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☐ **Planetary Defense – Recent Progress & Plans**
☐ **NEO Discovery**
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☐ **Mitigation Techniques & Missions**
☐ **Impact Effects that Inform Warning, Mitigation & Costs**
☐ **Consequence Management & Education**

KEYHOLE FEATURES

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ABSTRACT

The term “keyhole” was introduced by Chodas (1999) to denote a small region of the b-plane of a specific close encounter of a small body with a planet, e.g. the Earth, such that, if the small body passes through it, it will hit the planet at a subsequent encounter.
In fact, in a keyhole the perturbations due to the planet are "just right" to put the small body on a collision course. If the collision takes place at the next planetary encounter we speak of a primary keyhole while, if additional encounters take place before the collision, we speak of secondary, (or tertiary, or n-ary) keyhole, as appropriate.
Using Öpik's theory of close encounters, it is possible to show that a primary keyhole is described by a rather simple geometry, and that its location on the b-plane is given by simple analytical expressions, geometrically corresponding to an intersection of the Line of Variations (Milani et al. 2005), describing the uncertainty in the position of the small body, and the circle obtained by imposing that the post-encounter orbit of the small body has to have a specific orbital period (Valsecchi et al., 2003).
The theory allows also to describe the size and shape of the keyholes, and to find the way in which secondary keyholes are nested within primary ones.
While in most practical cases keyholes are "small" (whence the name), that is, much smaller than what would be the "image" of the Earth on the b-plane, there are cases in which keyholes can be exceptionally large, as found by Milani et al. (2009) and by Chodas (2012). The smallness of most keyholes is a bonus in case a deflection would be needed to prevent a collision, and is one of the founding pillars of the current strategy aiming at the identification of collision possibilities as early as practically possible.

Starting from the characterization of keyholes given by the theory, we study a number of practical cases, comparing the theoretical predictions with the results obtained with state-of-the-art numerical integrations. We pay special attention to the issues related to the sizes of keyholes, and to the way in which they are located and clustered in the b-plane.

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