Abstract Submitted
for the DPP12 Meeting of
The American Physical Society

**Fluid theory of beam spiraling in high intensity cyclotrons** ANTOINE CERFON, NYU CIMS, FELIX PARRA, JEFFREY FREIDBERG, MIT PSFC — Novel uses of cyclotrons for basic science, national security and medical therapy applications require the production of beams with ever higher intensities. At these high intensities, uncontrolled beam loss must be minimized. To satisfy the stringent beam loss criteria, it is crucial to have a detailed understanding of the beam dynamics in high intensity cyclotrons, and more specifically, an understanding of the effects of space charge on the dynamics. Using a two-dimensional fluid description, we investigate the nonlinear radial-longitudinal dynamics of intense beams in cyclotrons. With a multiscale analysis separating the time scale associated with the betatron motion and the slower time scale associated with space-charge effects, we show that the longitudinal-radial vortex motion can be understood in the frame moving with the charged beam as the nonlinear advection of the beam by the ExB velocity field, where E is the electric field due to the space charge and B is the external magnetic field. This interpretation provides simple explanations for the stability of round beams and for the development of spiral halos in elongated beams. By numerically solving the advection equation, we show that it is also in quantitative agreement with results obtained in PIC simulations.

Antoine Cerfon
NYU CIMS

Date submitted: 11 Jul 2012

Electronic form version 1.4