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Foreword

Nearly two decades ago, a renewed interest began to emerge among physicists in pattern-forming systems. Particularly, the experimentalists focused on hydrodynamic systems such as Rayleigh–Benard convection and Taylor-vortex flow in simple fluids, because in these systems the boundary conditions could be well controlled in the laboratory, and the stress parameter could be varied with high accuracy and resolution. These systems were complicated enough to be interesting, and yet simple enough to yield quantitative answers to important specific questions with relative ease. However, gradually the questions being asked became more complex, and the need arose for systems which would exhibit richer phenomena. These more complex systems in some cases were extensions of the simpler ones, created by the addition of a second control parameter. Specific examples are convection in binary-fluid mixtures and Taylor-vortex flow in the presence of a Coriolis force. Some of the new physical phenomena which occur in these systems are by now well understood, but others are as yet only incompletely explored.

When the nonequilibrium system is no longer a simple fluid but rather has its own anisotropies and/or additional dynamic degrees of freedom, an additional level of complexity arises. Clearly the hydrodynamic instabilities in these systems are even richer in variety, but at the same time also more difficult to understand. Nematic liquid crystals are an example of such complex liquids. From an experimental point of view, these systems actually have some advantages in spite of their greater complexity. For instance, in the liquid crystals, large-aspect-ratio cells can easily be constructed, the response times are much smaller than those in simple liquids, and a preferred direction for the average molecular orientations can be prescribed at the boundaries. Because of these properties, liquid crystals have become favored systems in the study of instabilities, pattern formation, and defects.

Other examples of complex liquids with interesting instabilities are electrorheological fluids. These are suspensions which show a transition to a solid-like phase in the presence of electric fields. Their potential industrial

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applications were recognized early on by engineers and chemists and their unusual properties are beginning to be appreciated by physicists. Their physical properties are still poorly understood and not much work has been done on the study of their instabilities. We feel that they deserve greater attention by the physicists interested in nonlinear dynamical structures in liquids than they have received heretofore.

The NATO Advanced Research Workshop on Nonlinear Dynamical Structures in Simple and Complex Liquids was held in Los Alamos, New Mexico, USA, June 26–29, 1990. The idea was to bring together experts and active researchers in all of the above mentioned areas, to review the progress made and to increase the interaction between the different subfields in the nonequilibrium physics of liquids, simple and complex. In this issue of *Journal of Statistical Physics*, 17 of the papers presented at the Workshop are included. For completeness, we list here the titles of the other papers which were presented.

Helmut Brand, "Interaction of Localized Solutions for Subcritical Bifurcations."

L. J. Campbell, "High-Energy Equilibrium States of 2D Point Vortices: Negative Temperature and Turbulence."

David Cannell, "Localized States in Binary Fluid Convections."

F. Dowell, "Theoretical Predictions of Nonlinear Dynamic Properties of Polymers, Including First Super-Strong Polymers."

Jerry Gollub, "Patterns Determined by Surface Tension at Fluid/Solid Interface."

Pierre Hohenberg, "Fronts, Pulses and Shocks in the Complex Ginzburg–Landau Equation."

B. Holian, "Molecular Simulations of Large-Scale Hydrodynamic Phenomena."

Darryl Holm, "Low Dimensional Behavior in Solutions of the Complex Ginzberg–Landau Equation."

Lorenz Kramer, "On the Theory of Electroconvection in Nematics."

L. Lam, "Surface-Tension Driven Convection in Liquid Crystal Films."

Alan Newell, "The Statics and Dynamics of Patterns."

Peter Palffy-Muhoray, "Dynamics of Filamentary Pattern Growth in Liquid Crystals."

Philip Rosenau, "Evolution and Breaking of Interfaces."

Adam Simon, "Dynamics of a Moving Nematic–Isotropic Interface."

Cliff Surko, "Transition from Traveling-Wave to Stationary Convection in Fluid Mixtures."

Randall Tagg, "Amplitude Equations and Experiments in Flow Between Rotating Cylinders."

David H. Van Winkle, "Criterion for Pattern Instability in Nematic Electrohydrodynamic Flow."

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Sponsors: NATO Scientific Affairs Division, Center for Nonlinear Studies of Los Alamos National Laboratory, and Department of Physics of San Jose State University.

Director: Lui Lam.

Co-directors: Guenter Ahlers and Flonnie Dowell.

International Organizing Committee: G. Ahlers, H. Brand, F. Dowell, P. Huerre, L. Lam and J. Wesfreid.

Lui Lam
San Jose State University, San Jose, California, USA
Flonnie Dowell
Los Alamos National Laboratory, Los Alamos, New Mexico, USA
Helmut Brand
University of Essen, Essen, Germany
Guenter Ahlers
University of California, Santa Barbara, California, USA