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Optimizing the discovery of underlying nonlinear beam dynamics and moment evolution

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One of the Grand Challenges in beam physics relates to the use of virtual particle accelerators for beam prediction and optimization. Useful virtual accelerators rely on efficient and effective methodologies grounded in theory, simulation, and experiment. This work extends the application of the Sparse Identification of Nonlinear Dynamical systems (SINDy) algorithm, which we have previously presented at the North American Particle Accelerator Conference. The SINDy methodology promises to simplify the optimization of accelerator design and commissioning by discovery of underlying dynamics. We extend how SINDy can be used to discover and identify underlying differential systems governing the beam's sigma matrix evolution and corresponding invariants. We compare discovered differential systems to theoretical predictions and numerical results. We then integrate the discovered differential system forward in time to evaluate model fidelity. We analyze the uncovered dynamical system and identify terms that could contribute to the growth(decay) of (un)desired beam parameters. Finally, we propose extending our methodology to the broader community's virtual and real experiments.

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Footnotes

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Yes

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