Abstract Submitted
for the DFD07 Meeting of
The American Physical Society

Instability of the 3D boundary layer flow over a rotating cone. ZAHIR HUSSAIN, SHARON STEPHEN, University of Birmingham — The flow over a rotating cone is susceptible to crossflow and centrifugal instability modes, depending on the sharpness of the cone nose. The boundary layer instability is visualized by the formation of spiral vortices, which wrap around the cone surface in a helical nature. For parameters ranging from propeller nose cones to rotating disks, the instability triggers co-rotating vortices, whereas for sharp spinning missiles, counter-rotating vortices are observed. In the presence of a forced free-stream, the flow is essentially a battle between the oncoming axial flow and the azimuthal shear flow due to the rotating surface. Experiments in the literature have shown that increasing the incident free-stream has a stabilizing effect on these spiral vortices. We derive the mean flow boundary layer equations and investigate the asymptotic stability of the flow to inviscid crossflow modes at large Reynolds number for a cone in still fluid as well as in axial flow. The influence of the cone half-angle and axial flow strength on the number and orientation of the spiral vortices is examined, with comparisons made with previous experimental and numerical results.

Sharon Stephen
University of Birmingham

Date submitted: 02 Aug 2007 Electronic form version 1.4