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REVIEW

Turbulence in Fluids. By M. Lesieur. Martinus Nijhoff, 1987. 286 pp. Dfl155.00 or £54.75.

In his own words, Lesieur 'discovered the fascination of Fluid Dynamics through the somewhat abstract studies of turbulence' and the stated aim of his monograph is to reconcile 'the statistical point of view and the basic concepts of fluid mechanics'. The actual purpose is perhaps more clarification than reconciliation. In this context, the basic concepts are a synthesis of dimensional arguments and quantified intuition (or instructed handwaving). The former can be justified while usually the second cannot: nonetheless it may be extremely valuable.

This combination has achieved much, but it leaves many questions unresolved. Lesieur deploys in addition the (two-point) statistical closures in the hope that they will resolve issues that less formal methods cannot address. He hopes that the closures 'could contribute to a decisive advance of our understanding of real world anisotropic and inhomogeneous turbulence'.

He would perhaps agree that up till now this hope has been realized to a small extent only. The theorists have laboured mightily, but they are imprisoned by the Fourier representation. Some of the closures, though not the Eddy Damped Quasi-Normal Markovian approximation (EDQNM) on which Lesieur focuses, can be formulated more generally; but practical calculations are only possible when both the tensors and the $\partial/\partial x_i$ are diagonal.

This means that anisotropy can be handled to some extent, though the algebra rapidly becomes very heavy: curiously, there seems to be no mention of the pioneering paper of Herring (*Phys. Fluids* vol. 17, 1974, p. 859) who was the first to implement this possibility. However, the effects of inhomogeneity are in practice out of the reach of the two-point closures. Since most of the difficulties of real-world turbulence are associated with strong inhomogeneities, this limitation poses a real problem for the author. It seems to me that he has resolved it as well as the present state of knowledge will allow, by concentrating on small-scale phenomena which can reasonably be treated as homogeneous.

The book is quite short (258 pages of main text) and Lesieur has limited himself to a small number of flows, which are a sufficient framework for the points he wishes to make. His choice is biased towards geophysical flows, with some emphasis on shallow-water flows over topography and the effects of rotation. Such flows are quasi-two-dimensional in the large and are of particular interest to the two-point theorist, in view of the large amount of theoretical work done on two-dimensional flows. The mixing layer is included, although not specially geophysical, because it is at first sight so strongly two-dimensional.

At a rough count, at least half the book is devoted to two-point closures. The appearance of such a book is welcome, since it is 13 years since the last major text with such an emphasis (Monin and Yaglom) was published. However, this is not a book on the theory for its own sake, which is sensible, since the theory seems to be somewhat stuck. Lesieur says, and I wholly agree, that it is more important to find a simple analytical way of handling the present closures than to develop new ones which would behave in essentially the same way. For this reason, he has concentrated on one closure (EDQNM) and has taken it more or less as read.

He should perhaps have given more prominence to the Direct Interaction

Approximation (DIA), in view of its status as the unique first-order reversion of the Navier–Stokes equations. This status is obscured by his deduction of the DIA from the Random Coupling Model and it will not be evident to the inexpert reader that the DIA is potentially able to answer such vexed questions as the effect of anisotropy on the timescales.

The first formal chapter is entitled 'Basic fluid dynamics'. Naturally it does not cover the whole of this vast subject, but it is a good introduction to that part of it which will be needed later. There are admirable discussions of what is turbulence, and of two-dimensional and quasi-geostrophic turbulence. The chapter on transition is less happy, and could focus more clearly on the consequences of a finite disturbance being the most unstable. A chapter is devoted to absolute equilibrium ensembles, which are dull in three dimensions but interesting in two dimensions, particularly over topography. The discussion of intermittency is very clear.

The chapter on large-eddy simulation (LES) is idiosyncratic at first sight, but it is in fact well adapted to Lesieur's purpose. His discussion of the implications of predictability theory (which also has a chapter to itself) shows the virtues of his approach. He rejects the idea that LES is useless at large times, and has some very sensible things to say about what might reasonably be expected of it.

The final chapter 'Towards "real world turbulence"' discusses the collapse of stably stratified turbulence and the evolution of the mixing layer. The discussion is attractive and informative, but the fact that all the information comes from numerical simulation and not from two-point closures does underline the difficulties of the latter.

The book is attractively produced. There are some beautiful photographs, and it is pleasing that the publishers have felt able to afford 3 pages in colour. (For Anglophone readers, the Alboran sea of figure I.8 appears to be the western end of the Mediterranean). The book deserves to go to a second edition and if it does I hope the opportunity will be taken to rethink the layout rather radically. The combination of a numbered reference system and a sparse index makes it hard to discover whether a particular paper is cited. The equation numbers do not tell the reader which chapter he is in, and the numbering of the figure captions is inconsistent with the references to them in the text.

All in all, this is an interesting and attractive book. Everyone interested in the more theoretical aspects of turbulence will want to read it.

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