Title: Nanostructured surfaces to catch two-dimensional heavy fermions

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Short description of the project:

Recently, we have shown two-dimensional heavy fermions to be laterally quantized in narrow surface terraces [1]. Having achieved this key milestone, this project proposes a coordinated endeavor to create ad-hoc atomic scale nanostructures on the surface of heavy fermions and manipulating heavy quantum states at f-electron surfaces. The methodology includes novel techniques to control over the geometry of surface nanostructures through specific cleaving arrangements; this will serve to identify bulk symmetries and relate the microscopic f-electron properties to bulk macroscopic behavior. We will use a Scanning Tunneling Microscopy at very low temperatures (0.1 K) to access the quantum interference pattern, produced by the confinement of the electrons at the nanostructured surface, by measuring the tunneling conductance in a small energy range (few meV). Through the proposed studies of the f-electron surfaces, we intend to gain key insight into fundamental and unresolved problems in four model systems where atomic resolution can be achieved. These problems are the hidden order of URu2Si2, magnetism in CeRu2Si2, nearly ferromagnetic superconductivity in UTe2 and unconventional superconductivity in CeCoIn5.

[1] Quantum-well states at the surface of a heavy-fermion superconductor. Nature 616, 465–469 (2023)