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Linearization of the Liouville Equation, Multiple Splits of the Chandler Frequency, Markowitz Wobbles, and Error Analysis

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Author(s)

Cheh Pan

ABSTRACT

The rotation of the physical Earth is far more complex than the rotation of a biaxial or slightly triaxial rigid body can represent. The linearization of the Liouville equation via the Munk and MacDonal perturbation scheme has oversimplified polar excitation physics. A more conventional linearization of the Liouville equation as the generalized equation of motion for free rotation of the physical Earth reveals: 1) The reference frame is most essential, which needs to be unique and physically located in the Earth; 2) Physical angular momentum perturbation arises from motion and mass redistribution to appear as relative angular momentum in a rotating Earth, which excites polar motion and length of day variations; 3) At polar excitation, the direction of the rotation axis in space does not change besides nutation and precession around the invariant angular momentum axis, while the principal axes shift responding only to mass redistribution; 4) Two inertia changes appear simultaneously at polar excitation; one is due to mass redistribution, and the other arises from the axial near-symmetry of the perturbed Earth; 5) The Earth at polar excitation becomes slightly triaxial and axially near-symmetrical even it was originally biaxial; 6) At polar excitation, the rotation of a non-rigid Earth becomes unstable; 7) The instantaneous figure axis or mean excitation axis around which the rotation axis physically wobbles is not a principal axis; 8) In addition to amplitude excitation, the Chandler wobble possesses also multiple frequency-splits and is slow damping; 9) Secular polar drift is after the products of inertia and always associated with the Chandler wobble; both belong to polar motion; 10) The Earth will reach its stable rotation only after its rotation axis, major principal axis, and instantaneous figure axis or mean excitation axis are all completely aligned with each other to arrive at the minimum energy configuration of the system; 11) The observation of the multiple splits of the Chandler frequency is further examined by means of exact-bandwidth filtering and spectral analysis, which confirms the theoretical prediction of the linearized Liouville equation. After the removal of the Gibbs phenomenon from the polar motion spectra, Markowitz wobbles are also observed; 12) Error analysis of the ILS data demonstrates that the incoherent noises from the Wars in 1920-1945 are separable from polar motion and removable, so the ILS data are still reliable and useful for the study of the continuation of polar motion.

KEYWORDS

Liouville Equation; Polar Motion; Chandler Wobble; Markowitz Wobble; Error Analysis

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