Speaker: **Alessio LEROSE (University of Oxford, UK)**

Title: **Theory of weak ergodicity breaking in quantum spin systems with long-range interactions**

Recent years have seen the discovery of a number of routes to strong or weak forms of ergodicity breaking in isolated quantum many-body systems. Quantum many-body scars (QMBS) - exceptional energy eigenstates associated with absence of thermalization for special non-equilibrium initial states - rank as a remarkable possibility. The various systematic constructions of QMBS, however, require fine-tuning of local Hamiltonian parameters. In this talk I will demonstrate that long-range interacting quantum spin lattices generically host robust QMBS. This result is based on the analysis of spectral properties on raising the power-law decay exponent α of spin-spin interactions from the solvable permutationally-symmetric limit $\alpha=0$. We introduce a novel analytical approach based on mapping the quantum spin Hamiltonian onto a relativistic quantum rotor coupled to an extensive set of bosonic modes. We find an original exact solution for the eigenstates of this interacting impurity model, and show their self-consistent localization in large-spin sectors of the original spin Hamiltonian for $0<\alpha<d$. Our theory unveils the stability mechanism of such QMBS for arbitrary system size, and predicts instances of its breakdown, which we verify numerically in long-range quantum Ising chains. As a byproduct, we find a predictive criterion for absence of heating under periodic driving beyond existing Floquet-prethermalization theorems.