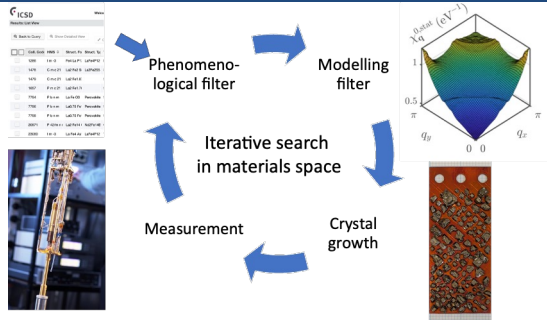




Quantum Matter Group

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Discovery research in quantum materials



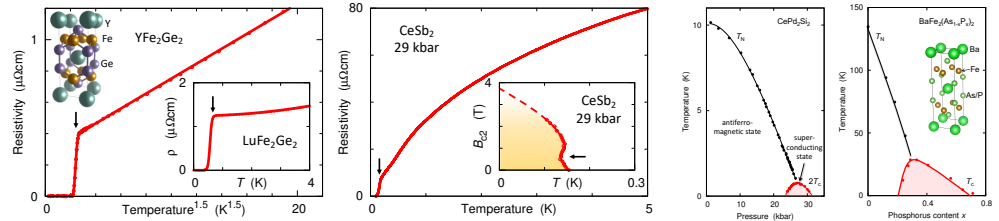
Summary

Strongly correlated systems:
 Charge and spin order, electronic structure determination, unconventional superconductivity (Cu- or Fe-based, heavy fermion, layered materials), ferroelectrics and multiferroics, topological states of matter

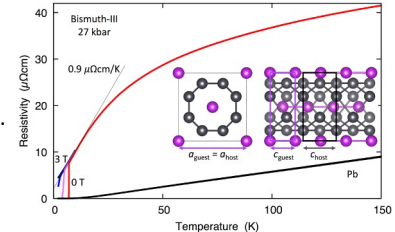
Quantum functional materials:
 New superconductors, refrigerants (magnetic, electric, Peltier), battery technology

Instrumentation and techniques:
 Materials synthesis and crystal growth
 High pressure measurements into the mega-bar regime
 Low temperature, high magnetic field; quantum oscillations

1. Unconventional superconductivity in transition metal compounds
 Many materials, notably cuprates, iron pnictides and Ce- and U-based heavy fermion compounds:
 → superconductivity cannot be explained by conventional phonon-mediated pairing.
 Investigate the nature and origin of unconventional superconductivity, e.g. in the newly discovered superconductors YFe_2Ge_2 , $LuFe_2Ge_2$, $CeSb_2$ and in related materials.
 Solve jigsaw of data and theoretical models to guide the search for new and potentially useful superconductors.



2. Electronic and lattice excitations in aperiodic crystals
 Quasiperiodic high pressure structures in elements: two sublattices with incommensurate lattice constants.
 No discrete translational symmetry, no unit cell, and no Brillouin zones.
 What are vibrational and electronic excitations?
 Examine the consequences for superconductivity and investigate their electronic structure.



3. Fermi-surface instabilities near pressure-induced quantum phase transitions
 Use high pressure quantum oscillation measurements to track the electronic structure in regions of the phase diagram of interest, e.g. in metallised Mott insulators.

