

Uncertainty Quantification in Impulsive Deflection Scenarios

For the majority of NEO impact scenarios, optimal deflection strategies use a massive impactor or a nuclear explosive, either of which produce an impulsive change to the orbit of the object. However, uncertainties regarding the object composition and its interaction with the deflection event will lead to a non-negligible uncertainty in both the deflection velocity and direction. Propagating this error through the resulting orbit will create a positional error ellipse for the original time of impact. We calculate an analytic evolution of an impulsively deflected NEO and perform a full propagation of errors that is nonlinear in the deflection velocity vector. This provides a complete understanding of both the optimal deflection velocities needed for a given time-to-impact scenario, as well as the resulting positional error and corresponding residual impact probability. This result will also guide our computational efforts of deflection scenarios by providing a computational accuracy needed to obtain the desired deflection.

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