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Modulation of Geomagnetic Intensity by Elliptic Instability in Earth's Core

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A significant coherence at periods of several thousand years has been found between composite records of paleointensity and simulated lunar tidal strain rate over the past 2 myr. Our search for this coherence followed from our modeling of the observed fluctuations in composite paleointensity as the signature of an externally driven elliptical instability. While the geodynamo can be sustained by compositional convection, it is now understood (Cebron et al, 2010) that elliptical instability can be excited coincidentally in a fluid that is unstable gravitationally. Thus our interpretation of modulation in composite paleointensity records as evidence for elliptical instability is consistent with a geodynamo driven by compositional convection.

Using only composite paleointensity, six reversals of the geomagnetic field over the past 2 myr have been found at previously established times by our model of the decay of elliptical instability at the reversal's onset and growth of this instability following the reversal. Visual observations in laboratory experiments on elliptical instability show that previously axial columns of vortices bend into the equatorial plane during the onset of elliptical instability. Such a collapse in Earth's core would break equatorial symmetry globally, a condition now thought to be associated with reversals of the geomagnetic field. Accordingly, elliptical instability is consistent with observations of composite paleomagnetic intensity and provides a physical explanation for breaking the equatorial geomagnetic symmetry at the time of a reversal.