Structure-property relations in a correlated quasi-2D ferromagnet

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Correlations lead to novel ground states, including magnetic order, nematicity, density wave orders and unconventional superconductivity. To be able to describe these phenomena requires understanding the subtle interplay of electronic and structural degrees of freedom. In magnetic materials, magnetic interactions couple to lattice degrees of freedom resulting in magnetoelastic coupling – an effect that is typically small and only detectable on macroscopic samples.
I will demonstrate that – to a very good approximation – magnetism in $Sr_4Ru_3O_{10}$ behaves as if it was a 2D ferromagnet. To study its magnetic properties at the atomic scale, we establish that Van Hove singularities [1] in the electronic structure can be used as probes of the magnetism. We detect these in low temperature scanning tunneling microscopy, and establish control of the magnetism in the surface layer. We use this control to probe the impact of the magnetism on its electronic and structural properties. Through the control of the magnetism and from comparison with DFT calculations, we determine the consequences of the exchange force on the relaxation of the surface layer, and find a giant magnetostriction. Our results provide a direct measurement of the impact of exchange interactions and correlations on structural details and reveal how electronic correlations result in strong electron-lattice coupling. They establish $Sr_4Ru_3O_{10}$ as a model system to study magnetism in 2D.
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References

1. C.A. Marques *et al.*, *Spin-orbit coupling induced Van Hove singularity in proximity to a Lifshitz transition in $Sr_4Ru_3O_{10}$*, npj Quantum Materials 9, 35 (2024).