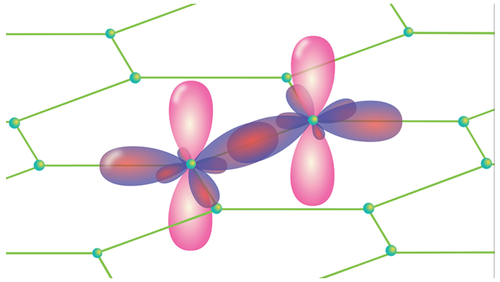
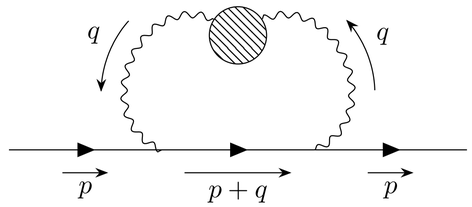
Calculation of the Fermi Velocity renormalization in graphene



$$\hat{H} = -\kappa \sum_{\sigma,\langle x,y\rangle} (\hat{a}^{\dagger}_{\sigma,x}\hat{a}_{\sigma,y} + \text{h.c}) + \tfrac{1}{2}\sum_{x,y} V_{x,y}\hat{q}_x\hat{q}_y$$

Suspended graphene with strong long range Coulomb interactions



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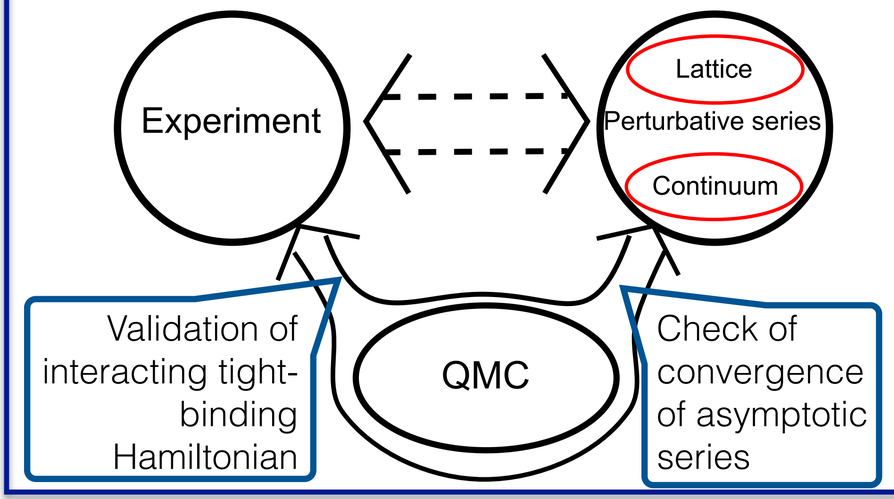
Effective QED in 2+1D with the fine structure constant $\alpha \approx 2$.
Thus free-standing graphene is an ideal playground to test the properties of asymptotic series in strongly-correlated QFT

$$S = \int dt d^2x (i\bar{\psi}_a\gamma^0\partial_0\psi_a + iv_F\bar{\psi}_a\gamma^i\partial_i\psi_a - e\bar{\psi}_a\gamma^0\psi_a A_0) + \tfrac{1}{2}\int dt d^3x (\partial_i A_0)^2$$

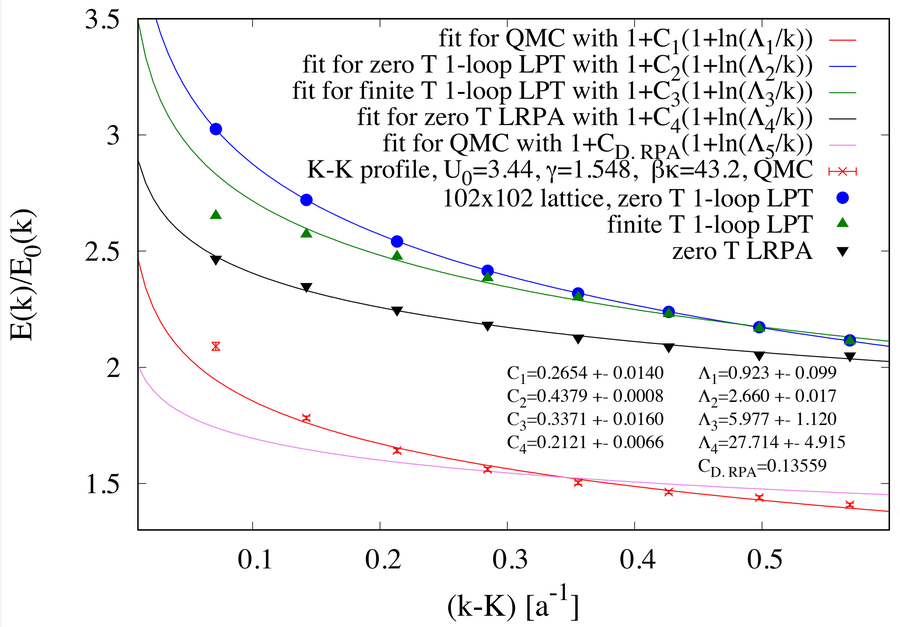
Infrared v_F renormalization: QMC on 102x102 lattice

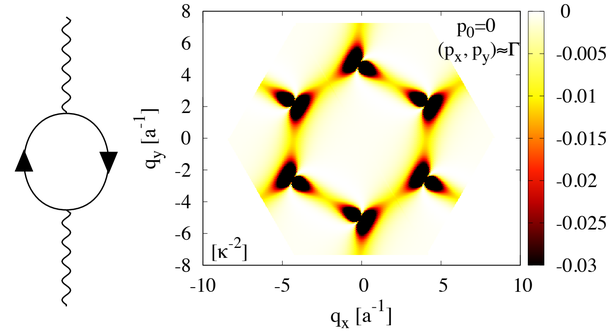
$$v_F(k) = v_{F,0}(1 + C\ln\Lambda/k)$$

$$E(k) = E_0(k)[1 + C(1 + \ln\Lambda/k)]$$



QMC vs Perturbative Series

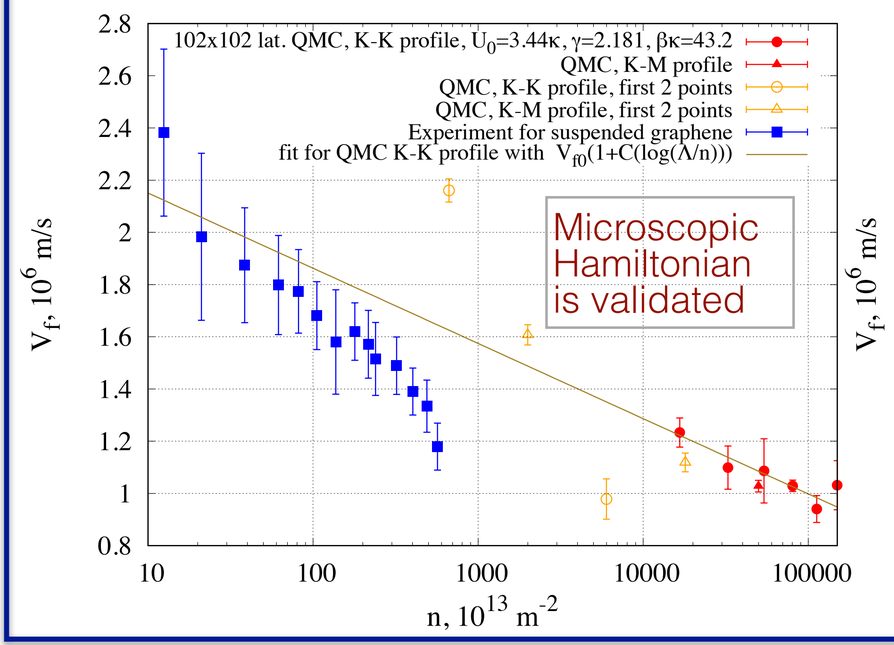


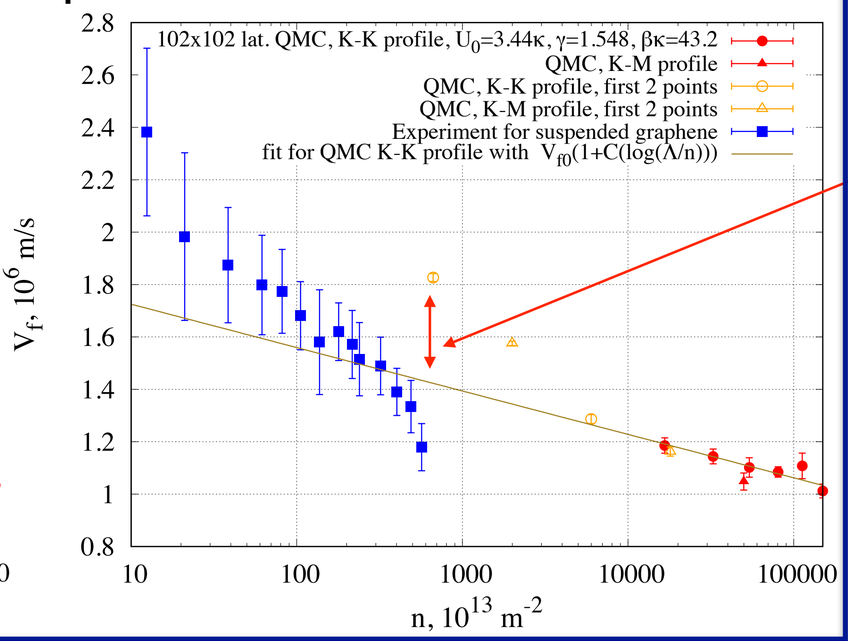


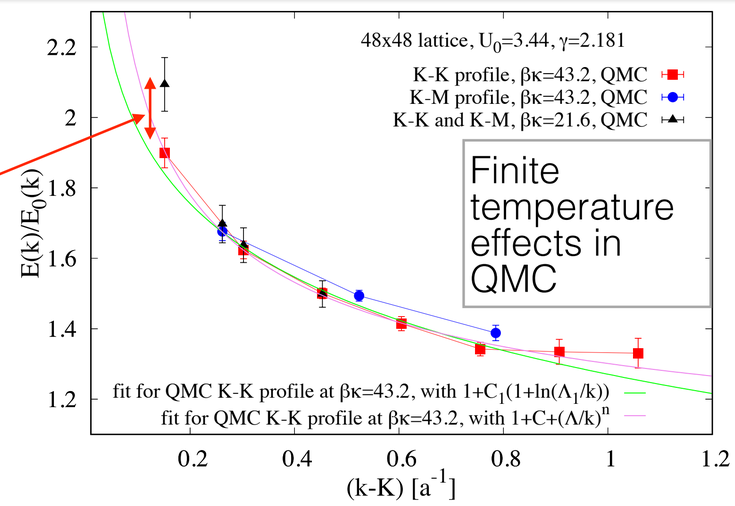
Lattice vs continuum perturbation theory: Lattice-scale physics influences both C and cutoff Λ (inter-valley scattering in the polarization loop)

QMC vs Lattice Perturbation Theory: Higher order corrections beyond RPA level are important

QMC vs Experiment







Prediction for future experiments: deviation of v_F upwards from logarithmic curve (opposite to any perturbative corrections) at very small momenta