BOOKS

Plasma Kinetic Theory; a Quintessentially Russian View

Lectures on Non-linear Plasma Kinetics

Vadim N. Tsytovich
Translated from the Russian by D. ter Haar
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Reviewed by Donald B. Melrose

During the period in the 1950s in which research on plasma physics was classified in both the United States and what was then the Soviet Union, plasma kinetic theory developed in quite different ways in the two countries. The prominent Soviet physicists involved were well versed in quantum electrodynamics and freely used quantum concepts whenever convenient. After its declassification and publication in 1956, the Russian approach was viewed with suspicion by Western plasma theorists. The equivalence of the different approaches is now well recognized, but obvious differences in style remain.

Vadim Tsytovich, through his voluminous research papers, review articles and books, has developed a systematic approach to plasma kinetic theory that, to Western eyes, appears quintessentially Russian. Tsytovich, who has influenced nearly two generations of Russian plasma theorists since the mid-1960s, is renowned for his lecturing style. In his highly mathematical lectures, he presents detailed mathematical derivations on the blackboard without reference to any notes.

The material covered in his lectures during the 1960s was presented in two of his earlier books: *Nonlinear Effects in Plasma* (Plenum, 1970; Russian version, 1967) and *Theory of Turbulent Plasma* (Consultants Bureau, 1977; Russian version, 1971). *Lectures on Non-linear Plasma Kinetics* is an English-language translation of lecture notes that, unlike the earlier books, have not been previously published in Russian.

In the preface to this book, Tsytovich remarks that he has given the lecture course on nonlinear plasma kinetics for more than a decade, updating the notes each year. The first chapter gives brief, qualitative overviews of 12 diverse applications of nonlinear plasma kinetic effects. Tsytovich's forte is in the mathematical formalism, which is developed in detail in the next 12 chapters, many of which have qualitative introductions that attempt to put the formalism in context. However, the connection between the formalism and the suggested applications is not explained in detail.

There are several highlights. I found the derivation and discussion of the important but often overlooked Landau–Balescu collisional integral in chapter 4 enlightening. (Tsytovich published essentially this material in *Uspekhi Fizicheskikh Nauk* **32**, 911, 1989.) The discussion of strong turbulence in chapter 10 should be of interest to any active worker in the field. An informative introduction and overview of current ideas on strong turbulence are followed by developments of many aspects of the modern theory, each flavored by Tsytovich's unique approach.

I was particularly interested in the discussion of the plasma maser effect in chapter 11. Tsytovich and I were involved in a controversy over an earlier version of this effect, which he called turbulent bremsstrahlung. My understanding of the outcome of our controversy is that, *sotto voce*, he has acknowledged our point that the plasma maser effects cannot occur in a closed system, and we have no disagreement with the claim that it can operate in an open system. However, I found this chapter disappointing in that there is no clear discussion of the physical implications of the requirement that the system be open.

Tsytovich's style is both a strength and a weakness in this book. For those who are familiar with his approach, this book will prove a useful addition to his earlier works. For those unfamiliar with Tsytovich's approach, these lecture notes are likely to appear as a highly mathematical exercise with no obvious connection to practical applications.

Another weakness is the lack of references; the book leaves the reader with no way to distinguish Tsytovich's work from that of others and no way to find original or recent references on any specific topic in the book. There is a "recommended literature" section at the end of chapter 1 that lists 39 books and review papers, but there is no reference to this literature elsewhere. The reader will need to complement this book with either Tsytovich's earlier books or other sources of references to the literature. This book will nonetheless be a useful addition to the library of those teaching advanced plasma physics and of researchers active in nonlinear plasma physics.

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Wavelets: An Analysis Tool

Matthias Holschneider
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Wavelets have been steadily gaining strength as an analysis tool for pure and applied mathematics as well as disciplines that use mathematics, including physics, engineering and neural network theory. The study of wavelets arose very rapidly from observations made in the mid-1980s by Stephane Mallat and Yves Meyer that orthonormal bases for functions (of the same nature as familiar sine and cosine bases of Fourier analysis) could be obtained from essentially a single function $\psi(x)$ through dilations and translations.

The advantage of wavelets is the localization of these basis functions, since the dilations and contractions of the "mother wavelet" $\psi(x)$ allow for functions in the basis that have arbitrarily small support (nonzero extent). Familiar Fourier analysis techniques on the entire real line use sines and cosines (or equivalently complex exponentials) that, by their nature, have support over the entire line, which causes confusion when specific local features of functions are sought from the Fourier transform. For example, local singularities of the function being expanded will result in a slow convergence of the Fourier transform everywhere. This is one of several problems alleviated by wavelets.