

Can the Earth Change Its Axis of Rotation? Modeling the Dzhanibekov Effect

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Abstract

This paper explores the potential manifestation and dynamics of one of the most fascinating phenomena in classical mechanics—the Dzhanibekov effect (also known as the tennis racket theorem)—on an Earth-wide scale. Based on Euler's equations for rigid body dynamics, the rotation of an asymmetric rigid body around its intermediate axis of inertia is characterized by sharp instability and periodic "flipping." In this study, a hypothetical scenario is analyzed: what geophysical and kinematic factors would be required for an Earth-like spheroid to approach such a kinetic crisis? Although the actual Earth currently rotates around a stable axis corresponding to its maximum moment of inertia, internal mass redistribution (tectonic processes, global catastrophic events, core displacement) theoretically alters the components of the inertia tensor. Using mathematical modeling and computer simulations (MATLAB), this work demonstrates the general model of the Dzhanibekov effect alongside a model calibrated for Earth, evaluating the critical threshold at which geodynamic perturbations could trigger a shift in the rotation axis.

Keywords: Dzhanibekov effect, Euler's equations, inertia tensor, rotational instability, geodynamics.

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