Towards a new experiment for studying degenerated quantum gases in optical lattices
Research axis: Lasers and materials

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For some time now, theoretical physicists in condensed matter face a major problem: the computing power needed to numerically simulate and study some interacting many-body systems is insufficient. As the use of ultracold atomic systems has experimented a significant grown, an alternative might be to use optical lattices and atoms cooled to quantum degeneracy to simulate the properties of materials. Indeed, an analogy can be made between the behavior of electrons in the crystalline structure of a solid, and trapped atoms in optical lattices, thus reproducing the electrical properties such as conductivity or insulating behavior, and the magnetic ones, as antiferromagnetism. Additionally, the big advantage of using cold atoms is that the parameters of the simulated solid, such as the geometry of the lattice, the intensity and the sign of the interactions between atoms, their bosonic of fermionic nature (while the electrons are always fermions!), the number of atoms per site, etc, can be well controled, which would allow us to "create" artificial quantum matter. My PhD thesis focuses on the construction of a new experiment, which will aim at reproducing these properties. In order to do so, we will use a fermionic gas of potassium (40 K). Quantum degeneracy regime will be achieved by sympathetic cooling with a bosonic rubidium gas (87 Rb), and the gas will then be loaded into an optical lattice of variable geometry.

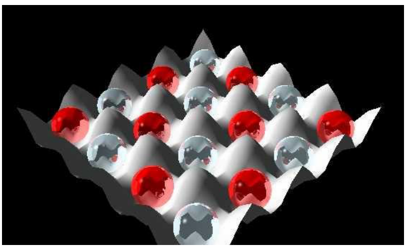

FIG. 1. Two species of atoms trapped in an optical lattice.

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