Temporary Capture of Small Bodies by an Eccentric Planet

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We have investigated the probability of temporary capture of asteroids in eccentric orbits by a planet in a circular or an eccentric orbit by analytical and numerical calculations. We found that in the limit of the circular orbit, the capture probability is \(~0.1\%\) of encounters to the planet's Hill sphere, independent of planetary mass and semimajor axis. In general, the temporary capture becomes difficult, as the planet's eccentricity ($e_p$) increases. We found that the capture probability is almost independent of $e_p$ until a critical value ($e_p^c$) that is given by \(\sim 5\) times of Hill radius scaled by the planet's semimajor axis. For $e_p > e_p^c$, the probability decreases approximately in proportional to $e_p^{-1}$. The current orbital eccentricity of Mars is several times larger than $e_p^c$. However, since the range of secular change in Martian eccentricity overlaps $e_p$, the capture of minor bodies by the past Mars is not ruled out.

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