Results from 2-D Numerical Simulations of the Solar Granulation

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We have performed detailed numerical simulations of solar granular convection in axially symmetrical cells of different horizontal dimension. The calculations account for the basic physics of compressible convection, including ionization of hydrogen and non-local 3-D radiative transfer. Magnetic fields are not taken into consideration.

On the basis of these hydrodynamics/radiative transfer simulations we are able to address a number of questions concerning the thermal structure and dynamics of the solar photosphere. We have investigated the effect of CO-cooling in a 2-dimensional atmosphere (Steffen and Muchmore 1988, Astron. Astrophys. 193, 281), and have studied the dependence of the dynamical and spectroscopic properties of granular convection on the horizontal scale of the convection cells (Steffen, Ludwig, Krüß 1989, Astron. Astrophys. 213, 371). The numerical simulations can also help to elucidate the nature of "exploding granules" and to enhance the theoretical understanding of the complicated interaction of convection and solar oscillations.

We have developed a spectrum synthesis code to compute the line spectrum emerging from the model granules (spatially resolved or horizontally averaged) as a function of time and position on the solar disk. Corresponding spectroscopic observations can be used for a direct comparison to assess the realism of the hydrodynamical models.

Recently, the thermodynamics has been extended to allow also for ionization of He and He$^+$ as well as molecule formation of H$_2$. A study of convective motions in the photospheres of F- and A-type stars is under way.