## Flow diagram of the longitudinal and Hall conductivities in ac regime in the disordered graphene quantum Hall system

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In the physics of graphene with its realization of a massless Dirac system at low energies, dynamical (ac) responses should be interesting. We have recently shown for the graphene integer quantum Hall effect (QHE) that the plateau structure is retained even in the ac Hall conductivity $\sigma_{xy}(\omega)$ in the $\omega \sim$ THz regime although the plateau height deviates from the quantized values in both the massless Dirac model [1] and the original honeycomb lattice [2]. The plateau structure in the ac region is attributed to localization effect, as confirmed quantitatively from a dynamical scaling of the plateau-to-plateau transition width of $\sigma_{xy}(\omega)$ [3]. Here we numerically study both longitudinal and Hall optical conductivities to discuss the scaling flow diagram for $\sigma_{xx}(\omega) - \sigma_{xy}(\omega)$, since the flow diagram in the static case is well-known to beautifully capture QHE as a fixed-point property but has never been examined in the ac regime. The result shows that the *ac flow diagram* is not significantly altered for the small-$\omega$ region. There, a fixed-point behavior emerges as in the dc case, which we interpret in terms of the dynamical scaling analysis. We also discuss the dependence of the flow diagram on the disorder strength.

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