Quantum Simulations in Quantum Dots Arrays

Pierre Barthelemy[1], **Lieven Vandersypen**[1]

[1] *Quantum Transport, Kavli Institute of Nanoscience, TU Delft, The Netherlands*

Arrays of laterally-defined quantum dots in semiconductor heterostructure offer a unique platform for quantum simulations of the Hubbard model[1, 2]. Indeed, placing such a device in a dilution refrigerator would bring the system to a temperature low enough to observe the influence of spin exchange onto the electron wavefunctions. So far, the main issue to reach this goal has been the strong disorder in the (doped) semiconductor heterostructures.

By using capacitance spectroscopy techniques[3], we propose to measure the density of states in a quantum dot lattice defined by placing a surface grid-shaped gate above a 2D electron gas (2DEG). The use of capacitive measurement schemes allows to strongly decrease the influence of disorder: first, is allows the use of undoped systems, thereby removing the dominant contribution to the disorder. But the vicinity of the back electrode of these capacitive systems to the 2DEG strongly screens the remaining disorder. Our calculations showed that onsite fluctuations should fall below 10-20μeV, low enough to efficiently simulate Hubbard physics with hopping energies of the order of 100μeV. We present in this contribution the advances made in our group towards towards the fabrication and measurement of the density of states in capacitive quantum dots arrays.

[1] T. Byrnes, N.Y. Kim, K. Kusudo and Y. Yamamoto, Phys. Rev. B, **78**, 075320 (2008).
[2] A. Singha, *et al.*, Science**332**, 1176-1179 (2011).
[3] R.C. Ashoori, J.A. Lebens, N.P. Bigelow and R.H. Silsbee, Phys. Rev. B, **48**, 4616-4628 (1993).