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# On the scales of formations in the fine structure of the brightness field in the solar photosphere

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**Abstract.** Analysis Wavelet-spectra has shown that in the with earlier our works, in a field of brightness of thin structure of photosphere scales of formations of granules, protogranules, and mezogranules come to light.

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In order to understand, how the fine structure of the solar photosphere is organized, it is necessary, in particular, to reveal all more or less stable scales of formations in the range from a granule to a supergranule and to investigate their properties. Ikhsanov (1970, 1975) has analyzed the best direct images of the solar surface and was the first to find out that between the scales of granules and supergranules there exist two more stable scales - the clusters of granules and the groups of the clusters of granules with the sizes of 3000 and 8000-10000 km, respectively. Later on they were called protogranules (Ikhsanov et al., 1997) and mesogranules (November, et al, 1981). For investigating the brightness field of the photosphere, we have chosen four images of the solar surface taken during the flight of the stratospheric solar station in 1970 (Krat et al., 1970) with a resolution of about 0.25". The photometric scanning of the selected frames was carried out with a step of 100 urn using the slit of microphotometer 100x100 um (0.17"x0.17"), followed by calculation of spectra with the use of Marly wavelet for each photometric scan, made over 2.5". The size of the areas under investigation was 45"x45" on one of the frames and 105"x77" on all the others. In order to get a quantitative picture of the spatial distribution of these photospheric formations, a statistical distribution of their sizes has been analyzed. This was carried out by calculating the number of formations (in total 572) in all 18 photometric scans with a step of 0.3". The result is presented in Fig.1a a in the form of a histogram. A peak of the number of formations clearly stands out at about 1.5". This mode corresponds to the scale of granules. Somewhat weaker, but still clearly distinguished is the scale of protogranules with a peak at 3.6". However, in order to make a reliable estimate of the number of formations of definite size, it is necessary to take into account that within a limited area the number of formations decreases proportional to their size.

The normalized histogram (Fig.1b) shows that in addition to two formations already mentioned three more modes are observed in the region of a mesogranule: a rather high peak at 11.1", a lower peak at 18" and a broad low peak at 6-7". If we consider only the modes, which are significantly higher than half-height of the first peak, there will be only four of them including a supergranule (see Table 1 from Ikhsanov et al., 1997). Half-width of the first three peaks of these scales cover the size intervals 1.2"- 2.4", 3.0"-5.0" and 8"-15", respectively. Let us note that a depth of a gap in the number of formations ($> 60\%$) between granules and protogranules is an essential argument in favor of reality of the scale of protogranules. Wavelet analysis allows retracing the peculiarities of changes of

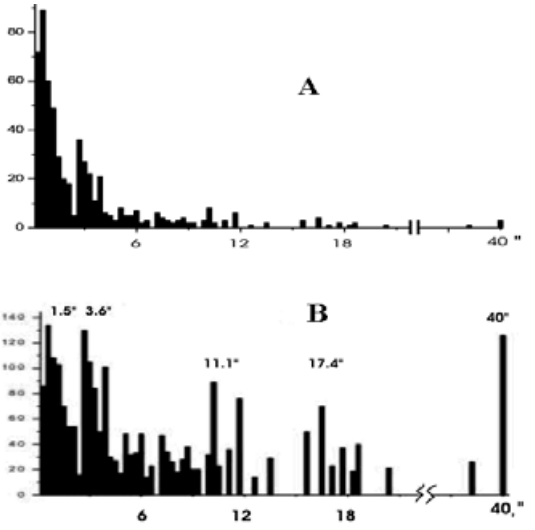


**Figure 1.**

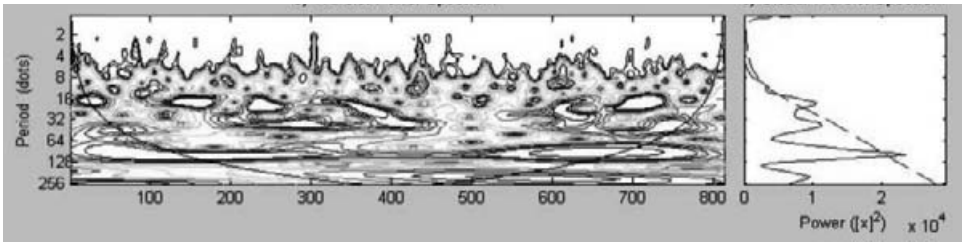


**Figure 2.**

a certain scale along the scan. Similar analysis concerning a grouping of different scales has revealed a tendency for neighboring scales to aggregate into hierarchical structures.

The next three frames were obtained with a time interval between exposures 1m 40s and 1m 20s. Fig.2 presents an example of processing of approximately the same scan on these three frames. The power spectrum (right panel) shows three significant peaks: 1.5"-2.1", 4."-5", and 12"-14". As one can see from Global Wavelet Spectrum (c), basic formations have not changed significantly over the time period under consideration. Thus, the analysis of wavelet-spectra of the brightness field of the solar surface speaks in favor of an existence of two more stable scales between the scales of granules and supergranules - protogranules and mesogranules, clustering within the size limits, given in Table 1. Moreover, in addition to mesogranules with the sizes 8"-15" between the scales of protogranules and supergranules, two more low modes centered at 6.5" and 20" can be distinguished.

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