D3.2.1: Experimental determination of the energy spectrum of a molecular device, M12,WP3

Lead beneficiary P4 UNSW

In the first year of **WP3 P4** determined the energy spectra of a molecular devices and delivered **D3.2.1**. In accordance with the description of work, the device consists of two coupled dopants and is probed with a low temperature STM. This allows the determination of at least the first 4 eigen-states of the molecule and the spatial mapping of the wave-function. The device consists of a metallic layer of heavily doped silicon with a lighter doped region on top that contains randomly dispersed dopants. Pairs of dopants in one crystal plane with different separations were identified and their spectrum was measured [1]. To fabricate complex molecules deterministically placed dopants are required which to date is only possible for donors. In the final part of year 1 **P4** demonstrated spectroscopic and imaging capability for subsurface donors. Several buried arsenic dopants were imaged down to more than 30 lattice planes below the Si - vacuum interface with unprecedented resolution. This work for the first time yielded the direct observation of the valley degree of freedom which is manifested as an interference pattern that is non commensurate with the lattice [2]. Besides the added degree of the valleys for logic applications, the direct determination of the wave-function with sufficiently high resolution to determine the valley composition allows a new level of comparison to the theory of **P1**.

[1] Salfi J, Mol JA, Rahman R, Klimeck G, Simmons MY, Hollenberg LCL, Rogge S. Quantum correlations and entanglement in a solid-state molecule. To be submitted in October 2013

[2] Salfi J, Mol JA, Rahman R, Klimeck G, Simmons MY, Hollenberg LCL, Rogge S. Valley quantum interference in silicon. To be submitted in October 2013