Project: Mathematical structure of Tensor Network states

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Tensor Networks form an ansatz where a complex high-dimensional tensor is expressed through the contraction of a number of elementary low-dimensional tensors. In particular, Tensor Networks form a powerful ansatz for the modeling of the structure of complex correlated quantum many-body systems (that is, multi-dimensional tensors with special properties) in various scenarios. A key question in the application of tensor networks, both for the analytic classification and numerical simulation of quantum many-body systems, is their mathematical structure and in particular their representation theory. Here, the key question is to classify the inequivalent ways in which a collection of elementary tensors can give rise to the same high-dimensional tensor, and to characterize the structure of the gauge transformations which map these representations into one another.

Possible PhD projects concern the study of the representation theory of tensor networks and its application in different scenarios, such as for systems with specific types of symmetries (e.g. local symmetries, global symmetries, or symmetries acting on parts of the system), as well as the investigation of the consequences arising from the structure of the underlying gauge ambiguities, in particular in the classification and characterization of phases, or as a novel tool in numerical tensor network algorithms.

The concrete thesis project will be developed jointly with the successful applicant along the lines described above, within the topical area “Mathematical structure of Tensor Network states”.

Basic requirement for the position are thorough knowledge of the fundamentals of (linear) algebra, representation theory, and ideally functional analysis, as well as interest in physically motivated problem settings, and the willingness to interact with both mathematicians and physicists, as well as both analytically and numerically oriented collaborators, alike.