

# Micromagnetic approach to exchange bias

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We present a micromagnetic approach to the exchange bias (EB) in ferromagnetic (FM)/antiferromagnetic (AFM) thin film systems with a small number of irreversible interfacial magnetic spins. We express the exchange bias field  $H_{EB}$  in terms of the fundamental micromagnetic length scale – the exchange length  $l_{ex}$ . The benefit from the proposed approach is a better separation of the factor related to the FM from the factor related to the FM/AFM coupling at interfaces. The model identifies the range of  $H_{EB}$  (and interfacial exchange coupling energy  $J_{EB}$ ) compatible with those observed in experiment. Using the model, we proved that the highest effective number of irreversible spins is lower than  $\sim 30\text{--}40\%$ .