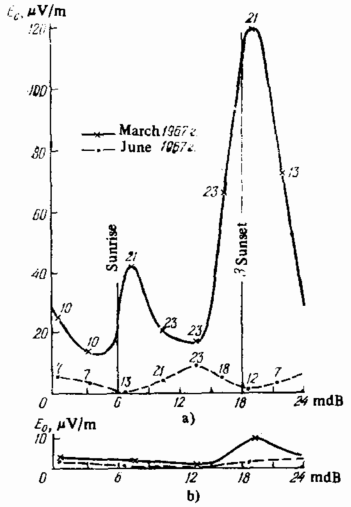
É. I. Mogilevskiĭ, The Fine Structure of the Solar Magnetoplasma. 1. Investigation of the nature of the fine structure (FS) of the solar magnetoplasma has become a prime concern of solar physics. The basic properties of solar-activity phenomena and the related complex of sun-governed geophysical phenomena are determined by the characteristic filamentary FS of the magnetoplasma. Almost all of the magnetic field in the active and undisturbed regions of the sun is concentrated in a set of regularly arrayed small-scale (sizes $\gtrsim 1''$) pointlike (in cross section) filamentary elements. In these elements, the field strength ranges from a few hundred (in the so-called filigrees—bright points on the boundaries of convective supergranules) to 10^3 Oe (in spots, pores, magnetic "nodules"). The filamentary FS of the magnetic field and the equally fine structure of the velocity and solar magnetoplasma emission distribution that is associated with it can be traced in optical, x-ray, and radio observations at all levels in the photosphere, chromosphere, and corona and in the interplanetary plasma. The evolution and dynamics of the FS are under investigation with the most modern solar-research equipment (vacuumized tower telescopes, extraatmospheric solar telescopes, etc.).

2. Studies of certain subtle effects of Zeeman splitting of Fraunhofer lines in the spots have made it possible to indicate[1] the possible existence of large magnetic fields in the closely spaced magnetic bundles of the FS, between which there is an oppositely directed field ($\approx 200-300$ Oe). This conception is favored by differences in the Doppler velocities determined from the σ and π components ($v_\sigma = v_\pi - \nabla$, where $0.25 \lesssim \nabla < 0.5$ km/sec).

3. Studies of the FS of the solar magnetoplasma and of the hierarchic discrete macrostructure of solar activity can also be pursued by detailed investigation of the quasiperiodic oscillations (QPO) of the magnetic field and the associated QPO of the optical, x-ray, and radio emissions.

Observations of the QPO of the magnetic-field vectors in spots, made simultaneously at two levels with two vector magnetographs[2,3], have made it possible to detect a discrete power spectrum of the low-frequency QPO of the field and the radial velocities. These field QPO are propagated at the local Alfven velocity from the photosphere to the chromosphere and corona of the active region. The QPO in the radio emission (especially for the S component of the radiation above spots, type IV radio bursts, and noise storms, in whose generation the magnetic field is a decisive factor) are closely related to the QPO of the magnetic fields. The QPO power spectrum carries information both on the FS of the magnetoplasma (in the modulation-frequency range $\approx 10^{-1}-10$ Hz) and on its macrostructure (at modulation frequencies $\approx 10^{-2}$ to 10^{-4} Hz). This is also confirmed by numerical modeling of the process and by comparison with QPO observations for the magnetic fields and radio emission. Hence the QPO power spectrum and the results of regression analysis can serve as quantitative characteristics of active-region evolution[4]. This offers a possible way of constructing a quantitative probability forecast of solar activity and sun-governed geophysical phenomena[5].



4. An attempt can be made to construct a theoretical model of the solar magnetoplasma FS by introducing the distribution function of a statistical ensemble of current-eddy discrete (subgranular) elements[6,7]. An anisotropic distribution is obtained from Vlasov's equation for collisionless magnetically interacting discrete elements that are bounded in phase space. It is possible, for example, to arrive by this route at an effective conductivity in the magnetoplasma that is smaller than the classical conductivity by a factor R_m (the magnetic Reynolds number). This may make it possible to understand a number of "strange" properties of the magnetoplasma in solar phenomena (the relatively high dynamism and weak "freezing" of the magnetic fields in the solar plasma, etc.). Formally, the solar magnetoplasma can be treated in the same way as a magnetic fluid. The results of solar observations (the pulling-in and ejection of fine-structure elements in several solar phenomena in the neighborhood of strong fields, vortical motions and cylindrical waves in FS elements, etc.) indicate greater profundity of the analogy between the solar magnetoplasma and the magnetic fluid[6].

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Translated by R. W. Bowers