Torsional oscillations in Jupiter's metallic hydrogen region

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The Juno magnetometer has been mapping Jupiter's magnetic field from the closest ever passes to a planetary dynamo and is expected to define its secular variation. This will provide us with unique information about the deep interior of the gas giant, particularly on the predicted metallic hydrogen region. In Earth, the magnetic variation allows us to infer the dynamics in the liquid iron core, including waves. Hybrid theoretical models for the deep-seated Jovian dynamo, assuming radial changes of density and electrical conductivity, have managed to reproduce its strong, dipolar magnetic field. Here, adopting those successful models, we explore wave motions that are potentially excited in the metallic region. Theory suggests the existence of torsional Alfven waves in the compressible, anelastic approximation; typically these waves have been examined for incompressible fluids. Our numerical simulations demonstrate axisymmetric fluctuations which travel in radius on timescales of several years and are identified as anelastic torsional waves. Being excited by vigorous convection at an outer radius of the Jovian dynamo region, they can propagate both inwards and outwards and be reflected from a magnetic tangent cylinder, enabling a standing wave. Moreover, they can transport the angular momentum to the overlying molecular hydrogen region and possibly give rise to variations in the length-of-day. We speculate that changes in the rotation period of the planet, which have been a debate in analogous precision, could indeed hinder the true variation arising from the deep internal dynamics.

Keywords: Waves, Rotating MHD, Deep interior, Magnetic field, Length of day