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BOOK REVIEW: ROTATING THERMAL FLOWS IN NATURAL AND INDUSTRIAL PROCESSES

(Marcello Lappa, Chichester, United Kingdom: Wiley, 2012, 540 pp., $230.00 USD)

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As with Lappa's earlier book, "*Thermal Convection: Patterns, Evolution and Stability*" (Wiley, 2010), this book is not about heat transfer. The focus of the book is about the fluid mechanics of flows in rotating systems in which thermal gradients are present. Again, similar to the previous volume, the emphasis is on the physics and the mathematical treatments of such flows; in particular the stability of these flows. There is therefore no discussion of either numerical or experimental procedures. The results of computational simulations and complex experiments are used to illustrate and develop the ideas being discussed.

This book is hardly an introduction to thermal flows in rotating systems and is not designed for a novice in the subject. Rather, it is a voyage through the physics of a myriad of wonders which occur in such situations. In fact, one can almost imagine the author exclaim as he writes, as is attested by his comment "The incredible richness of convective modes"—and this is only about Rayleigh-Bénard convection with rotation.

The range of scales presented is truly prodigious—from giant gas planets and atmospheric phenomena to crystal growth. The amount of material presented is therefore quite large, so to keep the manuscript to a reasonable length, it seems to me that the author has had to condense the explanations to the bare minimum. As a consequence it makes for difficult reading. Should the reader put the book down for a few days before resuming reading, the lack of a nomenclature and the use of the same symbol for a number of variables as well as the use of many acronyms make it even more difficult to read.

The first chapter, entitled "Equations, General Concepts and Nondimensional Numbers," lays the foundation for the remainder of the book. The remaining chapters are entitled: Rayleigh-Bénard Convection with Rotation; Spherical Shells, Rossby Waves and Centrifugally Driven Thermal Convection; The Baroclinic Problem; The Quasi-Geostrophic Problem; Planetary Patterns; Surface Tension Driven Flows in Rotating Fluids; Crystal Growth from the Melt and Rotating Machinery; Rotating Magnetic Fields; and Angular Vibrations and Rocking Motion.

The main emphasis of the book is on the stability of the flows with the last three chapters directed more to applications. The coverage, albeit briefly presented at times, is generally very extensive as the 37 pages of references clearly confirm.

There is so much in the book that it is impossible to discuss any one topic in particular, so I will confine myself to a couple of remarks about fundamentals.

The author deplores the fact that because he had to restrict the length of the book, a "cross-link between macro- and micro-scales" has not been presented so that "the Navier-Stokes and energy equations are presented directly." This is not an elementary textbook and would, I expect, be intended for research students and researchers, and I see no need for such a development in the pages of this book, particularly as that had appeared in the "*Thermal Convection*" volume. Similarly, had the phenomena presented not been idealized by the use of the Boussinesq approximation, the length of the book would have been intolerable and it would not have been published. This, of course, allows the author to free himself of the problems which occur from "real world" effects which make comparisons of numerically generated results with experimental data quite difficult.

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Unfortunately, it is clear from page 2 of the book that the complications due to internal heat generation and possibly effects resulting from fluid-radiation interactions would not be discussed as the relevant term has been left out of the energy equation. This is a pity, since there could not then be a discussion of weather and climate—or Global Warming—a topic of such gigantic present-day importance to the world.

The author writes "*Both forces* [centrifugal and Coriolis] *are of an inertial nature and can be regarded as 'fictitious' or 'pseudo' forces (to introduce a clear distinction with respect to gravity which is a real force, i.e. a force not dependent on the adoption of a rotational reference frame).*" I agree with this statement, except if there is a constraint. For example, the River Nile which flows, or perhaps it is better to say that it is constrained to flow, between its banks, almost due north from near the equator almost to the Mediterranean Sea. Being a big river, this means that near its mouth the level of the water on the east bank is some centimeters higher than on the west bank. This is because the necessary reaction to the Coriolis force has to be "provided" by the banks to keep the river within their "constraint."

Despite its limitations, this is an excellent reference book and should be on the shelf of anyone seriously interested in thermal flows in rotating systems.