Minimoons & drifters

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We will present an overview of our recent work on understanding the population of natural objects that are temporarily captured in the Earth-Moon system. We use the term 'minimoon' to refer to objects that i) have negative total energy (kinetic+potential) relative to the Earth-Moon barycenter that ii) make at least one full revolution around the barycenter in a co-rotating frame relative to the Earth-Sun axis iii) while they are within 3 Earth Hill-sphere radii. There has been one confirmed minimoon, the 2–3 meter diameter object designated 2006 RH_{120} that was discovered by the Catalina Sky Survey [1]. That object's size, capture duration, geocentric trajectory, and pre-and post-capture heliocentric orbits are in perfect agreement with the minimoon model proposed by Granvik et al. (2012) [2]. We expect that there are one or two 1 to 2 meter diameter minimoons in the steady state population at any time and about a dozen larger than 50 cm diameter. Minimoons have an average lifetime of about 9 months. 'Drifters' are like minimoons except that they do not fulfill the requirement of making at least one revolution in the Earth-Moon system. The population of drifters is about 10× the minimoon population so that the largest drifter in the steady state is about 5–10 meters in diameter and there are perhaps ten of about 1 meter diameter at any time. The combined population of minimoons and drifters, henceforth 'cis-lunar objects' (CLO), provide a formerly unrecognized opportunity for scientific exploration and testing concepts for in-situ resource utilization [3]. They could provide large samples of main-belt asteroids that are unaffected by passage through Earth's atmosphere or weathering on the ground, with the added convenience of already being gravitationally bound in the Earth-Moon system. The CLOs provide interesting challenges for rendezvous missions because of their limited lifetime and non-elliptical trajectories while they are bound objects [4]. The problem is that detecting the CLOs is difficult — they are small, captured for only limited time periods, and their apparent rates of motion are more like artificial satellites than the more distant NEOs [5]. New technology may enable the detection of a small number of CLOs from the ground in the next few years [5,6] but the only way to discover a reliable stream of these interesting objects is from a space-based platform.

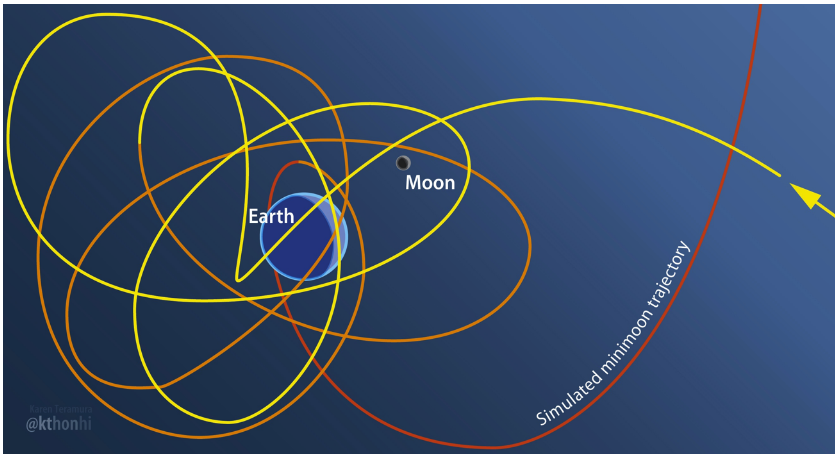

Figure: A synthetic minimoon's trajectory through the Earth-Moon system.

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References: [1] Kwiatkowski, T. et al. (2009), Astron. Astrophys. 495, 967–974. [2] Granvik, M. et al. (2012), Icarus 218, 262–277. [3] Granvik, M. et al. (2013), in Asteroids: Prospective Energy and Material Resources, Badescu, Viorel (Ed.). [4] Chyba, M. et al. (2013), in PROMS Series: Advances of Optimization and Control With Applications, Springer Verlag. [5] Bolin, B. et al. (2014) to appear in Icarus. [6] Shao, M. et al. (2014) ApJ, 782.