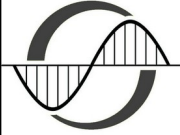




UNIVERSITÀ
degli STUDI
di CATANIA



DIPARTIMENTO DI FISICA E
ASTRONOMIA
“ETTORE MAJORANA”

DOTTORATO DI RICERCA IN FISICA
CICLO XXXIX A.A. 2023/2024

TITLE

Selected topics in Quantum Technologies

2 CFU

Teaching staff

Giuseppe Falci, Luigi Giannelli

Email: giuseppe.falci@unict.it

Office: DFA 212

Telephone: +39 095 3785366

Reception hours: Monday 17:30-19:30, Friday 17:30-19:30 (to be confirmed by e-mail)

Program of the course:

Quantum Technologies (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>
<https://doi.org/10.1016/j.physleta.2022.12805>