WEDNESDAY, 13 JUNE

MORNING SESSIONS

Special Session 13: 0900–1000 (Alumnae Hall)
Invited (George Ellery Hale Prize Lecture)

08.13.03 George Ellery Hale and Active Magnetic Fields. E. M. Parker, U. Chicago.
George Ellery Hale invented the spectroheliograph to study the activity of the sun and then established from the Zeeman splitting of a number of lines in sunspot umbrae that strong magnetic fields are an intrinsic part of the sunspot. These pioneering observations, and the spectroheliograph and magnetograph in their various modern forms, are the basis for modern studies of the magnetic activity of the sun and of stars and galaxies. Most astronomical bodies have magnetic fields and, hence, are active. The theoretical understanding of magnetic fields embedded in highly conducting gases has progressed over the decades but is still without solid explanations for much of the activity. Observation continues to lead the way, continually turning up new effects that not only were not anticipated but have yet to be understood after the fact. The turbulent diffusion of magnetic fields is, after three decades of theoretical controversy, well established as a real effect in nature, but with the surprising associated effect of negative diffusion in suitably long lived eddies. The behavior of magnetic fields in a convective stellar envelope, then, is complicated by the buoyancy of the field, by convective propagation, and by turbulent diffusion. Together these effects guarantee that the magnetic fields within the envelope are delivered to the surface where the intrinsic internal non-equilibrium of magnetic fields produces the extensive array of suprathermal effects collectively called activity. For all the wide occurrence of magnetic activity in the Universe, the sun and the magnetosphere of Earth are the two places where the physics of the activity can be observed in enough detail to progress toward understanding the physics. The primary cause of magnetic activity is the nonequilibrium that results when any flux tube extends from one pattern of winding of about its neighbors into another. For in that circumstance there is at least one thin layer from which the fluid is squeezed so that the gradient of the magnetic field increases without bound, until resistive diffusion steps in and dissipates the field. The sunspot, and its magnetic field discovered by Hale, is a particularly vexing phenomenon, having resisted any overall self-consistent explanation up to the present time. We have suggested that the sunspot is merely the magnetic debris on the surface of the sun marking the position over an unseen subsurface downdraft. No other concept seems to account for the spontaneous clustering of so many separate individual flux tubes into a single bundle. As a final point, the observed strong variation of the mean level of solar activity over the centuries is presumed to be a consequence of changes in the internal convection and circulation beneath the visible surface of the sun. Hence we would expect at least some slight change in the total luminosity of the sun in step with the changing level of activity. This entire question is of fundamental importance to the physics of stellar interiors and stellar activity, besides being of profound consequence to the correlated variations of the climate of Earth. Hence, precise measurements of the absolute intensity of the sun, to absolute accuracies of at least one part in $10^3$, must be begun now and extended indefinitely into the future, as the only direct means for studying the problem (measurements by Hoyt are ongoing) and should be measured to supplement the direct observations of the sun, showing by the changes in each of many stars, the possible variations of the sun over long periods of time.

Session 13: 1000–1100 (Room 377)

SOLAR DIVISION MEETING

08.11.03 Solar Luminosity Variation: Observational Evidence and Basic Mechanisms. P. V. Foukal, AER, Inc. and CENTER FOR ASTROPHYSICS.
We review the evidence on variations of the total solar luminosity, with particular attention to the results on changes over time scales between days and tens of years. We summarize the time behavior of the solar constant and of the solar spectral irradiances for comparison with observations of other late-type stars, and also for its possible importance as an input to climate models. We discuss some physical processes that might give rise to variations of the total luminosity in the shorter time scales, and point out how the observable parameters of solar luminosity variation can be used as useful techniques to study the dynamics of gas and magnetic fields in the convection zone. We suggest some useful observations to be made from the ground and from space in the future.

08.11.05 Optical Variability of Late-Type Dwarfs and RS CVn Stars: Evidence for Luminosity Changes and Searches for Spot Cycling. L. Hartmann, CfA.
- The observational evidence for luminosity variations that may be related to solar-type activity on other stars is reviewed. Spots have been identified on late-type stars, based on the demonstration of inhomogeneous surface brightnesses derived from eclipses of binaries, and on