**Anomalous Transport in Fracton Quantum Matter**

Prof. Dr. techn. Michael Knap

*Technische Universität München*

We experience a golden era in testing and exploring relativistic gravity. There is an unparalleled access to experimental data that allow us to pursue the question, as to whether Einstein's theory of gravity is our last word in our understanding of gravity. Besides results from gravitational wave detectors, satellite or lab experiments, radio astronomy plays an important complementary role - whether it is the cosmic microwave background, black hole imaging or, obviously, binary pulsars. This talk will provide an overview how these methods relate to each other, and will in particular focus on new results from the study of binary pulsars, where we can test the behaviour of strongly self-gravitating bodies with unrivalled precision. The talk will also give an outlook of what we can expect from new experiments, such as with MeerKAT or the SKA. Universality in equilibrium asserts that microscopic details are irrelevant for the emergent quantum phases of matter and their transitions. Rather, symmetries and topology determine the essential macroscopic properties. By contrast, all scales, from low to high energies, are relevant for quantum systems which are driven far from their thermal equilibrium. Recent experimental progress in engineering coherent and interacting quantum simulators made it possible to create and explore exotic non-equilibrium states, which can exhibit a wealth of dynamical phenomena. Despite this apparent complexity, a common anticipation is that diffusive transport of globally conserved quantities emerges universally for any complex quantum systems, since strong interactions entangle and effectively mix local degrees of freedom.

Recent developments, however, showed, that a variety of largely unexplored classes of hydrodynamics may exist. In certain constrained many-body systems the structure of conservation laws can cause a drastic modification of this universal dynamical behavior. For example, fractonic systems which conserve the dipole moment exhibit a localization transition separating an ergodic dynamical phase from a frozen one; a phenomena known as Hilbert space fragmentation. Even in the ergodic phase, transport is anomalously slow and exhibits sub-diffusive scaling.

In this colloquium, I will review some of the theoretical progress in studying anomalous transport in strongly interacting quantum many-body systems and discuss recent quantum simulation experiments with ultracold atoms and trapped ions.