DPP05-2005-000367

Abstract for an Invited Paper
for the DPP05 Meeting of
the American Physical Society

Wave particle interaction and Hamiltonian dynamics investigated in a traveling wave tube

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For wave-particle interaction studies, the 1D beam-plasma system can be advantageously replaced by a Traveling Wave Tube (TWT). This led to detailed experimental analysis of the self-consistent interaction between unstable waves and a small either cold or warm beam.[1] More recently a test electron beam has been used to observe its non-self-consistent interaction with externally excited wave(s). The velocity distribution function of the electron beam is investigated with a trochoïdal energy analyzer[2] which records the beam energy distribution at the output of the TWT. An arbitrary waveform generator is used to launch a prescribed spectrum of waves along the slow wave structure (a 4 m long helix) of the TWT. The nonlinear synchronization of particles by a single wave responsible for Landau damping is observed.[3] The resonant velocity domain associated to a single wave is also observed, as well as the transition to large scale chaos when the resonant domains of two waves and their secondary resonances overlap.[4] This transition exhibits a "devil's staircase" behavior when increasing the excitation amplitude. A new strategy for control of chaos by building barriers of transport which prevent electrons to escape from a given velocity region is successfully tested.[5] This work was done in collaboration with Dr. Kh. Auhmani, Dr. D. Guyomarc'h, and A. Macor for the experimental part.

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