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Reversals in a nutshell

F. Stefani, G. Gerbeth, U. Günther

Forschungszentrum Rossendorf, P.O. Box 510119, D-01314 Dresden, Germany
(F.Stefani@fz-rossendorf.de)

An appropriate theory of Earth's magnetic field reversals has to explain a number of observations:

The first observation concerns the different time scales relevant in the process. The very polarity transition takes only about 5 kyr which is much shorter than the typical interval between reversals (varying between 200 kyr in the present and some tens of Myr during superchrons). In between lies the so-called inhibition time (approximately 40 kyr) during which a follow-up reversal is very unlikely. A second remarkable feature of reversals is their typical asymmetric (saw-toothed) shape with a slow decay and a fast recovery of the opposite field. A third, although controversially discussed hypothesis points to a correlation of the interval time between reversals and the magnetic field amplitude. A fourth observation concerns the bimodal distribution of the virtual dipole moment that has been observed with two peaks at about 4×10^{22} Am^2 and at about twice that value.

Using a paradigmatic mean-field dynamo model with a spherically symmetric helical turbulence parameter α which is quenched by the magnetic energy and disturbed by additional noise we attribute all these reversal features to the magnetic field dynamics in the vicinity of an exceptional point of the spectrum of the non-selfadjoint dynamo operator (Phys. Rev. Lett. 94 (2005), 184506).

A weakness of this reversal model is the apparent necessity to fine-tune the magnetic Reynolds number and/or the radial profile $\alpha(r)$ in order to adjust the operator spectrum in an appropriate way. It can be shown, however, that this fine-tuning is not necessary in the case of higher supercriticality of the dynamo (arxiv.org/abs physics/0509118). For increasing magnetic Reynolds number there is a strong tendency for the exceptional point and the associated local maximum to move close to the zero growth rate

line were the indicated reversal scenario can be actualized.

Special focus is also laid on the astonishing similarities between numerically computed time series and paleomagnetic observations from the last five reversals (arxiv.org/abs/physics/0601011).