Physics of thermonuclear plasma

V. I. Petviashvili

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K. Nishikawa and M. Watanabe, *Plasma Physics: Basic Theory with Fusion Applications,* (Ed.) G. Ecker, Springer-Verlag, Berlin, 1990, 312 pp. [Springer Series on Atoms and Plasmas)

As is clear from the subtitle, this book is devoted to an introduction to the theory of thermonuclear plasma, and it gives the reader an idea of the current state of thermonuclear studies and prospects for the future.

The first book of this type, *Physics of Fully Ionized Gases* by L. Spitzer, appeared in 1956 (the latest Russian edition appeared in 1965) and was very popular. Then, the stellarator program was considered to be the leading program, and no tokamak was mentioned in the book. Nonetheless, of the large number of books on plasma theory, it is Spitzer's book which is closest in style and content to *Plasma Physics.*

Experiment description occupies a small part of this book. This is followed by a detailed exposition of the theory of equilibrium, stability, and transport in plasma primarily as applied to tokamaks. A description of stellarators is also given, as well as descriptions of relatively new systems such as the spheromak and a pinch with a reversed field. The neoclassical and turbulent theory of diffusion and thermal conductivity in plasma is presented. The transport processes in convective cells are examined.

There is a clear exposition of the most complex part, the theory of plasma stability. Instabilities are examined, which are of interest for magnetic thermonuclear fusion. Unfortunately, the classification admits an inaccuracy: balloon instability is discussed in the section on resistive instabilities.

The first half of the book is devoted to the general theory: motion and collisions of charged particles in electromagnetic fields, high-frequency pressure, the derivation of Vlasov's equation and the equations of hydrodynamics. A detailed linear theory of waves in plasma is provided, including drift waves (but only potential drift waves).

Only an elementary theory of nonlinear waves is presented: quasi-linear theory, parametric instabilities, and nonlinear Landau damping. It is not clear why the nonlinear Schrödinger equation, and not the Zakharov equation, is used to describe the collapse of Langmuir waves.

Overall, the book can be considered successful pedagogically and in its selection of material, which is aided by good formulation. It is of interest for those who have a general physics education, and also for specialists, because it brings together the body of knowledge accumulated in the last decade.

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