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A joint scientific session of the Division of General Physics and Astronomy and the Division of Nuclear Physics of the USSR Academy of Sciences was held on February 25 and 26, 1981 at the P. N. Lebedev Physics Institute of the USSR Academy of Sciences. The following papers were presented:

February 25

1. *S. I. Vaǐnshteǐn*, Magnetic-field dynamos in space.

2. *G. M. Zaslavskii*, Aspects of the origin of stochasticity in quantum systems.

February 26

3. *N. G. Basov, A. F. Plotnikov, and V. N. Seleznev*, Electronic processes in metal-selicon nitride-silicon dioxide-semiconductor (MNOS) structures.

4. *N. G. Basov, A. B. Kravchenko, A. F. Plotnikov, and V. É. Shubin*, Self-stabilized avalanche process in a metal-dielectric-semiconductor (MDS) structure. Avalanche MDS photodetectors.

Below we present brief contents of the papers.

S.I. Vaǐnshteǐn. *Magnetic-field dynamos in space*. The problem of the dynamics of large-scale magnetic fields (the interstellar-gas field of the Galaxy as a whole, of a star as a whole) is regarded as solved in general outline. The turbulent motion of the conductive gas results in the appearance of turbulent diffusion and turbulent field generation. The origins of the Galactic and stellar fields and the solar cycle are explained in this way.[1,2] But when it comes to the fluctuation fields (FF) (with scales of the order of magnitude of the interstellar clouds in the Galaxy and the line-structure fields on the sun), it has not yet been possible to analyze the main question: whether or not the turbulent medium produces FF dynamos.

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A difficulty of the problem is that turbulence results in two competing processes: amplification of the field ("tangling of force lines") and a decrease in the scale of the field. The rates of these processes are of the same order of magnitude. Consequently, the problem must be solved *exactly*, since only then will it be possible to establish whether or not an FF turbulent dynamo exists. Batchelor's analysis,[3] which was based on the similarity of the equations for the field H and curl v (v is the velocity) met with lively discussion and criticism because the physical conditions are fundamentally different for H and curl v.[4]

The small parameter $\varepsilon = \tau v/l$, where τ is the correlation time, l is the turbulence scale, and v is the rms velocity, has been used up to this time to establish the dynamics of the field in the highly conductive cosmic plasma. At very small $\tau(\tau \to 0)$, the v field is a random white-noise process (the v field "remembers" nothing concerning its past value), while the field H is a Markoff process. The field-dynamics problem can be solved rigorously for this model. For the large-scale field, the diffusion and generation coefficients can be determined with accuracy sufficient for astrophysics in the Markoff model. It is possible in principle to derive an FF dynamic equation for the Markoff model and to establish whether or not a dynamo exists. But this would not by any means imply that the answer has a bearing on real turbulence. This is because $\varepsilon \approx 1$ in actuality (for Kolmogorov turbulence, the turbulence of interstellar clouds, turbulent convection on the sun, etc).

The situation changed radically after the appearance of Ref. 5, which establishes the behavior of the large-scale field without the assumption that $\varepsilon \ll 1$. This made it possible to construct an *exact* theory of the FF.[6] We set forth the essentials of this approach.

The exact solution of ideal magnetohydrodynamics is taken as a base:

$$H_i(\mathbf{x}, t) = \frac{\partial x_i}{\partial a_m} H_m(\mathbf{a}, 0); \tag{1}$$

where x is the coordinate of a fluid parcel that departed point a at time $t=0$. An expression for the correlation tensor $B_{ij} = \langle H_i(x) H_j(x) \rangle$ is obtained by multiplying (1) by the corresponding expression at point x' and with the index j and averaging. It is clear that $B_{ij}(t)$ will be expressed in terms of $B_{mn}(0)$ and in terms of the Lagrangian tensor $L = \langle (\partial x_i/\partial a_m)(\partial x'_j/\partial a_n) \rangle$ in principle, the problem is now solved: the tensor L characterizes the motion and is simply a given quantity while B_{ij} is expressed in terms of its own initial form.

For properly conditioned specification of $\hat{L}$, the partial derivatives in (1) are replaced by finite differences; then the numerator of the expression for $\hat{L}$ will contain four points. Averaging means multiplying the entire expression by the four-point distribution function $p_4(x_\alpha | a_\beta, t)\alpha$, $\beta = 1, 2, 3, 4$—the density of the probability that fluid parcels will be at point x_α if they were at points a_α at time $t=0$. Thus, the task has been reduced to specification of p_4.

Let us formulate the results. Specification of the distribution function p_4 makes it possible to obtain the exact FF dynamic equation. In the range of very small scales that appears in a medium with extremely high conductivity, the equation is of universal form. This makes it possible to answer the main question of FF dynamos in the affirmative: a growing solution is obtained, i.e., generation occurs. Specification of the two-point distribution function p_2 leads to the dynamic equation of the large-scale field.

Thus, determination of the Lagrangian characteristics of the motion from experimental and observational data (for example, from the motion of fine-structure elements that have been "frozen into" a plasma) would make it possible to establish the dynamics of the magnetic field. We note that direct laboratory or numerical modeling of the turbulent dynamo is not possible at this time, and that observational data cannot be interpreted without ambiguity.

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[2]S. I. Vaĭnshteĭn, Usp. Fiz. Nauk **120**, 613 (1976) [Sov. Phys. Usp. **19**, 987 (1976)].

[3]G. K. Batchelor, in: Problems of Space Aerodynamics (Russ. transl.), IL, Moscow, 1953, p. 179.

[4]S. I. Vaĭnshteĭn, Ya. B. Zel'dovich, and A. A. Ruzmaĭkin, Turbulentnoe dinamo v astrofizike (The Turbulent Dynamo in Astrophysics), Nauka Press, 1980.

[5]R. H. Kraichnan, Phys. Rev. Lett. **42**, 1677 (1979).

[6]S. I. Vaĭnshteĭn, Zh. Eksp. Teor. Fiz. **79**, 2175 (1980) [Sov. Phys. JETP **52**, 1099 (1980)].