Chaos and Stability in the Long-term Dynamics of the Inner Planets in the Solar System

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Abstract

The orbits of the inner planets within the Solar System exhibit chaotic behavior, forbidding deterministic predictions of their future positions and velocities beyond tens of millions of years. Despite this chaos, the planetary orbits demonstrate remarkable stability over timescales comparable to the age of the Solar System. The likelihood of Mercury's eccentricity exceeding 0.7, leading to potential catastrophic events such as close encounters, collisions, or planet ejections, is estimated to be only about 1% over the next 5 billion years. In this presentation, I will discuss recent advancements in understanding the origins of the chaotic behavior in the planetary orbits and the factors contributing to their enduring stability. Furthermore, I will present some connections between these findings and astrochronology —the field concerned with the dating of sedimentary series by calibration with astronomically tuned timescales, such as Milankovitch cycles.