A new form of ergodicity breaking from quantum many-body scars

In my lectures I will review a new mechanism of the weak ergodicity breaking relevant for the experimentally realized Rydberg-atom quantum simulator [1]. This mechanism arises from the presence of special eigenstates in the many-body spectrum that are reminiscent of quantum scars in chaotic non-interacting systems [2]. In the single-particle case, quantum scars correspond to wave functions concentrated in the vicinity of unstable periodic classical trajectories. I will demonstrate that many-body scars appear in the Fibonacci chain, a model with a constrained local Hilbert space which can be realized by a Rydberg chain. The quantum scarred eigenstates are embedded throughout the otherwise thermalizing many-body spectrum but lead to direct experimental signatures, as I show for periodic recurrences that reproduce those observed in the experiment [1]. Using algebraic approach, I will construct the weak deformation of the Rydberg chain Hamiltonian that makes revivals virtually perfect [3]. In a different direction, using variational approach I will predict new initial states that lead to long-lived oscillations. I will conclude with discussing a new opportunities for the creation of novel states with long-lived coherence in systems that are now experimentally realizable and a brief overview of the recent experiments [4] that uncovered surprising interplay between scars and and time crystalline physics [5].


