OBSERVATIONAL RELATIONSHIP BETWEEN MESO-SIZED CONVECTION AND 5-MIN OSCILLATION IN THE SOLAR ATMOSPHERE

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1. Introduction

Solar convection has been studied theoretically and observationally for very long time. At present, three kinds of solar surface structures are supposed as manifestations of solar convection; granulation, mesogranulation, supergranulation, in increasing order of spatial size. Among them, observations of mesogranulation, however, do not have long history, yet, since November's discovery (1981). Their basic characteristics such as lifetime, velocity field, radial size, and relation to other kinds of convection, have not been precisely determined, yet.

By the way, currently, there are important discussions about where the source of the excitation of the solar oscillation is situated. The small sized oscillating cell compared with the granulation scale had been considered as beat phenomena between larger scale oscillations for a long time (White & Cha 1971; Wolff 1973; Fossat & Ricort 1975; Deubner 1975). There are even opinions that meso-granulation is also the apparent phenomenon by superposition of oscillating cells. Quite recently, however, a few observations showed very important results. Rimmele et al. (1995) and Espagnet et al. (1996) showed that strong solar oscillations (having large amplitudes) often seem to be closely associated, both temporally and spatially, with the dark lanes of granulation and down flowing regions.

Then, in this time, we observationally observed time variations of granulation, meso-granulation, and 5-min oscillation and 3-dimensional velocity components of meso-granulation, in order to investigated features of the mesogranulation and relationship between solar convections and 5-min oscillation cells.

F.-L. Deubner et al. (eds.), New Eyes to See Inside the Sun and Stars, 457–458.

2. Observation, Analysis and Results

For the purpose described in section 1, we performed two different kinds of observation simultaneously with the Domeless Solar Telescope (DST) of Hida Observatory. One is 2D imaging observation of solar quiet photosphere in wavelengths around $\lambda 4308$ Å, whose duration is 90 min. The other one is slit spectroscopy of the neutral iron line $\lambda 6302.5$ Å at the central region of the field-of-view of the 2D imaging observation; its duration is only 30 min. Thus the horizontal velocity field is obtained from the former observation by local correlation tracking method (November & Simon 1988; Kitai et al. 1997; UeNo & Kitai 1997) using granulation patterns as tracers, while the radial velocity field is obtained from the latter one at the same region.

From the map of horizontal velocity field, we can find meso-sized velocity divergence structures which distribute all over the photosphere. By calculating the spatial power spectrum, we could know that the size of this structure is about 15". Moreover, we made a histogram of the meso-sized structures' lifetime from the time series of velocity field maps for 90 min. It shows a clear peak of lifetime at 40 min, and the frequency gradually decreases toward long lifetime, though this obtained lifetime is rather shorter than ones reported in the past studies.

Next, we separated the radial velocity field into four components, i.e. granulation, mesogranulation, oscillation, and high frequency noises, by Fourier filtering. We also calculated the power spectrum of the meso-granular radial velocity field, and obtained the same size as horizontal velocity structure. This clearly suggests the existence of a three-dimensional meso-sized structure . In fact, both patterns of the meso-sized radial and horizontal velocity fields are well consistent, and the values of velocities satisfy the continuity equation for convection.

Further, we investigated the temporal and spatial relationship between the 5-min oscillations and convection by using the data of the radial velocity field. At first, we investigated the temporal development of the velocity fields of granulation and oscillation. At the location where amplitudes of 5-min oscillation increase suddenly, or where large phase changes occur, we noted a strong downflow in the granular field, i.e. a granular collapse immediately before a change of the 5-min oscillation. This finding corroborates reports by Rimmele et al. and Espagnet et al.. Moreover, we checked the spatial relation between the meso-granular velocity field and the 5-min oscillation field. We found that regions, where oscillations are strongly excited for more than 30 min, correspond to downflow regions in the meso-granulation field.

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