Orbital stability of hypothetical terrestrial planets in extrasolar planetary systems based on 'Jumping Jupiter model'

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Orbital stability of hypothetical terrestrial planets in extrasolar planetary systems with gas giant planets in eccentric orbits is investigated through numerical integrations, based on 'Jumping Jupiter model'. In the model, giant planets originally in nearly circular orbits start orbital crossing until one of the giants is ejected, leaving the others in stable eccentric orbits. Orbital stability of hypothetical terrestrial planets in the present orbital configurations of known extrasolar planets has been investigated by many authors. However, the perturbations from the giant planets during the orbit crossing can be so strong. So, we have carried out orbital integrations of systems with three gas giants and hypothetical (massless) terrestrial planets in orbits inside the giants' orbits to investigate the orbital stability of the terrestrial planets during and after the orbit crossing. In the regions relatively close to the giants' orbits, terrestrial planets are ejected through close approach to the giants, while in the innermost region they are stable. However, we found that in a broad range of intermediate semimajor axis in which their orbits are stable in the configurations after the orbital crossing, they hit the host stars although they keep far away from the giants during the orbit crossing. We found that secular resonances that randomly move according to the giants' orbital change during the orbit crossing are responsible for it. Since the perturbations are secular, the eccentricities are monotonically increases, resulting in hitting the host star rather than ejection.