Abstract Submitted
for the DFD12 Meeting of
The American Physical Society

Impact of a vortex dipole with a semi-infinite plate SEAN D. PETERSON, University of Waterloo, MAURIZIO PORFIRI, Polytechnic Institute of New York University — Recently, several studies have been published on small-scale energy harvesting from fluids using electro-active polymers strips. Specifically, the feasibility of harvesting energy from vortex rings via impact with a cantilevered electro-active strip has recently been demonstrated. As a first step towards developing predictive models of the energy harvesting capacity of this modality, we develop a simplified two-dimensional representation of the vortex ring-deformable structure interaction, in which the vortex ring is modeled as a Lamb dipole, and the cantilevered deformable strip is replaced with a semi-infinite rigid plate. The interaction is explored numerically for a range of dipole Reynolds numbers from 500 to 3000, based upon the convection speed and dipole radius. The initial dipole trajectory results in an impact with the semi-infinite plate at its tip. As the dipole approaches, vorticity is induced in the boundary layer along the wall, which eventually separates and joins with half of the original dipole to form a secondary dipole. This interaction is similar to that of a dipole impacting an infinite wall. The other half of the original dipole merges with vorticity shed from the tip of the plate to produce another secondary dipole. The stagnation point is shifted away from the centerline of the original dipole, which differs from the case with an infinite wall. Of particular interest for the energy harvesting is the differential pressure across the semi-infinite plate, as it relates to the energy transferred to the wall in the event of a deformable, as opposed to rigid, structure, which will be discussed as well as the general flow features.

Sean Peterson
University of Waterloo

Date submitted: 03 Aug 2012 Electronic form version 1.4