COLLECTIVE COULOMB INTERACTION SUPPRESSION OF NOISE AND OF RADIATIVE EMISSION IN CHARGED PARTICLE BEAMS

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An effect of current shot-noise suppression at optical-frequencies in a drifting charged-particle-beam and the corresponding process of particles self-ordering are analyzed using an analytic 1D model, and verified by 3D numerical simulations. This self-ordering phenomenon, never yet observed in the lab at optical frequencies, takes place due to longitudinal collective Coulomb interaction, under the condition that the beam parameters are set to excite a single mode Langmuir plasma-wave oscillation [1].

The suppression of relativistic beam shot noise can be utilized to enhance the coherence of seeded free electron lasers and any coherent radiation device using an electron beam. It is shown that this can be attained at optical frequencies with state of the art high quality e-beams.

Our analysis of spontaneous emission suppression (sub-radiance [2]), results in fundamental theoretical limit expressions for the coherence of FELs and other e-beam radiators, analogous to the Schawlow-Towns limit [3]. After exceeding the shot-noise limit, the coherence of FEL radiation is limited in the IR by the e-beam energy spread (velocity noise). At UV and shorter wavelengths it is fundamentally limited by quantum noise.

Reference:
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[2] R. H. Dicke, Phys. Rev. **93**, 99 (1954).
[3] A.L.Schawlow and C.H.Townes, Phys.Rev., **112**, 1940