Grow the Future of Magnetism: Building Altermagnetic Crystals Atom by Atom

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Ever wondered how new magnetic materials are created—literally from the atoms up? In this project, you'll explore altermagnetism — a recently discovered form of magnetic order that joins ferromagnetism and antiferromagnetism as the third fundamental type of magnetism [1]. These materials show surprising effects driven by crystal symmetry [2], and they're quickly becoming a hot topic in spintronics research [3].

You'll work with magnetron sputtering, a plasma-based technique that deposits atoms onto a single-crystal substrate to grow epitaxial thin films — meaning the film grows in perfect alignment with the crystal beneath it. Achieving this level of order is key to revealing the exotic properties of altermagnets, and thin films offer the most promising route toward real-world applications.

Depending on your interests, the project can expand into structural and functional characterization of the grown films using: X-ray diffraction to study crystal structure, Magnetotransport measurements to probe electronic behavior, or Electron microscopy to visualize atomic order.

Basic programming skills are helpful, as many growth and measurement systems are computer-controlled and automated.

If you're excited by hands-on lab work, cutting-edge materials, and fundamental physics with real-world potential, this project is a great entry point into modern condensed matter research. The project can also be extended into a bachelor or master thesis for motivated students.

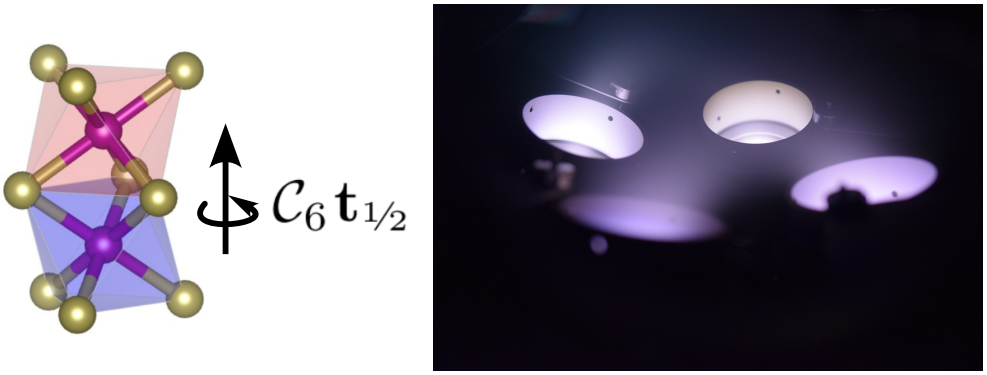

Figure 1: (left) Sketch of the unit cell of an altermagnetic material. (right) Photo of plasma in a magnetron sputter deposition system.

References

[1] Šmejkal, Libor, Jairo Sinova, and Tomas Jungwirth. *Physical Review X* **12**, 040501 (2024).

[2] Gonzalez Betancourt, R. D., et al. *Physical Review Letters* **130**, 036702 (2023).

[3] Krempaský, Juraj, et al. *Nature* **626**, 517 (2024).