Abstract Submitted
for the DFD06 Meeting of
The American Physical Society

Numerical simulation of the interaction of an unconfined vortex with a solid surface LUIS PARRAS, RAMON FERNANDEZ-FERIA, University of Malaga (Spain) — The interaction of an open vortex with a solid plane perpendicular to the axis of the vortex is analyzed numerically. We solve the axisymmetric, incompressible Navier-Stokes equations with boundary conditions that far away from the axis correspond to Long's near-inviscid similarity solution for an open vortex. Continuation techniques are used to solve the equations of motion for increasing Reynolds numbers. When this parameter is large enough, vortex breakdown occurs, producing a small region of reversed flow at the axis close to the solid plane. This region increases in size with the Reynolds number and, eventually, two breakdown bubbles appears at the axis. We also find non-uniqueness of the solutions at several ranges of the Reynolds number. At the end, for large Reynolds numbers, the region of reversed flow at the axis extends all along it, from near the plane to the flow exit far above the plane, where the flow tends to 'Type II' Long's self-similar solution. Thus we show that of the two different similarity solutions found by Long for a given flow force, only that with negative axial velocity at the axis (Type II solution) is compatible with the viscous interaction of the vortex with a solid surface. This flow configuration is in agreement with observations of intense tornado-like vortices, where the flow at the axis is directed downwards, while the mean flow is directed upwards. *Supported by the Ministerio de Educacion y Ciencia of Spain (FIS04-00538).

Ramon Fernandez-Feria
University of Malaga

Date submitted: 26 Jul 2006 Electronic form version 1.4