

Max-Planck-Institut für Struktur und Dynamik der Materie

Max Planck Institute for the Structure and Dynamics of Matter



IMPRS UFAST Call for PhD applications 2025/2026

PM6 & DK – Gradient quantum matter



Title of PhD Project	Gradient quantum matter
Type	2 Experimental, 1 Theoretical
Supervisor(s)	Philip Moll Dante Kennes
Affiliation(s):	Max Planck Institute for the Structure and Dynamics of Matter RWTH Aachen University
Number of positions:	3
Abstract:	Strongly correlated electron systems can easily be tuned by pressure, driving quantum phase transitions such as from a magnetic into a superconducting state. While this is well studied in the homogeneous, thermodynamic limit, inhomogeneous strain is at the forefront of research. If a strain field varies slowly within a crystal, simple phase coexistence is naturally expected. The goal of this project is to explore theoretically and experimentally how this picture breaks down in the limit of extreme gradients. One the strain varies significantly over the length scale relevant for its physics, new quantum phases in this elastic nonequilibrium are expected to emerge. You will pioneer single-crystal cantilevers of correlated oxides, high-Tc superconductors and intermetallics; and induce record gradients by bending them. The emergent phase landscape will be monitored by resistance, magnetization and elasticity measurements at millikelvin temperatures and in high magnetic fields. The microscopic strain gradients will be mapped by coherent Bragg diffraction contrast imaging at a synchrotron, and correlated with its physical state variables. Theoretically, the problem of strongly varying tuning parameters will be tackled in exactly solvable 1D systems, and 2D/3D by functional renormalization and tensor network approaches in collaboration with Dante Kennes at RWTH Aachen.
Contact person for scientific questions about the project:	Philip Moll: philip.moll@mpsd.mpg.de Dante Kennes: dante.kennes@mpsd.mpg.de