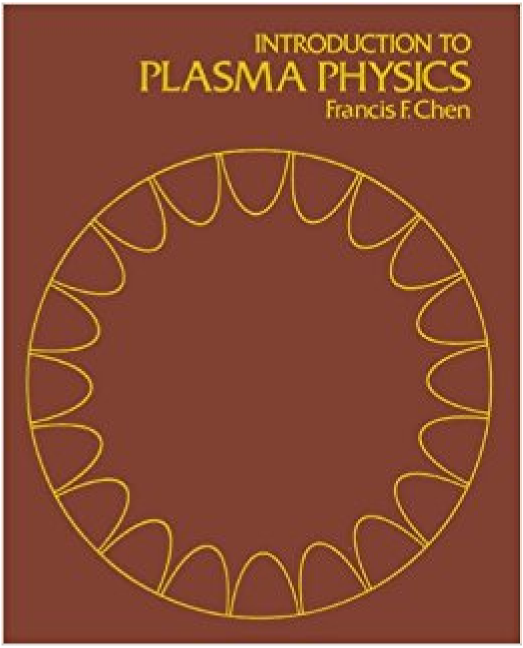
Introduction To Plasma Physics



Synopsis

This book grew out of lecture notes for an undergraduate course in plasma physics that has been offered for a number of years at UCLA. With the current increase in interest in controlled fusion and the wideÃ Â- spread use of plasma physics in space research and relativistic asÃ Â- trophysics, it makes sense for the study of plasmas to become a part of an undergraduate student's basic experience, along with subjects like thermodynamics or quantum mechanics. Although the primary purpose of this book was to fulfill a need for a text that seniors or juniors can really understand, I hope it can also serve as a painless way for scientists in other fields-solid state or laser physics, for instanceÃ Â- to become acquainted with plasmas. Two guiding principles were followed: Do not leave algebraic steps as an exercise for the reader, and do not let the algebra obscure the physics. The extent to which these opposing aims could be met is largely due to the treatment of a plasma as two interpenetrating fluids. The two-fluid picture is both easier to understand and more accurate than the single-fluid approach, at least for low-density plasma pheÃ Â- nomena.

Book Information

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Customer Reviews

Having used, read more than a dozen plasma physics monographs, and used at least two for a Ph.D. level plasma physics course (including 'Introduction to Plasma Physics' by D.R. Nicholson) I can safely say that Chen's is the best for the introductory or self-study student. I have also recommended it to those intent on working plasma problems on their own, such as questioners who've frequented the astrophysics forum on allexperts.com.As I've told several of them, Chen's book essentially "leads you by the hand"- going through particle motions, gyro-frequencies, adiabatic invariants etc., to magnetic mirror systems (including loss cone angles and Fermi accelerations applied to them) to plasma instabilities and MHD, whereas many others (even ’Plasma Physics’ by Krall and Trivelpiece) tend to assume too much.If there is one small complaint it’s that Chen, certainly in his earlier editions, tends to use the cgs system as opposed to the S.I.(For example, using ergs instead of joules, and cm/s instead of m/s etc.). But this is easily remedied if the student simply downloads the ’Plasma Formulary’ (google!) which contains a Table for conversions between the systems. It is certainly not enough of a problem to warrant notching the rating down!Chen’s best section (in Chapter Seven) is probably that which shows how MHD (magnetohydrodynamics) actually arises from a progressive degradation in physical detail, starting from two-fluid theory, to one fluid theory to MHD.Chen’s bottom line overview is that one proceeds by taking moments of the Boltzmann equation.E.g. given the Boltmann eqn. is: @f/ @t + v*grad f + F/m*@f/@t = (@f/@t)_Cwhere @ denotes partial derivative, and (@f/@t)_C is the time rate of change in f due to collisions.The first moment, which yields a ’two-fluid’ (e.g. electron-ion) medium is obtained by integrating the above eqn. with F = q/m (E + v X B). If one then assumes a sufficiently hot plasma so it’s collisionless, the term on the RHS, (@f/@t)_C -> 0.This is the **Vlasov** equation:@f/@t + v*grad f + q/m (E + v X B)*@f/@t = 0The 2nd moment is obtained by multiplying the original eqn. (Boltzmann) by m v then integrating it over dv.Anyway, the progression by using this procedure is that one gets in succession:Two -fluid theory (e.g. ions and electrons treated as a separate fluids)!!VOne fluid theory (introducing low frequency, long wave length and quasi -neutral approximations, e.g. n_e ~ n_i!!VMHD Theory (proceeds from 1-fluid theory with further assumptions, simplifications)In this development, one can see that the two-fluid paradigm embodies much more detail and accuracy than the cruder 1-fluid and MHD approaches, though it is or can be more difficult to apply. Basically given an "ion fluid" and an "electron fluid" there are two essential equations which apply to describe the properties, one for continuity, the other for force.I must also give prime kudos to Chen for his excellent treatment of Landau damping, and the meaning of Landau damping in the context of plasma oscillations, in the same chapter. Hands down, this is one of the best I’ve seen including his presentation of obtaining the Landau contour.In short, this text gets five stars because it’s the best I’ve seen for the beginning plasma physics student. The writing is clear, the examples and illustrations illuiminating (never redundant, or obscure) and the example problems are well-chosen.In addition, all the problems at the end of each chapter are easily doable if one has properly followed the arguments and examples in the chapters.

Francis F. Chen wrote a wonderfully clear, accessible book on plasma physics right for beginners. Even with a PhD, I find the book pleasant and insightful to read on the subject.

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