Dynamic Signatures of Spin-Lattice Coupling in the Layered Ferrimagnet $Mn_3Si_2Te_6$

Scientific Achievement

Ultrafast optical spectroscopy and theoretical modeling reveal strong spin-lattice coupling in the van der Waals (vdW) ferrimagnet $Mn_3Si_2Te_6$.

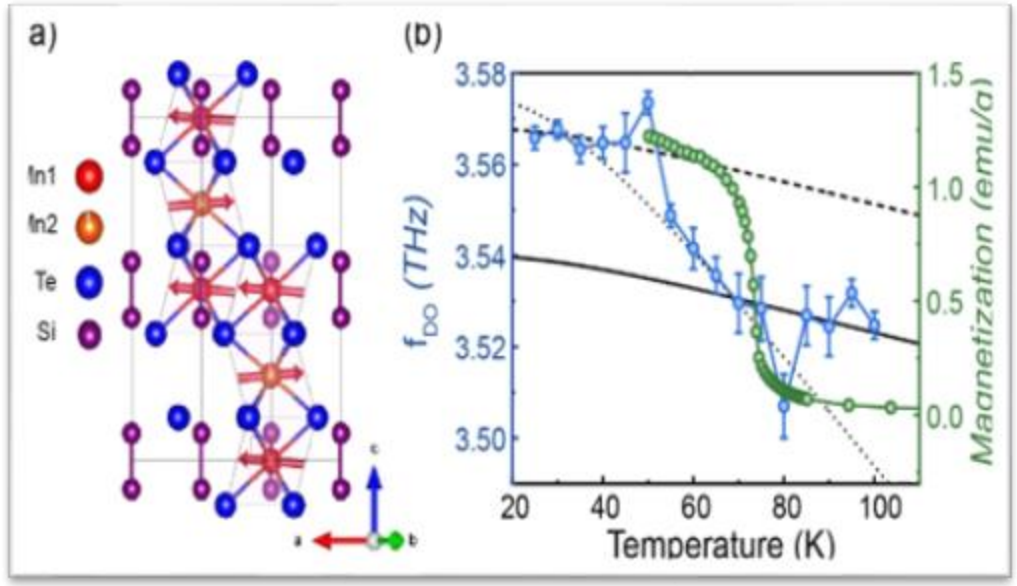

Figure: $Mn_3Si_2Te_6$ is a self-intercalated vdW ferrimagnet (a). Through ultrafast pump probe spectroscopy, a coherent phonon mode was observed whose damped oscillatory frequency (f_{DO}) shifts when measuring through its magnetic phase transition (T_C) (blue dots and lines) (b). This behavior mimics that of the temperature-dependent magnetization (green dots and lines) and behaves contrary to the anharmonic model (dotted, dash, and solid black lines).

Significance and Impact

Demonstrated that magnetic order can dynamically modulate lattice vibrations, providing a feasible route for dynamic control via a material's entangled degrees of freedom.

Research Details

- Ultrafast pump–probe spectroscopy was employed to investigate the coupled dynamics of electrons, lattice vibrations, and spins in $Mn_3Si_2Te_6$.
- An augmented two-temperature model revealed temperature-dependent electronic relaxation times, linked to the activation of spin-mediated scattering channels across its T_C.

Martinez, L. M.; Liu, Y.; Petrovic, C.; Haldar, S.; Griepe, T.; Atxitia, U.; Campbell, M.; Pettes, M. T.; Prasankumar, R. P.; Santos, E. J.; Singamaneni, S. R.; Padmanabhan, P. Dynamic Signatures of Spin-Lattice Coupling in the Layered Ferrimagnet Mn3si2te6. *npj Spintronics.* 2025.

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