Dynamical constraints on the mass of the largest body captured in Jupiter's Trojan swarm

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The Trojan asteroids orbit the Sun about the L4 and L5 Lagrangian points of Jupiter. These objects have a wide range of eccentricities and inclinations, and are thought to be captured bodies. Since the origin of the Trojan asteroids is expected to provide clues to the dynamical evolution of the planets and small bodies in the Solar System, various models have been proposed, e.g., capture due to gas drag from the solar nebula, capture during Jupiter's mass growth, or capture during smooth migration of Jupiter. However, such models failed to reproduce some important characteristics of the present Trojan asteroids, such as the total mass of the Trojans, the distribution of orbital elements, or the distribution of the libration amplitudes. On the other hand, models for the formation of the Solar System suggest that the giant planets likely experienced significant radial migration and orbital instability after their formation. Studies of capture of Trojan asteroids based on such models of giant planet migration show that icy planetesimals originally in the outer Solar System can be captured into Jupiter's Trojan regions, and the present total mass as well as the observed orbital characteristics of the Trojan asteroids can be explained in such models. However, in such studies of capture of the Trojan asteroids, asteroids were treated as test particles, thus gravitational interactions between planetesimals are not taken into account. Although effects of gravitational interactions between sufficiently small asteroids may reasonably be neglected, there may have been significantly large objects in the original swam of Trojan asteroids immediately after their capture. In the present study, we assume that a large body was captured into Jupiter's Trojan region, and examine its dynamical influence on other Trojan asteroids using orbital integration. From the results of our calculations, we will discuss constraints on the mass of bodies existed in the Trojan swarm in the past.

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