Giant planets of our solar system: an introduction

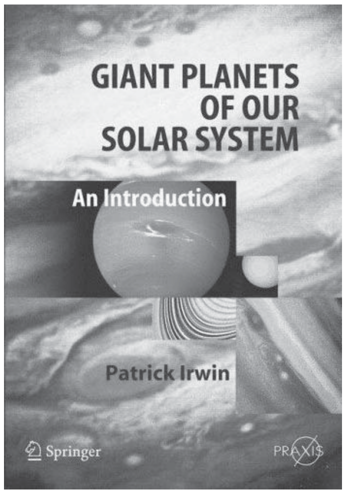
by Patrick Irwin

Springer-Praxis, 2006. ISBN 3-540-31317-6. Pp xxv + 320, £38.50 (pbk).

This book meets a long-standing need for a textbook of the atmospheric physics and chemistry of the four gas giant planets. As there is a severe shortage of funded research on giant planet atmospheres, a guide that makes the field more accessible is particularly welcome. Being aimed at final-year undergraduates and graduate students, it assumes more physics and mathematics than most BAA members will have (to the level of vector calculus), but it is also a good reference work. The author, at the University of Oxford, is an expert on chemical processes as inferred from spacecraft missions, and thus is one of the few scientists in the UK who works on giant planet atmospheres.

This paperback edition is abridged from the original 2003 hardback, but the only omission is a final chapter on future prospects. Topics covered include the formation and evolution of the giant planets, the theory of inferring atmospheric structures from the spectra, and the ground-based and space-borne instruments which produce the data. Two chapters, though, deserve special mention here.

Chapter 4 thoroughly covers the vertical atmospheric structure in terms of temperature, composition, and clouds. It elegantly explains the physics underlying the division of an atmosphere into stratosphere, troposphere, and additional sub-layers, and it authoritatively reviews the chemical composition of each atmosphere and its vertical layering.



Chapter 5 covers the topic of most relevance to BAA observers: atmospheric dynamics. The mathematical treatment proceeds from the basic physical equations, which cannot be solved explicitly, through successive approximations to produce equations that are manageable, and probably justified for our giant planets. Here are concise derivations of essential but non-intuitive concepts such as the thermal wind equation and conservation of potential vorticity. But we soon discover the limits of the physical theory. With regard to the average east-west winds, it is still a mystery why Jupiter and Saturn have enormous prograde equatorial currents. With regard to vortices and waves, it is still unclear which of the many possible forms of instability produce them, and what happens below the cloud-tops. Nevertheless the author explains several good reasons why models with deep circulations are more likely to be correct for Jupiter and Saturn: *a priori* theory; the *Galileo* Probe descent; the global thermostat; and the great equatorial currents. On the other hand, for Uranus and Neptune, the atmospheres are likely to be comparatively shallow.

The serious researcher on atmospheric dynamics will also want to consult more detailed sources; for example there are recent computer models that include both the horizontal and vertical structures of jet streams, which can test whether selected parameters can accommodate the observed properties of the jets and associated vortices. And of course, research is not standing still: for example we have recently shown that the slow-moving thermal wave pattern is entirely distinct from the rapidly-prograding hotspot pattern on opposite sides of the North Equatorial Belt. But the point of a textbook is to give the basis for understanding new developments, and this one succeeds admirably.

John H. Rogers

Dr John Rogers is BAA Jupiter Section Director, and author of The Giant Planet Jupiter *(Cambridge, 1995).*