

MECHANICAL ENGINEERING STUDENT SEMINAR

Wednesday, December 14 2022 at 10:00, D. Dan and Betty Kahn Building, Auditorium 1.

Stability and Transition on a Steady and Impulsively-Started Coandă Cylinder

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The Coandă effect is widely researched and applied in a variety of applications ranging from aerospace to automotive to fluidics. Despite extensive research, very little is known about the centrifugal instability associated with the Coandă effect and almost nothing is known about transients following impulsive initiation of the flow. In this research, we study the flowfield formed by a nominally two-dimensional jet flowing over a curved convex cylindrical surface in a quiescent environment. We focus on the stability and the transitional characteristics of the shear layer formed downstream of the slot, for both the steady-state case as well as the transient impulsively-started case. Flow visualization, particle image velocimetry and image processing were used to analyze the flowfield. For the steady-state case, spontaneous stationary streamwise structures, never previously observed, appeared. These structures ultimately exhibited a secondary time-dependent wavy instability that was followed by transition to turbulence. A linear stability analysis yielded a critical Görtler number of 3.5, which compared very favorably with the experimental value of 3.1 ± 1.25 . For the impulsively-started case, flow visualization revealed tightly-spaced vortex-ring-pairs wrapped around the starting vortex. These vortex-ring-pairs grow and merge downstream, leading to rapid diffusion of the starting vortex. This instability appears to be similar to “instability disks” observed following the impulsive rotation of a circular cylinder, however the dimensionless time-scales of formation are vastly smaller. A linear stability analysis accurately predicted the wavelength of this instability. As in the steady-state case, this appears to be the first observation of a centrifugal instability existing within a starting vortex.

Note: the seminar will be given in Hebrew