The Quest for the Holy Grail of Turbulence

Dr. Meredith Metzger
Department of Mechanical Engineering
University of Utah

Turbulence is believed by some to be one of the greatest unsolved problems of classical mechanics. The difficulty stems, in part, from the large range of inherent length and time scales, which, for the specific case of the turbulent boundary layer, increases with Reynolds number. In order to understand the nature of the turbulent boundary layer, all of the scales of motion must be resolved, thereby posing severe demands on sensor resolution at high Reynolds number. For practical engineering flows, such as commercial aircraft, ship hulls, and weather, the Reynolds number typically ranges between 10^5–10^8. Due to limitations in computational and experimental resources, however, most numerical and laboratory model studies are conducted at much lower Reynolds number. Results from these studies can only be effectively extrapolated to higher, more practical Reynolds numbers, if the appropriate scaling parameters and relations are known. The quest, then, is for the universal scaling laws governing all turbulent boundary layers, including both canonical and noncanonical. Presently, such scaling behaviors remain elusive. The presentation will address this question from a theoretical and experimental perspective, using a multiscale analysis of the mean momentum balance and well-resolved, high Reynolds number data obtained in Utah's western desert. [Supported by NSF CTS–0120061 and ONR N00014–04–0304]

Courtesy of Clayton Esterson