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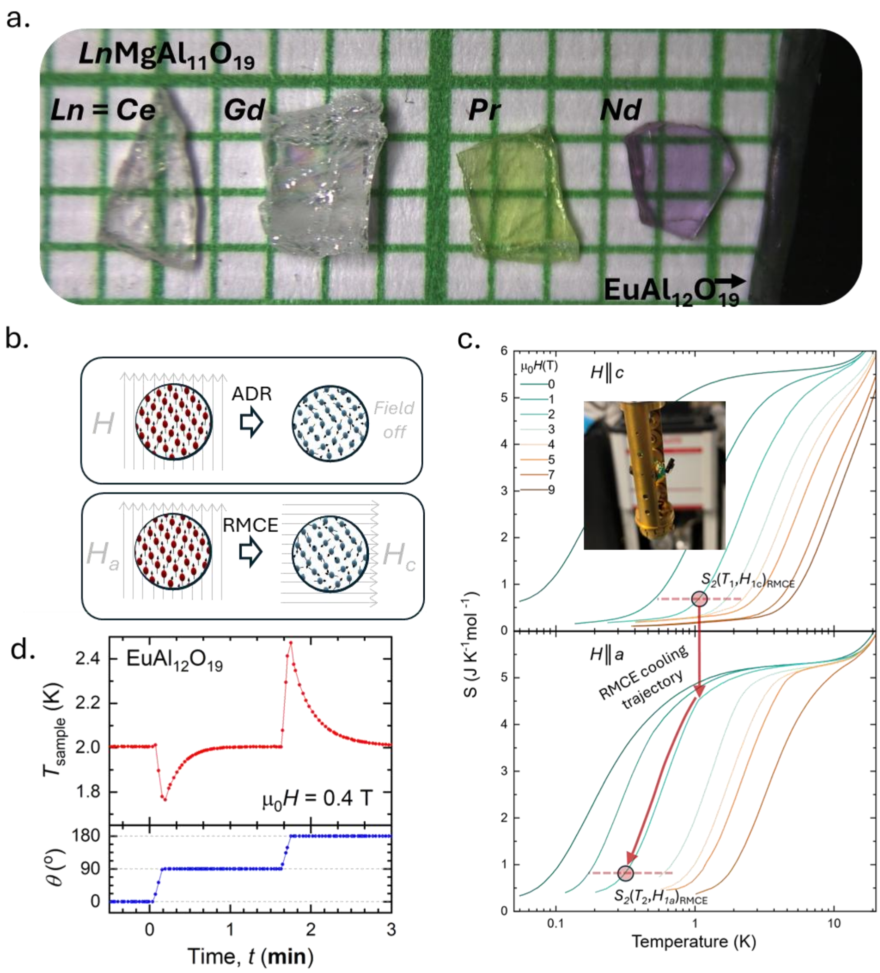
Rotational magnetocaloric measurements:

How cold can we go, just by rotating a crystal?

Adiabatic demagnetisation refrigeration works by reducing the applied magnetic field surrounding a paramagnetic material. The magnetic moments go from field-polarised (highly ordered) to paramagnetic (dynamic disordered), and to do that they ‘steal’ the phonon vibrational energy – cooling the material. In some materials we can cool down to millikelvin temperatures through this method – and several startup companies are developing refrigerators to cool quantum computers based on this technology.

The same effect is possible in some magnetically anisotropic materials, just by rotating the sample. A series of crystals we have grown (Fig.1) are just the right kind of anisotropic magnets to see these effects. In this project, the student would attempt to measure the cooling effect within a cryostat. **We would apply a magnetic field, thermalise at a moderately-low temperature (~2K), and then track the temperature change during rotation.** We can attempt this using several crystals, in a variety of applied magnetic fields.



The project might not be as easy as it seems, as the samples experience significant magnetic torque – so we’ll have to figure out how to clamp/glue the sample down well whilst also trying not to provide a significant thermal bridge for heat to leak back into our cooled-down crystals.

Figure 1.a. *Crystals of the magnetically anisotropic hexaaluminates.* ***b.*** *schematic of the RMC process compared to ADR.* ***c.*** *the isentropic pathway followed by an RMC experiment (with rotator picture inset).* ***d.*** *a preliminary result.*