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Controlled coupling of spin-resolved quantum Hall edge states

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Spin resolved edge states in quantum Hall systems at filling fraction $\nu = 2$ posses large coherence [1] and relaxation [2] lengths. They are ideal candidates for the implementation of dual-rail quantum computation architectures [3] by encoding the qubit in the spin degree of freedom of the co-propagating spin resolved edge states. An important element for realization of such architectures is a coherent beam splitter that controllably mixes the two co-propagating spin-resolved edge channels to create any superposition of the two logic states. In this talk we demonstrate a new method to controllably couple spin resolved edge states and induce inter-edge charge transfer associated to spin-flip scattering events [4]. The process exploits the coupling of the electron spin with a spatially-dependent periodic in-plane magnetic field that is created by an array of Cobalt nano-magnets placed at the boundary of the GaAs/AlGaAs modulation doped heterostructure. The maximum charge/spin transfer of 28 ± 1 % is achieved at 250 mK by fine tuning the perpendicular magnetic field. These results are key steps towards the realization of a scalable quantum interferometric device currently under investigation in our group.

[1] Y. Ji et al. Nature 422 (2003) 415.
[2] G. Muller et al. Phy. Rev. B 45 (1992) 3932.
[3] V. Giovannetti et al., *Phys. Rev. B* 77 (2008) 155320.
[4] B. Karmakar et al., (accepted in PRL).

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