The Abdus Salam International Centre for Theoretical Physics

Conference on Frontiers of Nanoscience
24 August - 1 September 2015, Trieste, Italy

Relaxation of an Electron Wave Packet at the Quantum Hall Edge at Filling Factor 2

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Abstract:

Motivated by the recent experiment of the group of Patrice Roche [S. Tewari et al., arXiv:1503.05057v1], we investigate the evolution of the single-electron wave packet in one of the two chiral one-dimensional electron channels at the edge of a quantum Hall (QH) system at filling factor two. The authors of the experiment have used a single electron source based on the phenomenon of resonant tunneling through a quantum dot in order to create such state. They have observed an unusual behavior that the degree of the phase coherence detected by the Mach-Zehnder interferometer saturates at high energies, instead of vanishing, and proposed that this observation may
be explained using the model of strongly interacting edge states.
The main result of our paper is that strong interactions are not able to fully equilibrate the initial state. We show that the integrability of the system remains in terms of collective charge excitations in the case of the linear electron spectrum, despite strong interactions. Thus, our work demonstrates that the simple model of strongly interacting QH edge states cannot be used for a consistent interpretation of experimental data and the additional physical mechanisms are required (such as, for example, non-linearities in the spectrum of electrons, disorder at QH edge, etc.).