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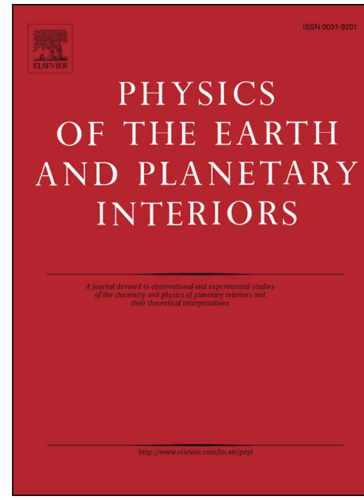

The dynamics of magnetic Rossby waves in spherical dynamo simulations: a signature of strong-field dynamos?

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The dynamics of magnetic Rossby waves in spherical dynamo simulations: a signature of strong-field dynamos?

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Abstract

We investigate slow magnetic Rossby waves in convection-driven dynamos in rotating spherical shells. Quasi-geostrophic waves riding on a mean zonal flow may account for some of the geomagnetic westward drifts and have the potential to allow the toroidal field strength within the planetary fluid core to be estimated. We extend the work of Hori et al. (2015) to include a wider range of models, and perform a detailed analysis of the results. We find that a predicted dispersion relation matches well with the longitudinal drifts observed in our strong-field dynamos. We discuss the validity of our linear theory, since we also find that the nonlinear Lorentz terms influence the observed waveforms. These wave motions are excited by convective instability, which determines the preferred azimuthal wavenumbers. Studies of linear rotating magnetoconvection have suggested that slow magnetic Rossby modes emerge in the magnetostrophic regime, in which the Lorentz and Coriolis forces are in balance in the vorticity equation. We confirm this to be predominant balance for the slow waves we have detected in nonlinear dynamo systems. We also show that a completely different wave regime emerges if the magnetic field is not present. Finally we report the corresponding radial magnetic field variations observed at the surface of the shell in our simulations and discuss the detectability of these waves in the geomagnetic secular

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