sprays during the last 20 years and its applicability in a number of important problems. At the same time, it should be noticed that the author almost everywhere uses only the results of numerical simulations of spray combustion and practically does not consider the results obtained using theoretical analysis of the phenomena in the framework of the classical methods of combustion theory: the thermal regimes of combustion, critical states of reactive multiphase systems, etc. Such an approach restricts the scope of the consideration.

The following two-chapters, "Droplet Interactions with Turbulence and Vortical Structures" and "Droplet Behavior at Near-Critical, Transcritical, and Supercritical Conditions" contain the results of investigation of droplet/turbulence interaction (the unsteady droplet motion, vortex/spray interaction, etc.) and droplet behavior under the conditions of a wide pressure variation.

The monograph of Sirignano is a substantial generalization of numerous researches dealing with the dynamics of droplets and sprays. The book exposes state of the art of this problem. It is of interest for a readership working in the field of gas-droplet flows.

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Fluid Dynamics and Transport of Droplets and Sprays
W.A. Sirignano, Cambridge University Press, 1999, $80, ISBN 0 521 63036 3

Droplets and sprays appear in a wide range of engineering applications. The primary focus of this monograph is on the theoretical and computational aspects where liquid fuel droplets and combustion applications are emphasized, an area in which the author has published extensively. Major attention is given to the works of the author's research team. Specifically, there are 421 papers listed in the reference, of which, 89 (~21%) are contributed by the author and his co-workers. The author undertook this writing because no previous treatise exists that broadly addresses theoretical and computational issues related to both spray and droplet behavior. Since this field is still developing in terms of both science and technology, he has undertaken a critical review. Among topics covered are transient heating and vaporization, multicomponent liquid droplet vaporization, near-critical and supercritical ambient conditions, interaction of droplets with turbulent or vortical structures, distortion of the spherical shape, secondary atomization of the droplets, and computational issues.

The book has nine chapters and three appendices. An overview of spray atomization and some comments about droplet-size determination are given in Chapter 1. In Chapter 2, the vaporization of individual droplet is discussed. Attention is given to the behavior of isolated

single-component droplets including the effects of forced convection due to relative droplet-gas motion and internal circulation of the liquid. Six types of droplet vaporization models, with varying degrees of complexity, are described. The vaporization of multicomponent droplets, including metal-slurry droplets, is discussed in Chapter 3. Droplet interactions in dense spray situations are covered in Chapter 4. Studies on array theory (a few droplets arranged in a well-defined geometry) and group theory (a statistical description of droplet spacing) are presented. Recent results on droplet collisions are also reported. In Chapter 5, the spray with its many droplets is considered. The spray equations are examined from several aspects; in particular, two-continua, multicontinua, discrete-particle, and probabilistic formulations are given. The choice of Eulerian or Lagrangian representation of the liquid-phase equations with these formulations is discussed, including important computational issues and the relationship between the Lagrangian method and the method of characteristics. Some computational issues associated with spray computations are discussed in Chapter 6. These issues include efficient algorithms for droplet-heating and vaporization sub-grid model computation, optimization of finite difference scheme for the spray equation, and numerical accuracy associated with grid interpolation for point-source approximation in spray calculations. This is followed by applications of the spray theory presented in Chapter 7 where integration of droplet and spray is attempted. A few selected configurations are considered which include: unsteady 1-D planar and spherical spray, 2-D planar parallel droplet streams, and counter-flow spray. Laminar, subcritical, separated spray flows are considered and effects of various sub-grid vaporization models explained in Chapter 2 are examined. The chapter ends with a discussion on liquid-fueled combustion instability where 1-D unsteady spray equations are used. Turbulence–droplet interactions are surveyed in Chapter 8. A brief discussion on turbulence models and DNS (direct numerical simulation) is also included. In Chapter 9, droplet behavior in near-critical and supercritical thermodynamic environments is discussed; secondary atomization and molecular dynamic methods are also covered. Both Chapters 8 and 9 are relatively short. Governing equations in primitive variable as well as in stream function–vorticity formulation in various coordinates are provided in Appendix A. Some key results on droplet models derived in Chapters 2 and 3 are summarized in Appendix B for convenience. A derivation of the two-phase flow equation is presented in Appendix C that is followed by an extensive list of references. The book also contains a detailed nomenclature section.

With the advent of the computer, the field of droplet and spray combustion is evolving from one which empiricism played a major role to one in which analysis and modeling can now be used to complement physical experimentation. In this reviewer's opinion, the author succeeded in providing an informative state-of-the-art review on this rapidly developing field. The integration of the two topics (droplets and sprays) is quite nicely done. The book is well written and maintains a good balance between theoretical analyses and underlying physical concepts. These are presented in a concise and well-referenced fashion. The monograph is reasonably easy to read and great care seems to have been taken to make sure that the typing is correct. The material in this book is appropriate for a graduate course in Thermoscience. The only self-serving suggestion this reviewer might make is that some exercise problems be included. However, considering that it is an advanced specialized text, this is hardly a fair criticism. The book also would serve as an invaluable reference for scientists and engineers

with research interest in droplets and sprays. It definitely belongs on the shelves of the libraries of academics in the field of spray combustion.

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