BOOK REVIEW

Measurement in Fluid Mechanics. By Stavros Tavoularis. Cambridge University Press, 2005. 384 pp. ISBN 0521 815185. £45.00.

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Late one Friday afternoon, two colleagues sit enjoying coffee in the common room while debating rival theories for that day's puzzling flow phenomenon. After some inconclusive coaster calculus, they agree that there is really only one way to resolve the argument: do an experiment. They disappear into the laboratory whereupon the matter is settled in minutes thanks to a plastic beaker, some tap water, three lengths of rubber pipe and a dash of food colouring. Their work done, our intrepid neophyte experimentalists return to finish the coffees that have barely cooled in the time that they have been away. Anyone who has ever worked in proximity to a fluid mechanics laboratory has a story like this to tell. The 'Friday afternoon' experiment is as ubiquitous in fluid mechanics as it is infamous. The findings from some of these laboratory fumblings even grace the literature as penultimate sections or appendices in papers that otherwise contain nothing but the most appropriate and sophisticated of mathematical and computational analyses. It seems improbable that a particle physicist, say, in their latest and greatest tome would treat the reader to an account of ping-pong balls shaken inside an electrostatically charged polythene bag. Yet in fluid mechanics we have a tendency to accept comparable experiments as evidence of fact. The reason for this is possibly that we feel blessed to have our familiar yet unfathomable equations of motion quite literally 'on tap' wherever we go. Barman, a pint of your best Navier–Stokes if you please! All we then have to do is jerry-rig the appropriate boundary conditions to produce a *deus ex machina* to rout those irksome twin foes of analytical and numerical intractability.

If only it was that easy. Indeed, such could be the subtitle of Professor Tavoularis's excellent book, which succeeds in bringing clarity and sense to the whole issue of experiments in fluid mechanics. This is a book that can be recommended to anyone working in fluid mechanics. On a basic level it provides a ready reference for the essential workings of the main experimental measurement processes that are so often referred to in the literature but which are rarely given sufficient explanation to adequately assist the uninitiated. However, this book can be used in a much more advanced way to plan an entire experimental programme in great detail prior even to setting foot in the laboratory. The style of exposition is uncomplicated and direct, and the layout of the material allows very direct access to items of interest without too much need to cross-reference.

The book is set out in two major parts of approximately equal length. The first part covers all the general concepts that are pertinent to experimental fluid mechanics, from the idealized analysis of the static and dynamic response of arbitrary measuring systems to very practical issues such as safety and record keeping. One can imagine this first part forming the basis of a lecture course to new graduate students in the first few weeks of their research programmes. Indeed, it is the sort of material that all experimentalists in the subject would benefit from reading once a year in order to be reminded of the full extent of the formal mechanisms and structures that exist to underpin the daily tasks in the laboratory. These can often seem like lowbrow activities in comparison with the typical to-do list of a theoretician, but in fact they represent the essential intermediary steps between asking the question and finding the answer by experimental means. The second part of the book focuses in considerable depth on the necessary techniques and technology for making measurements of the key quantities associated with the mechanics and dynamics of fluids, namely pressure, flow rate, local velocity, temperature, composition and wall shear stress. There is also a well-crafted chapter on the techniques, capabilities and limitations of flow visualization methods. Unlike the first part of the book, which is relevant as a whole to every experimental scenario, this second part should be viewed in terms of its constituent chapters and their varying degrees of applicability depending on the specific nature of the experimental arrangement or the problem to be investigated. Thus we have here many books contained within the one cover: at each reading begin with part one and then proceed by selecting the particular chapter or chapters from part two that suit.

It is almost inevitable in a book of this type that the specialization of the author will have a certain amount of bearing on the material that is presented. In this case the author has extensive interests in aerodynamics and turbulence, amongst others. This really only manifests itself notably in one chapter on fluid mechanical apparatus, which is in fact mainly restricted to the apparatus of wind and water tunnels and to the generation of certain turbulent flow profiles. It would have been better to extend the scope of the topic here to include a much more diverse portfolio of apparatus types. One thinks immediately of all the practical issues associated with the generation and propagation of waves, for example. Or of the apparatus that is required for generating and measuring within the rotating reference frame so essential for experiments in geophysical fluid mechanics. Overall this is a highly recommended textbook that deserves to sit on the shelf of every fluid dynamicist who is serious about undertaking experimental activity themselves or who wishes to develop a better understanding of the experimental processes engaged in by others. And if you happen to spot a couple of colleagues heading off into the laboratory one Friday afternoon sometime soon, perhaps you might care to leave a copy of Professor Tavoularis's book next to their cups of coffee to await their undoubtedly imminent return?

J. J. Kobine