

# Doubly-dressed states for near-field trapping and subwavelength lattice structuration

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Atomic physics and solid-state devices have developed on nearly parallel tracks for several years, merely regarding each other as a source of inspiration. Over the last decade, however, the concept of hybrid systems where the quantum mechanical properties of coupled systems cannot be disentangled has spurred a blossoming research activity. Here, I will discuss a novel hybrid quantum system that engineers Bose and Fermi quantum gaz dynamics in close proximity, and strongly interacting with, nano-structured surfaces capable of generating sub-wavelength lattice potentials with tailored electromagnetic properties. Such experimental platform belongs to the class of optical lattice quantum simulators. Compared to the state of the art, nano-structured lattices could strongly reduce lattice size and therefore enhance the relevant energy scale (tunneling, interaction) to enter more deeply into strongly correlated regimes. It would then bridge the gap between solid state (0.1 nm) and optical (500 nm) crystals to exploit simultaneously regimes free of far field fundamental limitations and cold atom controllability. The experimental challenge for such platform is to control the quantum gaz in the close vicinity of the surface where tremendous Casimir Polder (CP) force apply on atoms. In this presentation, I will detail a novel trapping method (Doubly Dressed State) [1] capable to overcome the CP force at short distance and to generate optical lattice potentials with sub-wavelength period and controllable lattice depth and trap to surface distance (see Figure 1).

[1] M. Bellouvet, C. Busquet, J. Zhang, P. Bouyer and S. Bernon, arXiv:1710.05696.

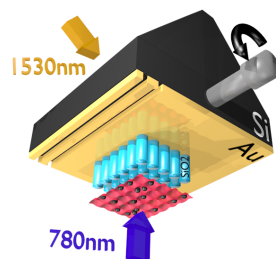


Figure 1: Hybrid quantum simulator: atoms (black balls) are trapped in the DDS near field trap (red) periodically modulated by the dielectric surface (blue cylinders).