AIAA JOURNAL
Vol. 44, No. 11, November 2006

Introduction: Turbulent Boundary Layers

DOI: 10.2514/1.27886

The boundary layer problem was once considered one of the best "understood" problems in turbulence. The law of the wall, the velocity defect law, the overlap layer described by the logarithmic law, and their universality are the foundations from which many theories and models for wall-bounded flow were built. For example, these ideas have been used in RANS and LES turbulence models, for calibration of many experimental techniques, and even design in aerodynamics. However, over the past 15 years or so, there have been concerns raised about the universality of the log law, the possible Reynolds number (and flow) dependence of κ, the von Kármán constant, and even the proper scaling of the inner and outer flows.

Some of the difficulties in experiments include measuring with great accuracy the single point statistics (e.g., mean velocity, Reynolds stresses, dissipation, transport terms, etc.) in the near the wall region. Another major problem is how to accurately measure the mean velocity and Reynolds stresses in the boundary layer at Reynolds number above $R > 200,000$. From the point of view of numerical simulations, the major problems lie in the cost of simulations at even modest Reynolds numbers due to the need to resolve the near the wall region, even for the flat plate boundary layer. Other problems include how to impose accurate inlet, outflow, and outside boundary conditions that can be expected to behave as either theory or experiment.

Therefore, the objective of this issue is to present a series of contributions. Some support the classical views; but others present new ideas or renew old challenges. This selection of papers was presented at The Turbulent Boundary Layer Session from the 4th AIAA Theoretical Fluid Mechanics Conference held in Toronto, summer 2005. It includes invited papers as well as contributed papers presented at the meeting. Because of the range of ideas and tools, which include theoretical, experimental, and simulations, one hopes that the reader will gather a better understanding of the current status of the problem and what remains unanswered. Furthermore, we hope the reader can judge what needs to be done next and what new tools might have potential for greater impact in the field and engineering design. Most of all, we want to stimulate interest and open debate, in the hope that the attention will lead to new input and new understanding.

From the experimental point of view, contributions include studies of separation, strong adverse pressure gradient, as well as the role of initial conditions on flow control. On the theoretical side, the articles deal with issues on scaling, Reynolds number dependence, and the argument of log law versus power law. In simulations, contributions are made on roughness via direct numerical simulations. A unique feature of this special issue is the spectrum of ideas disseminated in one single issue. Therefore, we hope that the contributions serve as a catalyst to promote more collaboration between groups with different views with the sole purpose of *enhancing the knowledge of the field*.

We would like to thank the Editor-in-Chief of the AIAA Journal, Elaine Oran, as well as the reviewers who contributed their expertise during the review process. Also, the guest editors would like to thank Luke McCabe for handling many of the challenges faced. Last, we would like to thank the authors who participated in the meeting, either with scientific contributions or through the exchange of ideas. We hope that this issue inspires others in the community to embrace different views and disseminate their findings and data.

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Guest Editors