Many-body quantum mechanical systems are described by tensors. If a system has \( n \) particles, its state is an element of \( \mathcal{H}_1 \otimes \ldots \otimes \mathcal{H}_n \), where \( \mathcal{H}_j \) is a Hilbert space associated to the \( j \)-th particle. Due to the exponential growth of the dimension of \( \mathcal{H}_1 \otimes \ldots \otimes \mathcal{H}_n \) with \( n \), any naive method of representing these tensors is intractable on a computer. However, most tensors are unlikely to appear as quantum states. Tensor network states were defined to reduce the complexity of the spaces involved by restricting to a subset of tensors that is physically reasonable. States of physical interest seem to be well parameterized as tensor networks with a small number of parameters. The construction essentially consists of a decorated graph, and the structure of the graph determines which tensors can be constructed from the configuration. This leads to questions regarding the best (still tractable) structures for graphs.

Approximating a state in terms of a tensor network makes the entanglement nature of the state itself apparent, which is not visible when approximating the state in a physical coordinate system. Recently a tensor network on a classical computer apparently was more effective than Google’s quantum computer. In this workshop we will compare the computational advantages of quantum computing vs tensor networks. It is important to investigate this question both practically and theoretically. Beyond tensor networks, the workshop will explore additional classes of tensors useful for many-body physics and quantum information theory and their utility in areas such as high dimensional probability. This workshop will include a poster session; a request for posters will be sent to registered participants in advance of the workshop.