

**About Self Similarity or Routes to Reversibility in the Space Charge Dominated Beams,**  
A. PIQUEMAL, CEA/Bruyeres - It is known for a long time, from analytical calculus, that r.m.s. emittance is conserved when a charged particle beam is uniform or self similar. We can show, from the envelope equations, that if either property is verified, r.m.s. emittance is a real invariant of the system, which has now a "natural" closure. This leads to the idea that the beam energy is enclosed in a bag which could be stressed and stretched in the phase space. One can prove that r.m.s. radius and thermal energy limits exist, authorizing such a behaviour. These boundaries determine a domain in which the beam can effectively be reversibly transported. But, some severe questions arise, like the notion of irreversibility before the beam gets reversible, or the notion of thermalization, and particularly the processes which drive such a thermalization. We analysed these questions, analytically from the envelope and hydrodynamic equations, and numerically from the results (1-2D) of the self-consistent code Renoir simulating real situations of transport. Self-similarity shows up very quickly after some periods, in the integral, position and phase spaces. The notion of bag of energy is more and more subtle. The beam is always thermalizing, but the zone which is thermalized has a self-similar behaviour.