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Advances in a perturbation theory for the microbunching instability in free-electron laser injectors

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The microbunching instability is one of the most significant effects, which can lead to a severe degradation of the beam quality in the linac section of free-electron lasers.
Direct analytical treatment of the microbunching instability is however challenging.
In particular when multiple bunch compression stages are considered, an exact closed-form expression for the charge density of the electron bunch typically cannot be derived.
As a remedy, perturbative methods might be considered.
Here, the instability is investigated by analyzing the propagation of small perturbations to an otherwise stable phase-space density.
One such approach is based on the expansion of the collective Perron-Frobenius operator of the collective system into a Frechet-Taylor series.
Applying the expanded Perron-Frobenius operator to a slightly perturbed phase-space density allows to derive closed-form expressions for the propagated perturbation term, potentially to arbitrary order.
In this contribution new advances in a perturbation theory based on the Frechet-Taylor expansion of collective Perron-Frobenius operators are presented.

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Footnotes

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