Ultracold fermions trapped in nanostructured optical lattices

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Ultracold atom systems used as quantum simulators offer an alternative way to simulate many-body systems behavior in condensed matter. Indeed, we can create artificial matter with optical lattices : the stationary wave reproduces the potential wells in the crystalline structure. Moreover, the big advantage of using cold atoms is that the parameters of the simulated crystal can be well controlled so that we can understand the electrical and magnetism properties of the condensed matter such as conductivity, ferromagnetism [1][2]... The common approach for generating optical lattices is by interfering two laser beams in one direction. In free space the lattice spacing is limited by half the wavelength. However, the more the lattice spacing decreases, the more the interaction energies increase [3]. In the new ongoing project, we are going to produce subwavelength lattices by irradiating a nanostructured surface. The subwavelength potential is created thanks to the control of the interactions between the beams, the atomic cloud and the surface. This system will be able to study new interaction regimes with very high tunability (different lattice geometries, impurities...).

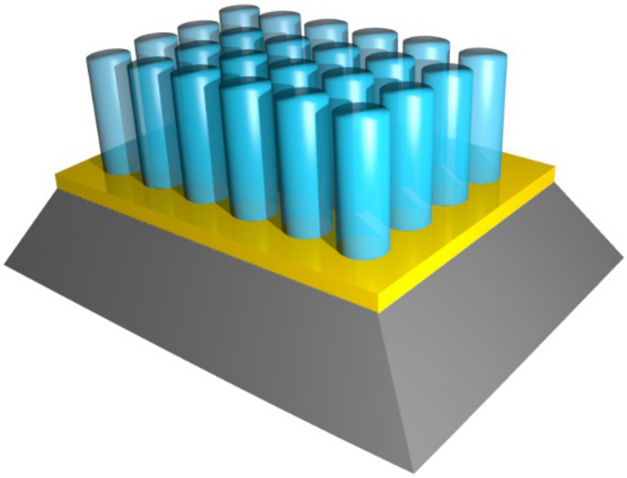

FIG. 1. Nanostructured surface to create the subwavelength potential : SiO_2 pillars (400 nm height) on a gold surface (40 nm thick) fixed on silicon substrate. The distance between two pillars is the lattice spacing, which is 100 nm.

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[3] Gullans M. and al., *Physica Review Letters*, 109, 235309, 2012

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