sis suggest that the radial flows for typical supergranules have speeds about 9% that of their associated horizontal flows or about 30 m/s. The ratio of the radial to horizontal flow speed increases from 9% to about 13% as the size of the cells decreases from >30 Mm to <5 Mm. Data simulations are used to confirm these conclusions.

5.05

Sunspots: Frontside and Backside Measurements with Time-Distance Helioseismology

T.L. Duvall, Jr. (NASA/GSFC), A.G. Kosovichev, P.H. Scherrer (Stanford Univ.)

In time-distance helioseismology, travel times measured between different surface locations are used to infer subsurface flows, temperature inhomogeneities and magnetic fields. It has been suggested that most of the travel time reduction near sunspots may be due to the lowered reflection layer associated with the Wilson depression. This will be examined by looking at rays that travel below the sunspot but do not begin or end in the spot. A time-distance method of imaging sunspots on the backside will be compared with that of Lindsey and Braun.

5.06

The Influence of Internal Heating on Nonlinear Compressible Convection

N.E. Hurlburt (Lockheed Martin Solar and Astrophysics Laboratory), N.O. Weiss (University of Cambridge)

In the bulk of the solar convection zone we expect convection to be efficient and therefore maintain an adiabatic temperature gradient. In most numerical simulations of solar convection the total energy flux within this region is due to the conduction down this gradient (which is small) and the various contributions due to the convective motions. What has often been neglected is the contribution that is transported by radiation.

The contribution of this flux decreases across the layer and thereby deposits a significant amount of thermal energy in the midst of the convection zone. This is in contrast to most simulations of the convection where the input of energy is supplied exclusively by conduction from the boundaries. Mixing length models predict that approximately half of the total energy input to the solar convection zone is deposited, more-or-less uniformly over the convection zone, with the remaining half being conducted from the lower boundary. Thus the study of the behavior of internally-heated compressible convection is warranted.

Previous studies of internally heated compressible convection have been inconclusive due to the stirring instabilities that arise in simple, periodic domains. Here we suppress these instabilities by considering flows in axisymmetric geometries. We conduct surveys of the structure and dynamics of the resulting flows and present possible applications to observed solar and stellar phenomena.

Session 6: Waves as a Tool
Oral Session
Chair: J. B. Gurman
3:30-5:00pm, Forum

6.01

Helioseismology: what happens just below the surface?

A.G. Kosovichev (Stanford University), T.L. Duvall, Jr. (Laboratory for Astronomy and Solar Physics, NASA GSFC)

Helioseismology (or time-distance helioseismology) is a relatively new tool for diagnostics of internal structures and dynamics of the Sun. It is based on inversion of travel times of acoustic wave packets propagating through the solar interior and bouncing back to the surface. The travel times provide information about the variations of temperature, magnetic fields and flow velocities along the wave paths. These properties of the solar interior are inferred from the travel times by tomographic inversions. Helioseismology has provided a three-dimensional view of the interior, not accessible by traditional helioseismology based on mode frequencies. This method has been applied to study both large-scale flows (meridional circulation, North-South asymmetry of solar rotation) and small-scale phenomena (supergranulation, sunspots, emerging magnetic flux). The results reveal very dynamical and complicated structures below the surface, associated with convection and magnetic fields, and shed new light on the formation and evolution of active regions and sunspots. We discuss the current limits for the temporal and spatial resolution and recent achievements. Most inversion results provide the results to a depth of 20 Mm. It has been demonstrated that with this method we can measure the solar flows to the base of the convection zone, which is 200 Mm deep. However, resolving deep and small-scale features is very challenging, and requires concentrated efforts for developing both the measurement techniques and theoretical interpretations. We review the recent progress in developing a wave-theory approach to helioseismographic inversions, and perspectives for the diagnostics of the physical processes below the Sun’s surface.

6.02

Coronal Seismology: Using Oscillations to Understand Coronal Structure

J. M. Davila (NASA-GSFC)

Recent high resolution observations from TRACE have demonstrated that oscillations in the corona can be observed from space. In this paper we consider the following question. What is the nature of these motions, and how can they be used to understand something about the corona? We briefly review some of the observational results, and discuss the interpretation of these results within the framework of MHD wave propagation and damping in coronal loops, open flux tubes, and loops with cusp structures. The prospect for future improvements in the theory and observations will be discussed.

6.03

Are the EIT waves really waves?

C. Delannee (Goddard Space Flight Center), T. Amari (Ecole Polytechnique)

One sample of EIT wave is presented and discussed. The bright front of the wave present two parts: one stationary and one moving arch. The stationary part of the wave is compared to the magnetic field lines extrapolated in spherical coordinates with the potential assumption. The stationary part is located where the footpoints of the separatrix of the magnetic field are. Another case of a moving arch of an EIT wave is analyzed in conjunction with a numerical simulation of the ejection of a magnetic flux rope. The phenomenology and the morphology of the both the moving arch and the electric currents created by the ejection of the flux rope are similar. We conclude that the EIT wave phenomenon is possibly related to the generation of electric currents while the magnetic field lines are opening during a coronal mass ejection.

6.04

Three-dimensional MHD modeling of an impulsive excitation of a coronal loop motivated by TRACE observations

L. Ofman (Raytheon ITSS/NASA GSFC), J.M. Davila (NASA GSFC)

Recently, decaying transversal oscillations of bright coronal loops in the 171Å and 195Å emission lines were observed with the imaging telescope on-board the TRACE satellite. The loop oscillations were excited impulsively by a solar flare in the adjacent active region. Using 3D MHD model of the loop the period and the decay rate of the oscillations, together with the loop geometry, density, and temperature can be used to determine the average magnetic field of the loop, and the magnetic or viscous Reynolds number (R). Recently, Nakariakov et al. (1999) used the $R^{15}$ heating time scaling to