Contribution ID: **1569** Contribution code: **MOPB104** Type: **Poster Presentation**

Analytical model for the transition to superradiance in seeded free-electron lasers

Monday 2 June 2025 16:00 (2 hours)

Free-electron lasers (FEL) seeded by short radiation pulses can exhibit superradiant behavior. In the superradiant regime, the pulse simultaneously compresses and amplifies as it propagates through the FEL, making superradiance very promising for pushing the performance limits of attosecond x-ray FELs. To date, this regime has been studied in asymptotic limits, but there is no model for how the initially linear dynamics of the seeded FEL transition into the nonlinear superradiant behavior. We derive an analytical model for the 1D FEL seeded by a short pulse which accurately captures the linear dynamics, the nonlinear superradiant evolution, and the smooth transition between them. Our model fills a critical gap in our understanding of FEL superradiance and nonlinear time-dependent FEL physics more broadly, and may provide a bridge to the corresponding problem in three-dimensions, and analogous problems in other fields exhibiting soliton behavior.

Footnotes

Paper preparation format

LaTeX

Region represented

America

Funding Agency

U.S. DOE, Office of Science, Office of BES under Contract No. DE-AC02-76SF00515
U.S. DOE, Office of Science, Office of BES Accelerator and Detector Research Program

Author: ROBLES, River (Stanford University)

Co-authors: MARINELLI, Agostino (SLAC National Accelerator Laboratory); HEMSING, Erik (SLAC National Accelerator Laboratory); STUPAKOV, Gennady (xLight Incorporated)

Presenter: ROBLES, River (Stanford University)

Session Classification: Monday Poster Session

Track Classification: MC2: Photon Sources and Electron Accelerators: MC2.A06 Free Electron Lasers (FELs)