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

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Flat bands with narrow energy dispersion can give rise to strongly correlated electronic and topological phases, especially when located at the Fermi level. Whilst flat bands 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 kagome lattices have emerged as an attractive alternative platform as they can natively host flat bands which have been observed experimentally in quasi-2D bulk-crystal kagome metals. An outstanding experimental question is whether flat bands can be realized in ultra-thin metals, with opportunities for stronger electron-electron interactions through tuning of the surrounding dielectric environment. Here we use angle-resolved photoelectron spectroscopy, 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 of 50 meV. 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 applications in quantum computing, spintronics and low-energy electronics.

Author: Dr ZHAO, Mengting (Monash University)

Co-authors: TADICH, Anton (Australian Synchrotron); CAUSER, Grace L. (Monash University); ZHANG, Hongrun (School of Physics, Beihang University); Mr BLYTH, James (Monash University); LIU, Jiayu (Shanghai Synchrotron Radiation Facility); YE, Mao (Shanghai Synchrotron Radiation Facility); EDMONDS, Mark T. (Monash University); FUHRER, Michael S. (Monash University); BHUIYAN, Mohammad T. H. Bhuiyan (Monash University); YU, Tianye (Shenyang National Laboratory for Materials Science, Institute of Metal Research, Chinese Academy of Sciences); JING, Wenchuan (Shanghai Synchrotron Radiation Facility); DU, Yi (School of Physics, Beihang University); LIU, Zheng-Tai (Shanghai Synchrotron Radiation Facility); YIN, Zhiping (Beijing Normal University)

Presenter: Dr ZHAO, Mengting (Monash University)

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