PREFACE

This book contains lecture notes, albeit not covering all material, delivered at the Advanced Course 'Thin Films of Soft Matter' that took place at CISM Udine in July 18-22, 2005.

Thin film flows of soft matter (either simple Newtonian liquids or polymeric and other complex materials) are often encountered in a wide variety of natural phenomena and technological applications: from gravity currents under water and lava flows to heat and mass transport processes in conventional engineering applications and more recent developments in the area of nanotechnology and MEMS. In the vast majority of cases, thin film flows are bounded by either free surfaces which separate the film from the surrounding phases, as in the case of jets or soap films, or by a free surface and a solid substrate. The involved scales range from the nanometer level as for dewetting thin polymer films and break-up of nanojets to the centimetre scale as for heat and mass transport applications to the meter scale as for lava flows.

The Course aimed at giving a detailed overview of the main and most up-to-date advances in the area of thin films and jets, through a balanced combination of theory and experiments. Since the subject is essentially an interdisciplinary area and as such it brings together scientists and engineers with different educational backgrounds, it was important to offer a research-oriented exposition of the fundamentals of free-surface flows in confined geometries. The goal was to arrive at ready-to-use mathematical models of different degrees of complexity which are capable of describing accurately thin film and jet flows in a relatively 'simple' (i.e. avoiding using the full Navier-Stokes equations) and experimentally testable way.

A wide range of topics was covered: basic equations and interfacial boundary conditions, as well as derivation of model equations for the evolution of the free surface including long-wave expansions and equations of the boundary-layer type; linear stability analyses, weakly and strongly nonlinear analyses including construction of stationary periodic, solitary wave and similarity solutions; interfacial instabilities and formation of complex wave structures; dewetting on chemically homogeneous and heterogeneous substrates; influence of surface tension gradients due to the thermal Marangoni effect and thermocapillary Marangoni instabilities; rupture/dewetting for very thin one- and two-layer films; miscible fingering in electrokinetic flow as a model system to study extended domain dynamics problems, such as the falling film problem, driven by the dominant zero modes associated with key symmetries; influence of chemical reactions and three-dimensional effects on falling liquid films; generic treatment of self-similarity, scaling laws, dimensional analysis and scaling theory of singularities, which is crucial not only *for the specificity of the Course but also from the point of view of general mechanics; singularity formation and topological transitions such as drop break-up and nanojet break-up; experimental characterization of capillarity such as spreading drops, wetting of textured surfaces, wicking and coating; experimental characterization of thin films using atomic force microscopy, ellipsometry and contact angle measurements, and analysis of patterns using Minkowski functionals.*

The Course was organized at the suggestion of Professor Manuel G. Velarde, while he was in office as Rector of CISM (2002-2005). It was not a mere suggestion. He provided the organizers (now the editors of this book) with valuable recommendations about topics, names of potential lecturers and an important advice: emphasis on combination of theory, natural phenomena, lab experiments and numerical experiments. This was the natural thing for he had been and still is engaged in the field covered by the Summer School. On the other hand both the present editors had been and still are collaborating with him in some of the themes discussed here. Though Rector of CISM he participated as a student in our School.

Professor Velarde was born in Almeria, Spain, September 7, 1941 and hence he is turning 65 in 2006. He has made seminal and long lasting contributions to fluid physics and, in particular, to our understanding of hydrodynamic instabilities and convective pattern dynamics, wetting and spreading dynamics, interfacial hydrodynamics, and nonlinear wave dynamics. In the latter subfield he is responsible for introducing the concept of 'dissipative soliton' to account for experiments on surface tension gradient-driven waves. In spite of the diversity and heterogeneity of his publications, Professor Velarde has always emphasized the unifying perspective underlying them all. This he taught us to look for in our own research.

We the editors take pleasure in dedicating this book to Professor Manuel G. Velarde on his 65th birthday, with the hope of seeing him again as a student in another of our courses while continuing collaborating with him, a superb teacher.

Manuel G. Velarde amicitiae et admirationis ergo.

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Serafim Kalliadasis (London), Uwe Thiele (Dresden)