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Focusing of electrons and holes in semiconductors: from semi-classical dynamics to spintronics

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The dynamics of charge carriers in spin-orbit coupled systems is a vital area of investigation for the extremely active field of spintronics. Controlling and manipulating the flow of electrons and holes serves as the foundation of an entire class of spintronic devices, most notably the Datta-Das spin transistor \cite{Datta1990}. In this talk, I give an overview of the dynamics of charge carriers in such semiconductor systems, subject to external fields, in the context of magnetic focusing experiments. This experimental technique involves the coherent focusing of charge carriers over a scale of micrometers by a weak magnetic field, from an injector to a collector quantum point contact (QPC) \cite{Vanhouten1989, Rokhinson2004}. I will present a detailed semi-classical theory for the focusing of both electrons and holes for general spin orbit interactions, and show that for the experimentally interesting case of polarization inducing in-plane magnetic fields, a significant change in the magnetic focusing spectrum is possible.

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