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Properties of Wide Spanwise or Azimuthal Velocity Modes in Turbulent Boundary Layers, Channels, and Pipes[1] JON BALTZER, RONALD ADRIAN, Arizona State University — While the motions that exist after instantaneously spanwise averaging a plane turbulent channel or boundary layer would vanish as spanwise domain size is increased, the motions from azimuthally averaging a pipe have clearer physical significance due to the constrained geometry. These averages also arise as the spanwise $k_z = 0$ and azimuthal $k_\theta = 0$ modes in a Fourier (or POD) decomposition. The $k_z/k_\theta = 0$ modes of velocity contain 3.0, 3.5, and 7.2% of the streamwise, wall-normal, and spanwise turbulent kinetic energy at $0.25h$ above the wall for a $Re_\tau = 590$ channel DNS with πh wide domain (Moser, Kim, & Mansour, Phys. Fluids, 1999), and 1.5, 2.3, and 4.2% for a $Re_\tau = 685$ pipe DNS at $0.25R$ above the wall. These increase to 9–11% for each component at the channel centerline. These modes are studied for channel and boundary layer DNSs with several domain widths and a pipe. Time evolution and traveling wave behavior of these modes are explored. The modes are characterized with proper orthogonal decomposition, and the results are compared to 2D POD modes for planes without spanwise/azimuthal averaging.

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Jon Baltzer
Arizona State University

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