INTERNSHIP PROPOSAL
MASTER 2

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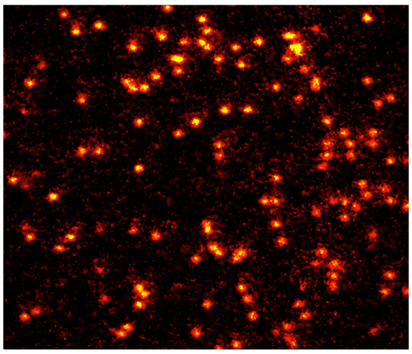
Location: **ENS Physics Department**

Thesis possibility after internship: **YES**
Funding: **YES**

Tailoring optical potentials for ultracold Fermi gases

Our research group focuses on the understanding of low temperature strongly-correlated Fermi gases in the BEC-BCS crossover, combining theoretical and experimental expertise. Strongly-correlated fermions are ubiquitous in nature, from the quark-gluon plasma of the early universe to neutron stars found in the outer space, they lie as well at the heart of many modern materials such as high-temperature superconductors, colossal magneto-resistance devices or graphene. While being a pressing issue covering a wide fundamental and technological scope, the understanding of strongly-correlated fermions constitutes a serious challenge of modern physics, which is often hindered by the complexity of the host systems themselves.



Potassium 40 atoms pinned in an optical lattice and exposed to cooling laser beams. The atoms absorb and re-emit photons which are collected via a high resolution objective. Each bright spot signals the presence of an atom with a fidelity > 99.6%. This method has also been demonstrated for ^{6}Li. *Courtesy of M. Zwierlein MIT*

The contribution of ultracold gases experiments in this outstanding quest resides in the ability to set fermions in a well-characterized environment. In these systems, one can add a single ingredient at a time (spin mixture, interactions, lattice, etc) with a high degree of control, allowing for an incremental complexity, which represents an ideal playground for a direct comparison to many-body theories. So far, the experiments performed with ultracold Fermi gases used inhomogeneous traps, typically harmonic potentials. While such potentials were proven to be extremely useful and well suited for some thermodynamic studies, they constitute at the same time the main obstacle to quantitatively access other crucial observables.

The aim of the internship will be to realize a homogeneous potential for ultracold lithium atoms trapped in a 2D geometry (a plane). This project requires both theoretical and experimental skills (light-matter interaction, optics, etc.). This internship is a first step towards the study of homogeneous 2D Fermi gases with single atom resolution (see Figure).