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Decay and Spatial Diffusion of Turbulent Kinetic Energy In The Presence of a Linear Kinetic Energy Gradient[1]

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A topic that elicited the interest of John Lumley is pressure transport in turbulence. In 1978 (JL, in Advances in Applied Mechanics, pages 123-176) he showed that pressure transport likely acts in the opposite direction to the spatial flux of kinetic energy due to triple velocity correlations. Here we examine a flow in which the interplay of turbulent decay and spatial transport is particularly relevant. Specifically, using a specially designed active grid and screens placed in the Corrsin wind tunnel, such a flow is realized. Data are acquired using X-wire thermal anemometry at different spanwise and downstream locations. In order to resolve the dissipation rate accurately, measurements are also acquired using the NSTAP probe developed and manufactured by Princeton researchers and kindly provided to us (M. Hultmark, Y. Fan, L. Smits). The results show power-law decay with downstream distance, with a decay exponent that becomes larger in the high kinetic energy side of the flow. Measurements of the dissipation enable us to obtain the spanwise gradient of the spatial flux. One possible explanation for the observations is upgrading transport of kinetic energy due to pressure-velocity correlations, although its magnitude required to close the budget appears very large. Absence of simultaneous pressure velocity measurement preclude us to fully elucidate the observed trends.

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