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Book review

Advances in Applied Mechanics (vol 39)
E van der Giessen and H Aref (eds)
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Volume 39 of *Advances in Applied Mechanics* comprises four disparate reviews, forming an eclectic mix of mathematics applied to science. The four articles are on vortex crystals, by Aref *et al*, on computation of multiphase flows, by Tryggvason *et al*, on cracks and fractures in piezoelectrics, by Chen and Lu, and on environmental mechanics research in China, by Li *et al*. In their preface, the editors (new to the job) enunciate their view that the reviews will continue to be authoritative surveys, and not simply shopping lists of references.

In the first article, on vortex crystals, the editor Aref and his co-authors indicate how to write such a review. Vortex 'crystals' are invariant patterns of ideal hydrodynamic vortices, interacting according to potential theory, as mathematics undergraduates are taught early on. The patterns may be stationary, or more generally, move as a rigid body. If $\{z_i\}$ are the complex position of the vortices, then their motion is given by

$$\dot{z}_i = -\frac{1}{2\pi \mathrm{i}} \sum_{j \neq i} \frac{\Gamma_j}{\bar{z}_i - \bar{z}_j};$$

rigid body motion occurs when $\dot{z}_i = V + \mathrm{i}\omega z_i$, and so the determination of the patterns reduces to a problem of algebra. Thus, in much of this article occur various algebraic tricks, and this is rather dry. It seems a somewhat abstruse subject, but has its historical roots in Kelvin's atomic theory, and the extensive bibliography indicates that it is a very fertile area of investigation.

The next article, on computation of multiphase flows, has an even more extensive bibliography, but there is a greater tendency for this to be cited in the manner of a shopping list. This is unavoidable, since it is in the nature of the subject that numerical techniques are alluded to, rather than described in detail. Computation here means direct simulation of the motion of both phases of a two-phase flow, rather than methods for computation of the various kinds of averaged models which are commonly studied. As such, the focus of the article is on how to track the interface between two fluids in, for example, a bubbly flow, with fairly large (but not enormous) numbers of bubbles. There are short discussions of models for solidification and boiling.

The article by Chen and Lu, on cracks and fracture in piezoelectrics, is even more citation-bound, with great strings of references coagulating like spaghetti; on page 127 we get fifteen lines of references in one parenthesis. A piezoelectric substance is one which becomes electrically polarized when stressed. Such materials are widely used in commercial applications. This review skips over the sort of basic information which a non-specialist needs, and assumes the reader is familiar with the subject (for example, the article does not define what a piezoelectric material is). The mathematical language of the text is that of linear elasticity, within which fracture mechanics is set. The piezoelectric effect is manifested by the inclusion of electric field coupling to the stress field. The focus of the presentation is on different types of crack boundary condition, for example electrically insulating or conducting cracks, and there is much relation of the theory to experimental results. There is a brief concluding discussion of three-dimensional cracks and dynamic fracture.

The last article in this volume, by Li *et al*, is on environmental mechanics research in China. The title is slightly misleading insofar as the subject is not, for example, civil engineering, but concerns process-based modelling of environmental pollution problems, specifically water resources and soil erosion. The authors emphasize the importance of process-based modelling, and describe various environmental processes, before describing three detailed case studies involving sea water intrusion (essentially the Saint-Venant equations with sediment and salt transport), soil erosion on the Loess Plateau via a model of overland flow with erosion, and desertification in arid areas. This article will be of interest to mathematical modellers in general, and in particular to those interested in environmental process modelling.

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