Robotic Mission Trajectory Design To (99942) Apophis

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Because of its close Earth encounter during 2029, potentially hazardous asteroid (99942) Apophis collision with Earth in 2036 cannot be ruled out [1]. Robotic missions to Apophis are being considered to reduce its trajectory prediction uncertainty and to study its physical characteristics. Prior to 2029, a heliocentric resonance with Earth exists such that Apophis orbits the Sun 9 times in 7.97 years [2]. In late 2012, Apophis briefly phases ahead of Earth just before reaching aphelion in early 2013. Near this interval, heliocentric transfer from Earth can be initiated to arrive at Apophis with minimal relative speed. Data are presented indicating this speed can be minimized at values less than 1.0 km/s, depending on the transfer interval. A rendezvous with Apophis, followed by extended scientific operations in its proximity, should therefore be practical in the 2013 timeframe and in 2021.

[1] Giorgini, J. D., Benner, L. A. M., Ostro, S. J., Nolan, M. C., Busch, M. W., "Predicting the Earth encounters of (99942) Apophis", *Icarus*, Vol. 193, 2008, pp. 1 - 19.

[2] Giorgini, J. D., Yeomans, D. K., Chamberlin, A. B., Chodas, P. W., Jacobson, R. A., Keesey, M. S., Lieske, J. H., Ostro, S. J., Standish, E. M., Wimberly, R. N., "JPL's On-Line Solar System Data Service", *Bulletin of the American Astronomical Society*, Vol. 28, No. 3, 1996, p. 1158.

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