Dynamo Fields in Simulations of Receding Turbulent Rotating Convection

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Abstract

Rotating turbulent convection can generate magnetic fields through dynamo action. Since massive stars have convective cores that recede over time, dynamo-generated magnetic fields may be deposited outside the core, forming long-lived structures in the surrounding stably stratified layer.

To investigate this process, we present idealized, rotating magnetohydrodynamic (MHD) simulations in spherical geometry using the Dedalus framework. The model features internally heated convection bounded by a stably stratified layer whose interface evolves in time, extending classical rotating Rayleigh-Bénard convection to include an adjacent stable layer. We examine how dynamo-generated magnetic fields are embedded in the stable layer and how their geometry and persistence depend on rotation and convective intensity.

Using the simulation results, we identify how magnetic fields are transported and deposited outside the convective region. We then analyze how these remnant fields influence large-scale mean flows and Reynolds-Maxwell stress balances across the convective-stable interface. These results highlight how magnetism and evolving boundary conditions can regulate mean flows in rotating convective systems.

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