# Magnetic Dynamo Action in Magnetohydrodynamic Turbulence

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Johnson Space Center (JSC) conducted research that may help solve the "dynamo problem"—that is, the problem of explaining how the generally turbulent magnetofluids (i.e., plasmas) contained in stars and planets (and some laboratory devices) produce large-scale magnetic fields.

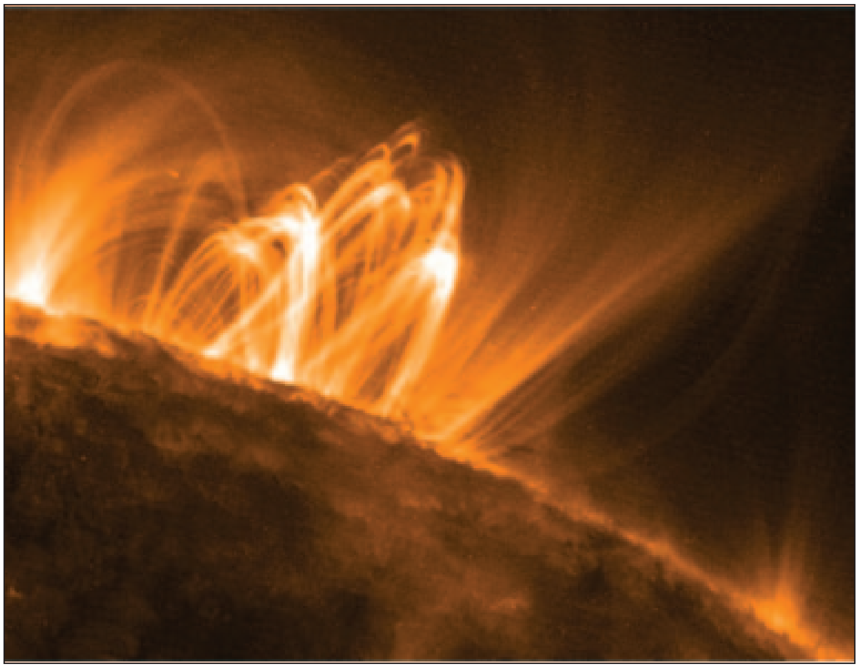

***Fig. 1.*** *NASA Transition Region and Coronal Explorer image of the sun on September 12, 2000.*

A number of complicated attempts have been made to solve this problem, and there have also been quite intricate numerical simulations that reproduce solar magnetic and geomagnetic phenomena. A general mechanism was found that does this in a relatively simple way and that could be applicable to more realistic cases.

In brief, most researchers have long believed that if you take a magnetofluid and stir it up, as it relaxes it produces turbulent magnetohydrodynamic fluctuations at all length scales, but the average direction of any of these fluctuations over a reasonably long time will be zero, which is in keeping with ensemble predicitions based on the statistical mechanics of ideal (i.e., non-dissipative) turbulence. (When time averages and ensemble averages match, the system has "ergodicity.")

JSC found a mechanism that breaks the ergodicity (hence, "broken ergodicity") and produces quasi-stationary, large-scale magnetic fields. This is a qualitatively new result and a conceptual change with regard to a long-held paradigm (the so-called mean field dynamo theory) concerning the origin of magnetism in planets and stars. The results pertain to the plasmas associated with plasma engines and some other devices that confine plasmas if these devices can maintain relatively stable plasma for a long enough period of time, as is the case for stars and planets (figure 1).