Graduate Program in Spintronics Lecture

Lecture Series: Basic Concepts and Hardware Platforms of Quantum Computing

Prof. Dr. Thomas Schäpers

Peter Grünberg Institut, Forschungszentrum Jülich
Professor at RWTH Aachen University, Germany
and Visiting Professor at Tohoku University

The Course "**Basic concepts and hardware platforms of quantum computing**" will give an overview on solid-state quantum bits based on semiconductor nanostructures, superconducting circuits, as well as on topological materials. Furthermore, ion-trap based realizations are introduced.

subjects:

- Basics of quantum computing
- Quantum algorithms
- Spin qubits in semiconductor quantum dots
- Superconducting qubits
- Ion trap quantum computers
- Topological materials and topological quantum computing

The lecture, in total 15 appointments, is held on Wednesdays and Thursdays, 16:30 – 18:00 (Tokyo time)

December 1, 2, 8, 15, 16, 22. 2021
January 6, 12, 13, 19, 20, 26, 27. 2022
February 2, 3. 2022

Zoom Meeting details:
https://rwth.zoom.us/j/93505191920?pwd=VHVUM2pFVFExU2owaEhXU3lGZSs3UT09
Meeting-ID: 935 0519 1920 / Pass Code: 621327

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First lecture: 1.12.2021
Final lecture: 3.2.2022

Subjects:

- Basics of quantum computing
- Quantum Algorithms
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- Superconducting Qubits
- Ion trap quantum computers
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Zoom Link

Lecture: Basic Concepts and Hardware Platforms for Quantum Computing - Zoom Meeting of Thomas Schäpers

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Join via SIP

93505191920@zoomcrc.com
Join via H.323

207.226.132.110 (Japan Tokio)
149.137.24.110 (Japan Osaka)

Pass Code: 621327
Meeting-ID: 935 0519 1920

Detail Schedule

	Date	Day	Time (Sendai)	Subject
1	1.12.2021	Wed.	16:30-18:00	Introduction, basic quantum gates
2	2.12.2021	Thurs.	16:30-18:00	Semiconductor qubits
3	8.12.2021	Wed.	16:30-18:00	Semiconductor qubits
4	15.12.2021	Wed.	16:30-18:00	Semiconductor qubits
5	16.12.2021	Thurs.	16:30-18:00	Quantum algorithms, Shor, Grover, Deutsch-Josza
6	22.12.2021	Wed.	16:30-18:00	Quantum algorithms, Shor, Grover, Deutsch-Josza
	23.12.2021	Thurs.	16:30-18:00	
	5.1.2022	Wed.	16:30-18:00	
7	6.1.2022	Thurs.	16:30-18:00	Superconducting qubits
8	12.1.2022	Wed.	16:30-18:00	Superconducting qubits
9	13.1.2022	Thurs.	16:30-18:00	Superconducting qubits
10	19.1.2022	Wed.	16:30-18:00	Superconducting qubits
11	20.1.2022	Thurs.	16:30-18:00	Ion trap quantum computers
12	26.1.2022	Wed.	16:30-18:00	Ion trap quantum computers
13	27.1.2022	Thurs.	16:30-18:00	Topological insulators
14	2.2.2022	Wed.	16:30-18:00	Topological quantum computing
15	3.2.2022	Thurs.	16:30-18:00	Topological quantum computing
	16.2.2022	Wed.	16:30-18:00	Optional date for quantum communication
	17.2.2022	Thurs.	16:30-18:00	
	23.2.2022	Wed.	16:30-18:00	
	24.2.2022	Thurs.	16:30-18:00	

Possible subjects and estimated time required

Introduction, Basics	1 x 1.5h
Semiconductor Qubits	3 x 1.5h
Superconducting Qubits	4 x 1.5h
Ion Trap Qubits	2 x 1.5h
Algorithms	2 x 1.5h
Topological Insulators/topological quantum computing	3 x 1.5h
Quantum Communication (optional)	2 x 1.5h

Lecture subjects with keywords:

- Basics of quantum computing
  - Principles of quantum states
  - Qubit and qubit register
  - Single qubit gates
  - Two qubit gates
- Quantum Algorithms
  - Deutsch-Josza algorithm
  - Grover data base search algorithm
  - Shor algorithm for number factorization
- Spin qubits in semiconductor quantum dots
  - Basics on semiconductor quantum dot
  - Readout of spin qubit
  - Single qubit gate by electron spin resonance
  - Singlet/triplet qubit in double quantum dot
- Superconducting Qubits
  - Harmonic superconducting oscillator
  - Basics on Josephson junctions
  - Flux based qubits
  - Charge based superconducting qubit
  - Phase qubit
  - Transmon
- Ion trap quantum computers
  - Working principle of Paul trap
  - Realizing a qubit in an ion
  - Collective motion and bus qubit
  - Ion trap quantum computers based on microfabricated traps
- Topological materials and topological quantum computing
  - Properties of topological insulators
  - Transport in topological surface states
  - Majorana fermions
  - Qubit operation by braiding