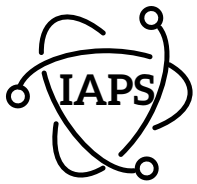
Fundamentals of Quantum Computing

Course info and summary



INSTITUTE *for* ADVANCED
PHYSICAL STUDIES

QUANTERALL

Vesselin Gueorguiev, Vladimir Gerdjikov, Stoyan Mishev

`https://indico.iaps.institute/e/qc-fundamentals`

Course outline

TIME: $\forall$ Friday @ 16:30-18:00 ~ 15 weeks (ends in July)
PLACE: Sofia Tech Park, Laboratory Complex, 1st floor,
https://us02web.zoom.us/j/81178059893

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Lecture `recordings` will be available for participants.

Topics:
- History and current state of quantum computers (V. Gueorguiev) $\sim$ 2 lectures
- Basic math for quantum mechanics and quantum computers (V. Gerdjikov) $\sim$ 4 lectures
- Programming with quantum gates (V. Gueorguiev and S. Mishev) $\sim$ 3 lectures
- Quantum machine learning (S. Mishev) $\sim$ 3 lectures
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$\sim$ 5 home works and 2 exams

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- Vector spaces, tensor product. Eigenspaces. Pauli matrices.
- Matrix decompositions - LU, QR, SVD.
- Lagrange multipliers.
- Metric spaces. Hilbert space. Kernel Hilbert space. Operators and spectra.
- Basics of quantum mechanics.

Programming with quantum gates

- Quantum circuits and Qiskit
- Deutsch–Jozsa algorithm
- Grover and Simon algorithms

Quantum machine learning

- Classical and quantum ML - PCA, SVM, NN
- QML with kernel functions
- Classical and quantum generative algorithms

- Basics of cryptography
- Shor algorithm
- Quantum encryption protocols

Lecturers

(a) Dr. Vesselin Gueorguiev is an established researcher with research interests spanning from group theoretical methods in physics to General Relativity and Cosmology.

(b) Prof. Vladimir Gerdjikov is a renowned scientist with seminal works in soliton theory and non-linear waves.

(c) His research interest are in machine learning and many-body quantum theory with applications to atomic nuclei and nuclear astrophysics.