Development of an axisymmetric wave packet in rotating-disk flow

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The three-dimensional flow on a rotating disk admits two kinds of wavy disturbances induced by the cross-flow instability and the streamline-curvature instability. Their separate appearances by some artificial forcing are very desirable for experimental investigation of differences in dynamics and structure between the two instabilities. Thus the present study considers an instantaneous excitation of the boundary-layer flow through an annular slit on the disk surface and describes temporal and spatial development of the excited wavy disturbances by applying the method of complex characteristics to eigensolutions of approximate stability equations. Computational results show that observation at a downstream station will first catch the streamline-curvature disturbances with smaller circumferential wavenumbers and then the familiar cross-flow ones, because of a definite difference in propagation speed of the two modes. This study provides evidence to show that the method of complex characteristics is a very useful tool for theoretical prediction of dispersive properties of such instability waves.

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