Symposium Quantum Computing and Communication: Early Days and New Developments (SYCC)

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Quantum mechanics has transformed our understanding of the physical world. In the last four decades, there has also been an increasing awareness of the implications that quantum physics has for information science and technology. This has led to the thriving field of quantum information science. This symposium brings together some of the pioneers and leading researchers in this field.

Overview of Invited Talks and Sessions

(Lecture hall ZHG010)

Invited Talks

SYCC 1.1	Tue	10:45–11:25	ZHG010	**Founding Concepts for Solid State Quantum Computers** — •David DiVincenzo
SYCC 1.2	Tue	11:25–12:05	ZHG010	**Semiconductor spin qubits - vision, opportunities and challenges** — •Lieven Vandersypen
SYCC 1.3	Tue	12:05–12:45	ZHG010	**Perspectives on Control and Characterization of Temporally Correlated Nonclassical Noise** — •Lorenza Viola

Sessions

SYCC 1.1–1.3	Tue	10:45–12:45	ZHG010	**Quantum Computing and Communication: Early Days and New Developments**

SYCC 1: Quantum Computing and Communication: Early Days and New Developments

Time: Tuesday 10:45–12:45 Location: ZHG010

Invited Talk SYCC 1.1 Tue 10:45 ZHG010

Founding Concepts for Solid State Quantum Computers — •David DiVincenzo — QuTech, TU Delft; RWTH Aachen

From 1994 onwards, the question always has been, "when will we have a quantum computer?" The answer was mostly, "a long time from now." But within a few years, new concepts from quantum information came into being that would transform the subject of quantum device physics. Over time, what once were physics experiments have morphed into installations. I will discuss the fact that, throughout these thirty years, the dreams about the "installation" have, time and again, fueled novel scientific insights, both about the nature of quantum computing, but also about the solid-state physics underlying our qubits.

Invited Talk SYCC 1.2 Tue 11:25 ZHG010

Semiconductor spin qubits - vision, opportunities and challenges — •Lieven Vandersypen — QuTech and Kavli Institute of Nanoscience, Delft University of Technology, Delft, Netherlandds

Quantum computation has captivated the minds of many for several decades. For much of that time, it was seen mostly as an extremely interesting scientific problem. In the last few years, we have entered a new phase as the belief has grown that a large-scale quantum computer can actually be built. Quantum bits encoded in the spin state of individual electrons in silicon quantum dot arrays, have emerged as a highly promising direction. In this talk, I will present our vision of a large-scale spin-based quantum processor, and ongoing work to realize this vision.

Recent steps include the realization of high-fidelity multi-qubit registers, novel qubit control schemes, high-fidelity shuttling of electron spins, two-qubit gates implemented on mobile spins, two-qubit gates acting on spins separated by 250 micron. When combined, the progress along these various fronts can lead the way to scalable networks of high-fidelity spin qubit registers for computation and simulation.

Invited Talk SYCC 1.3 Tue 12:05 ZHG010

Perspectives on Control and Characterization of Temporally Correlated Nonclassical Noise — •Lorenza Viola — Dartmouth College, Hanover, NH 03755, USA

Accurate characterization and control of realistic open-quantum system dynamics is vital for exploiting the full potential of quantum technologies. Over the past decade, substantial progress has been made in developing qubit-based quantum noise spectroscopy techniques, which have revealed how realistic noise often exhibits strong correlations both in space and time. Still, even in the simplest setting of a single qubit exposed to pure-dephasing noise, understanding the full implications of modeling the environment as a genuinely quantum, as opposed to a classical system, remains surprisingly subtle. I will revisit the use of dynamical decoupling to protect a single-qubit gate in the presence of dephasing noise that is both temporally correlated and nonclassical, and show how the evolution of the quantum bath statistics causes the gate fidelity to depend strongly on the applied control history even if the system-side error propagation is fully removed through perfect reset operations. As a result, the fidelity can saturate at a value substantially lower than the one achievable with no intervening history. Only if decoupling can keep the qubit highly pure over a timescale larger than the noise correlation time, the bath is shown to approximately re-equilibrate to its original statistics and a stable-in-time control performance is recovered. I will conclude by discussing ongoing extensions to multi-qubit settings and implications for fault-tolerant quantum computation.