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Similarity Theory for an Axisymmetric Turbulent Wake with Rotation MARTIN WOSNIK, University of New Hampshire — Axisymmetric wakes are special cases of turbulent shear flows in the sense that the local Reynolds number based on velocity deficit and wake width decreases with downstream position. Recently, Johansson et al. (Physics of Fluids, **15**, no.3, 603-617, 2003) showed that two distinct similarity solutions for the non-swirling axisymmetric turbulent wake exist – one for infinite and one for low local Reynolds number. Every axisymmetric wake, no matter how high the initial Reynolds number, will eventually transition to the low Reynolds number similarity state in the far wake. Here equilibrium similarity considerations are applied to axisymmetric turbulent wakes with rotation (swirl), as can be found downstream of wind or hydrokinetic turbines. By examining under which conditions the reduced momentum and Reynolds stress transport equations for swirling wakes as well as the momentum integrals admit to similarity solutions, asymptotic scaling relations for the decay of velocity deficit and swirl are found. Swirl is introduced as an initial condition, and additional constraints on the similarity solution are introduced from the turbine (wake generator) operating parameters, e.g., tip speed ratio, angular induction, etc. The consequences of having a non-point source of thrust (drag) and angular momentum are investigated. Implications of the findings on the operation of wind and hydrokinetic turbines and turbine arrays are discussed.

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