Irregular Scattering at Atoms and Designer Atoms

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Abstract

The investigation of irregular and chaotic dynamics in unbound systems has become the focal point of interest within the field of 'quantum chaos' or, more precisely, the quantum mechanics of classically chaotic systems. Chaotic motion in the continuum differs from bound motion in fundamental ways: the energy hypersurface is non- compact and the chaotic motion is intrinsically transient connecting the phase flows of asymtotically separable Hamiltonians in the entrance and exit channels. Accordingly, also the quantum description of irregular scattering requires features characteristically different from bound systems: While the global S matrix is unitary, its representation within the subspace of the transient " compound " system connecting to the open channels becomes non-unitary. One consequence is that the parametric dynamics of eigenvalues takes place in the complex energy plane. Signatures of transient chaos can be clearly identified in properties of the S matrix. In particular, rapidly fluctuating cross- sections can be directly related to the chaotic classical phase flow. We will present examples for Rydberg atoms interacting with a sequence of ultrashort pulses and for electron scattering at ballistic semiconductor microstructures (" designer atoms").