

Using Landau Zener tunneling to overcome the trilemma of magnetic data recording

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The principal goal in the miniaturization of magnetic bits down to the fundamental limits of single molecules and atoms is maximizing their magnetic anisotropy energies (MAE) for high temperature stability. However, the high MAE compounds or distracts from the equally important question of how to write to microscopic bits. Holmium single atom magnets are an example of this trend. They exhibit excellent magnetic bistability and high coercivity, but their writing required the use of high energy electrons incompatible with actual data storage device architectures. Here we use the magnetic stray field created by the tip of a spin-polarized scanning tunneling microscope (SP-STM) to controllably move the Ho state into the quantum regime, allowing us to modify its state via the quantum tunneling of magnetization (QTM). The hyperfine interaction causes both the excellent magnetic bistability, even at zero applied magnetic field, and the avoided level crossings which we use to control the magnetic state via QTM. We finally introduce a high-fidelity single atom NOT gate (inverter). Our example highlights the prospect of combining the best traits of the classical and quantum worlds for next generation data storage.