

# Physikalisches Kolloquium

**Hendrik Blum, RWTH Aachen**  
**»Semiconductor spin qubits –  
from proof of principle demonstrations to the challenges of scalability«**

*Einführung: A. Ustinov*

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Quantum information processing promises an exponential speedup for certain computationally hard problems and could thus solve currently practically intractable computational tasks. Reaching this goal would require on the order of 10<sup>8</sup> quantum bits (qubits), each of which has to be controlled with high fidelity. Several types of qubits have now been shown to allow the latter while also carrying promise for scalability.

Among these are qubits based on electron spins trapped in fabricated semiconductor nanostructures. Starting from an outline of the development of key concepts, I will give an overview of the current state of the art of GaAs and Si based spin qubit devices. Key results include single shot readout, high fidelity single-qubit manipulation, and first demonstrations of two-qubit gates. One particular focus will be effects from the hyperfine interaction of nuclear spins with the electron spin qubit, which is a source of strong decoherence when present. Si qubits have the advantage to allow for the nearly complete elimination of nuclear spins. While this route is not open in III-V semiconductors such as GaAs, the intricate physics emerging from hyperfine coupling is now rather well understood and effective methods to reduce the associated dephasing and achieve high fidelity qubit control exist as well.

I will conclude with an outlook of what may be required to implement a fully scalable, semiconductor based quantum information processor building on the above progress.

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**Donnerstag, 03.12.2015, 17:30 Uhr,**

**KIT, Campus Süd,  
Otto-Lehmann-Hörsaal, Physik-Flachbau (Geb. 30.22).  
Anschließend Nachsitzung im Gastdozentenhaus „Heinrich Hertz“**