07.01.04 Polar Deceleration and Convection Zone Depth for the Sun, GILMAN, P. A., HAO/NCAR. Previous nonlinear model calculations by the author, of convection in a rotating spherical shell of depth 20% of the outer radius, indicate that the equatorial acceleration at the sun has provided the influence of rotation upon convection is strong enough. The model equatorial acceleration is maintained by Reynolds stresses in the convection which transport angular momentum toward the equator from higher latitudes. A second prominent feature virtually always present in the model is a local polar acceleration or vortex. This feature has shown for on the sun by Beckers and by Howard, but not found. Recently, we have made new convection calculations for deeper shells, and we find that for strong but not over powering influence of rotation upon convection, the polars are decelerated and little or no polar vortex appears. An equatorial acceleration is still formed. We interpret this result as being due to a) the Reynolds stresses reaching to a higher latitude in the deeper shell, and b) the moment of inertia of "polar regions" being a smaller fraction of the total moment, for deeper shells ("polar regions" being defined as the parts of the shell inside the tangent cylinder to the equatorial inner boundary). The results suggest that since polar regions on the sun are spun-down relative to the equator, the convection zone depth must be substantially greater than the 20% usually obtained from stellar structure calculations applied to the sun. Although the convection model calculations are for a stratified liquid, the depth moment of inertia is even stronger and the standard picture of semiconvection is incorrect. The approach uses models by Lamb, Iben, and Howard (1976, Ap. J., 201, 200) to define zeroth order profiles of the thermodynamic variables and radius as functions of mass, as well as hydrogen mass fraction X in the core and the position of the core boundary as functions of time. Then time dependent turbulent mixing is modeled by numerically solving simplified transport equations for X and the turbulence kinetic energy density q. The X equation is a diffusion equation with a q-dependent eddy diffusivity, and it uses the X of the core as a boundary condition. The q equation takes into account the finite decay time of turbulence and its diffusive nature (including convective overshoot as a special case). As the core boundary recedes, the fossil turbulence left behind decays so slowly and diffuses so strongly that significant amounts of mixing occur above the core boundary, preventing the formation of a semiconvection zone for a wide variety of conditions. In particular, choosing the turbulence length scale equal to a pressure scale height results in homogenization of the star far beyond the maximum extent of the semiconvection zone.


Submitted by E.N. Parker

07.02.04 The Eddy Viscosity Approach to Stellar Convection, DEUPREE, R.G., Boston U. - A study has been undertaken to study the effects of variation in horizontal cell size and eddy viscosity coefficient on eddy viscosity approach solutions for convective structure in the hydrogen ionization region. The changes in the convective flux produced by this parameter study are rather small, much smaller than can be made by changing the mixing length in the local mixing length theory. It is concluded that no single value of the ratio of mixing length to pressure scale height can reproduce the hydrodynamically computed convective flux.

07.03.04 Very Elongated Convective Cells in the Sun, GЕRRONICHOLAS, E.A., U. of Chicago - The observed presence of a single dominant rigidly rotating active longitude and the 180° separation of the observed secondary ones have been interpreted as manifestations of the presence of very elongated convective cells with lateral dimensions of the order of the solar circumference. Similarly, the presence of giant unipolar photospheric magnetic regions and the interplanetary sector structure are shown to support the above ideas. We show that elongated cells are obtained in the presence of the anisotropic effects of the solar differential rotation with depth (dΩ/dr), provided that the bottom of the convective zone rotates at least 5% faster than the photospheric gas.

07.04.04 A New Look at Semiconvection, CLAYTON, L.D., Los Alamos Scientific Laboratory, Theoretical Division - A major uncertainty in the evolution of massive stars (M ≥ 9 M☉) is the treatment of semiconvection just outside the convective hydrogen-burning core. Preliminary results of a new approach to this problem suggest that the standard picture of semiconvection is incorrect. The approach uses models by Lamb, Iben, and Howard (1976, Ap. J., 201, 200) to define zeroth order profiles of the thermodynamic variables and radius as functions of mass, as well as hydrogen mass fraction X in the core and the position of the core boundary as functions of time. Then time dependent turbulent mixing is modeled by numerically solving simplified transport equations for X and the turbulence kinetic energy density q. The X equation is a diffusion equation with a q-dependent eddy diffusivity, and it uses the X of the core as a boundary condition. The q equation takes into account the finite decay time of turbulence and its diffusive nature (including convective overshoot as a special case). As the core boundary recedes, the fossil turbulence left behind decays so slowly and diffuses so strongly that significant amounts of mixing occur above the core boundary, preventing the formation of a semiconvection zone for a wide variety of conditions. In particular, choosing the turbulence length scale equal to a pressure scale height results in homogenization of the star far beyond the maximum extent of the semiconvection zone.

07.05.03 Secular Changes in Solar Rotation, 1888-1964, BARY, J.A., NOYES, R.W., WOLKICH, J.G., CFF, and BOORMAN, A.A., S. Ross & Co. - We have analyzed the extensive compilation of daily sunspot positions from the Greenwich Photographic Results for the period 1888-1964 (solar cycles 13-19) to investigate long-term