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Inferring nonlinear phase space from spectral correlations in free-electron laser radiation

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It has been known for decades that the intensity fluctuations of free-electron laser radiation conceal some information about the temporal characteristics of the light. In particular, by measuring the ensemble-averaged spectral intensity correlation function, one can reconstruct the average length of the x-ray pulse [1]. This method in its original form starts to break down once the electron beam has any energy chirp, which is often a feature during practical operating conditions. We recently extended the spectral intensity correlation method to linearly chirped electron beams, however this is still not completely representative of everyday beams [2]. We present here further analysis of nonlinearly chirped electron beams and their spectral statistics, and show that measurement of the spectral intensity correlation function provides non-trivial information about the nonlinear electron beam phase space and therefore the x-ray pulse phase space.

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Footnotes

[1] Lutman, A. A., et al. "Femtosecond x-ray free electron laser pulse duration measurement from spectral correlation function." Physical Review Special Topics-Accelerators and Beams 15.3 (2012): 030705.
[2] Robles, R.R., et al. "Reconstruction of x-ray free-electron laser pulse duration and energy chirp from spectral intensity fluctuations." Submitted to Physical Review Accelerators and Beams (2022).

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