On the field strength and field topology in anelastic spherical dynamo simulations

Ludovic Petitdemange

Magnetic fields of low-mass stars and planets are thought to originate from self-excited dynamo action in their convective interiors. Observations reveal a huge variety of stellar and planetary magnetic fields that differ in their field strength and topologies. We try to better understand the conditions responsible for this diversity by means of numerical dynamo simulations. In a previous study (Schrinner, Petitdemange, and Dormy 2012) we investigated more than 70 three-dimensional, self-consistent dynamo models obtained by direct numerical simulations using the Boussinesq approximation. The control parameters, the aspect ratio and the mechanical boundary conditions were varied to build up this sample of models. Both, strongly dipolar and multipolar models were obtained. We showed that these dynamo regimes can be distinguished by the ratio of a typical convective length-scale and the Rossby radius. Models with a predominantly dipolar magnetic field were obtained, if the convective length scale was at least an order of magnitude larger than the Rossby radius. Moreover, we highlighted the role of the strong shear associated with the geostrophic zonal flow for models with stress-free boundary conditions. In this case, the above transition disappeared and was replaced by a region of bistability for which dipolar and multipolar dynamos co-exist. We pointed out that the nature of the mechanical boundary conditions has only a minor influence on the scaling law for the magnitude of the magnetic field. Solving now the anelastic equations using a new version of the PaRoDy code, we follow these lines of research and examine the magnitude and the topology of the magnetic field in models with some density stratification. Furthermore, we discuss how these findings relate to our previous models and to observations.