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The Hubbard interaction at finite temperature on a Hexagonal lattice

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The temporal finite volume induces significant effects in Monte Carlo simulations of systems in low dimensions. An example is graphene, a 2-D hexagonal system known for its unique electronic properties and numerous potential applications.

In this work, we explore the behavior of fermions on a graphene sheet with a Hubbard-type interaction characterized by coupling U. This system exhibits zero or near zero-energy excitations that are highly sensitive to finite temperature effects. Therefore, accounting for this dependence is essential to obtaining reliable zero-temperature extrapolations. We compute corrections to the self-energy and the effective mass of low-energy excitations, as well as the shift in ground state energy. These analyses are conducted for both zero and finite temperatures. Our findings reveal that the first-order $\mathcal{O}(U)$ contributions are absent, leading to non-trivial corrections starting at $\mathcal{O}(U^2)$. We validate our calculations against numerical results from Hybrid Monte Carlo simulations on small lattices and extrapolate the behavior at low temperatures.

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