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NEOTωIST: Determining the Momentum Enhancement

Siegfried Eggl[a,*], Simon Delchambre[b], Line Drube[c], Kilian Engel[b], Albert Falke[b], Tobias Ziegler[b], Daniel Hestroffer[d]

[a] *Jet Propulsion Laboratory, California Insititute of Technology, 4800 Oak Grove Drive, CA, USA*
[b] *Airbus DS GmbH, Claude-Dornier-Str., 88090 Immenstaad, Germany*
[c] *Institute of Planetary Research, German Aerospace Center (DLR), Rutherfordstr. 2, 12489 Berlin, Germany*
[d] *IMCCE, Observatoire de Paris, PSL res. univ., CNRS, 77 avenue Denfert-Rochereau, 75014 Paris, France*

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Kinetic impactors (KI) are deemed to be among the most mature concepts for changing the trajectory of sub-kilometer sized potentially hazardous objects. Still, predicting the total momentum delivered onto a target asteroid remains one of the challenges of KI-based deflection methods. The main issue lies in estimating the mass and velocity distribution of the momentum carrying material that is excavated during the impact. Although ongoing laboratory experiments and modeling efforts have been successful in constraining the range of possible scalar momentum enhancement (β) values, uncertainties in the direction and magnitude of the net ejecta momentum vector remain uncomfortably large [1, 2, 3, 4]. Field-testing of kinetic impactors is, therefore, not only vital in demonstrating the technological prowess to hit an asteroid at hypervelocity - it is also crucial to validate ejecta models and momentum enhancement predictions that are needed to assess the changes in the target's heliocentric orbit. In this contribution we present different methodologies that allow for a reconstruction of the momentum enhancement vector in the framework of the asteroid deflection demonstration mission concept NEOTωIST [5, 6, 7]. Consisting of an impactor, a flyby vehicle and cube-sat chasers, the NEOTωIST mission concept aims at changing the spin state of the asteroid (25143) Itokawa. Targeting a well characterized object offers substantial advantages, such as a reduction in uncertainties for both mission design and the deflection process itself. NEOTωIST would deliver constraints on the momentum enhancement vector through direct observation of the ejected material, as well as through tracking changes in the asteroid's heliocentric orbit and spin state via Earth-based observations. Discussing the merits and limitations of all three observables, we determine the quality of data NEOTωIST can provide on mitigation relevant parameters, in particular on the momentum enhancement vector.

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*Corresponding author
Email address: siegfried.eggl@jpl.nasa.gov (Siegfried Eggl)

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