Three-dimensional flat band in ultra-thin Kagome metal, Mn_3Sn

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Flat bands (FBs) can give rise to strongly correlated electronic and topological phases because of their narrow energy dispersion, especially when located at the Fermi level. Whilst FBs have been experimentally realized in two-dimensional (2D) twisted van der Waals heterostructures, they are highly sensitive to twist angle, necessitating complex fabrication techniques. Geometrically frustrated lattices, such as the kagome lattice, have emerged as an attractive platform as they can natively host FBs due to destructive interference. While FBs have been observed in bulk Kagome metals, an outstanding experimental question is whether flat bands can be realized in the atomically-thin regime, with opportunities for stronger electron-electron interactions and the emergence of nontrivial topological phases.

Here we use angle-resolved photoelectron spectroscopy (ARPES), scanning tunnelling microscopy and band structure calculations to show that ultra-thin films of the kagome metal Mn_3Sn host a robust, dispersionless flat band with a bandwidth below 150 meV[1]. Furthermore, we demonstrate chemical tuning of the flat band to near the Fermi level via manganese defect engineering. The realization of tunable kagome-derived flat bands in an ultra-thin kagome metal, represents a promising platform to study strongly correlated and topological phenomena, with potential applications in quantum computing, spintronics and low-energy electronics.

Keywords: Kagome metal, Mn3Sn, flat band, ultra-thin film, strong correlation

[1]J. Blyth, M. Zhao, G. L. Causer, *et. al.* S., "*Three-dimensional flat band in ultra-thin Kagome metal Mn_3Sn film*", arXiv: 503.05544 (2025).

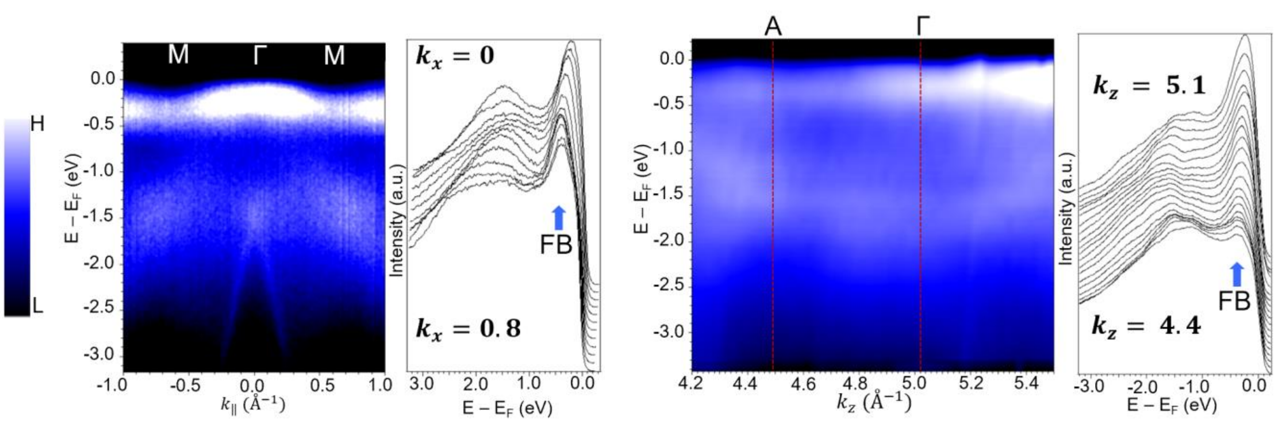

Figure 1. Observation of 3D flat band in Mn_3Sn ultra-thin films. (left panel) ARPES spectrum taken at hv = 104 eV along the ΓM direction. A high intensity band at ~ -300 meV persists across the entire momentum space with minimal dispersion (<150 meV) as shown in the single energy-distribution cuts. (right panel) out-of-plane (k_z) dispersion of the flat band extracted from photon-energy-dependent measurements where the variation in the flat band maximum is below 100 meV, indicating it is a 3D flat band.