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Title: *Solar Dynamo Source*

Cluster: *Cross-Theme Theory and Data Analysis/SECTP*

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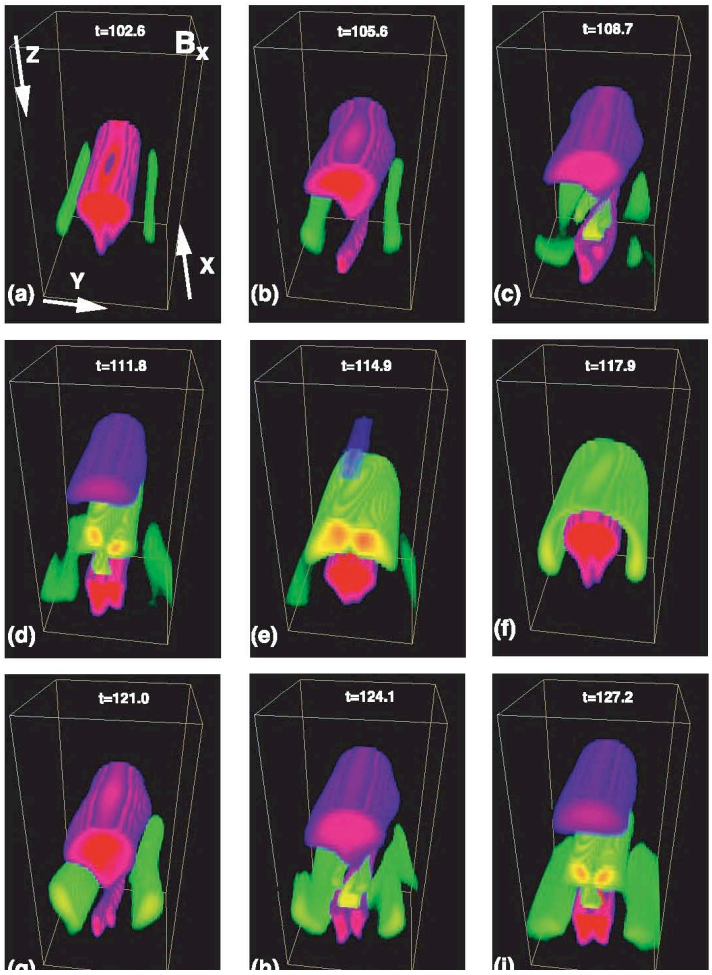
- **First Example of Fully Self-Consistent Dynamo Driven by Magnetic Buoyancy**

Solar active regions are believed to be the surface emergence points of toroidal magnetic structures that rise through the convective zone from deep within the sun. This field arises from dynamo action within the solar interior. The U. Colorado Boulder SEC Theory Program group have created a model based on solutions of the full 3D MHD equations, without any presupposed assumptions or approximations, that examines the creation of magnetic structures in, and their rise out of, the solar tachocline, the region containing the strongest velocity shear. Surprisingly their recent study showed that a simple system, consisting of only a stratified layer of conducting fluid subject to a localized velocity shear was sufficient to produce dynamo action. The dynamo was the result of a complex interaction between magnetic buoyancy and a magnetically-driven secondary instability. The calculation appears to represent the first example of a fully self-consistent solar dynamo in which buoyancy is the crucial driver. This result is a significant improvement of our understanding of the dynamics of the large-scale solar dynamo. This dynamo is responsible for the solar activity cycle whose understanding and prediction are fundamental objectives of NASA's SEC and LWS programs.



Modeled magnetic toroidal structures (the red magnetic flux tubes) successively form and rise (in –Z direction) out of the shear layer, maintaining self-generating dynamo cycles.

(This is a volume rendering of the toroidal magnetic field component, B_x. Blue-green represent negative toroidal fields and red-yellow positive field. Time, t, is in seconds)

Cline, K.S., N.H. Brummell and F. Cattaneo, Dynamo Action Driven by Shear and Magnetic Buoyancy, *Astrophys. J., 599,* 1440-1468, 2003.