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Measuring complexity & synthetic Hamilton matrices

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Photo-electron spectra obtained with intense pulses generated by free-electron lasers through self-amplified spontaneous emission are intrinsically noisy and vary from shot to shot. We extract the purified spectrum, corresponding to a Fourier-limited pulse, with the help of a deep neural network. It is trained on a huge number of spectra, which was made possible by an extremely efficient propagation of the Schrödinger equation with synthetic Hamilton matrices and random realizations of fluctuating pulses. We show that the trained network is sufficiently generic such that it can purify atomic or molecular spectra, dominated by resonant two- or three-photon ionization, non-linear processes which are particularly sensitive to pulse fluctuations. This is possible without training on those systems. This purification method implies the hidden information in the spectra that never be extracted in the analytical solution manner. By utilizing the perspective on the autoencoder model, we can then measure the complexity (information) of any given spectrum dataset.

Poster title

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