

Epitaxial design of thin-film quantum materials and interfaces

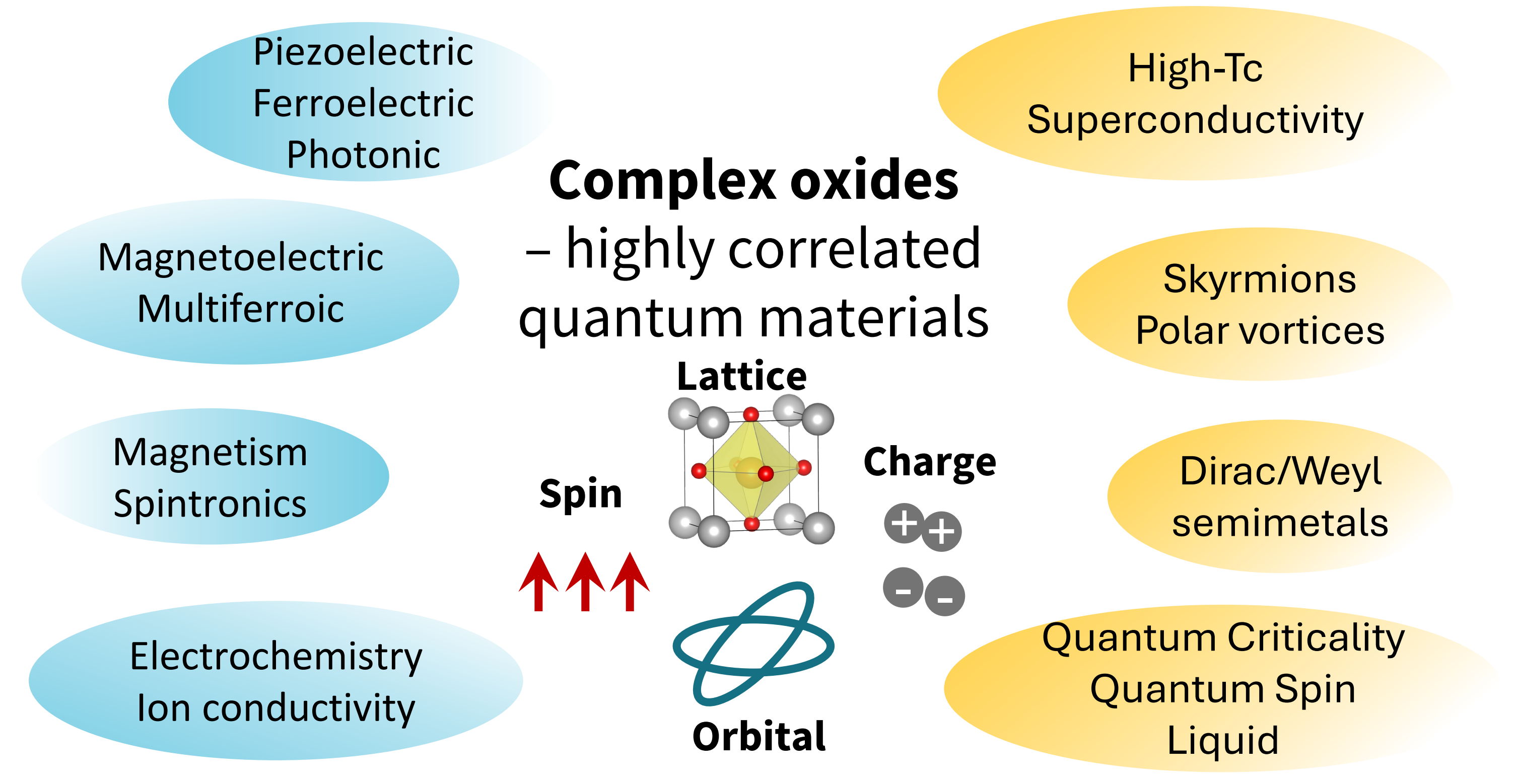
Motivation – Exploring novel physics in thin films of multifunctional materials

Thin films can display fundamentally different physics than bulk materials:

- Constrained dimensions → quasi-2D systems
- Surface and interface properties dominate over bulk properties
- Possibility to access completely new or metastable phases

Thin-films are “device-ready”:

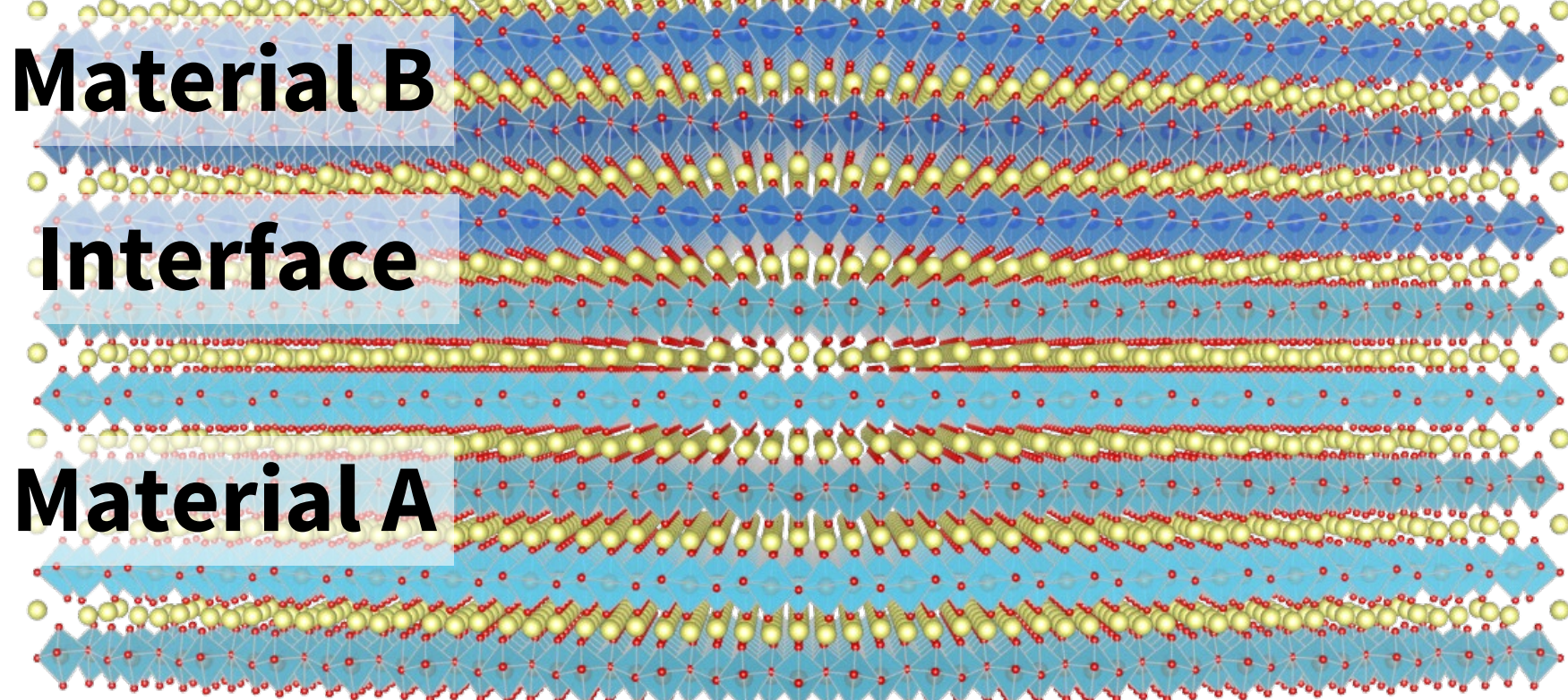
- Possibility to integrate with established technology
- Creation of functional surfaces and interfaces



Pulsed laser deposition – enabling monolayer control of epitaxial heterostructures

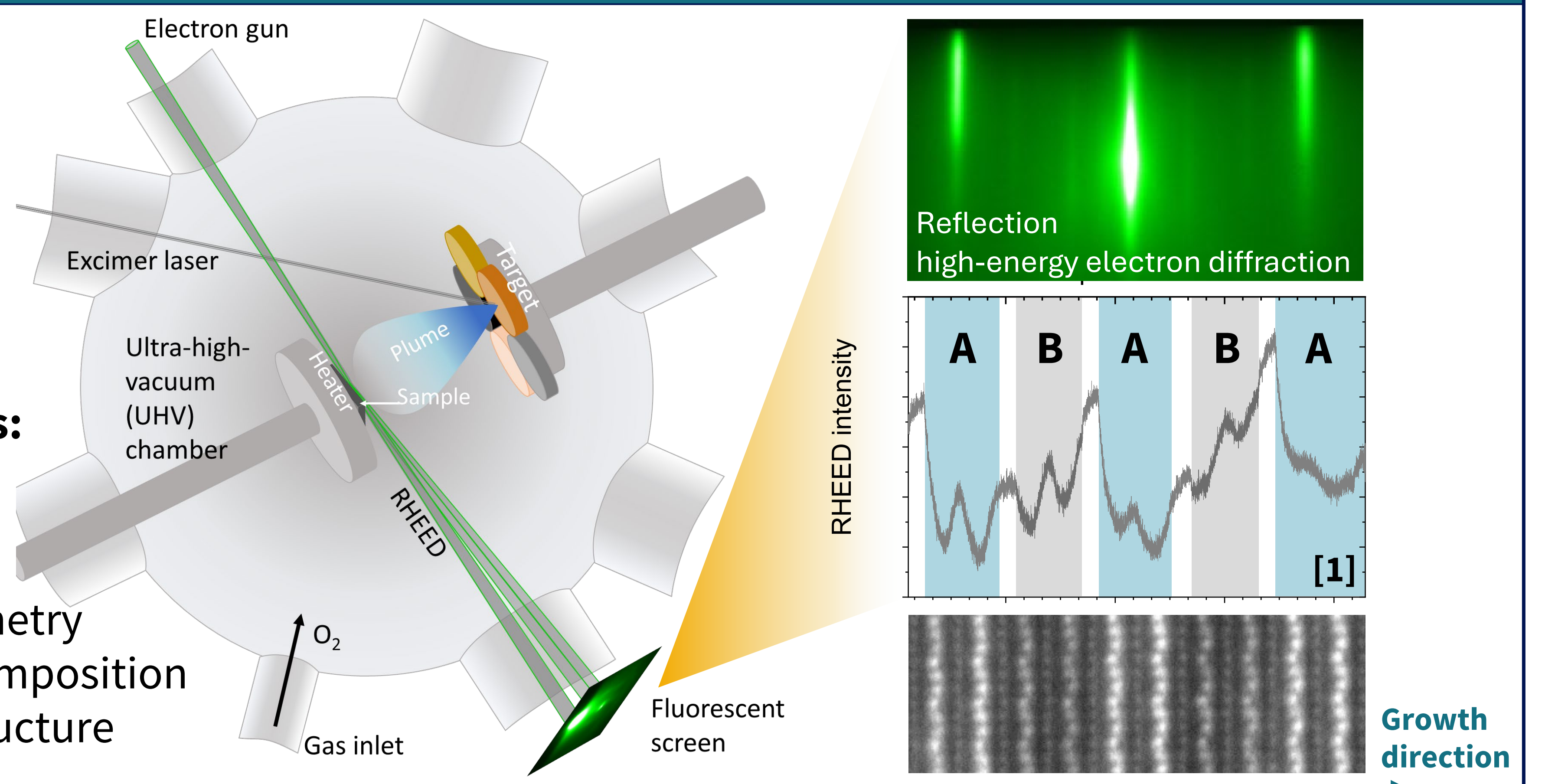
What is epitaxy?

The coherent growth of a crystalline layer of one material, with a specific orientation and structure, on top of a crystalline substrate (often of another material)



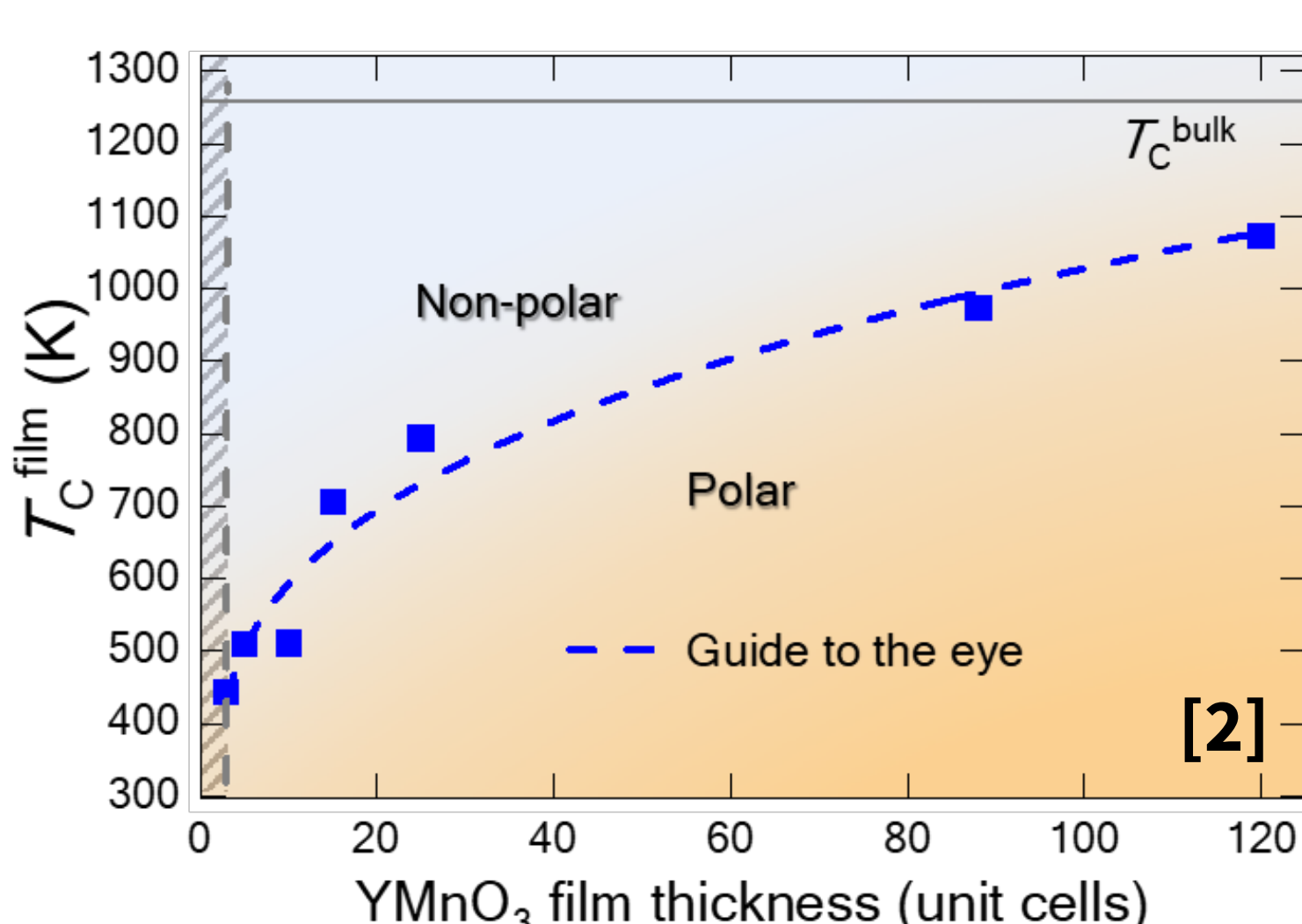
Epitaxial tuning knobs:

- Thickness
- Strain
- Lattice geometry
- Chemical composition
- Interface structure
- ...and more



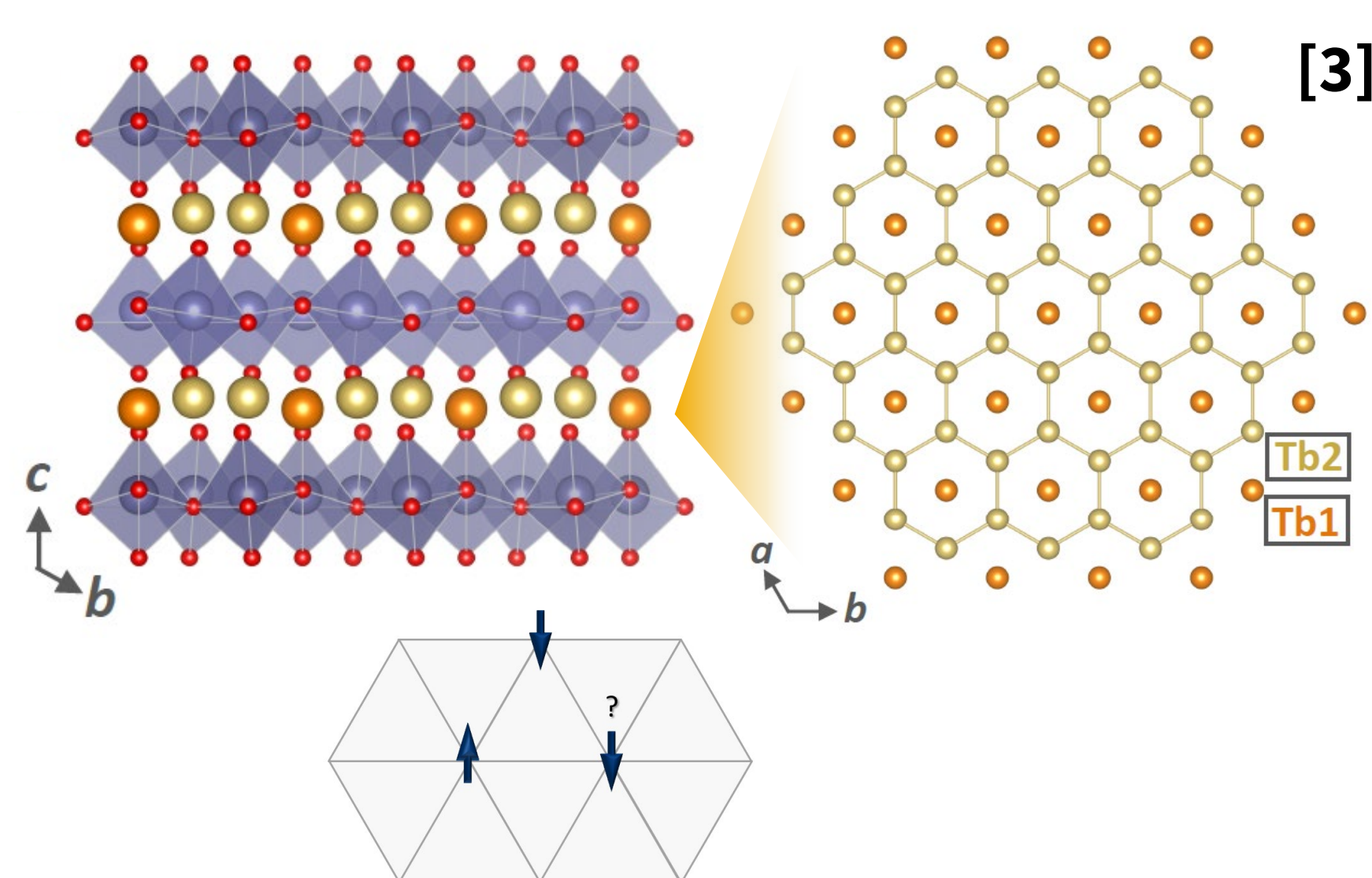
Physical phenomena in nanoscale epitaxial layers

Ultrathin limit of bulk properties



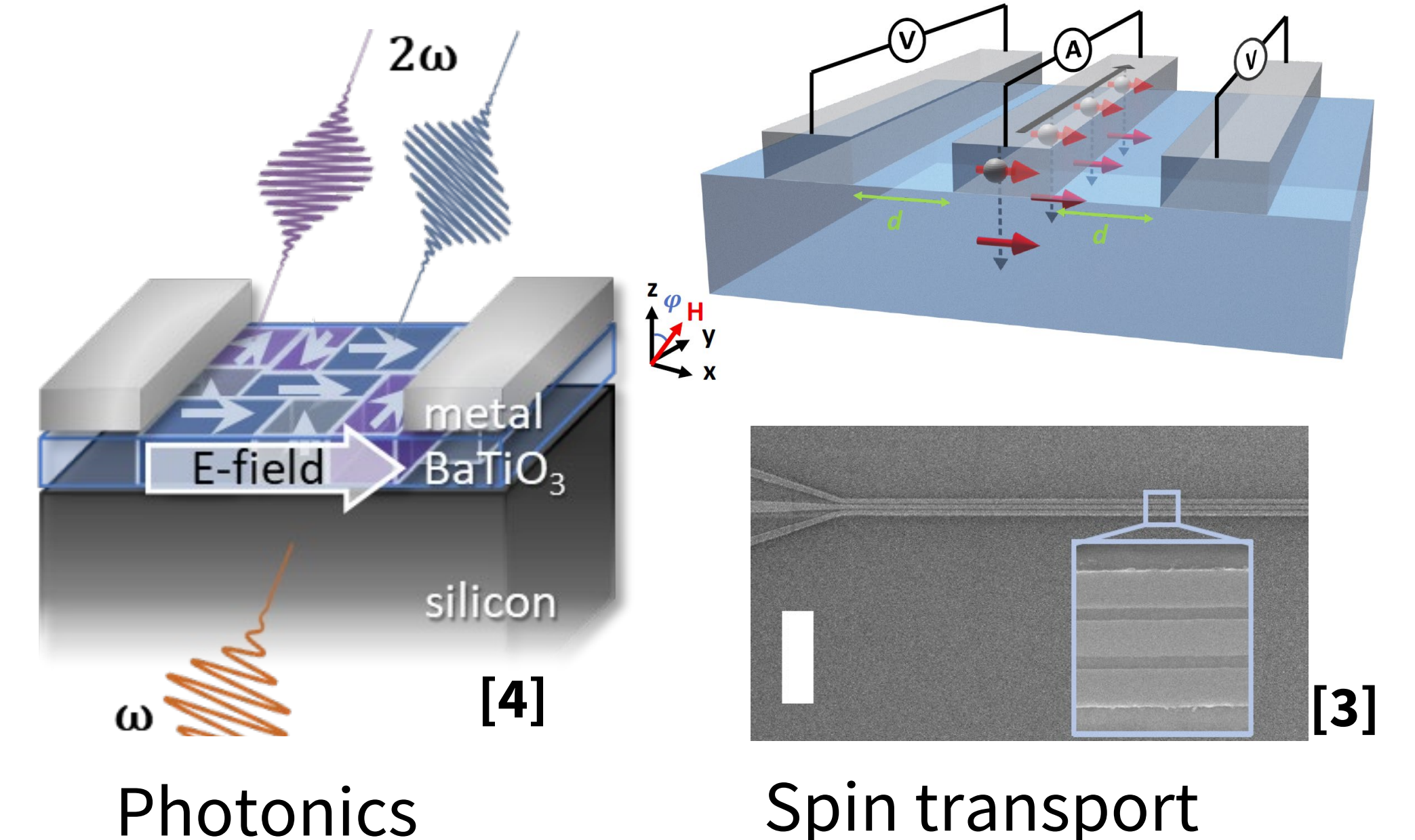
Thickness scaling of ferroelectricity [2]

Synthesis of new thin-film materials



Exploring unconventional (quantum) magnetism in thin film form [3]

Enabling proof-of-concept devices



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References

- [1] Nano Lett. 21, 2780 (2021); [2] Nat. Commun. 10, 5591 (2019)
[3] Appl. Phys. Rev. 9, 031309 (2022); Chem. Mater. 63, 2325 (2024); manuscript *under review* (2024)
[4] Phys. Rev. Mater. 4, 034406 (2020)