

PDC2023
Vienna, Austria

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NEO Characterization

Near-Earth Objects' Forecast of Collisional Events (NEOForCE)

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Keywords: *Near-Earth objects, impact probability, numerical methods, asteroid orbits, uncertainty propagation*

ABSTRACT

Estimating the probability of a collision of asteroids with the Earth is an important task for planetary defense. There are systems that compute impact probabilities of near-Earth asteroids with the Earth on a regular basis: Sentry (Nasa, Jet Propulsion Laboratory) and CLOMON-2 (originally University of Pisa, now ESA). Here we present NEOForCE (Near-Earth Objects Forecast for Collisional Events) a new monitoring system developed at Institut de mécanique céleste et de calcul des éphémérides (IMCCE, Paris Observatory). This system is original and independent. As ephemeris of major planets and the Moon we use INPOP [1]. The asteroids' orbits and covariance matrices are taken from DynAstVO database [2]. For computing the impact probability we use the Line Of Variation (LOV) sampling method [3] but with significant modifications. The longest axis of the confidence ellipsoid is chosen to be sampled obtaining virtual asteroids. Each virtual asteroid's orbit is propagated from the time of discovery 100 years ahead with variational equations. Each virtual asteroid is a representative of its small vicinity and we apply the Partial Banana Mapping method (PBM) [5] for each of this vicinity to look for possible collisions. Then the results are combined and the procedure to find explicitly the initial conditions of the collisional trajectory is launched.

The main differences with the existing monitoring systems are: usage of INPOP ephemeris of major planets instead of DE, having our own orbit fitting and propagation procedure of asteroids from DynAstVO, and implementation of Partial

Banana Mapping method. Hence the system provides an independent assessment of the impact probability, which in case of risks is crucial.

[1] Fienga, A., et al. (2020) *INPOP new release: INPOP19a*. *Astrometry, Earth Rotation, and Reference Systems in the GAIA era*. p. 293-297.

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[3] Milani A., et al. (2005) *Nonlinear impact monitoring: line of variation searches for impactors*. *ICARUS*, V. 173, p. 362-384.

[4] Vavilov D.E. (2020) *The partial banana mapping: a robust linear method for impact probability estimation*. *MNRAS*, V. 492, p. 4546–4552.

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