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Geometric Correlations and Breakdown of Mesoscopic Universality in Spin Transport I. ADAGIDELI, Sabanci University, PH. JACQUOD, University of Arizona, M. SCHEID, University of Regensburg, M. DUCKHEIM, D. LOSS, University of Basel, K. RICHTER, University of Regensburg — Although the spin Hall effect is by now relatively well understood in bulk diffusive systems, an extension of the theory to mesoscopic quantum dots have proven elusive. Because of its underlying geometric structure, average spin Hall conductance is not described by conventional statistical methods that are used to describe charge transport in quantum dots, such as random matrix theory. In this work, we develop a unified semiclassical theory of transport that is capable of describing how charge currents in mesoscopic systems, be they diffusive or ballistic, induce spin currents and vice versa. Using this theory, we show that, while the charge transport is universal in spin-orbit coupled quantum dots, the geometrical spin correlations break the universality and generate finite average spin conductances. Our results on spin conductance extend beyond the well-known diffusive limit to the strong spin-orbit regime (i.e. when the spin rotation time is shorter than the momentum relaxation time), for which there have been no previously available analytical results.

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