

Giant-exchange-driven Vectorial Control of a Minimal Topological Magnet in $\text{Eu}_3\text{In}_2\text{As}_4$



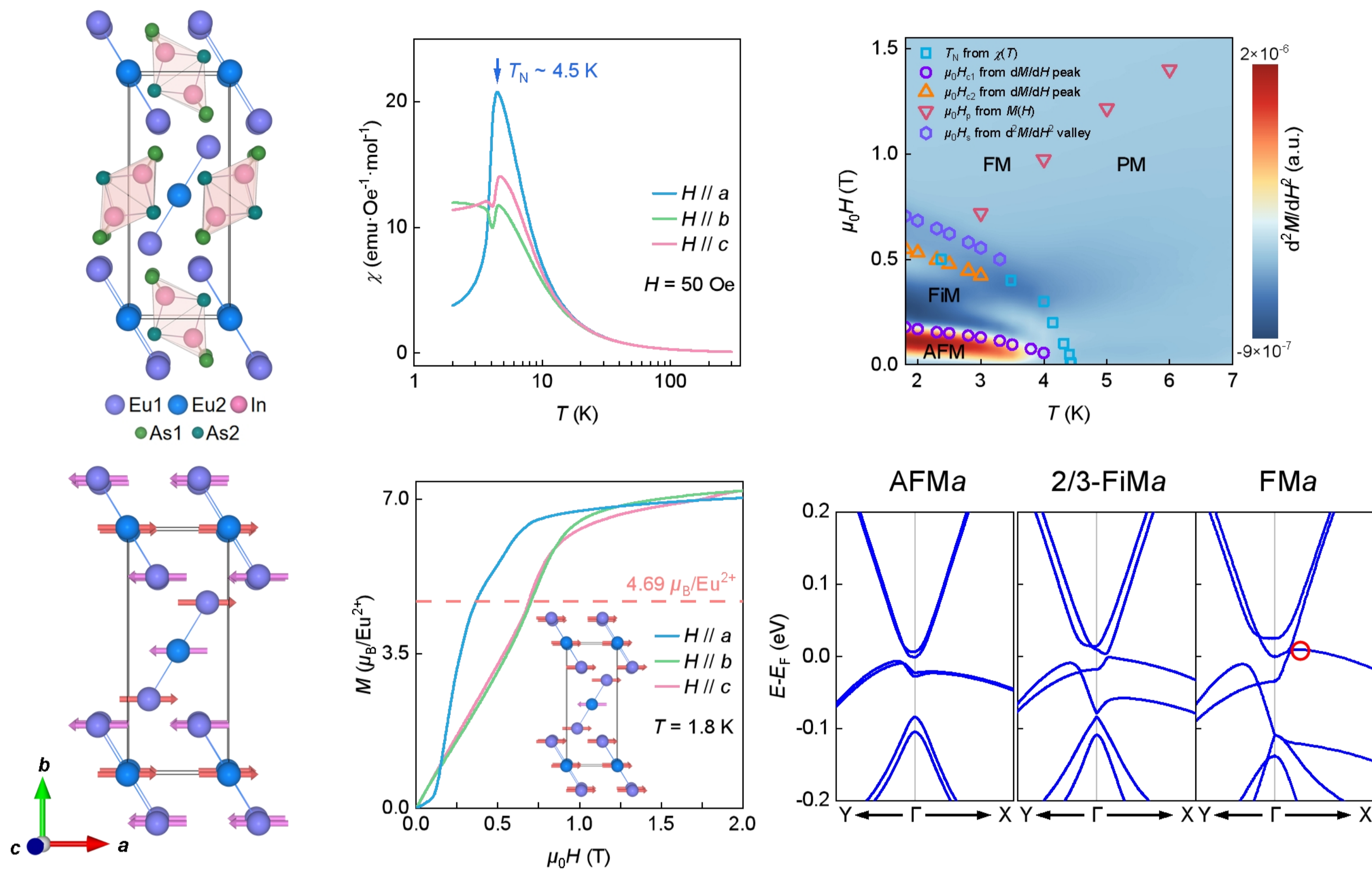
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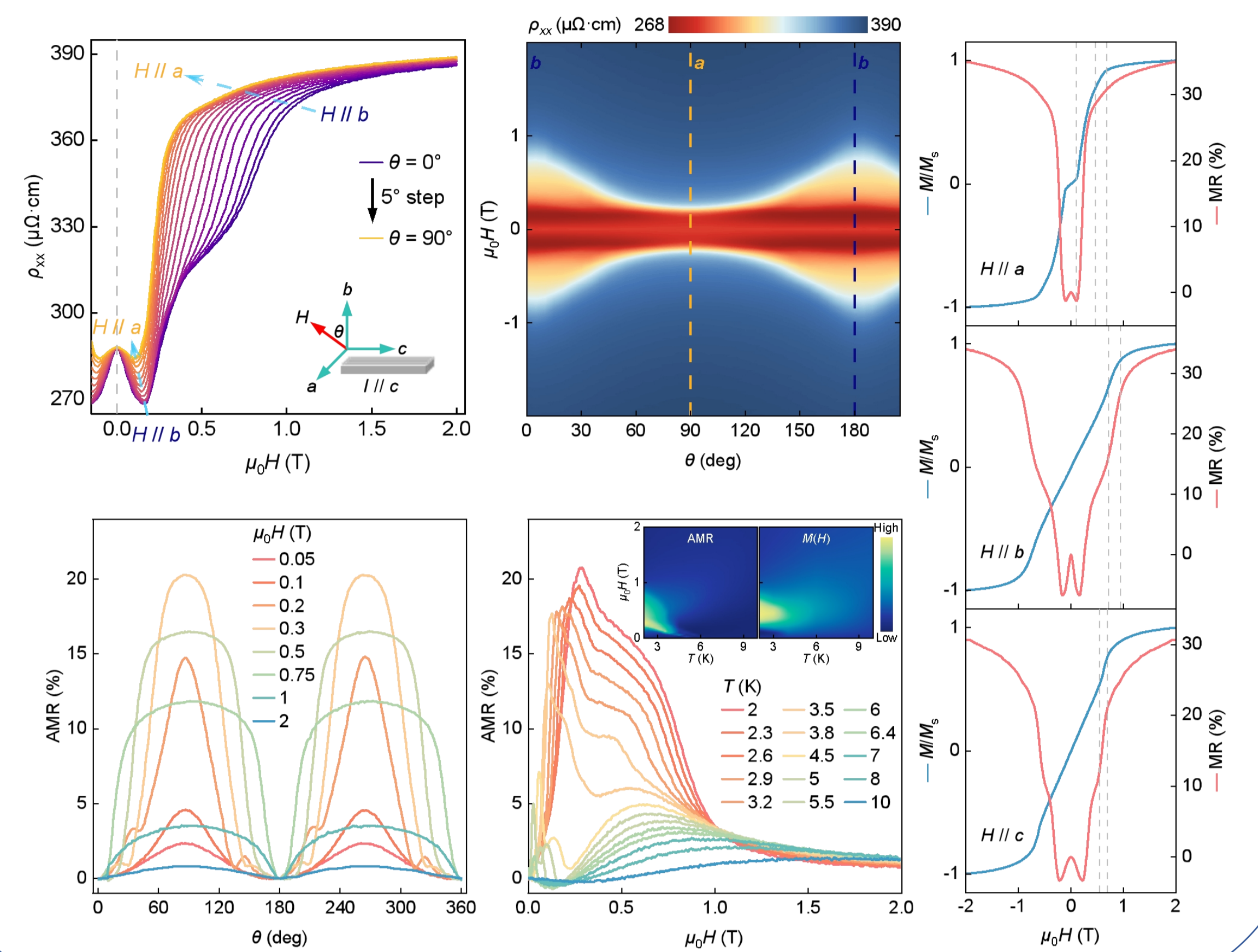
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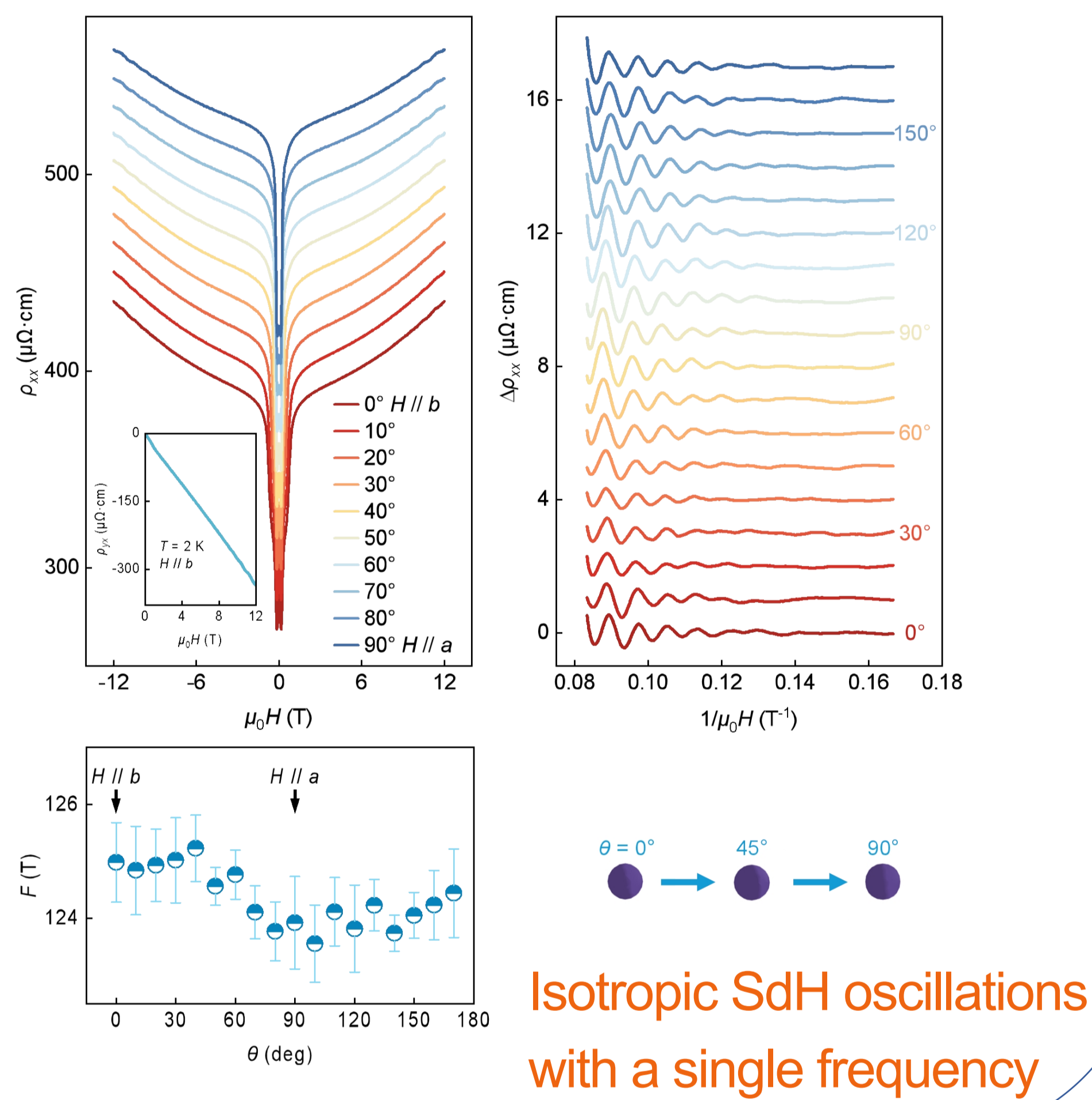
Diverse Magnetic and Topological phases in $\text{Eu}_3\text{In}_2\text{As}_4$



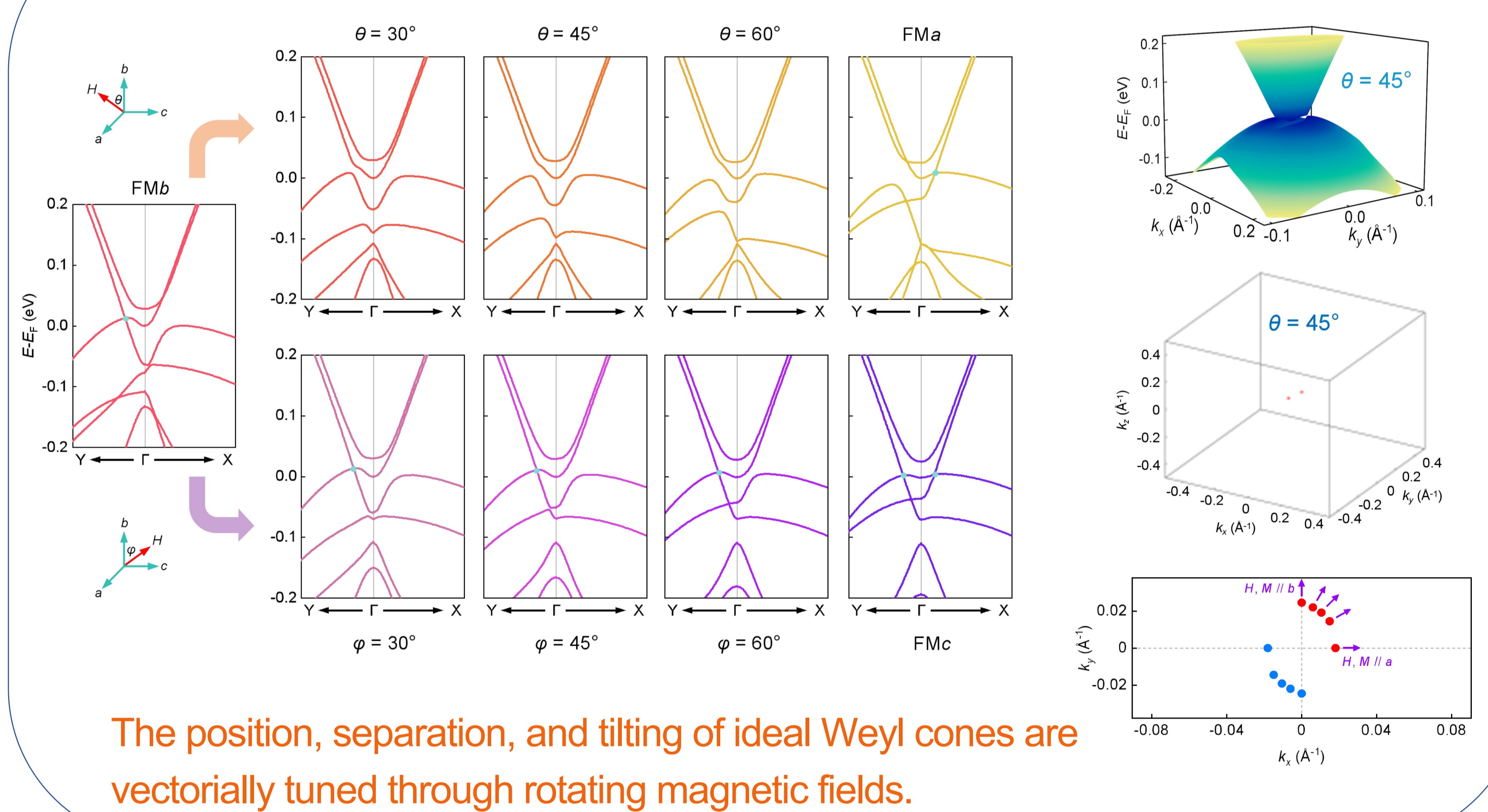
Anisotropic Magneto-transport



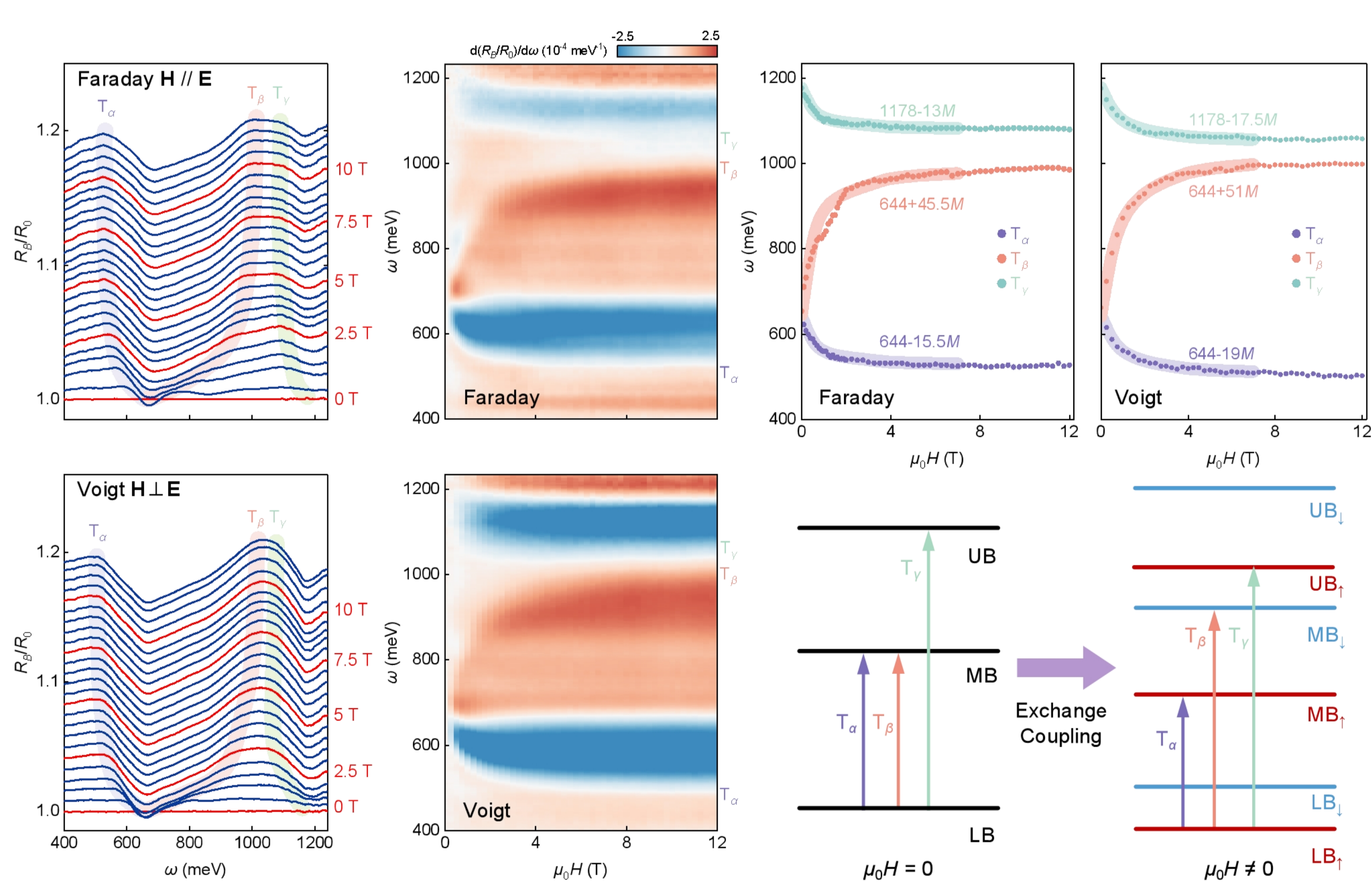
SdH oscillations in FM- $\text{Eu}_3\text{In}_2\text{As}_4$



Vectorial Control of the Minimal Weyl Mode in $\text{Eu}_3\text{In}_2\text{As}_4$



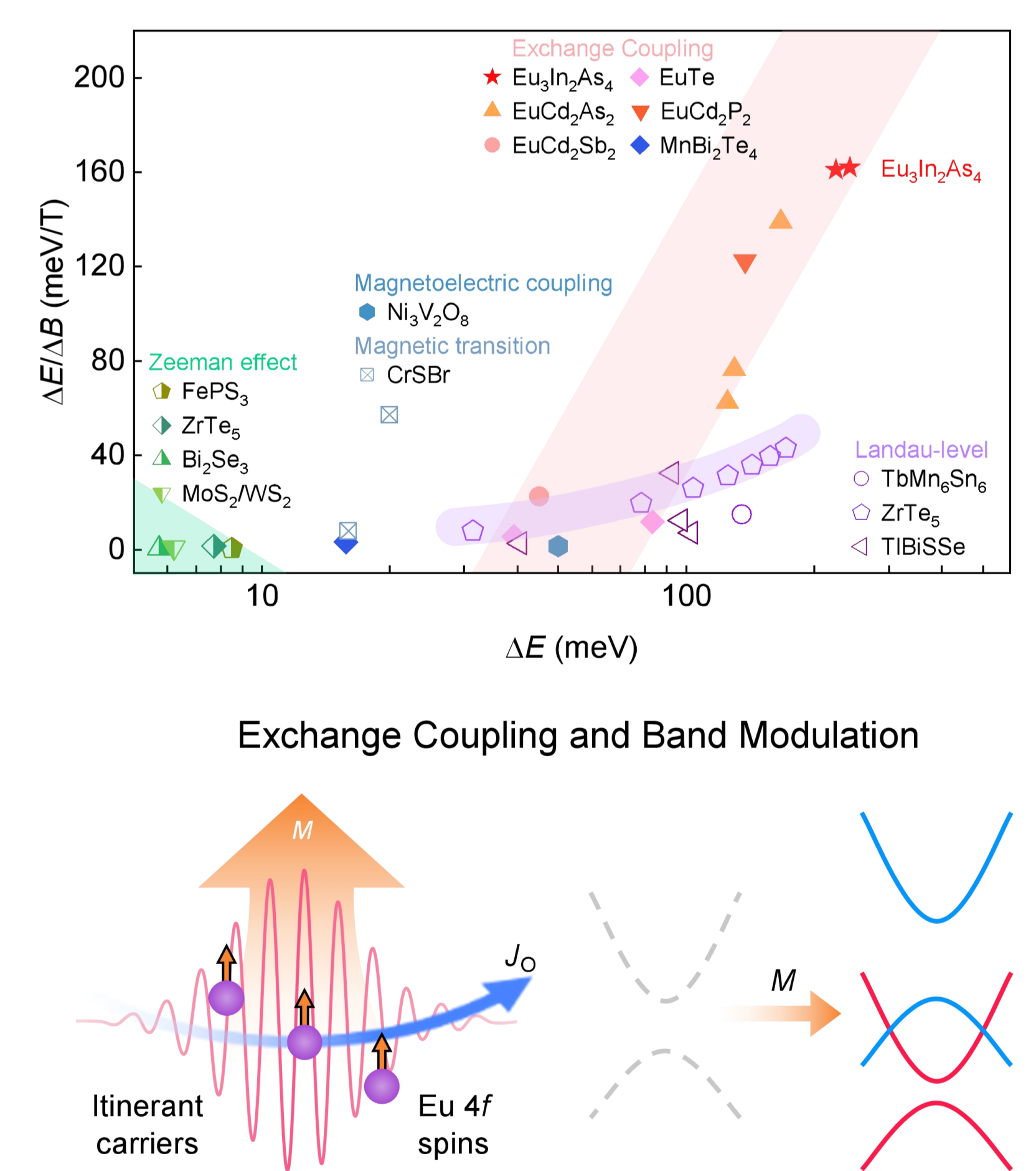
Exchange-driven Band Modulation under Magnetic Fields



The observed energy shifts with M -dependence in magneto-infrared spectrum provide direct evidence for strong exchange couplings.

$$\Delta E = E(B) - E_0 = -\frac{1}{2} J_{\text{eff}} S M(T, B) / M_{\text{sat}}$$

Giant Exchange Coupling



Band splitting/shift and Weyl crossing through strong exchange coupling between Eu^{2+} 4f spins and carriers.

Conclusion

- $\text{Eu}_3\text{In}_2\text{As}_4$ emerges as a uniquely efficient and versatile platform for exploring exchange-driven band engineering and magnetic topological phases, combining large band tunability, high carrier mobility, and exceptional magnetic controllability.
- The exchange-driven band modulation is directly visualized by large, magnetization-dependent optical-transition energy shifts, reaching ~ 300 meV within 3 T. Together with its intrinsically soft magnetism, this strong coupling enables systematic tuning of topological phases by both the magnitude and orientation of magnetic fields. The magneto-topological phase diagram is mapped out in which an antiferromagnetic topological insulator ground state evolves, under modest fields, into a 2/3-ferrimagnetic phase with axion-insulator characteristics, and further into ferromagnetic states realizing either Weyl or nodal-ring semimetals.
- The exchange-driven Weyl phase corresponds to a minimal model hosting a single pair of Weyl nodes. Rotation of the magnetization provides an efficient means to tune the momentum-space positions and separations of the Weyl nodes.