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An Hypothesis for a Fully Reversing Geomagnetic Field Generated by Thermoelectric Currents Across the CMB

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Arguments that the geomagnetic field is generated by an MHD-based geodynamo within the outer core have been sustained more by lack of a competing idea than by success in explaining its characteristics. In particular, its reversibility, polarity bias variation and long periods without reversals have seemed well out of reach of MHD models.

Despite a lack of data on thermoelectric potentials under CMB conditions it is likely that temperature differences at the CMB, as between sites of core upwelling and downwelling, may set up electric current loops within the lower mantle and **outermost** core. P.H.Roberts has shown*[1] that **in the absence of a magnetic field threading the core** a two-cell 'double-doughnut' convection pattern would be likely, with upwelling either at the equator or at the poles. Earth rotation is likely to cause the sub-CMB polewards (say) flow to break up into a spaced-out series (2-5?) of flattened 'ropes', along which the flow is helical. A latitudinal (but not equatorial) cross-section would then show differential potentials of alternating sign spaced out around the CMB, marking the up- and down-welling edges of the ropes. The polarity and strength of the resulting overall magnetic field will then depend on the circumferential spacing of these points, with electric current loops joining the closer set of pairs. If the ropes are wider than the spaces between, the current loops will enclose the spaces and give a corresponding field polarity. As the ropes shrink in width a point will be reached at which the currents will switch to joining the other set of pairs, reversing the current flow and the magnetic polarity produced. When the points of oppositely-directed potential are rather equally spaced, small changes will produce frequent reversals.

This basic model, crude at present, has the potential to explain several aspects of geomagnetic reversals, could increase electromagnetic core-mantle coupling and offer insight into the latitudinal variation of the westward drift. Note that where core motions have hitherto been inferred by assuming that all flux originates within the core, this is not so in the new model.

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[1] * Note added 2011. Subsequently, despite an exhaustive search of PH Roberts' work in the Roy Soc library (Phil Trans and Proc RS) for this remark, I have failed to find it. I now think I must previously have seen it in an adjacent paper but failed to note the author. A double-doughnut layout has the potential to cause the various N-S asymmetries of the field; these include ~6% greater present S-pole total flux, and palaeomagnetic 'polar far-sidedness' which French work has seen to nearly as far back as 300Ma. Ken Creer's argument (1950s) that secular variation washes this out over quite short times is clearly wrong. To match that, I see independent evidence that such 'south polar dominance' swapped from N-polar dominance at some time in the Pennsylvanian. This involved the **similar** change of palaeolatitude of all continents - a most improbable dynamical occurrence.