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On the dynamics of Reynolds stresses in the tip region of axial turbomachines[1] HUANG CHEN, The Johns Hopkins University, YUANCHAO LI, DAVID TAN, JOSEPH KATZ, Johns Hopkins University — Experiments examining the flow in the tip regions of axial turbomachines have been performed in a refractive index matched facility, enabling unobstructed optical access. Stereo PIV measurements in closely spaced planes provide high-resolution 3D distributions of the strain rate and Reynolds stress tensors in the rotor passage. In areas dominated by large vortical structures, such as the tip leakage vortex (TLV) and the backflow vortex that propagates circumferentially, the strain and Reynolds stress tensors are poorly correlated, and the measured eddy viscosity fluctuates from large negative to positive values. In the vortex cores, a substantial fraction of the unsteady motion involves large-scale structures. The turbulence is highly anisotropic and inhomogeneous, with an anisotropy tensor shifting from 1D to 2D to 3D over small distances. Ingestion of turbulence across the tip gap enhances the turbulence production and increases the Reynolds stresses substantially. However, the distributions of Reynolds stresses depend on their history, hence affected by advection and diffusion in addition to local production and dissipation rates. The TLV breaks up in the aft part of the passage generating a broad area with elevated turbulence, but with lower peak values.

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