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Crossover to the anomalous quantum regime in the extrinsic spin Hall effect of graphene[1] AIRES FERREIRA, University of York, U.K., MIRCO MILLETARI, National University of Singapore — Recent reports of spin-orbit coupling enhancement in chemically modified graphene have opened doors to studies of the spin Hall effect with massless chiral fermions. Here, we theoretically investigate the interaction and impurity density dependence of the extrinsic spin Hall effect in spin-orbit coupled graphene. We present a nonperturbative quantum diagrammatic calculation of the spin Hall response function in the strong-coupling regime that incorporates skew scattering and anomalous impurity density-independent contributions on equal footing. The spin Hall conductivity dependence on Fermi energy and electron-impurity interaction strength reveals the existence of experimentally accessible regions where anomalous quantum processes dominate. Our findings suggest that spin-orbit-coupled graphene is an ideal model system for probing the competition between semiclassical and bona fide quantum scattering mechanisms underlying the spin Hall effect.

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