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15.12
On Magnetic Diffusion in a Turbulent Fluid
S. Vainshtein, F. Cattaneo, and R. Rosner (UChicago)
We show that the turbulent magnetic diffusivity for large-scale magnetic fields embedded in a conducting fluid can be substantially depressed even if the large-scale magnetic field is very weak, e.g., much smaller than the equipartition value \( B_{eq} = 2\sqrt{\rho \nu} \) (where \( \rho \) is the plasma mass density and \( \nu \) is the mean flow velocity). This result has important implications for the loss of magnetic flux in the solar interior and for the solar dynamo, which we shall discuss.

15.13
A Sub-Grid-Scale Magnetic Resistivity Formulation
M. L. Theobald, P. Fox, and S. Sofia (Yale/CSSR)
We have developed a sub-grid-scale (SGS) magnetic resistivity for use in numerical simulations of magnetized convection. Its derivation is analogous to that of the SGS viscosities in use in simulations of unmagnetized flow, both in the Earth’s atmosphere and in the solar convection zone. SGS viscosities are used to make consistent representations, on the resolved scale lengths of the simulation, of those processes involving unresolved scales. In these cases, the relevant energy containing scale lengths are much larger than those involved in dissipation, making direct simulations exceedingly difficult. A similar scale separation is present in the structure of the magnetic field in the solar convection zone.

In our formulation, the magnetic resistivity plays the same role for the magnetic field as the SGS viscosity does for the flow field; namely, to model the effects of magnetic dissipation at unresolved scale lengths. We will present our derivation of the SGS term, and give examples of its application to the study of magnetized convection.

16.02
An Acoustic Poynting Vector for Solar p-Mode Oscillations
D. C. Braun and C. Lindsey (IFA, Univ. Hawaii)
We derive and demonstrate a relatively simple technique for locating local sources and sinks of oscillatory power at the solar surface. A vector \( \mathbf{S} \) is defined as \( \mathbf{S} = \mathbf{v} \times \nabla \varphi \) where \( \mathbf{v} \) is the velocity or intensity field observed at the surface and the brackets indicate the time-average. For traveling waves, \( \mathbf{S} \) points in the direction of propagation with a magnitude proportional to the square of the wave amplitude. Therefore, the divergence of this quantity should directly indicate the presence of any source or sink of waves.

The technique is applied to a velocity data set taken with the 512-channel magnetograph at the Kitt Peak vacuum telescope. For the purpose of isolating p-mode waves, a temporal filter centered at 3 mHz is applied to the data before computing \( \mathbf{S} \). The result shows a large negative divergence of acoustic waves within the penumbra of a sunspot. This confirms the absorption of p-mode power by sunspots which had been previously recognized by the decomposition of the waves into cylindrical Hankel functions centered on the spot.

16.03
Analysis of p-modes in a Sunspot Umbra
Matthew Penn, Barry LaBonte (JAAUH)
Imaging spectroscopy data of the main umbra of NOAA #8536 was collected on 15 December 1999 with the MCCD instrument at Mees Solar Observatory, Hilo, Maui, Hawaii. The data contains several molecular absorption lines at \( \lambda = 4044 \) Å which are formed only in the sunspot umbra and not in the surrounding quiet sun. Each scan covers a 12 x 29 arcsecond region centered on the umbra with 0.6 arcsecond sized pixels; the umbra covers an area roughly 10 x 20 arcseconds in each scan. Observations were made continuously every 47.5 seconds for a 7.2 hour duration, which gives a frequency resolution of 3.90 x 10^-7 mHz and a Nyquist limit of 10.53 mHz.

For the lowest order standing wave mode (corresponding to \( J_{\text{num}} (k=0) \)), we find the line of sight velocities are always less than 105 m s^-1, and usually less than 50 m s^-1. A power spectrum analysis of the velocity time series of this spatial mode reveals several distinct, unresolved oscillation peaks between 2.5 mHz and 4.0 mHz, with powers ranging from \( 4 \times 10^7 \) m^2 s^-2 Hz^-1 to \( 7 \times 10^8 \) m^2 s^-2 Hz^-1. (The high frequency noise power is \( 1.1 \times 10^9 \) m^2 s^-2 Hz^-1.) These oscillation modes are closely spaced in frequency with separations near 0.16 mHz. We present an analysis of the umbral oscillation power in several \( J_{\text{num}} (k) \) spatial modes.

16.04
The Role of Slow Mode Waves in P-mode Absorption by Sunspots
Y. Fan, G.H. Fisher and A.N. McClymont
We analyze the local dispersion relation for Magnetic-Acoustic-Gravity waves in a uniformly magnetized and vertically stratified atmosphere. We found that slow mode waves are not trapped in the upper layer of the convection zone, so that they can carry energy...