UNIVERSITY OF MARYLAND

THE DEPARTMENT OF AEROSPACE ENGINEERING PRESENTS THE JOINT AEROSPACE ENGINEERING AND FLUID DYNAMICS REVIEWS

INVESTIGATIONS OF TURBULENCE: A JOURNEY FROM NANOMETER TO KILOMETER

Thursday, September 28, 2017
3:00-4:00p.m.
3164 Martin Hall, Aerospace Conference Room

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ABSTRACT

Our inability to predict turbulence introduces significant uncertainty in the design of many engineering applications. Many theoretical predictions and models have been developed for turbulence in the limit of infinite Reynolds numbers. However, no real-world application operates at infinite Reynolds number, and it is typically unknown how large the Reynolds number needs to be in order to expect the theoretical predictions to hold. It is also not well understood how low Reynolds numbers affect the flow dynamics and how to best model them. What makes turbulent flows particularly challenging—theoretically, numerically and experimentally—is the large range of spatial and temporal scales contained within them, with the smallest eddies typically many orders of magnitude smaller than the largest eddies. To enable fully resolved investigations of high Reynolds number turbulent flows, a range of novel subminiature sensors have been developed. To ensure accurate representation of the flow field, the thermal and mechanical properties of the sensors and sensor systems are characterized in detail. This knowledge acts as a guide for further sensor improvements. In combination with extreme facilities, these sensors allow unique insights into flows that previously have not been possible. A model wind turbine setup has been developed that allows—for the first time—well-controlled laboratory tests at dynamic similarity to the full scale machine. The effect of Reynolds number on the performance of wind turbines is characterized and compared to field measurements and it is shown that the machine reaches a Reynolds number invariant state, but at Reynolds numbers higher than those experienced in the field

BIO

Marcus Hultmark is an assistant Professor in the Department of Mechanical and Aerospace Engineering at Princeton University. His research interests include a variety of problems related to fluid mechanics, with focus on problems involving turbulence, such as heat and mass transfer as well as drag reduction and wind energy. Theoretical work is combined with experimental studies, and an important part of his research program is the development and evaluation of new sensing techniques to investigate these phenomena with high accuracy, including velocity, temperature and humidity sensors. He was awarded the 2016 Air Force Young Investigator award, the 2017 NSF Career award and the 2017 Nobuhide Kasagi Award. He received his M.Sc. degree from Chalmers University in Sweden and his Ph.D. from Princeton University.

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