TITLE

Selected topics in Quantum Technologies

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Program of the course:

Quantum Tecnologies (QT) is an interdisciplinary subject where physics, computer science and chemistry merge. In the last decade interest has grown both for the conceptual importance of methods, requiring a deeper understanding of quantum mechanics, and for the enormous potential in applications. QTs aim at exploiting exquisite quantum behavior to perform tasks which are tackled inefficiently by that present day technologies. For instance quantum computation relies on superpositions and entanglement to achieve exponential speedup of certain algorithms, which in a standard digital computer take a time growing exponentially with the input. The course presents selected topical concepts, techniques and physical systems of interest in the field of QT.
1) Quantum circuits with superconductors [1] and circuit QED [1,2] (4 ore)
2) Quantum dynamics: Magnus expansion [3], Floquet theory [4], Shortcuts to adiabaticity [5] (6 ore)
4) Machine learning and Optimal control Theory for quantum systems [4] (4 ore)

Bibliography:

[1] Uri Vool and Michel Devoret, Introduction to quantum electromagnetic circuits, Int. J. Circ. Theor. Appl. 2017; 45:897–934

[2] S. Haroche and J.M. Raimond, Exploring the Quantum : Atoms, Cavities and Photons, Oxford, 2006.

[3] S. Blanes et al., The Magnus expansion and some of its applications,https://doi.org/10.1016/j.physrep.2008.11.001 https://doi.org/10.1016/j.physrep.2008.11.001

[4] G. Santoro, SISSA lecture notes

[5] L. Giannelli and E. Arimondo, Phys. Rev. A 89, 033419 (2014).

[6] L. Giannelli et al. , A tutorial on optimal control and reinforcement learning methods for quantum technologies, https://doi.org/10.1016/j.physleta.2022.12805

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