General Scope:
Superconductivity is a state of matter corresponding to zero electrical resistance and magnetic field expulsion occurring in some materials cooled down below a critical temperature. Microscopically it corresponds to a condensate of electron pairs. Such a condensate of fermions can occurred only because electron paired up to form Cooper pairs. In conventional superconductors, the glue binding the electron pairs is the exchange of lattice vibrations: the phonons.

Counterintuitively the materials achieving the highest critical temperatures at ambient pressure are not the metallic ones, but rather ceramic materials: the high temperature superconductors or cuprates. A priori, the conventional electron-phonon coupling mechanism cannot explain such high critical temperatures. Unraveling the mystery of the physical mechanism leading to high temperature superconductivity remains one of the most challenging issues of modern solid-state physics.

Research topic and facilities available:
The PhD student will look at an unconventional heavy fermions superconductor: UPt3 by means of two techniques of resonant cavity measurements. Such measurements give access to the electrodynamics of superconductors. The electrodynamics is very fundamental because it is directly related to the density of electrons forming the superfluid condensate and the density of quasi-particles generating dissipation. Its provides information on the symmetry of the superconducting order parameter ans thus hint on the probable glue.

Caption of the figure: Superconducting LC circuit probes the high frequency conductivity the superconducting thin films. The LC circuit can be directly etched in the film (panel a). An alternative way, is to disturb a LC circuit made of NbN by placing the superconducting sample at the center of the circuit (panel b). Panel (c) shows a typical measurement of the transmission of the feed-line at various temperature (from 100mK to 900mK by step of 50mK).

Possible extension as a PhD: yes

Required skills:
Solid state physic knowledge, taste for experimental manipulation and strong motivation.

Starting date: March or April 2021

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