Convection in rotating spherical shells and its dynamo action

Friedrich Busse*

Institute of Theoretical Physics, University of Bayreuth, Germany
e-mail: Busse@uni-bayreuth.de

ABSTRACT

The present understanding of convection in rotating spherical fluid shells is reviewed and some recent results on coherent structures and magnetic field generation are considered in detail. The constraints exerted by the Coriolis force leads to unusual properties not found in nonrotating systems, such as vacillations, localized convection, and chaotic relaxation oscillations. The differential rotation generated by the Reynolds stresses of convection in the case of Prandtl numbers of the order unity or less plays a central role. Only at very low Prandtl numbers when inertial wave convection predominates does the differential rotation become less important. Through the braking of the differential rotation the Lorentz force strongly enhances the convective heat transport. Torsional oscillations, oscillatory dynamos, and field reversals are of interest for planetary applications.

Imperfections and dynamics

Edgar Knobloch*

Dept of Applied Mathematics, University of Leeds, UK
e-mail: knobloch@maths.leeds.ac.uk

ABSTRACT

Spontaneous symmetry-breaking bifurcations in systems with symmetry are often associated with higher multiplicity eigenvalues. Such eigenvalues are fragile, and are destroyed by (almost) any symmetry-breaking imperfections in the system, typically resulting in an interaction among two or more nearly degenerate modes. This interaction can lead to novel dynamics at small amplitude, including chaotic dynamics, that are absent in the perfect system, i.e., when the modes are exactly degenerate. Several applications of these ideas arising in fluid dynamics will be described.

Taylor Couette Flow the long and the short of it.

Tom Mullin*

Manchester Centre for Nonlinear Dynamics, The University of Manchester, UK
e-mail: tom@reynolds.ph.man.ac.uk

ABSTRACT

Taylor Couette flow has formed one of the cornerstones of hydrodynamic stability theory since Taylor's pioneering work eighty years ago. He found remarkable agreement between theory and experiment for the stability of flow between concentric rotating cylinders which he devised as a test of a viscous version of the Rayleigh criterion. A central tenet of Taylor's model is that the cylinders are infinitely long so that periodic disturbances can be assumed in that direction. Some thirty years ago, Benjamin challenged this idea and used abstract mathematical arguments to suggest that the finiteness of the domain will be important in any experimental realisation. Benjamin's ideas are now supported by the weight of numerical and experimental evidence and they have lead to the discovery of many novel fixed point and temporal solutions. Indeed, it is now known that the simple physical symmetries are the defining conditions which determine complicated motions including low-dimensional chaos. A review of the central ideas will be given and perspectives for future research discussed.