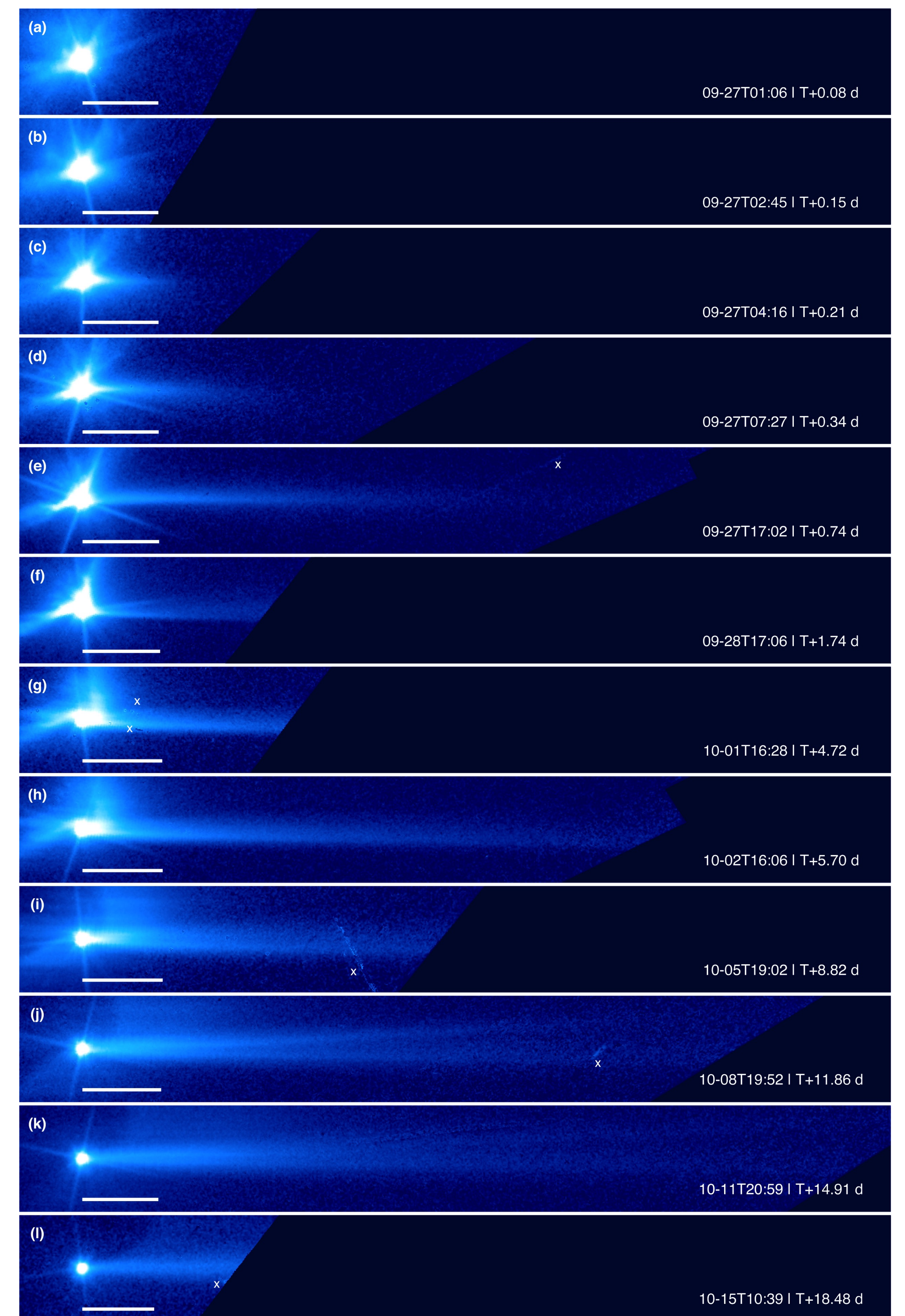


Figure 3. Evolution of the tail. All frames are rotated such that the expected orientation of the tail based on the synchronic analysis is in the horizontal direction. Scale bars are 200 km. A dust tail starts to form around T + 3 hr and T + 2 days, possibly caused by the initial ejection velocity of the ejecta or the orbit velocity of Dimorphos around Didymos. A secondary tail appears between T + 8.82 days and T + 14.91 days, with the cause under investigation. By the last image in T + 18.48 days, the ejecta has mostly dissipated into the tail direction.

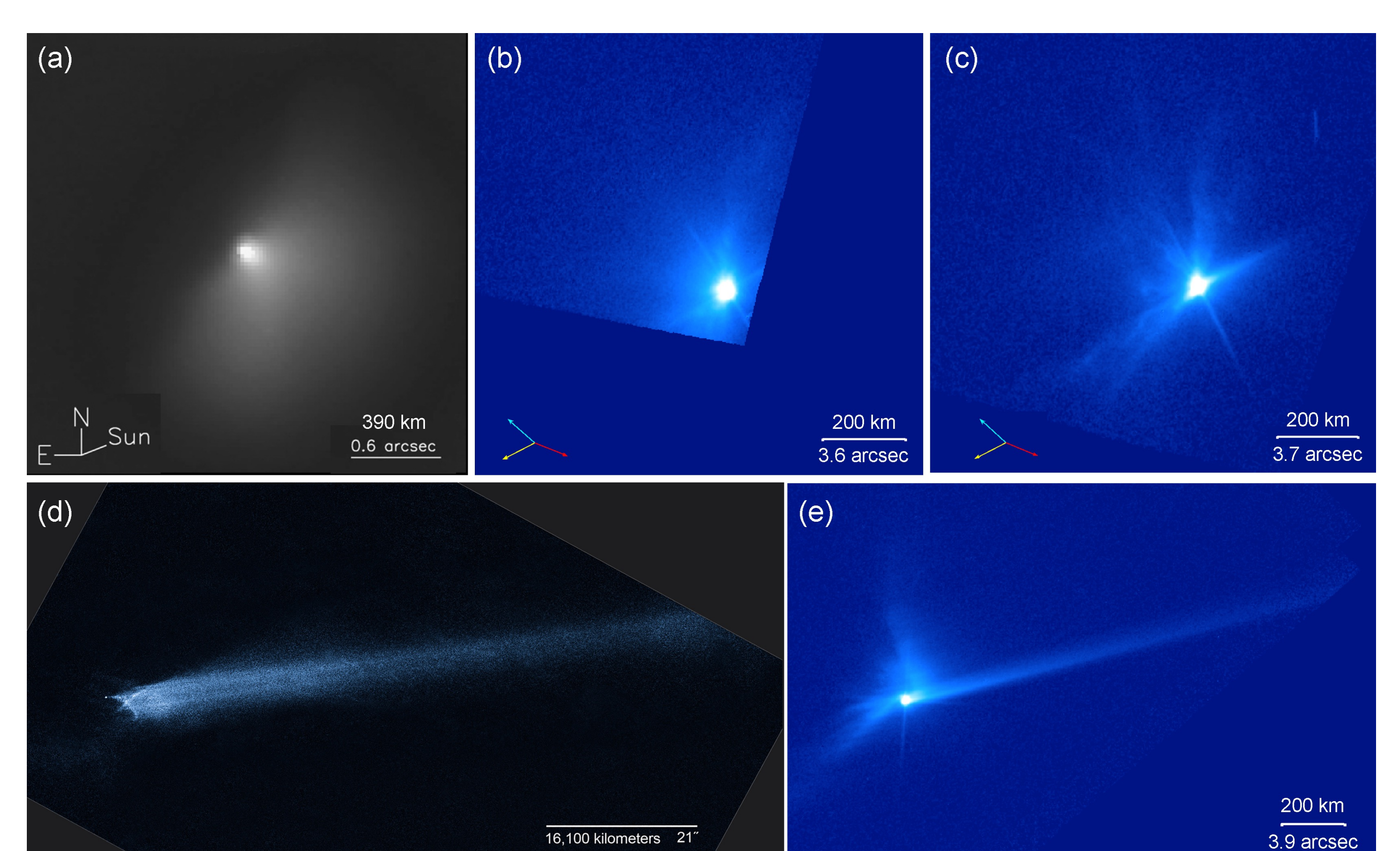


Figure 4. Comparison of Dimorphos's ejecta with the ejecta from Comet 9P/Tempel 1 created by the Deep Impact (a – c) (A'Hearn et al. 2005, Feldman et al. 2007), and Dimorphos's tail with the tail of P/2010 A2 thought to be produced by natural impact into the asteroid (Jewitt et al. 2010).

Author affiliations:
¹Planetary Science Institute, Tucson, AZ, USA, jyli@psi.edu
²Auburn University, Auburn, AL, USA
³Department of Astronomy, University of Maryland, College Park, MD, USA
⁴United States Naval Academy, Annapolis, MD, USA

⁵Departamento de Astronomía, Facultad de Ciencias, UdelaR, Uruguay
⁶Instituto de Astrofísica de Andalucía, CSIC, Glorieta de la Astronomía s/n, E-18008 Granada, Spain
⁷University of Edinburgh, Royal Observatory, Edinburgh, UK
⁸Jet Propulsion Laboratory, California Institute of

Technology, Pasadena, CA, USA
⁹University of Colorado, Boulder, CO, USA
¹⁰Northern Arizona University, Flagstaff, AZ, USA
¹¹Johns Hopkins University Applied Physics Laboratory, Laurel, MD, USA

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