

Fluid Mechanics and Its Applications

Volume 121

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Droplet Interactions and Spray Processes

 Springer

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Foreword by the University Rectors (*Università degli Studi di Bergamo* and *Universität Stuttgart-A Strategic Partnership*)

The regions of Lombardy in Italy and Baden-Württemberg in Germany are tied by close economic relations for hundreds of years. Today, there are permanent commercial structures between privately owned companies on the one side and publicly owned undertakings on the other side as well as between the Chambers of Commerce and Industry (CCI) of regional locations in Bergamo and Stuttgart. In addition, the research universities of Bergamo (*Università degli Studi di Bergamo*) and Stuttgart (*Universität Stuttgart*) foster a deepened scientific and academic collaboration since many years. Both universities have declared this relationship as a **strategic partnership** and have installed this partnership in their internationalization strategies. The main goal of strategic partnership is a widespread integration, global networking, and teamwork on all levels:

- Jointly supporting young academics, particularly through cooperation in doctoral training and by integrating career path models
- Strengthening international research collaborations and benefitting from synergies with complementary university facilities
- Promoting cooperation in teaching, for example, in the development and implementation of double degree programs
- Diversifying and establishing mobility options for students, for example, by establishing joint summer schools
- Development and establishment of sustainable structured mobility models for researchers and administrative staff
- Specifically supporting researchers in the acquisition of third-party funding to promote joint research and teaching projects.

From the beginning, not only the research institutes have taken in the center stage, but also the academic exchange of students, libraries, language centers, members of both Rectorates, and administration people as far as academic orchestras and choirs. Every year several bilateral visits cultivate the scientific and cultural exchange and thus introduce an international profile and cultural choice to both universities, of which all university staff and university members can benefit from.

The International Research Training Group (IRTG) for Droplet Interaction Technologies (DROPIT), which has been established in October 2016 by the German Research Foundation (DFG), is an impressive example of the strategic partnership between the two universities. The IRTG brings researchers from Bergamo and Stuttgart together to work on droplet dynamics. DROPIT is a structured doctoral program, which leads the accepted doctoral students to graduation within three years. The doctoral program is supervised by professors of both universities. Under the management of Prof. Bernhard Weigand (Stuttgart) and Prof. Gianpietro Elvio Cossali (Bergamo), a close and successful research cooperation has been developed. Hereinafter, the scientific results of DROPIT will be presented.

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Preface

Droplet interaction technologies find application in a large number of technological and industrial processes. These include spray cooling in the food and chemical industry, spray drying absorption for waste and pollutant treatment in process engineering, droplet collisions for the generation of powders and encapsulated material in the food and pharmaceutical industry, drop evaporation and droplet–wall interaction in internal combustion and aeronautical engines as well as in coating technologies. In all these applications, small-scale fluid dynamics may have a huge impact on the large-scale flow pattern, leading to drag reduction, heat transfer enhancement or depression, phase transition kinetics (e.g., drop condensation or nucleate boiling), acoustic impedance, and optical reflection.

To date, the consequences of the presence of different length scales on macroscopic properties and the associated amplification of surface transport have remained largely unexplored, being limited mainly to the formulation of empirical correlations based solely on macroscopic observations. On this basis, the International Research Training Group (IRTG) “Droplet Interaction Technologies - DROPIT” (GRK 2160/1) was established in October 2016 to focus on detailed droplet processes. The project is supported on the German side by the DFG (Deutsche Forschungsgemeinschaft), the German Science Foundation.

The objective of DROPIT is to identify the mechanisms through which small-scale interactions at the interface can couple with and influence large-scale features in the main flow. Here a systematic study is undertaken to investigate the interdependencies between small-scale and large-scale dynamics in the field of droplet interaction technologies. Due to the complexity of the problem, the analysis of such micro-/macro-interactions is not limited to a single aspect. Rather, an integrated approach is chosen that evolves along three parallel pathways, namely a numerical, experimental, and theoretical approach.

DROPIT is a joint initiative of the University of Stuttgart in Germany, the University of Bergamo, and the University of Trento in Italy. The project consists of 17 sub-projects, which are structured into three main research areas (drop–gas interaction, drop–wall interaction, and drop–liquid interaction). It involves researchers from a large number of different disciplines like mathematics, environmental engineering, aerospace and mechanical engineering, civil engineering, informatics and computer sciences and visualization. The project further consists of an extensive qualification program, which aims at fostering the education of young scientists and providing them the knowledge and skills to conduct independent research. More detailed information concerning the International Research Training Group GRK 2160/1 can be found online: www.project.uni-stuttgart.de/dropit/.

After three years of very successful work, selected current results of this project have been summarized in the present book.

In order to broaden the scope of this book, also two invited chapters have been included. These are written by Prof. Dr. S. S. Sazhin (University of Brighton) about “Classical and novel approaches to modelling droplet heating and evaporation” and by Prof. Dr.-Ing. G. Brenn (University of Graz) about “Droplet Shape Oscillations.”

The DROPIT project is strongly linked with the international workshop on Droplet Impact Phenomena and Spray Investigations (DIPSI), which is held yearly in Bergamo. The DIPSI workshop, which is now at its thirteenth edition, represents an important opportunity to share recent knowledge on droplets and sprays in a variety of research fields and industrial applications. Thus, some selected contributions of the DIPSI workshop of 2019 have been added in order to enlarge the scope of this book towards additional practical applications on spray processes.

Many people helped us in all phases of the preparation of this book. We are very grateful for all the support in bringing this manuscript together. First of all, we would like to thank all doctoral students and Postdocs involved in DROPIT for their contributions to the book. In addition, we thank all principal investigators of the project for their support. Special thanks go to all reviewers of the book contributions for their support and very good comments, and to Prof. Sazhin and Prof. Brenn for their invited contributions to this book and to the whole project, through the seminars delivered to the doctoral students along the past three years.

In addition, we would like to thank Dr. Anne Geppert for her help during the preparation of this book.

All members of the DROPIT project are very thankful for the financial support from the Deutsche Forschungsgemeinschaft (German Science Foundation) and for the financial support from the University of Bergamo.

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Contents

Droplet–Gas Interaction

An Analytical Approach to Model the Effect of Evaporation on Oscillation Amplitude of Liquid Drops in Gaseous Environment	3
Gautham Varma Raja Kochanattu, Gianpietro Elvio Cossali and Simona Tonini	

Improvement of the Level-Set Ghost-Fluid Method for the Compressible Euler Equations	17
Christoph Müller, Timon Hitz, Steven Jöns, Jonas Zeifang, Simone Chiocchetti and Claus-Dieter Munz	

A Solver for Stiff Finite-Rate Relaxation in Baer–Nunziato Two-Phase Flow Models	31
Simone Chiocchetti and Christoph Müller	

An Investigation of Different Splitting Techniques for the Isentropic Euler Equations	45
Jonas Zeifang, Klaus Kaiser, Jochen Schütz, Francesco Carlo Massa and Andrea Beck	

Enabling Simulations of Droplets with the Direct Simulation Monte Carlo Method	57
Wladimir Reschke, Marcel Pfeiffer and Stefanos Fasoulas	

Droplet–Wall Interaction

Fabrication and Evaluation Methods of Micro-structured Surfaces for Droplet Impact Experiments	71
Patrick Foltyn, Markus Guttman, Marc Schneider, Stephanie Fest-Santini, Dorthe Wildenschild and Bernhard Weigand	

Use of X-ray Micro Computed Tomography for the Investigation of Drying and Salt Precipitation in a Regular Glass Bead Structure	87
Robert Haide and Maurizio Santini	
Image Processing of Two-Phase Data for Drop-Surface Interaction Obtained by X-Ray Microtomography	101
Stephanie Fest-Santini	
A Phase Field Approach to Compressible Droplet Impingement	113
Lukas Ostrowski, Francesco Carlo Massa and Christian Rohde	
Numerical Simulation for Drop Impact on Textured Surfaces	127
Martina Baggio and Bernhard Weigand	
Upscaling of Coupled Free-Flow and Porous-Medium-Flow Processes	139
Sina Ackermann, Rainer Helmig and Stephanie Fest-Santini	
A Locally-Refined Locally-Conservative Quadtree Finite-Volume Staggered-Grid Scheme	149
Melanie Lipp and Rainer Helmig	
Droplet–Liquid Interaction	
A New Perspective for the Characterization of Crown Rim Kinematics	163
Ronan Bernard, Visakh Vaikuntanathan, Grazia Lamanna and Bernhard Weigand	
Analytical Model for Crown Spreading During Drop Impact onto Wetted Walls: Effect of Liquids Viscosity on Momentum Transfer	177
Anne Geppert, Ronan Bernard, Bernhard Weigand and Grazia Lamanna	
An Implicit High-Order Discontinuous Galerkin Approach for Variable Density Incompressible Flows	191
Francesco Carlo Massa, Francesco Bassi, Lorenzo Botti and Alessandro Colombo	
Visualization Techniques for Droplet Interfaces and Multiphase Flow	203
Alexander Straub and Thomas Ertl	
On the Measurement of Velocity Field Within Wall-Film During Droplet Impact on It Using High-Speed Micro-PIV	215
Visakh Vaikuntanathan, Ronan Bernard, Grazia Lamanna, Gianpietro Elvio Cossali and Bernhard Weigand	
Single-Camera 3D PTV Methods for Evaporation-Driven Liquid Flows in Sessile Droplets	225
Massimiliano Rossi and Alvaro Marin	

Towards Sprays

Drop Shape Oscillations 239
 Günter Brenn

Classical and Novel Approaches to Modelling Droplet Heating and Evaporation 251
 Sergei Stepanovich Sazhin

The Influence of Curvature on the Modelling of Droplet Evaporation at Different Scales 259
 Grazia Lamanna, Gianpietro Elvio Cossali and Simona Tonini

On the Importance of Kinetic Effects in the Modelling of Droplet Evaporation at High Pressure and Temperature Conditions 277
 Grazia Lamanna, Christoph Steinhausen and Bernhard Weigand

Direct Numerical Simulations of Evaporating Droplets at Higher Temperatures: Application of a Consistent Numerical Approach 287
 Karin Schlottke, Jonathan Reutzsch, Corine Kieffer-Roth and Bernhard Weigand

Effects of Very High Injection Pressures on GDI Spray Structure 301
 Alessandro Montanaro and Luigi Allocca