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Descriptive and Predictive Modeling of Chaos in Cold Atom Physics using Explainable Deep Learning

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Ultracold atom clouds have garnered significant attention for their intricate dynamics, which may exhibit chaotic behavior and remain without a comprehensive explanatory framework. This work explores these dynamics in a ^{85}Rb cold atom cloud through the integration of explainable deep learning techniques, given the recent meteoric rise of artificial intelligence (AI). This is employed through the analysis of image series data obtained in a laser cooling experiment in a magneto-optical trap. This study aims to uncover low-dimensional structures and chaotic behaviors within the system by employing convolutional autoencoders and dimensionality reduction methods, along with explainability strategies. Preliminary results reveal evidence of a potential phase transition between stable and turbulent regimes, with further analysis providing critical insights into system parameters. This interdisciplinary approach highlights the transformative potential of explainable AI in elucidating complex phenomena in cold atom physics.

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