

Capture of small bodies by a giant planet

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We have investigated the dependence of the prograde/retrograde temporary capture of asteroids by a planet on their original heliocentric semimajor axes through analytical arguments and numerical orbital integrations in order to discuss the origins of irregular satellites of giant planets. We found that capture is mostly retrograde for the asteroids near the planetary orbit and is prograde for those from further orbits. An analytical investigation reveals the intrinsic dynamics of these dependences and gives boundary semimajor axes for the change in prograde/retrograde capture. The numerical calculations support the idea of deriving the analytical formulae and confirm their dependence. Our numerical results show that the capture probability is much higher for bodies from the inner region than for outer ones. These results imply that retrograde irregular satellites of Jupiter are most likely to be captured bodies from the nearby orbits of Jupiter that may have the same origin as Trojan asteroids, while prograde irregular satellites originate from far inner regions such as the main-belt asteroid region.

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