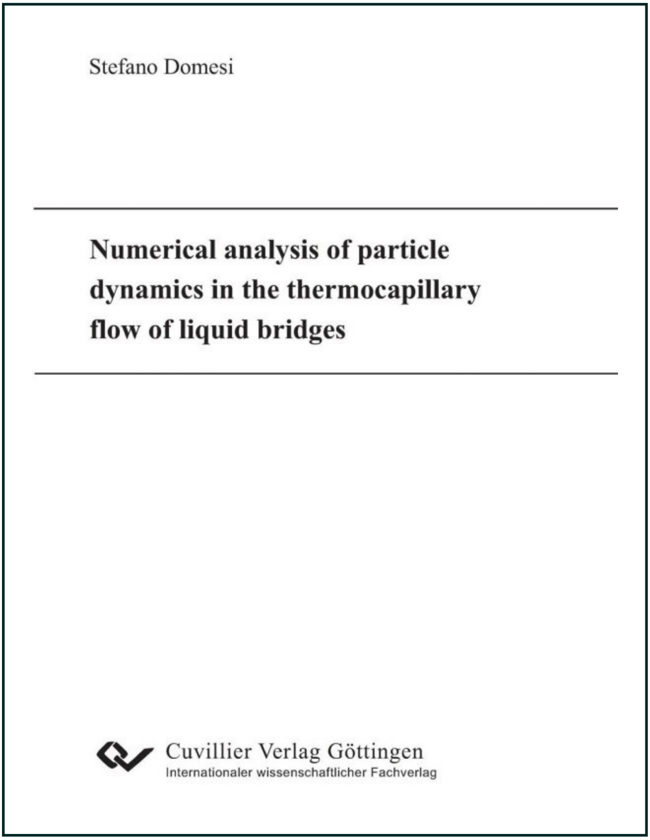
Stefano Domesi (Autor)

Numerical analysis of particle dynamics in the thermocapillary flow of liquid bridges



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Contents

Abstract **iii**

1 Introduction **1**

1.1 Experimental evidence of PAS . . . 2
1.2 Related work . . . 3
1.3 Aim and outline of the present work . . . 7

2 Mathematical Formulation **9**

2.1 Flow models . . . 9
  2.1.1 Analytical flows . . . 9
  2.1.2 Flow in the half-zone . . . 13
2.2 Equation of motion for a spherical particle . . . 18

3 Numerical Methods **25**

3.1 Flow in the half-zone model . . . 25
3.2 Particle tracking . . . 26

4 Results **33**

4.1 Introduction . . . 33
4.2 Taylor–Green flow . . . 35
  4.2.1 Linear Stability Analysis . . . 35
  4.2.2 Numerical simulations . . . 39
  4.2.3 Transient regime . . . 47
  4.2.4 Effect of gravity . . . 51
4.3 Half-zone flow . . . 56
  4.3.1 Axisymmetric toroidal flow . . . 56
  4.3.2 Three-dimensional oscillatory flow . . . 70
  4.3.3 Lift force and particle boundary conditions . . . 88

5 Conclusions **93**
5.1 Taylor–Green vortex flow 93
5.2 Thermocapillary flow in the liquid bridges 94

A Experiments on PAS **97**

B Stability of equilibrium points for the particle **101**

C Feigenbaum scenario **103**

D Nomenclature **105**
D.1 Roman Symbols 105
D.2 Greek Symbols 106
D.3 Other symbols 107
D.4 Similarity Numbers 107
D.5 Acronyms 108

Bibliography **109**

E Acknowledgments **115**

1 Introduction

The transport of small solid particles can be encountered in many natural processes like dust avalanches, transport of dust particles in the atmosphere (Hunt 1991), sediment transport and suspension of plankton in the ocean. The same can be said for technological applications in the field of chemical engineering, materials processing, pharmaceutical and mining industry. The fluid–particle interaction plays a fundamental role in affecting basic phenomena like spray dynamics (Ghosh & Hunt 1994), separation processes, solid formation in flames and plasma, dynamics of dusty gases, nanoscale particles in biological systems, gas and liquid-fluidized beds (Ramarao & Tien 1992, Jackson 2000), rheology of colloidal dispersions and suspensions, and turbulence modulation. The dynamics of suspended particles is then a basic question for the optimization of a wide range of technological processes and the efficiency of mechanical components. The performance of a combustor, for example, depends on the spatial and temporal distribution of the fuel droplets in the mixing layers inside the combustion chambers, whereas an uncontrolled motion of combustion products could cause blade erosion inside the gas turbines. Furthermore, particle-laden flows represent an interesting research subject in terms of pattern formation arising in sedimenting flows, dunes and ripples, or in the emerging field of the self-organized criticality (SOC) in the dynamical systems, which have been applied to study problems like instabilities in sandpiles and other granular flows. Particularly challenging are the application of the particle-laden flows to prove new theories for the formation of planets based on the transport of matter inside persistent gaseous vortices (Alfvén & Arrhenius 1976, Barge & Sommeria 1995).

This work is motivated by the results (see Sec. 1.1) of recent experiments on the behavior of particle tracers immersed in the thermocapillary flow arising inside the half-zone model of the floating-zone process, both on the ground and under microgravity conditions. In such a flow, the suspended phase represented by the tracers, shows a strong de-mixing process with respect to the fluid phase which leads to