Two-dimensional spectra and the large scales of wall turbulence

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Over the past decade or so, the importance of superstructures and large-scale motions in wall-bounded turbulent flows has been recognized and has attracted extensive study. This has come from laboratory studies and investigations in the atmospheric surface layer. In this talk we will review some of these developments. More recent studies will also be highlighted that consider how these structures are reflected in two-dimensional (2-D) spectra over a decade change in Reynolds number. Accordingly, we report experimental measurements of 2-D spectra of the streamwise velocity in a turbulent boundary layer for friction Reynolds numbers ranging from 2400 to 26000. The experimental technique involves employing multiple hot-wire probes and making use of Taylor's frozen turbulence hypothesis to convert temporal-spanwise information into a 2-D spatial spectrum that shows the contribution of streamwise and spanwise length scales to the streamwise variance at a given wall height. Several wall-normal heights through the logarithmic region are considered. Figure 1 below shows the 2D spectra in the start of the logarithmic region at low and high Reynolds numbers, and highlights the different behaviours at large scales observed as the Reynolds number increases. The implications for scaling laws will be discussed.

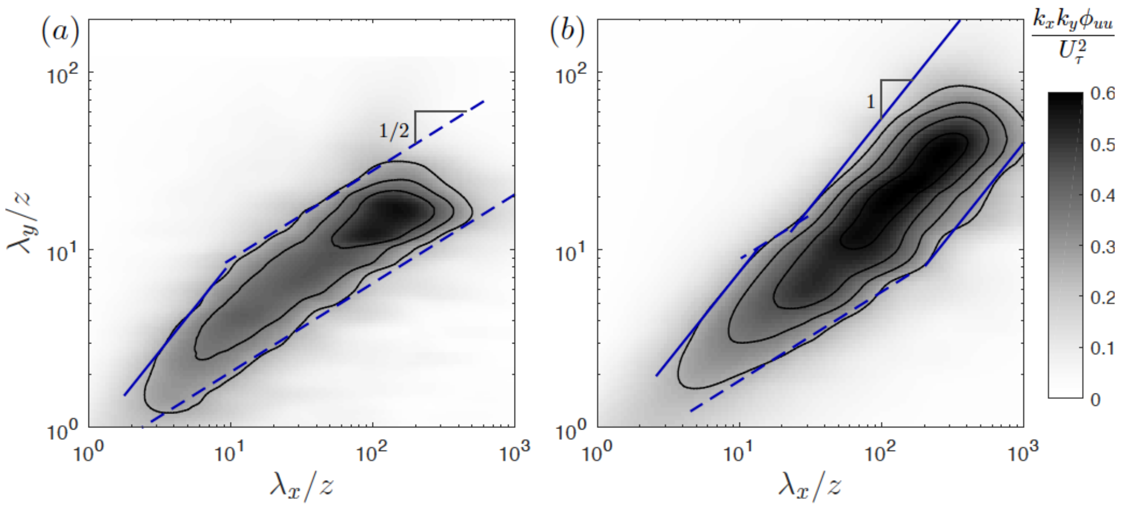

Figure 1: 2-D spectra at the start of the logarithmic layer for friction Reynolds numbers: (a) 2400; (b) 26000.

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