Date: March 17th

Time: 11:00 AM

Location: Maryland Hall 110

Speaker: Dr. Lorena Barba
Department of Mathematics
University of Bristol

Title: "Lagrangian analysis of vortex structures: the case of the tripole"

Abstract

When explaining the physical mechanism of merging of vortex pairs, it is now almost a standard approach to describe the process by means of the Eulerian flow geometry. In this approach, one looks at the streamlines in a frame of reference rotating with the vortex pair. The instantaneous streamline pattern possesses a set of stagnation points, and the associated separatrices divide the flow into different recirculation zones. The explanation of merging goes like this: if diffusive effects take vorticity across a separatrix into the outer recirculation region, this leads to the vorticity being forced to form filaments, leading to convective merger. Recent observations of the Lagrangian flow geometry of a vortex pair, however, have cast doubt over this explanation. Filamentation, from the Lagrangian point of view, occurs when a stable manifold of a hyperbolic trajectory enters the vortex, and this can occur *without* a saddle point entering the vortex. In a similar way, some authors have attempted to explain the formation and persistence of vortex tripoles by the formation of a "critial separatrix", which inhibits mixing of the tripole satellite vortices. Here, too, we can find several flaws to the argument. The Eulerian and Lagrangian geometries differ considerably, as these flows generally pass through an unsteady re-organization stage. Also, the separatrices (Eulerian description) are there initially, even for cases which become axisymmetric, rather than developing a quasi-steady tripole. By looking at the hyperbolic trajectories and their stable and unstable manifolds, calculated from the numerically generated time evolving velocity field, we make several observations regarding the tripole. When the stable manifolds fold and wrap around the areas of negative vorticity, thereby forming a barrier for their mixing, the flow is seen to develop a quasi-steady tripole. In contrast, when the manifolds exhibit short lobes, that do not wrap around areas of negative vorticity, the flow axisymmetrizes.