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Why isn't graphene a strongly correlated electron system?[1] P. ABBAMONTE, J.P. REED, B. UCHOA, Y.I. JOE, E. FRADKIN, University of Illinois, D. CASA, Advanced Photon Source — Graphene is usually described as a two-dimensional system of weakly interacting, Dirac fermions. The strength of the interactions is characterized by the so-called "fine structure constant", $\lambda = e^2/\hbar v_F \epsilon$, which if $\epsilon \sim 1$ is ~ 2, indicating the absence of a small parameter for EM interactions and the presence of strong correlations. However, the salient signatures of correlations, such as spectral weight redistribution with doping, are not observed in graphene. To find out why, we used inelastic x-ray scattering to measure the collective excitations in single crystal graphite. Using some new data analysis methods, which "remove" the van der Waals coupling between the layers, we reconstructed the density propagator for graphene, and then determined the dressing around an idealized point charge, e. The dressing is ~ 2 nm in size and renormalizes the charge to $e_{eff} = 0.065e$ greatly suppressing interactions. This suggests that, for length scales > 2 nm, graphene can be thought of as having a "background" dielectric constant $\epsilon = 15.4$, or a fine structure constant $\lambda \sim 0.14$. Our result explains the absence of spectral weight transfer with doping in graphene, the absence of a velocity divergence near E_F, and a number of other effects.

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Peter Abbamonte
University of Illinois

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