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Aspects of the Laminar-Turbulent Transition in Axisymmetric Boundary Layers

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The boundary layers over axisymmetric bodies have been studied far less than those over two-dimensional surfaces. Our main obective is to understand how the laminar-turbulent transition process in a boundary layer over an axisymmetric body is different from that over a two-dimensional surface. We study the primary (linear) instability, the secondary instability, and the transition zone, and find that all these are qualitatively different from 2D boundary layers. It is shown that transverse curvarture has a significant stabilizing effect on the primary stability. Consistent with the recent findings of Tutty *et al* [1], we see that three-dimensional modes can go unstable first, whereas over a 2D surface 2D modes are most unstable (Squire's theorem[2]), Interestingly, an opposing effect of curvature is seen on secondary instability behaviour: competing primary modes produce a rich variety in secondary disturbance growth, indicating early entry into the nonlinear domain. Early stages of the transition zone, where turbulent spots grow as they convect, are similar to 2D flow, while due to the spots wrapping around the body, transition proceeds slower in the later stages.

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