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Book reviews

The Motion of Bubbles and Drops in Reduced Gravity
by R. Shankar Subramanian and R. Subramaniam (Cambridge University Press, Cambridge, UK, 2001, xvi+471 pp.) £65 hardcover.

This large monograph for graduate students and researchers deals with the motion of bubbles and drops caused by variations in interfacial tension around their surfaces. The variations considered are mainly those due to thermocapillarity (temperature gradients causing interfacial tension gradients and hence shear stresses), though surface-active solutes are not ignored. Gravity and other body forces are ignored in most of the book, but one chapter is a review of motion under gravity.

The subject is highly specialised but is important on board spacecraft, where gravitational effects are so small that motion is often dominated by thermocapillarity. The authors have spent many years working with both the American and European space programmes, and they are clearly well-informed about their subject. If one wishes to know about thermocapillarity and some related topics, this is a good book to learn from.

Of the three main ways to investigate such problems, analytical theory, experiment, and numerical computation, the authors devote most space to the first, and on that their book reads rather like a textbook, though it is not quite self-contained. One must look up its references for the definitions of various special functions, for example. Much of the book deals with Stokes flow, because analytical work is harder when inertial and viscous forces are both important. Fortunately, that is not such a major limitation as it would be in flow due to gravity, as thermocapillary motion often is in the Stokes flow regime. On experiment and computation the book is more a guide to the literature than a textbook. But it is a good guide apart from the lack of an author index: there are over 400 references.

A recurring theme is the difference between the Stokeslet flow due to a point force (velocity varying as $1/r$ at a distance r) and the irrotational flow due to a dipole (velocity varying as $1/r^3$). This has many important consequences, because if a bubble or drop moves at low Reynolds number due to a body force, the dominant flow far from it is a Stokeslet, but if the bubble or drop moves due to thermocapillarity the resultant force on it is zero and the dominant flow is a dipole. For example, if the Péclet number is much less than one as well as the Reynolds number, and the motion is axisymmetric and purely thermocapillary, then a pair of equal bubbles will move at the same speed as an isolated one whatever the separation distance.

The book has very few errors, though on p. 26 we are told that the terms in the Navier–Stokes equation have the dimensions of momentum per unit volume (instead of its time rate of change), the Φ on Fig. 2.6.3 ought to be ϕ, on p. 60 we get the misleading impression that $f = \mathrm{O}(g)$ excludes the possibility that $f = \mathrm{o}(g)$, and on p. 116 Ferrers functions are called Ferrer functions.

There are a few other annoyances, none really serious. It is a pity, in a book devoted to how variations of surface tension affect bubbles and drops, to find no mention of interfacial turbulence (or any other form of instability, if one consults the index: there is no entry for either stability or instability, but the topic does in fact appear occasionally in the book). Another problem with the index is that most of the special functions used are mentioned, but error functions and Ferrers functions are not. If books like this one are to be published without author indexes, it would have been even better to see at the end of each reference a list of the pages where it is referred to. Even in the pre-LaTeX era of typesetting Oxford could manage that, e.g., in L. Rosenhead (Ed.), Laminar Boundary Layers, Oxford University Press, 1963, and I wish Cambridge had here: LaTeX 2_ε was used for the book under review, and presumably also BibTeX, and that would have allowed the task to be automated. Your reviewer dislikes the small print that LaTeX 2_ε uses for fractions like $\frac{A}{B}$ and would have preferred the traditional style A/B, keeping A and B the same size wherever they appear, but either the authors or the publisher disagree.

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