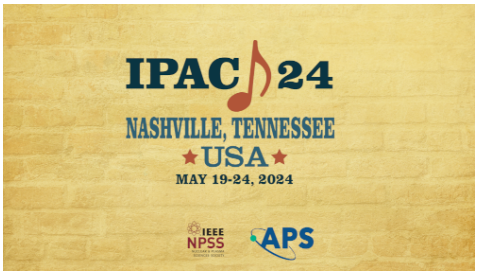

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Superradiant cooling and dynamics of ultrashort electron beams

Monday, 20 May 2024 16:00 (2 hours)

Accelerator-based light source can produce extremely high brightness radiation and has been an indispensable tool in various fields. By exploiting the collective dynamics of electrons in external fields, high-gain free electron lasers can generate radiation with powers several orders of magnitude higher than typical synchrotron radiation. This collective enhancement, could also be realized in future synchrotrons with ultrashort electron beams stored. The classical theory of storage ring cannot be extended to describe such devices since it assumes the emission of radiation is independent for each electron. To incorporate this collective radiation effect, a fundamentally different theory of storage ring physics has to be developed. In this paper, we consider a quantum electrodynamics treatment of the collective radiation of electrons in storage rings. We find that the ultimate limit on beam brightness in classical theory will break down due to the failure of the independence assumption and electrons will be cooled superradiantly. Moreover, we give a complete analysis of the intricate beam dynamics under the coherent synchrotron radiation effect and superradiant cooling effect.

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