Preface

This book is dedicated basically to numerical modeling of gas discharge phenomena in gas flows. To define the specificity of computing models of discharge phenomena presented in the book, it is necessary to give some classification of computational models of discharges of different kinds.

Unfortunately, the problems considered in the framework of the book arising at numerical modeling of gas discharge physical mechanics processes are far from complete. A wide class of problems of physical and chemical kinetics of gas discharge plasma is out of this review. Hybrid, kinetic, and stochastic models of gas discharge processes are also not featured. For acquaintance to those models, studies such as Capitelli M., et al. (2000), Birdsall C.K., et al. (1985), Hockney R.W., et al. (1981), and Boeuf J.P., et al. (1982) can be recommended. The reason for such restriction of considered problems was that problems of electrodynamics and physical mechanics of discharges were covered as a rule separately from problems of the physicochemical kinetics so far. Undoubtedly, it is a principal question of the modern state of the computational physics and physical mechanics of gas discharges. It is obvious that the problem of combining the specified two concepts is extremely real. In this book, the author hopes that the explained models of the combination of discharge and gas dynamic processes will promote their further combination with models of physical and chemical kinetics.

Discussing the problems of combining computational models of a different class, it is necessary to mention the studies devoted to the numerical modeling of electrodischarge and gas dynamic lasers (Losev S.A., 1980; Anderson G., 1989). However, modern lines in the development of aerophysics of electrodischarge processes demand to review many similar problems about some other positions. Interest in studying electrodischarge effects in subsonic, supersonic, and especially, hypersonic gas flows has arisen in the last decades in view of attempts at developing hypersonic flying vehicles (HFV). The following lines of research are discussed for the uses of electric discharges in hypersonic aerodynamics:

- problems of global modification of the aerodynamic characteristics of HFV;
- control of the flow under conditions of external flow and in internal flows, for example, in the circuits of hypersonic scramjet engines; and
- raising the efficiency of energetic devices utilizing plasma chemical methods of combustion at high velocities of flow.

A detailed analysis of the processes of interaction of gas flows with discharges of various types has been performed in the book, as well as analysis of the prospects for application of magnetoplasmadynamic methods in aerophysics. Of the problems of discharge effects in hypersonic aerophysics identified earlier, a separate class of problems is associated with the use of electromagnetic actuators for the purpose of local modification and control of rarefied flow, which is of fundamental importance

from the standpoint of developing HFV capable of performing flights at altitudes of 30–50 km.

The book as a whole is intended for those who wish to develop without assistance computing models of physical mechanics of glow discharges or other types of discharge. For this reason, the book contains typical statements of problems, modes of buildup and testing finite-difference schemes, some methods of solution of the finite-difference equations, algorithms of numerical modeling, and a series of test variants. The statement of the given material does not claim for completeness at all, but it is quite enough to create one's own theoretical model.

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