Bistability and hysteresis of dipolar dynamos generated by turbulent convection in rotating spherical shells

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The coexistence of two essentially different turbulent attractors of nonlinear convection-driven dynamos in rotating spherical shells is demonstrated. This phenomenon is of general interest as it is relatively rare in fluid dynamics and magnetohydrodynamics. The distinct chaotic attractors are characterized by rather different properties including a pronounced difference in the amplitude of the axisymmetric poloidal field component, the form of the differential rotation and their temporal behaviour. A hysteretic transition between these attractors is established as a function of all governing parameters of the model. The width of the basins of attraction is investigated. In particular, the bistability occurs from the onset of dynamo action up to about 9 times the critical value of the Rayleigh number for onset of convection and over a wide range of values of the ordinary and the magnetic Prandtl numbers including the value unity near which most of the simulations previously published in the literature have been carried out. We suggest that bistability may provide a mechanism for aperiodic magnetic field polarity reversals similar to those of the geodynamo.