Silicon-based quantum electronics

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Low-dimensional silicon-based nanostructures constitute a versatile and convenient platform for novel electronic devices with quantum functionalities. After a brief overview of the most promising development routes, I shall report on a recent experiment in which we have been able to observe a gate-tunable tunneling current through a series of two donor atoms embedded in the channel of a multi-gate silicon transistor. The lowest energy states, corresponding to a single electron on either of the two donors, form a two-level system well separated from all other electronic levels. Gigahertz driving results in a quantum interference pattern associated with the absorption or the stimulated emission of up to ten microwave photons, from which we estimate a charge dephasing time of 0.3 nanoseconds. This experimental achievement is an essential step towards either charge- or spin-based quantum computing devices in silicon.

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