Dipolar to non-dipolar transition and equatorial symmetry breaking in rotating spherical shells. Influence of the Prandtl number

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Previous numerical studies of convection driven dynamos in rotating spherical shells, mainly at large Prandtl number ($Pr \geq 1$), have shown that the transition between dipolar and multipolar dynamos take place when the local Rossby number approximately reaches the value of 0.1, and that this threshold seems to be very robust on changes of the boundary conditions, the shell geometry or the Ekman number, E. Recently, the transition was characterized in terms of a three term force balance of the nongradient part of the Coriolis, viscous and inertial forces and was accurately described by the hydrodynamic parameter $RoE^{-1/3}$, being Ro the Rossby number.

As a first step, we address the Prandtl number dependence of the dipolar/multipolar transition by considering $Pr < 1$ dynamo models. We have found that the local Rossby number, as well as $RoE^{-1/3}$, increase by decreasing Pr and that exist sig- nificant differences between large ($Pr > 1$) and small ($Pr < 1$) Prandtl numbers, pointing out the need of further research on low Prandtl number dynamos.

Because of the dipolar/multipolar transition is described by hydrodynamic pa- rameters we perform non-magnetic simulations in a second step to see if a transition also exist when considering only purely convective flows. We have found that at a local Rossby number value slightly smaller than 0.1 the equatorial symmetry break- ing of the flow takes place. In addition, the three terms balance is also satisfied. This makes tempting to link the polarity transition with the equatorial symmetry breaking. In contrast to the relatively large helicity needed to maintain dipolar fields at $Pr = 1$, low Prandtl number flows are characterized by a relative low helicity but still seem able to sustain dipole dynamos.
