Principles of Astrophysical Fluid Dynamics

Fluid dynamical forces drive most of the fundamental processes in the Universe and so play a crucial role in our understanding of astrophysics. This comprehensive textbook introduces the fluid dynamics necessary to understand a wide range of astronomical phenomena, from stellar structures to supernovae blast waves, to accretion discs.

The authors' approach is to introduce and derive the fundamental equations, supplemented by text that conveys a more intuitive understanding of the subject, and to emphasise the observable phenomena that rely on fluid dynamical processes. It has been developed for use by final year undergraduate and starting graduate students of astrophysics, based on the authors' many years of teaching their astrophysical fluid dynamics course at the University of Cambridge. The book contains over 50 exercises.

CATHIE CLARKE is Reader in Theoretical Astrophysics at the University of Cambridge and Director of Studies in Astrophysics at Clare College. She developed the original course in astrophysical fluid dynamics as part of Part II Astrophysics in 1996 and delivered the course 1996–9. Her research is based on accretion disc theory and star formation (both of which are strongly based on fluid dynamics). She has taught extensively within the University of Cambridge, having also delivered lecture courses in statistical physics, mathematical methods and galactic dynamics, and has supervised for a variety of courses within the Natural Sciences and Mathematics Triposes.

BOB CARSWELL is Professor of Astronomy at the University of Cambridge. He lectured the Part II Astrophysics course on astrophysical fluid dynamics 2000–3, and developed the course notes to reflect a revised syllabus to include accretion discs and some MHD concepts. He has also given courses in relativity to both third-year and fourth-year undergraduates, as well as specialist courses on gaseous nebulae at the postgraduate level. His research relates to quasars, the intergalactic medium, and large-scale structure.

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Cathie Clarke and
Bob Carswell
University of Cambridge

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Preface

The material in this book is based on lecture notes of a course on astrophysical fluid dynamics which has been given for several years to third-year students at the University of Cambridge. There are several excellent books which cover fluid dynamics from a terrestrial standpoint, but very few provide a full introduction to the concepts and methods used to deal with the highly compressible flows which arise in astrophysical contexts. Our aim with this book is to provide just such an introduction, and we hope that it will also serve as a reference volume for advanced undergraduate and graduate students.

Several people have provided input at various stages of the preparation of this book. In particular we thank Jim Pringle, Donald Lynden-Bell and Giuseppe Lodato for their help. We are also grateful to the students who have taken the course at Cambridge for correcting typographical errors in the lecture notes, drawing our attention to parts where the description was less clear than it should have been, and helping us to develop the exercises.