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REVIEW

Notes sur les Ecoulements Rotationnels de Fluides Parfaits. By R. K. Zeytounian. Springer, 1974. 407 pp. $10.80 or DM 28.

Perfect fluid motions involving continuously distributed vorticity provide essential components of models of the oceans and atmosphere, of interior flows in the earth's core as well as in a turbine, and of viscous wakes at high Reynolds number. In some respects our theoretical understanding of high Reynolds number phenomena hinges on the ability (or inability) to complement boundary-layer theory with the requisite rotational Euler flows. These notes in the Springer-Verlag series "Lecture Notes in Physics", based upon the author's course at the University of Lille in 1972–3, are devoted to these difficult problems of considerable contemporary interest.

The book divides roughly into two parts, the first five chapters comprising a thorough summary of the classical general theory and its recent extensions, and the last five chapters treating applications to some specific problems. Of particular interest in the former is the powerful use of the Lagrangian description, not only in chapter II on material invariants, but also in the kinematic and dynamic analysis of adiabatic baroclinic flow given in chapter III. Chapter IV treats in detail the question of compatibility between velocity and force fields, that is, conditions under which the given fields determine a forced perfect fluid flow. This chapter is overly technical and really not needed in the later applications, and might have been sacrificed for the sake of an expanded discussion of variational principles (chapter V). As it stands the latter lacks the depth the subject deserves, especially in view of the substantial preparation provided for the reader in the earlier chapters.

The heart of the remainder of the book is chapter IX on the asymptotic theory of axial flow through a turbine, which will likely be of considerable interest to specialists. The analysis is a fascinating unravelling of a complicated engineering problem using asymptotic methods with the basic large parameter being the number of turbine blades per rotor. The remaining chapters, concerned with linearized flow, asymptotic models, stationary flows, and a final chapter on meteorological applications, are not nearly so comprehensive, although most of the problems treated are rather advanced. For example, in anticipation of chapter IX, one linearization describes three-dimensional perturbations of a helicoidal flow. Curiously, the asymptotic methods given in chapter VII are restricted to the low Mach number limit process, and derivation of equations for shallow and deep convection, although the latter should fall naturally in the final chapter. There one misses an equally formal treatment of the beta-plane approximation, which is introduced without discussion. Especially noteworthy among the meteorological problems is the discussion of three-dimensional lee waves.

It is unfortunate that, by entirely excluding real fluid effects, the author has not considered the several interesting examples (in nonlinear stability theory, internal rotating flows, cavity flows, to name a few) where rotational Euler flows arise as a formal inviscid limit. Furthermore, the earlier chapters tend to develop equations in succession with little immediate attention to their relative importance and physical implications. In spite of these defects, the reader wanting an excellent and complete summary of the more formal, manipulative aspects of the theory will find it in these notes, along with a number of interesting applications not readily found elsewhere. An extensive bibliography is provided.

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