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Small-Scale Plasma Structures in a Plage Region of the Solar Photosphere

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Results of high-resolution ground-based observations and spacecraft measurements (e.g., taken from the Swedish 1-m Solar Telescope on La Palma and the Solar Optical Telescope on the Hinode satellite) provide good ground for study of small-scale processes in the solar photosphere. Formation of small-scale structures in plasma density of the photospheric plage region and dependence of their characteristics on the magnetic field strength $\mathbf{B}$ is considered in the present report. It is shown that the structures can be generated in the plage due to turbulent mixing of the photospheric gas. The process can be described in the framework of three-fluid equations. Taking into account a low degree of ionisation of the gas in the photosphere, one can assume that ion-electron plasma is embedded in turbulent flow of the gas and has no influence on its motion. According to data of observations the statistics of random velocity field of the gas corresponds to the Kolmogorov turbulence. For analysis of the effect of field $\mathbf{B}$ on plasma density structures, analytic expressions describing the spatial spectrum of the structures and the rms fluctuation level were derived. Estimations of the spectral shape and the fluctuation level were made for the photosphere around 350 km altitude under the magnetic field strength B from 100 to 1000 G. It was shown that the rms amplitude of plasma density fluctuations (with length-scales smaller than 100 km) around the mean value of background density has to increase from 8.23 to 9.41 % with the magnetic field strength. The spatial spectrum can be approximated by a power-law dependence k^{-p} and the power index p has to decrease with $\mathbf{B}$ from 1.61 (B=100 G) to 1.29 (B=1000 G). Relatively weak influence of the magnetic field on the amplitude of plasma density fluctuations results from a more important role of local gradient in the background plasma density for generation of the plasma structures.