Experimental Study of the Rotating-Disk Boundary-Layer Flow

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The laminar-turbulent transition of the rotating-disk boundary-layer flow has been investigated not only as a simple flow model of three-dimensional boundary layers, but also for industrial applications of rotating bodies. One interesting characteristic of this flow is that transition to turbulence occurs at a well-defined Reynolds number, attributed to an absolute instability by Lingwood in 1995. At KTH Mechanics both numerical and experimental studies are currently made in order to understand to what extent the absolute instability is involved in the transition process and how surface roughness and the finite extent of the disk affects the transition. The figure shows ensemble averaged time series of azimuthal fluctuating velocity obtained by hot-wire anemometry over a smooth disk, showing the development of stationary vortices. Their breakdown at a particular radius independent of amplitude can be observed. This radius corresponds to a Reynolds number associated with the theoretically predicted absolute instability.