# Reversible ionic control of antiferromagnetic anisotropy

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Antiferromagnets (AFMs) are a ubiquitous class of magnetic materials, holding the promise of low-dissipation spintronic computing devices that can display ultra-fast switching, density scaling and robustness against stray fields[1]. However, magnetic sublattice compensation makes it difficult to detect and control AFM textures in a reversible and scalable manner via standard techniques[2].

We overcame this limitation by developing a novel ionic approach to reversibly tailor AFM anisotropy[3]. We focussed on the earth-abundunt AFM $\alpha$-$Fe_2O_3$, which exhibits a spin-reorientation (Morin) transition between in-plane and out-of-plane configurations. Developing reversible control of AFM anisotropy in $\alpha$-$Fe_2O_3$ is important for prospects in (i) topological spintronics[4,5] and (ii) magnonics[6,7]. Regarding the former, I will discuss our recent results where the Morin transition was exploited to stabilize a wide family of exotic AFM topological textures - half-skyrmions and bimerons - at room temperature. These topological textures have core sizes (of $\approx$ 100 nm) and can be scaled further with anisotropy tuning[4].

In this context, I will discuss our findings on ionic control of antiferromagnetism in epitaxial $\alpha$-$Fe_2O_3$ films[3]. The catalytic-spillover process employs Pt nano-structures to hydrogenate the AFM films, thereby, driving pronounced changes in the anisotropy, Néel vector orientation and canted magnetism via local charge-doping. As H ions are very small and light, they can be added/removed from the host lattice, without significantly disturbing the overall structure. This allows our approach to be stable yet reversible[3]. Tailoring our work for future applications, we demonstrated reversible control of the room-temperature AFM-state by doping/expelling H ions in Rh-substituted $\alpha$-$Fe_2O_3$. I will conclude by presenting the wider implications of our work, such as how AFM-state control could eventually be realized with E-fields[8] and translated to a wider variety of AFMs (e.g. orthoferrites, orthochromites)[9], enabling the construction of low-energy antiferromagnetic applications.

**References:**

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