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On the Origin of the Supergranulation and the Magnetic Network in Solar Quiet Regions

Haruhisa Iijima[1*], Yokoyama, Takaaki[1]

[1]Department of Earth and Planetary Science, University of Tokyo

The supergranulation and the magnetic network are the most conspicuous horizontal structures observed in the lower-atmospheric (UV and IR) emission of the sun.
The origin of these structures remains unsolved for over 50 years. We newly develop a radiative magnetohydrodynamic simulation code for the realistic calculation of the solar surface magneto-convection. The results of two-dimensional convection simulations are presented to show the formation process of supergranulation and the magnetic network.

When the magnetic field strength is moderate, no supergranular peak is found in the kinetic energy spectrum. However, the magnetic energy spectrum has an clear peak at the scale of the magnetic network. The horizontal structure of this magnetic network has a correlation with the horizontal flow at a depth of about 3 Mm. This result is interpreted that the large-scale structure of the magnetic network is formed by the merging of the strong downflows with the smaller scale convection.

When the magnetic field becomes sufficiently strong, the back reaction from the magnetic network to the supergranular convection occurs and the supergranular spectral peak appears in the kinetic energy spectrum. This suggests that the magnetic network is not the result of the supergranulation but the exciter of the supergranular convection in the solar surface.

Based on the results above, we suggest a scenario for the formation process of the magnetic network and supergranulation.

Keywords: supergranulation, magnetic network, photosphere, convection