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REVIEW

Turbulence and Random Processes in Fluid Mechanics. By M. T. LANDAHL and E. MOLLO-CHRISTENSEN. Cambridge University Press, 1986. 154 pp. £20.00 or $34.50.

The first author is best known for his work on stability theory; the second was principal of a very useful teaching film on stability (for the US National Committee for Fluid Mechanics Films), and is widely admired as a clever experimentalist, most recently in wave phenomena. This seems to me an unusual pair to have produced a book with this title, and the book is a curious result.

There is indeed an introduction to the statistical description of turbulence (with an aside on the response of linear systems to random excitation), but there is an even longer section on small-disturbance instability theory (with a nod to chaos at the end), and one almost as long on wave theory. There is a section on 'homogeneous' turbulence (meaning homogeneous in some direction: channel flow, the boundary layer and thermal convection, followed by isotropic turbulence; this bizarre usage is sure to cause confusion), but the part on non-isotropic flows never gets beyond mean-velocity profiles and Reynolds stresses; by contrast, the section on isotropic turbulence goes into considerable detail on invariant forms and spectral transfer. A brief section on shear-flow turbulence structure is primarily a qualitative description of Kline's observations in the boundary layer, with one of Brown and Roshko's pictures at the end. A few pages on closure schemes is virtually all Boussinesq, Prandtl and Heisenberg. A brief section on aerodynamic noise, and a few pages on thermal convection complete the book.

The authors say that the text is the outgrowth of notes for a graduate course intended for a mixed audience. Leaving aside the sections that have only peripherally to do with turbulence and random processes, I would say that the rest avoids the issue of turbulence *per se*, and presents only the related things that can be dealt with in a relatively clean mathematical way. When real turbulence is mentioned, the discussion becomes brief and qualitative. Essentially nothing is said about real turbulence dynamics, not even the presentation of the simple observation that $\epsilon \approx u^3/l$ and its explanation, which embodies so much of what we understand about the dynamics of three-dimensional turbulence.

While it is true that turbulence arises when a laminar flow becomes unstable, and it is also true that every person educated in fluid mechanics must understand stability theory, it is not at all clear what one can learn in general about turbulent flows that occur in nature and technology from studying stability theory. The relationship between chaos and turbulence is even less clear, except in some very special circumstances in which the complexity of the flow is severely restricted by the parameter values. I do think there is a place at the beginning of a course on turbulence for some qualitative remarks about instability, transition and chaos, primarily to answer the philosophical question of how a deterministic system can display such complexity as to require a statistical approach.

I am at a loss to determine what the section on waves (nice as it is) is doing in this book. They are not treated as a random process. A brief introductory paragraph attempts to lend an air of verisimilitude by saying, among other things, 'Although pure wave motion never occurs in turbulent flow situations, the flow may nevertheless contain important wave components in the form of, say, a distribution of waves of random phases and amplitudes. These may show up in statistical quantities such as wave number-frequency spectra.' I feel that this is misleading in the extreme (despite the demurrer), quite apart from being tenuous justification for including a treatment of weakly nonlinear waves and solitons in a book on *Turbulence and Random Processes*.... There is nothing wave-like about turbulent motion. Wavenumber-frequency spectra have bandwidth to centre-frequency (or centre-wavenumber) ratios of order unity, so that propagation is not a useful concept. Disturbances propagate of the order of a wavelength before losing identity. Turbulence is not a hyperbolic phenomenon. I hope a generation of students will not be raised thinking there are possibilities in this direction.

I do not intend by these remarks to single out these authors, or their course or book, for unusual criticism. Unfortunately, I am afraid courses such as the authors' are all too common. It is much easier to present nice rational linear analysis than it is to wade into the morass that is our understanding of turbulence dynamics. With the analysis, professor and students feel more comfortable; even the reputation of turbulence may be improved, since the students will find it not as bad as they had expected. A discussion of turbulence dynamics would create only anxiety and a perception that the field is put together out of folklore and arm waving.

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