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A simple mean-field model of polarity reversals

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The Earth magnetic field undergoes polarity reversals with a mean reversal rate that varies from zero during the supercrons to (4-5) per Myr in the present. Typically, these reversals have an asymmetric, saw-toothed shape. Recently, a bimodal distribution of the dipole moment has been observed with two peaks at about 4×10^{22} Am^2 and at about twice that value.

In an attempt to identify the basic mechanism of such reversals, we study a mean-field dynamo model with a spherically symmetric helical turbulence parameter α which is quenched by the magnetic energy and disturbed by additional noise (arXiv.org/abs/physics/0411050). The basic features of geomagnetic polarity reversals are shown to be generic consequences of the dynamo action in the vicinity of branching points of the spectrum of the dynamo operator where two real eigenvalues coalesce and continue as complex conjugated pair of eigenvalues. The model yields long periods of constant polarity which are interrupted by asymmtric polarity reversals. In certain parameter regions, it exhibits a bimodal field distribution, and it gives a natural explanation of the correlation between polarity persistence time and field strength. Typical features of coherence resonance are identified in the dependence of the polarity persistence time on the noise.