A LOOK AT THE CAPTURE MECHANISMS OF THE "TEMPORARILY CAPTURED ASTEROIDS" OF THE EARTH

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Asteroid 2006 RH_{120} was discovered as it became temporarily captured around the Earth in 2006, yielding the discovery of a new class of the natural population of asteroids, known as *temporarily captured* asteroids. These objects get naturally captured within the gravitational potential of the Earth, but due to the strongly perturbed environment the capture has a limited duration until the asteroids escapes the Earth-Moon system. 2006 RH_{120} is so far the only known member of this population, though statistical studies by Granvik et al. [1] claim such objects are actually common companions of the Earth, and thus an increasing number of them are believed to be found as survey technology improves [2].

Since these asteroids are technically orbiting the Earth rather than the Sun during their temporary capture phase, they are in energetically favourable conditions to affordably reach them [3], and therefore they become interesting targets for asteroid missions and eventually future resource utilization [2]. Given their enormous potential interest, Urrutxua et al. [4, 5] suggested the idea of artificially extending the duration of these temporary captures, and even the possibility of inducing temporary capture phases to asteroids that would not otherwise get temporarily captured at all. These ideas were proven plausible, but the systematic design of asteroid deflection laws to achieve these goals was found to be difficult due to a lack of understanding of the underlying physical mechanisms that result in these asteroids getting captured.

Anderson and Lo [6] studied the temporary capture of 2006 RH_{120} in more detail, highlighting the significant role that the invariant manifolds of the orbits around L_1 and L_2 had in both the capture (through a stable manifold) and the escape (through an unstable manifold) phases. However, it is not yet well understood if this process is extensible to the full population of temporarily captured asteroids, or important differences may exist between members of the population, thus giving rise to diverse realizations of the mechanisms that drive the capture.

This paper intends to address this point, by studying the capture phase of a synthetic population of temporarily captured asteroid. In particular, energy-related indicators, interaction with the Earth-Moon system, and the geometric layout throughout the temporary capture will be studied and related to the characteristics of the resulting capture, to infer signature patterns that correspond to key features of the temporary capture. In brief, the intend of the paper is to answer the fundamental question of *why* and *how* these asteroids get temporarily captured, understand the principles and mechanisms that ensure the capture, and ultimately learn how to artificially induce temporary capture phases that could be exploited for asteroid retrieval and Earth-delivery purposes.

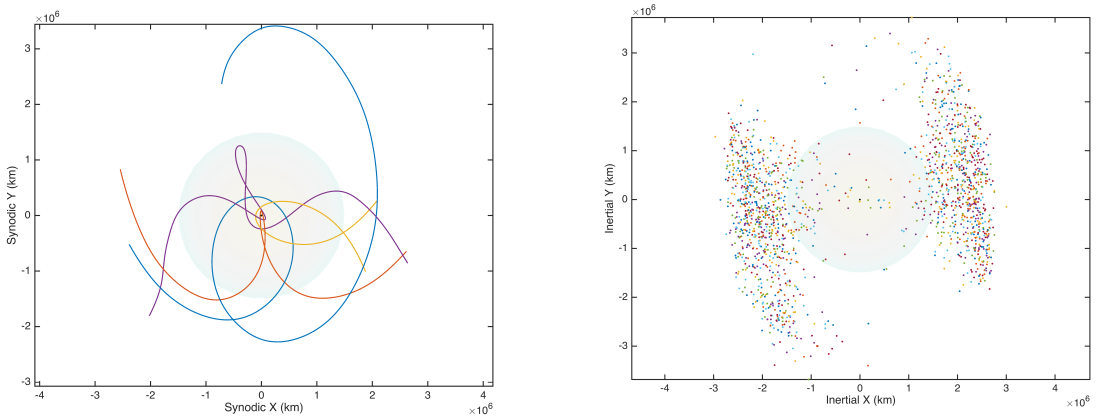

Figure 1. Left: Trajectories of four temporarily captured asteroids in the Earth-centered synodic frame. Right: Synodic position of 1683 temporarily captured asteroids at the beginning of the capture. The Earth's Hill sphere is displayed as visual reference in both plots.

1. References

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