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Near-field interaction between domain walls in adjacent permalloy nanowires

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A domain wall (DW) moving in a ferromagnetic nanowire may interact with the stray field from another DW travelling in an adjacent wire. This could greatly impact the operation of proposed DW based data storage schemes which rely on the controlled propagation of DWs in densely packed nanowires [1, 2]. Here we experimentally study the interaction between two DWs travelling in adjacent Permalloy nanowires [3]. We find that the interaction causes significant pinning, with measured pinning fields of up to 93 Oe ($\sim$5 times the intrinsic pinning field of an isolated wire) for the smallest separations. We present an analysis of the observed pinning field dependence on wire separation in terms of the full magnetostatic charge distribution within a DW. By considering an isolated DW, and accounting for finite temperature, it is possible to fully reproduce the experimentally observed dependence. This suggests that the DW internal structure is not appreciably perturbed by the interaction and so remains rigid, consistent with a finite sized quasi-particle description [4]. The full charge distribution must be considered in understanding these near-field interactions as other models based on simpler descriptions of the charge distribution within the DW, including a point-like distribution, cannot reproduce the observed dependence. Finally, we develop the idea of using localized stray fields to pin a DW and show how specific potential landscapes can be created by tailoring a pinning charge distribution, with the added advantage that neither DW internal structure nor nanowire geometry is appreciably perturbed.

[1] Allwood, Cowburn et al. Science **309**, 1688 (2005)
[2] S. S. Parkin, Science **320**, 190 (2008)
[3] O'Brien, Cowburn et al. Phys. Rev. Lett. **103**, 7, 077206 (2009)
[4] Saitoh, Miyajima et al. Nature **432**, 203 (2004)