Abstract for Dynamics Days Crete 2006
Topic: Quantum Chaos

Influence of disorder correlations on wave-packet dynamics at quantum critical points

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We consider the dynamics of wave-packets which are constructed from critical eigenstates of an integer quantum Hall system. It is well known [1, 2, 3] that the multi-fractal eigenstates govern the shape and the anomalous decay of the wave-packets, and also determine the critical conductance [4]. Here, we present results of our study on the influence of spatially correlated disorder potentials on the wave-packet dynamics.

We investigate a two-dimensional lattice model with lattice constant a where the electrons move in quenched disorder and a strong perpendicular magnetic field. We calculate the temporal evolution of wave-packets numerically for system sizes of up to $L/a \approx 5000$ using a special algorithm. Depending on the correlation length of the Gaussian disorder, a broad crossover from ballistic to diffusive motion is observed.

We discuss the impact of these findings on the frequency scaling of the ac quantum Hall effect which was found to depend on the disorder correlations. A power-law relation has been observed for the peak width Δ of the longitudinal conductivity, $\Delta \propto \omega^{\kappa}$, with an exponent $\kappa = 1/(\mu z) \approx 0.42$, where μ is the critical exponent of the correlation length at the critical point and z is the dynamical exponent that seems to depend on the disorder correlations.

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