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Long time semiclassical propagation in quantum chaos

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Semiclassical propagation of waves is a fruitful approach to understand and evaluate a wide set of physical processes. Nevertheless, long-time propagation in Hamiltonian systems with classically chaotic dynamics was a long-standing unsolved problem. In the last years, we have developed a semiclassical technique in order to propagate waves for long times of the order of the Heisenberg time and here, we describe the main points of this development. We construct, in the neighborhood of a given unstable periodic orbit A, a localized wave function consisting of a Gaussian beam with n excitations along A; this construction is named the resonance n of A. The forward (backward) evolution of the resonance is described by a WKB state existing on the unstable (stable) manifold of A. Then, the autocorrelation function of the resonance, being the overlap between the forward and backward evolved states, is evaluated semiclassically by the set of homoclinic orbits of A (this set defines the intersection of the stable and unstable manifolds of A). Here, we present the semiclassical computation of the autocorrelation function of resonances in the hyperbola billiard. Furthermore, we present the computation of the correlation function between resonances of A and B (with B another unstable periodic orbit) in terms of the set of heteroclinic orbits between A and B. As an application, by Fourier transforming the autocorrelation we find highly excited scarred eigenstates.

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