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REVIEWS

Numerical Simulation of Non-Newtonian Flow. By M. J. CROCHET, A. R. DAVIES and K. WALTERS. Amsterdam: Elsevier, 1984. 352 pp. $65.50/Dfl 170.0.

This is a good book, and in parts a very good book, largely because it is easy to read and understand and because it is a most felicitious blend of textbook and research monograph. The style harks back to the more intimate days of science; the prose is often conversational and occasionally the authors allow themselves to give avuncular advice to the reader. Yet at no stage is there any hint of intellectual sloppiness: difficulties are brought out and not hidden; complex issues are argued out in detail and with great care; a scholarly and fair analysis is given of the relevant literature.

The book has grown out of the research activities of two separate groups, one Belgian, one Welsh, which complemented one another exceptionally well. Finite-difference techniques were developed by the latter, finite-element by the former, to tackle the numerical simulation of flows of nonlinear viscous and elastico-viscous liquids. The leaders of both groups were already accomplished workers in analytical continuum mechanics when they turned of necessity to numerical methods. The book gains much from their confident presentation of rheological principles, as it does from the experimental work done at Aberystwyth to compare with numerical predictions.

Chapters 2, 3, 5 and 8 provide an introduction to the basic rheological equations of state, to flow classification and to finite-difference and finite-element techniques. They constitute a very useful primer that I can recommend for students or as a course text. Chapters 6, 7, 9 and 10 constitute a compact research monograph that I found stimulating and informative; the authors have restricted themselves to a well-defined field, namely planar and axisymmetric flow (primarily steady) of shear-rate-dependent viscous or Oldroyd B and Maxwell-type fluids. Inertial effects, ordered by Reynolds number, are considered fairly briefly on the grounds that suitable techniques have been developed by others. Elastic effects, ordered by Weissenberg number, are treated more carefully in view of the difficulty of obtaining convergent smooth solutions for large values of the ordering parameter. What the authors have to say is well worth reading by anybody working in the field, particularly the latter part of chapter 10 (finite-element calculations for viscoelastic flow). However, it may well be that the hyperbolic nature of the stress equations in the case of Maxwell-type fluids may be the key to understanding the mechanics of viscoelastic flow, as is rather summarily noted on p. 96; it is a pity that very recent work on this has not been fully analysed.

I particularly liked the development of variational theorems, as in chapter 9 for generalized Newtonian flow, and the way finite-element techniques are described. The reader is effortlessly persuaded that function spaces have a real part to play in any rigorous presentation of finite-element analysis, and Sobolev becomes a friendly figure rather than a source of irritation.

It has to be pointed out, as the authors do most firmly, that their work represents only a start in the simulation of industrially important flows of complex fluids. Their models do not cover all real-fluid behaviour; for example on p. 282 it is assumed that in viscometric flow the shear-stress function cannot decrease with shear rate; it can and I have handled a fluid which exhibits that characteristic without in any sense being unstable – it is merely very thixotropic with relatively long breakdown time for its structure. They do not include temperature effects, which in practice are often

the main cause of variable rheological behaviour. But such refinements are for the future.

If Elsevier can maintain the same standard for later volumes in the Rheology Series, of which this is the first, then they will do a singular service to modern scientific literature, in helping to make available to a wide readership some of the almost impenetrable specialist literature that has been produced in the last thirty years.

J. R. A. PEARSON

A Celebration in Geophysics and Oceanography – 1982. Edited by CHRIS GARRETT and CARL WUNSCH. Scripps Institution of Oceanography, 1984. 118 pp. np.

Walter Munk celebrated his sixty-fifth birthday over two years ago: that takes a bit of getting used to. There is a photograph of him on the cover of this book, looking boyish and enthusiastic as always, but with those questioning eyes that belie the grin. Since he joined the staff of Scripps Institution of Oceanography in 1939 he has done so many things, with so many people, that it was no wonder that some hundreds of his friends and colleagues, his students and admirers (the categories overlap) were glad to visit La Jolla to celebrate on 19 and 20 October 1982.

Most of the proceedings were of the light-hearted birthday kind but they were organized around fifteen somewhat less informal talks given by a selection of Walter's co-workers. They are of variable style, some serious reviews, some anecdotes, some essentially scientific party-pieces; it was a happy idea to bring them together in this book. By adding a biographical essay by Walter himself, a sort of *curriculum vitae* (mainly a long list of his many honours and awards, already happily incomplete) and a list of publications the editors have produced an attractive volume which will be a treasure to future historians of science. Where else will one find, for instance, that when Henry Stommel published his famous Westward Intensification paper in 1948 he hadn't seen Sverdrup's classic of 1947 on currents driven by the curl of the wind stress? Or that Sverdrup had worried for months because his result was so simple, thinking it must have been found before? At that time Sverdrup was Walter's Ph.D. supervisor, sitting in the next office analysing Nansen bottle observations from the equatorial Pacific.

'The luck of Walter Munk' is the title of Revelle's contribution and he was certainly fortunate in his mentors: Sverdrup, Eckart and Revelle himself. In Stommel's characteristically witty vignette he contrasts the three: Eckart powerfully astringent, formidably formal (Stommel has some interesting remarks on rigour and vigour in seience); Revelle the romantic, seeing the ocean in relation to the human predicament; and Sverdrup perhaps having the most effect by convincing Walter that knowledge of the ocean comes from familiarity with observations.

Sverdrup and Munk did wartime work on waves (and had difficulty with security clearance) and here Hasselmann discusses their famous monograph HO 601. They did not consider wave spectra (that was left for Deacon's Group W) but since computers became available many of Walter's achievements have come from a sympathetic and informed analysis of long data series, typically using high-resolution spectra (Tukey contributes an erudite note on 'style in spectrum analysis'). Many of his interests are recalled, including the geophysical discussion of the Earth's rotation leading to the monograph with MacDonald (here Lambeck discusses the rotation of the earth; MacDonald spoke on the greenhouse effect and acid rain). From the short waves that dominate sun glitter Walter turned to the long swell that travels halfway round the world, to surfbeats, edge waves, tsunamis, tides (Cartwright

contributes an essay on clock faces and anti-amphidromes). There is a background of good instruments, due mainly to Snodgrass, and to skilled use of the biggest computers available.

The joint work with Garrett that compacted many observations of the internal wave spectrum is well known; here Garrett sketches some recent advances but there is much to learn about this widespread phenomenon. Certainly internal waves affect the distribution of sound speed in the ocean and Walter has done much to bring together oceanographers and acousticians; here Flatté discusses sound transmission through an internal wave field and Wunsch writes amusingly about observing the ocean, acoustic tomography and satellite altimetry.

Over the years Walter has enjoyed a fruitful interaction on a wider variety of topics, and with a wider variety of people, than most oceanographers. Most of his colleagues have been from North America, but then Scripps has always seemed further from Europe than Woods Hole. Both institutions share a basic interest in the central problem of the general circulation of the ocean and Rhines has contributed some typically overarching 'notes on the general circulation of the oceans' (I enjoyed it, but would have preffered 'ocean'). We have come a long way since Walter combined the now classic models of Sverdrup and Stommel (did he really invent the term 'ocean gyre'?) and Walter has been a constant stimulus.

I suppose he has been lucky. To be clever, to be in near the start of a developing subject, to have a supportive wife and family, to be cheerful and a good communicator. But it isn't all luck, Walter works at it and harder than most: his much admired presentations, that intrigue the experts while informing the audience at large, may seem spontaneous but a lot of thought goes into them. Last time I saw him we stood on the stage of the little theatre he has built in his garden and recited, in unison, Shakespeare's sonnet that starts 'When in disgrace with fortune and men's eyes...' (well, it was late at night and we had had a good dinner). It doesn't seem likely that Walter will have cause to beweep his outcast state, he remains rich in hope and with many friends possessed. It's my belief he really would scorn to change his state with kings.

HENRY CHARNOCK