Preface

This book is based on the lecture notes of a course offered by the authors to PhD students in the field of turbulent combustion at the Engineering Department, University of Cambridge. The motivation is to assist the researcher to understand the basic concepts involved in turbulent reacting flows and to provide key entries to the vast literature of this field. The book should not be considered as a research monograph, but it is hoped that it can offer to the student who studies such monographs some additional tutorial support. Our emphasis is on the physical intuition and on the background understanding that the researcher should possess to make a better job at finding the limitations, differences, similarities, and links between the numerous turbulent reacting flow theories that have been developed over the last 30 years. Finding the historical roots of a particular theoretical development is interesting in its own right and quite useful from an educational point of view, and we try to establish these for the various proposed concepts.

A deeper understanding of the models is of course academically interesting. However, we believe that it becomes truly imperative now that many such models appear as "turn-key" options in commercial software that is increasingly being used for design purposes. On the one hand, this is a remarkable achievement that allows us to perform calculations for flames that were beyond our reach in the past. On the other hand, a false sense of security can beset the user of such software concerning the accuracy and general validity of the models involved. The same comment applies to recently-developed scientific instruments, many of which are commercially available. Often, the researcher treats these as a "black box" without realizing the uncertainties or particular features involved in the data processing due to the turbulent nature of the flows. This books aims to provide some

of the background that is necessary to put the existing knowledge into the right context.

The choice of material is biased towards some of the necessary background that the student of turbulent reacting flows should possess. We review some mathematical techniques that appear often in turbulent combustion, some aspects of turbulence itself, and we proceed with a detailed presentation of various models and concepts for flows with non-premixed and premixed reactants. We close with a brief review of numerical and experimental methods, both of which have advanced tremendously the past few years. We do not mean to provide complete reviews, but we try to give to the reader what we consider to be some of the best references for further study. Our intended audience includes research students, practicing engineers, and newcomers to the field of turbulent flames. We do not limit ourselves to combustion, but also aim to make comments relevant to other turbulent reacting flows, e.g. in the atmosphere and in chemical engineering.

The content has been developed over a number of years and unfortunately many students have suffered as a result of its being only a loose collection of bullet points. Our own teachers and the many colleagues with whom we have interacted in our research have played a major role in shaping our understanding of the subject and perhaps our style of presentation. Thanks to all of them. Particularly, we wish to acknowledge the influence of (in alphabetical order) Profs. R.W. Bilger, K.N.C. Bray, Dr. J.H. Chen, Profs. J.F. Clarke, D.A. Goussis, W.P. Jones, T.J. Poinsot, C.J. Rutland, A.M.K.P. Taylor, and the late J.H. Whitelaw. We thank Dr. Nilanjan Chakraborty of Liverpool University for his extensive comments on a draft of this book. Drs. S.F. Ahmed, I.S. Kim and C.N. Markides have kindly provided experimental and numerical data from their research to include in this book. We acknowledge the assistance of Mrs. Kate Graham in CUED for typesetting portions of the text in an early version. Finally, we wish to thank our families for their continuing patience and support.

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