Designing Quantum Matter: fabrication and characterization with atomic scale precision

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In the realm of novel 2-D electronic materials in which the nanoscale geometry is a deciding factor for the electronic band structure, it has been realized that electron gases on well-defined metal surfaces form an excellent basis to design 2-D electronic lattices of nearly any geometry, often difficult to realize in real materials [1]. Such lattices can be formed by atomic manipulation in a cryogenic scanning tunnelling microscope, and can then be investigated by scanning tunnelling spectroscopy and wave function mapping, resulting in a comprehensive data set.

In this talk, I will show how the inherent tunability of the system can be used to engineer and explore novel quantum states of matter. Specifically, I will show examples of how to control the geometry, the orbital-degree of freedom, as well as the dimensionality in these 2D electronic lattices [2,3].

References

[1] K.K. Gomes *et al.*, Nature, 483 (2012) 306
[2] M.R. Slot *et al.*, Nature Physics 13, (2017) 672
[3] S.N. Kempkes *et al.* submitted (2018)

Figures

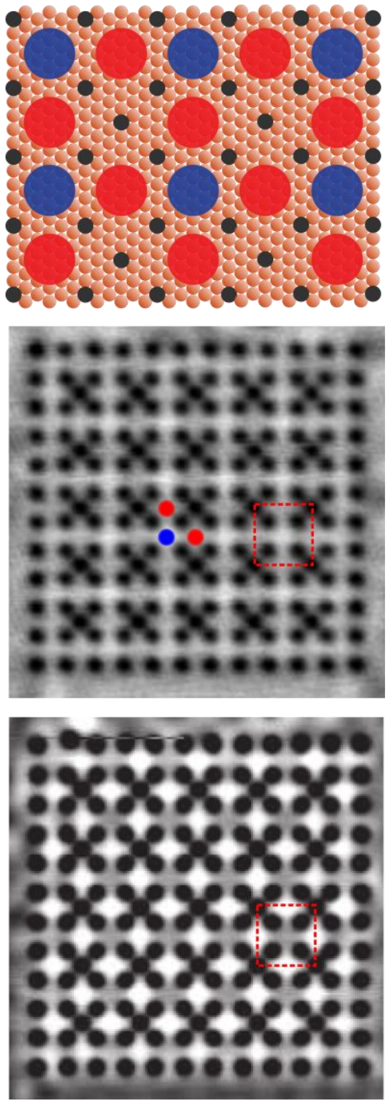

Figure 1: Top: The blue and red spheres denote the geometry of the 2D Lieb lattice. The smaller red and black circles indicate the atoms of the Cu(111) surface and CO molecules, respectively. Middle: constant-current STM image of a lattice of CO molecules which confine the surface state electrons to the Lieb lattice geometry. Red and blue dots correspond to the red and blue spheres in the top image. Bottom: wave function map showing how the electrons are localized.