

Orbital Stability of Earth-Type Planets in Stellar Binary Systems

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A pivotal requirement for advanced life forms to flourish is the orbital stability of the life-bearing planet. About half of all known stellar systems with Sun-like stars consist of two or more stars, significantly affecting the orbital stability of any planet in these systems. When a system consists of two stars, the planet may orbit one or both stars, depending on the physical conditions, or may be even kicked out of the neighborhood of the stars entirely, thus lost in space forever. Here we study the onset of instability for an Earth-type planet that is part of a binary system. Our investigation makes use of the rotating (synodic) coordinate system, implying a constant of motion, which allows describing the permissible region of planetary motion. As the initial conditions are varied, this permissible region passes through the three collinear equilibrium points with noticeable changes the planetary orbit. Mathematically, the synodic velocity phase space portraits can be used to conveniently depict the transition between orbital stability and instability. This allows posing criteria for the orbital stability of possibly life-bearing planets, only depending on the system parameters, which can be used to optimize the search process for habitable planets in binary systems in future NASA planet missions.