S E M I N A R S

(matematika mugaz bestalde)

(bcam)
basque center for applied mathematics
Bizkaia Technology Park, Building 500
E-48160 DERIO - Basque Country- Spain
www.bcamath.org

March 26, 2010

12:00 Iñigo ARREGUI, Universitat de les Illes Balears, Palma de Mallorca, Spain

MAGNETOHYDRODYNAMIC SEISMOLOGY OF THE SOLAR ATMOSPHERE

The magnetohydrodynamic (MHD) approximation provides a mathematical description of a plasma in the presence of a magnetic field in which the plasma is treated as a continuous medium. It can be viewed as classical fluid dynamics with the additional complication that the fluid is electrically conducting. Its applications extend to a wide range of magnetized plasmas throughout the Universe, including laboratory plasmas, the solar atmosphere, and the Earth's magnetosphere. In the solar atmospheric context, we will discuss its use in the modeling and analysis of the physical conditions in magnetic and plasma structures by a combination of observations of MHD wave activity together with theoretical models for the propagation of magnetohydrodynamic waves in those structures, a discipline known as MHD seismology. This remote diagnostics technique is akin in philosophy to Earth seismology, the sounding of the Earth interior using seismic waves, and helio-seismology, the acoustic diagnostic of the solar interior. It constitutes the only way for obtaining a knowledge on important physical parameters, such as the magnetic field strength or transport coefficients, that cannot be measured by direct means. A good understanding of the physical conditions in the solar atmosphere is crucial, since plasma and magnetic field interactions in our star affect directly Earth and its geomagnetic environment.

In this seminar we will first describe the basic elements of the MHD approximation for the mathematical description of a magnetized plasma. Next, the observational evidence for MHD wave activity in several magnetic and plasma structures of the solar corona, obtained by both ground-based as well as instruments onboard satellites, and theoretical MHD models developed in order to explain the observed wave properties are briefly reviewed. Finally, we present results from the application of the MHD seismology technique to oscillations in coronal loops and prominence fine structures. In coronal loops, we show how the combination of observed periods and damping times with analytical and numerical results for wave modes in non-uniform flux tube models allows us to obtain estimates for the Alfvén speed (connected to the magnetic field strength), the transverse density inhomogeneity, and the density scale height in the solar corona using multiple mode oscillations. In solar prominences, the typical large values of the prominence to coronal density ratios allow an even better determination of the physical parameters of interest. Some open issues and future directions in the field are also discussed.