Examples of viscosity and inertia-free mean-field dynamos

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To date our community has computed many dynamos in which viscosity plays a role in the dynamics. In planetary bodies such as the Earth, viscosity plays a tiny role in comparison to, say, the Coriolis force. Although viscosity in the Earth is not zero, we can compute dynamos with no viscosity to provide a data point that brackets true behaviour and provides a starting point for future calculations in which viscosity might be treated through parametrised boundary effects only.

We present examples of mean field axisymmetric dynamos that have no inertia and no viscosity. These dynamos saturate to a state in which Taylor's condition is satisfied, namely there is no Lorentz torque on any cylinder coaxial with the rotation axis. To perform these calculations, careful treatment must be made of the geostrophic flow. We provide examples of two ways to do this, either through satisfaction of Taylor's constraint at all times, or through the tracking of torsional oscillations, the axisymmetric zonal flows that can develop from unbalanced Lorentz torques.