Breakdown of Universal Dynamical Resistance of a Mesoscopic Capacitor

Y. Hamamoto[a], T. Jonckheere[b], T. Kato[c], and T. Martin[b,d]

[a]Institute of Physics, University of Tsukuba, Tsukuba, Japan
[b]Centre de Physique Théorique, Case 907 Luminy, 13288 Marseille cedex 9, France
[c]Institute of Solid State Physics, University of Tokyo, Kashiwa, Japan
[d]Université de la Méditérannée, 13288 Marseille cedex 9, France

Dynamical response of a mesoscopic capacitor is now attracting a renewed interest from a viewpoint of universal transport phenomena[1]. The mesoscopic capacitor is a quantum analog of a classical RC circuit and exhibits universal quantization of dynamical resistance at low frequency $\omega \ll \tau_{RC}^{-1}$. An intriguing question is how the quantized resistance, often referred to as charge relaxation resistance, is modified by electron-electron interactions, which become prominent as the system size is reduced. Recently we have investigated this issue theoretically and revealed that the behavior of the dynamical resistance is strongly dependent on the nature of an electron reservoir[2]. The dynamical resistance is universally quantized even in the Coulomb blockade regime, as long as interaction in the reservoir is sufficiently weak. If the interaction exceeds a critical point, on the other hand, the dynamical resistance diverges due to the Kosterlitz-Thouless transition. A similar divergent behavior occurs also in a mesoscopic capacitor with a noisy gate voltage coupled to an ohmic bath.

[1]J. Gabelli *et al.*, Science **313**, 499 (2006); G. Fève *et al.*,*ibid* **316**, 1169 (2007).
[2]Y. Hamamoto, T. Jonckheere, T. Kato, and T. Martin, Phys. Rev. B **81**, 153305 (2010).