

## **Asteroid 1950 DA's Encounter with Earth in 2880: Physical Limits of Collision Probability Prediction**

J. D. Giorgini (NASA/JPL), S. J. Ostro, L. A. M. Benner, P. W. Chodas, S. R. Chesley, R. S. Hudson (Washington State University), M. C. Nolan (Arecibo Observatory), A. R. Klemola (UCO/Lick Observatory), E. M. Standish (NASA/JPL), R. F. Jurgens, R. Rose, A. B. Chamberlin, D. K. Yeomans, J.-L. Margot (Caltech)

Integration of the orbit of asteroid (29075) 1950 DA, based on radar and optical measurements spanning 51 years, reveals a 20-minute interval in March 2880 when there could be a non-negligible probability of the 1-kilometer object colliding with Earth. The impact scenario is three orders of magnitude more probable than any previous case, or about 1.5 times greater than the entire background risk through the year 2880, but depends on the physical properties of the asteroid. Trajectory knowledge remains accurate until 2880 because of extensive astrometric data, an inclined orbit geometry that reduces in-plane perturbations, and an orbit uncertainty space modulated by gravitational resonance. Analysis of sources of uncertainty in this long-term prediction include the effects of numerical integration error, galactic tides, perturbations due to encounters with other asteroids, solar mass loss, solar particle-wind, solar oblateness and radiation pressure, the uncertainties in planetary masses, and accelerations due to the time-delayed anisotropic thermal re-radiation of incident solar radiation, also known as the "Yarkovsky" effect. This latter effect depends on the shape, mass, spin axis, composition, and surface properties of the asteroid, all of which are either unknown or weakly determined, such that refinement to a specific collision probability may require direct inspection by a spacecraft.

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