

## Quantum field tomography and continuous matrix-product states

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We introduce the concept of quantum field tomography, the efficient and reliable reconstruction of unknown quantum fields based on data of correlation functions. At the basis of the analysis is the concept of continuous matrix product states, a complete set of variational states grasping states in quantum field theory. We innovate a practical method, making use of and developing tools in estimation theory applied in the context of compressed sensing such as Prony methods and matrix pencils, allowing us to faithfully reconstruct quantum field states based on low-order correlation functions. In the absence of a phase reference, we highlight how specific higher order correlation functions can still be predicted. We exemplify the functioning of the approach by reconstructing randomised continuous matrix product states from their correlation data and study the robustness of the reconstruction for different noise models. Furthermore, we apply the method to data generated by simulations based on continuous matrix product states and using the time-dependent variational principle. The presented approach is expected to open up a new window into experimentally studying continuous quantum systems, such as encountered in experiments with ultra-cold atoms on top of atom chips. By virtue of the analogy with the input-output formalism in quantum optics, it also allows for studying open quantum systems.