A three-dimensional Array of Quantum Dots

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Spin qubits in germanium have shown significant progress in system interconnectivity and scalability, with recent advances extending from single quantum dots [1] to one [2]- and two-dimensional arrays [3-5].

Here, we demonstrate the next step in dimensional scaling: a three-dimensional cuboid array of germanium quantum dots. This architecture is enabled by a bi-layer germanium quantum well [6-8] integrated with a planar gate structure. We furthermore demonstrate coherent spin control by shuttling holes in the out-of-plane direction, confirming the viability of vertical spin transport and coherence in this 3D platform. Our results establish a new pathway toward high-density quantum computing and 3D quantum simulation in germanium.

References

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Figures

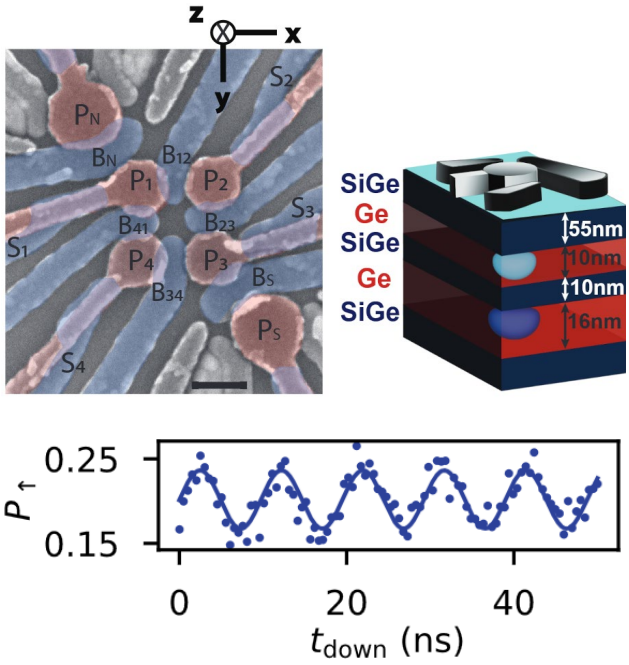

Figure 1: A three-dimensional quantum dot array in germanium. A planar gate architecture (SEM micrograph, top left) combined with a bi-layer quantum well structure (schematic, top right) enables the formation of a 3D cuboid array of quantum dots. By shuttling a hole into a lower quantum dot, coherent spin oscillations can be induced (bottom).

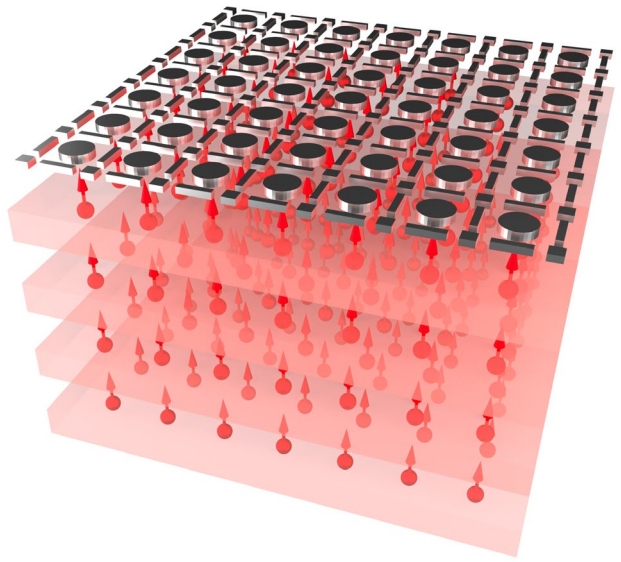

Figure 2: Artistic depiction of a large 3D spin qubit array in germanium. The demonstrated prototype features a 2×2×2 array, illustrating the feasibility of scalable 3D integration.