Statement of Recent Work (Sep/2014 - Sep/2019)

The applicant’

quantum chaos, especially in the context of many-body physics, with new insights coming from fields as diverse as high energy physics, quantum information science, atomic and molecular physics, and condensed matter physics. The applicant has made important contributions to the fundamental question of what defines many-body quantum chaos.

Contrary to the widespread view that chaos causes the initial exponential decay of autocorrelation functions, the applicant's group showed that decays even faster than that can happen in isolated systems, and they are independent of spectral properties [8], depending instead on the strength of the perturbation that takes the system out of equilibrium. Furthermore, this behavior necessarily slows down at long times and becomes power law, due to the unavoidable presence of bounds in the spectrum [9]. Universal behaviors as in random matrix theory emerge only much later in time, when the dynamics resolve the discreteness of the spectrum and can finally detect the correlations between the eigenvalues [10]. The applicant's group has used these dynamical manifestations of spectral properties as detectors of integrable-chaos and metal-insulator transitions.

The search for the quantum counterpart of the exponential instability observed in chaotic classical systems has been pursued for many years. Recently, the subject has undergone intense investigation due to new studies that relate the exponential growth rate of out-of-time order correlators (OTOCs) with the classical Lyapunov exponent. This correspondence was indeed corroborated for one-body systems. Together with collaborators, the applicant made a step up towards an explicit quantum-classical correspondence for interacting many-body systems, by confirming the relationship for the Dicke model [19], which contains *N* atoms interacting with a quantized field. Yet, new results by this collaboration demonstrate that OTOCs can actually grow exponentially also in systems that are classically regular [21]. This finding is certain to shake the role that OTOCs have so far played in studies of many-body quantum chaos and to keep the debate about w0 1 72.024 349.97 Tmg00,0.125 rg0.137 0.122 0.125 RG[(qua)4(nti)-3(z)4(e)4(d fi)] TJ samples, since their properties are independent of the specific disorder realization. Lack of self-averaging, on the other hand, requires ensemble averages no matter how large the system is, which makes scaling analysis quite challenging. The group has shown analytically and confirmed numerically that self-averaging is not an intrinsic consequence of quantum chaos, as usually assumed. It depends on the quantity and on the time scale considered. Even in evolutions under full random matrices, one finds quantities that are not self-averaging at any time scale [17].

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