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Scaling with Freestream Fluctuations in the Laminar–Turbulent Transition Process

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It has been known for a century now that transition to turbulence is delayed when background disturbances are decreased. In boundary layers in quiet tunnels, the transition onset Reynolds number and the amplitude of freestream disturbance are related by a power law, with an exponent of -1. Recent experiments in pipe flows too show a power-law relationship between these two quantities, with the same exponent. We investigate here the relationship between background disturbance amplitude and the critical Reynolds number for a precursor to transition onset, namely, secondary disturbance growth in a channel. For each primary mode, the Reynolds number for a given secondary growth rate is found to obey a power-law with a frequency and growth-dependent exponent. The exponents are negative with magnitudes less than 1; the envelope of instability has an exponent close to -1. We conlude with the surprising observation that critical Reynolds numbers defined using the *disturbance velocity magnitude* as scale, are constant in all these cases.

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