GENERATION QI

Next generation of quantum information scientists.
series of international schools fof students in gdansk

16-26.08.2022

Fundusze Europejskie
Wiedza Edukacja Rozwój

Rzeczpospolita Polska

NAWA
NARODOWA AGENCJA WYMIANY AKADEMICKIEJ

Unia Europejska
Europejski Fundusz Społeczny

Target audience

- Undergraduates, graduates, postgraduates
- Students of Physics, Math, Chemistry, Computer Science, Engineering
- Anyone interested in quantum phenomena

Knowledge of quantum mechanics is not required but students will need to be comfortable with vectors and matrices. Prior experience with calculus is helpful but not essential.

Teaching staff

- dr Adrian Kołodziejski (Quantum Dynamics)
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- dr Krzysztof Szczygielski (Open Systems)
  krzysztof.szczygielski@ug.edu.pl
- and others

The structure of the school

1. The school is divides into two parts
   - Introduction to quantum mechanics
   - Introduction to the theory of open quantum systems
2. For every school there is 20 hours of lectures and 10 hours of problem solving sessions
3. Online lectures and practice sessions (via MS Teams)

Selected topics

- Postulates of Quantum Mechanics
- Operators and Measurement
- Schrödinger Time Evolution. Particle in a Box and Quantum Harmonic Oscillator
- Basic algebraic structures. Elements of a theory of ordinary differential equations. Positive, *n*-positive and completely positive maps. Trace norm
- Characterization of complete positivity: Choi theorem, Kraus representation, Stinespring dilation theorem
- A concept of density operator, its properties and physical interpretation. Microscopic model of open quantum system
- Evolution of open quantum systems as a completely positive and trace preserving map. Master Equation and its general form
- Markovian approximation. Standard form of Markovian Master Equation. Quantum Dynamical Semigroup
- Weak Coupling Limit and Davies form of Markovian Master Equation
- Some generalizations: time-dependent generators, non-markovian evolution

Selected literature

1. A. C. Phillips, *Introduction to Quantum Mechanics*. John Wiley & Sons, 2003.
2. N. Zettili, *Quantum Mechanics Concepts and Applications 2nd Edition*. John Wiley & Sons, 2009.
3. F. Schwabl, *Quantum Mechanics 4th Edition*. Springer, 2007.
4. J. Pade*, Quantum Mechanics for Pedestrians 1: Fundamentals*. Springer, 2014.
5. D. Griffiths, *Introduction to Quantum Mechanics 2nd Edition*. Pearson Prentice Hall, 2005.
6. R. Alicki, K. Lendi, *Quantum Dynamical Semigroups and Applications*, Springer-Verlag, Berlin Heidelberg 2007
7. H.-P. Breuer, F. Petruccione, *The Theory of Open Quantum Systems*, Oxford University Press, New York 2002
8. Á. Rivas, S. F. Huelga, *Open Quantum Systems. An Introduction*, Springer, Berlin Heidelberg 2012
9. I. Bengtsson, K. Życzkowski, *Geometry Of Quantum States*, Cambridge University Press, New York 2006
10. C. Chicone, *Ordinary Differential Equations with Applications*, Springer, New York 2006