Postdoc
Kondo cloud extension

Postdoctoral position
IRIG-PHELIQS-LATEQS, CEA Grenoble
Starting from January 2020, for two years.

Research:
Experimental Condensed Matter Physics
Quantum transport measurements at low temperatures
Kondo physics in quantum-dot structures

Skills asked for:
University PhD degree in Physics.
Experience in experimental condensed matter physics (low-temperature equipment, electrical transport, data acquisition).
Fundamental knowledge of quantum phenomena in solid-state physics.

Context:
ANR project "KONEX" in the field of Kondo physics in quantum dot structures, more specifically related to the Kondo-cloud extension around quantum dots.

In the frame of the research project "Kondo-cloud extension around quantum dots" funded by the French National Research Agency (ANR), the CEA Institute for Interdisciplinary Research of Grenoble (IRIG) has an open post-doctoral position at the laboratory PHELIQS for a period of two years. The project will be performed in close collaboration with the Néel Institute (CNRS, Grenoble), the Centre de Nanoscience and Nanotechnology (CNRS, Paris-Saclay), and the Institute for Condensed Matter and Nanosciences (UCL, Louvain-la-Neuve, Belgium).

Topic:
Known for a long time in metals with magnetic impurities, the Kondo effect has shown a revival since the late 1990's in the context of semiconductor quantum dots. The Kondo effect in quantum dots is a complex many-body effect that emerges at very low temperature and describes the screening of an unpaired electron spin in the dot by the conduction electrons of the reservoirs. Analogously to charge screening, the conduction electrons involved in this process form a screening cloud around the localized spin. The proposed research focuses on the spatial extension of this so-called Kondo cloud around the dot, which remains largely unexplored experimentally. According to theory, the Kondo cloud extends over several microns in the reservoirs with a high degree of spin entanglement. Despite its fundamental character and the numerous theoretical works on the topic, the Kondo cloud has so far eluded experimental observation, and its very existence remains an open question.

We propose to explore these Kondo-cloud properties by combining transport experiments and scanning gate microscopy at very low temperature on devices containing one or two semiconductor

quantum dots coupled to different reservoirs. By varying the size of the contact reservoirs, via either fixed lateral gates or a movable scanning gate, transport experiments of the quantum-dot yield information on the Kondo cloud extension. Experiments on devices consisting of two quantum dots connected by an electron reservoir of a certain length address the question of the mutual interaction between quantum dots mediated by the Kondo-cloud screening. The expected results include the first measurement of the Kondo cloud extension and, more challenging, the demonstration of its spin entanglement.

Scientific environment:
The host laboratory at CEA-IRIG-PHELIQS has a longstanding experience in quantum transport measurements at the extreme conditions of very low temperatures and high magnetic fields. Research topics cover a broad range of subjects in condensed matter physics, such as the proximity effect at superconducting interfaces, the metal-insulator transition, the two-dimensional properties of graphene-based structures, the Coulomb blockade in quantum dots, and the coherent manipulation of Silicon quantum devices in relation to quantum computing. Existing cryogenic equipment allows for transport measurements in dilution fridges down to 20 mK. The device fabrication will be carried out in collaboration with partners at C2N in Paris-Saclay. Related scanning gate experiments will be performed by a PhD student at the Néel Institute in Grenoble and at UCL-IMCN in Belgium.

Applications:
Send your CV and motivation letter to Louis Jansen (louis.jansen@cea.fr CEA Grenoble) and Hermann Sellier (hermann.sellier@neel.cnrs.fr CNRS Grenoble).