Preface

The eighth Summer Program of the Center for Turbulence Research took place in the four-week period, July 2 to July 27, 2000. This was the largest CTR Summer Program to date, involving forty participants from the U. S. and nine other countries. Twenty-five Stanford and NASA-Ames staff members facilitated and contributed to most of the Summer projects. Several new topical groups were formed, which reflects a broadening of CTR's interests from conventional studies of turbulence to the use of turbulence analysis tools in applications such as optimization, nanofluidics, biology, astrophysical and geophysical flows. CTR's main role continues to be in providing a forum for the study of turbulence and other multi-scale phenomena for engineering analysis. The impact of the summer program in facilitating intellectual exchange among leading researchers in turbulence and closely related flow physics fields is clearly reflected in the proceedings.

The development of the dynamic procedure at CTR has continued to generate renewed interest in LES over the past decade. During the Program, new averaging strategies, new equations and decompositions of the flow field using wavelets were evaluated and tested. In addition, efforts continued in modeling the near wall turbulence, which remains a pacing item, and in evaluating LES in predicting flow generated noise. The combustion group continued to attract researchers from around the world. Work on the development and assessment of combustion models was supplemented this year by a large efforts on evaluating the use of LES in industrial applications. The Reynolds Averaged Navier Stokes (RANS) modeling group continued its effort in developing models that capture the effects of rotation and stratification on turbulence. The ability of RANS models to predict transition was also evaluated. The program benefited from the infusion of novel new ideas from deterministic and stochastic optimization for flow control. These ideas were tested in optimizing microfluidic channels. A novel application of these optimization techniques was the use of evolutionary algorithms in developing strategies for the destruction of aircraft trailing vortices. The astrophysical group concentrated on protoplanetary disk modeling and simulation. New ideas and transformations of the governing equation promise new advances in this field in the near future. The geophysics group used DNS to study sediment transport on a wavy wall and the propagation of internal waves in the upper ocean thermocline. Finally, two new research topics were introduced to the CTR summer program, Nanofluidics and biology. The biology work on the life cycle of phytoplankton where turbulence plays a key role is a natural extension of CTR's expertise. The work on Nanofluidics which is based on molecular dynamics is an outgrowth of CTR's expertise in using advanced algorithms and large-scale simulations. Carbon nanotubes in water and flow in a nanometer-scale channel were simulated during the summer program.

As part of the Summer Program two review tutorials were given entitled: *Geophysical Turbulence and its Visible Consequences for the Giant Gaseous Planets - i.e., How Jupiter Earned its Stripes* (Phillip Marcus), and *Flamelet Modeling of Turbulent Reacting Flows* (Heinz Pitsch); and two seminars entitled *Molecular Dynamics Simulation* (Jonathan Freund), and *Immersed Boundary Technique for RANS/LES Simulations* (Gianluca Iaccarino) were presented. A number of colleagues from universities, government agencies, and industry attended the final presentations of the participants on July 27 and participated in the discussions.

There are twenty-nine papers in this volume grouped in six areas. Each group is pre-

ceded with an overview by its coordinator. Early reporting of eleven of the projects occurred at the Fiftieth Meeting of the Division of Fluid Dynamics of the American Physical Society in Washington, D.C., November 19-21, 2000.

This year's Summer Program was the last for Debra Spinks, the Center's long-term administrative associate, who has done an outstanding job of organizing the last seven programs and compiling the corresponding reports. She shall be missed, but carries with her our best wishes for success in her new position at Stanford.

Parviz Moin
William C. Reynolds
Nagi N. Mansour