40.08.05 Thermal Convection in Compressible and Boussinesq Fluids in Plane-parallel and Spherical Geometries, P. S. MARCUS, Cornell University — Methods of solving numerically for stable, steady-state motions of a thermally convecting fluid are developed and applied to Boussinesq and compressible fluids in plane-parallel and spherical geometries. A Galerkin method is used where the horizontal dependence of the velocity and thermodynamic functions are expanded in a set of $\sim$100 basis functions. The equations of motion are integrated in an "artificial time" that forces the thermal time-scale and the hydrodynamic time-scale to be equal. Calculated rates of heat transport agree well with those measured in the laboratory for a wide range of Rayleigh numbers, Ra. For 10^4>Ra> critical Rayleigh number, "rolls" are found to be stable; for 10^5>Ra>10^4, rectangles are found to be stable; for Ra>10^5, the fluid motions are too complicated to be described well by a planform with only one wavelength, making the single-mode theory used by other authors inaccurate in this range. In a fluid with constant viscosity and conductivity, hexagonal planforms are not stable. In a spherically convecting fluid, specialized planforms corresponding to the five regular polyhedral solids are found and the polyhedral harmonics are expressed in terms of the spherical harmonics. For 10^6<Ra<10^{10}, the dedocahedral plandorms are found to be stable. A new dimensionless number in the spherical, compressible, anelastic equations is found, are which plays the role of the Rayleigh number in the Boussinesq equations. In a model of a convecting red giant with Ra on the order of 10^{39} (but with new "effective" Rayleigh number of only 10^{10}) the temperature, pressure, density and convective velocity are computed using a dodecahedral planform.

40.09.04 Stochastic Convection: How Constant is the Solar "Constant?* M.J. Newman+, MPI für Astrophysik, München, and D. Dearborn=, U. Arizona. - Although stellar convection is recognized as being a largely chaotic phenomenon, in most studies on stellar and solar evolution, the structure of the convection regions is determined using mixing length theory, with the assumption of a ratio α of mixing length to pressure scale height constant in space and time. The small variations in the efficiency of convection resulting from the stochastic nature of convective motion can be represented as time variations of α, which can effect the temperature gradient, and structural adjustment of the convective region must follow. But this involves an interchange between the gravitational potential energy and internal energy of the material in the convection zone, and results in perturbations to the solar luminosity. The case in which the time scale τ_α for the variation of convective efficiency is longer than the thermal time scale of the convection zone τ_c has been considered by Ulrich (Science 190, 619, 1975), who found that the luminosity perturbation is proportional to the rate of change of α. However, if $\tau_\alpha<\tau_c$ the thermal response of the envelope cannot track the change in α, and the result of a sudden change $\delta\alpha$ in the efficiency of solar convection is a luminosity perturbation $\delta \log L \cong 0.2\ \delta\alpha$, decaying to the original luminosity on the time scale τ_c. Thus 1 % changes in the solar luminosity could result from fluctuations in the efficiency of convection as small as $\delta\alpha = 0.02$, and one must wonder to what level the solar "constant" is indeed a constant.

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=Caltech visiting research associate, summer 1977.

40.10.04 Evolution of the α Centauri System B.P. FLANNERY, CFA and T.R. AYRES, JILA. - Astronomic data and an analysis of available photometry suggest that the masses, luminosities, and temperatures of the A and B components of α Centauri are, respectively, (1.11, 0.92 [±3%]) $M_\odot$, (1.51, 0.47 [±4%]) $L_\odot$, and (5800, 5300 [±100] K. By constructing consistent evolutionary models for the binary, relative to a solar fiducial sequence, we find $Z_\alpha/Z_\odot \sim 2$, $Y_\alpha - Y_\odot = -0.01$, and a system age of 6 billion years. A previous curve of growth analysis by French and Powell supports the conjecture that the A and B components have similar compositions, and that the system is slightly metal rich compared to the Sun. This, coupled with the nearly identical galactic motions of α Centauri and the Sun, imply that if accretion of material from the interstellar medium has substantially altered the metallicity of the solar surface convection zone with respect to the interior, the bulk of the accretion must have occurred in a very small number of significant accumulations. Our results also suggest that the Sun and α Centauri do not obey the putative relation $\Delta Y \gtrsim (3 \text{ to } 5)\ \Delta Z$ for the galactic enrichment of helium and metals.

40.11.04 Photonuclear P-Processing in Degenerate Hydrogen Burning Regions and Its Relationship to Nova Outbursts T. G. HARRISON, No. Tex. St. Univ. We have investigated the possibility that the p-nuclei may have been produced in degenerate hydrogen burning zones similar to those expected at the base of envelopes accreted by white dwarf stars prior to a possible nova outburst. Under these circumstances, and as long as temperatures remain less than T_6=15 and densities greater than about 10,000 gm/cc, hydrogen burning closes via the $^3He(e^-)\,^3T(p,\gamma)\,^4He$ branch. The burning of tritium releases a 20 MeV photon which is capable of triggering (γ,n) and $(\gamma,2n)$ reactions on target nuclei. If these target nuclei are s-nuclei having approximately the