Unveiling the Orbital Density Waves in MnP

MnP is the first and only Mn-based superconductor, with T_C ~ 1 K under pressure (P_C ~ 8 GPa) [1]. At ambient pressure, MnP undergoes a ferromagnetic transition at 290 K, then a second transition to a double helical state at 50 K. The superconductivity in MnP is close to magnetic ordering, similar to the phase diagram in cuprate and iron based superconductors, strongly suggesting unconventional pairing mechanism. However, MnP is rather special in its low lattice symmetry and helical magnetic ground states, making it a novel playground to study the interplay between spin, orbital, and superconductivity in strongly correlated systems. The related information are critical to understand the occurrence of unconventional superconductivity [2].

Recently, by using the resonant soft x-ray scattering (RSXS) technique provided by Beam Line 13-3 at the Stanford Synchrotron Radiation Lightsource (SSRL) and the REIXS beam line at the Canadian Light Source (CLS), Pan *et al.* have revealed novel orbital density waves (ODWs) accompanying the helical spin order in MnP, as illustrated in Figure 1. One ODW in MnP has half the period of its spin order. The ODW and helical spin order further produce another new ODW with 1/3 the period of the spin order. The intertwining behaviors of orbital and spin orders were investigated at high detail and several interesting facts are revealed. For example, the ODWs start to develop at a higher temperature than the spin order, although they are likely driven by the spin degree of freedom. Moreover, the ODW domains are smaller than the spin domains. These findings reveal interesting intertwined behaviors of spin and orbital orders in a strongly correlated system with low lattice symmetry, and suggest that both spin and orbital degrees of freedom may participate in the superconductivity of MnP.

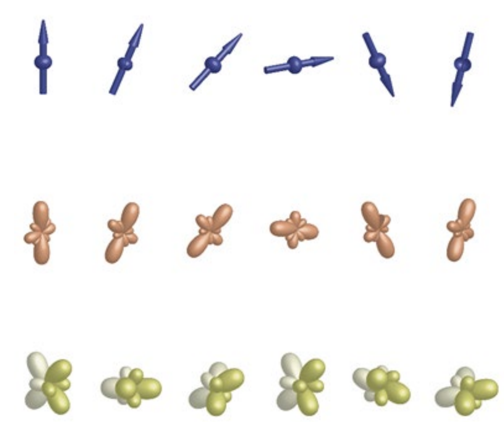

Figure 1. The helical spin density wave with a period of about 8.6*c* is shown with Mn ions with equal spacing in the *c* direction.

Reference

[1] J.-G. Cheng *et al.,* Pressure Induced Superconductivity on the Border of Magnetic Order in MnP, *Phys. Rev. Lett.* **114**, 117001 (2015)

[2] M. R. Norman, Superconductivity with a Twist, *Physics* **8**, 24 (2015)

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