UNIVERSITÀ DI TRENTO

Corso di Dottorato in Fisica / Doctoral Programme in Physics

Ciclo 40 / Cycle 40

A.Y. 2024 - 2025

Borse a tematica vincolata / Reserved scholarships:

A - Photonic neural networks and their applications, CUP: E61I18001560005 Reti neurali fotoniche e loro applicazioni, CUP: E61I18001560005
B - Near Term Quantum Simulations for Nuclear Physics Simulazioni quantistiche nel breve termine per la fisica nucleare
C - Theory of the electron-phonon interaction in magnetic systems with strong relativistic effects (in connection with the financing UE HE DELIGHT — ERC-2021-ADG), CUP: E63C22000860006 Teoria dell'interazione elettrone fonone in presenza di effetti magnetici e relativistici (nell'ambito del finanziamento UE HE DELIGHT — ERC-2021-ADG), CUP: E63C22000860006
D - Theory of Ultrafast phase transitions in quantum materials, (in connection with the financing) UE HE DELIGHT — ERC-2021-ADG), CUP: E63C22000860006 Teoria delle transizioni di fase ultrarapide in materiali con forti effetti quantistici (nell'ambito del finanziamento UE HE DELIGHT — ERC-2021-ADG), CUP: E63C22000860006

Scholarship A:

Topic	Photonic neural networks and their applications, CUP: E61I18001560005 Reti neurali fotoniche e loro applicazioni, CUP: E61I18001560005
Research group link	http://nanolab.physics.unitn.it/
Contacts	Prof. Lorenzo Pavesi lorenzo.pavesi@unitn.it
Synthetic description of the activity and expected research outcome	The research is about the design, testing and modeling of photonic integrated neural network for time series analysis and optical communication data equalization at more than 10 Gbps. The PhD student will characterize the device by using state of the art photonic components and will demonstrate the working principle of the same. The neural networks will be based on linear and nonlinear photonic components such as microring resonator and optical semiconductor amplifiers.
Ideal candidate (skills and competencies)	Previous experience in integrated photonics testing and modeling. Competences in modeling and computer programming (python programming, FEM and FDTD) are appreciated.

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Scholarship B:

Topic	Near Term Quantum Simulations for Nuclear Physics Simulazioni quantistiche nel breve termine per la fisica nucleare
Research group link	
Contacts	Prof. Francesco Pederiva, University of Trento, Italy (francesco.pederiva@unitn.it) Dr. Kyle Wendt, Lawrence Livermore NL, USA (wendt6@llnl.gov)
Synthetic description of the activity and expected research outcome	This fellowship is covered by funds from a subcontract between the Lawrence Livermore National Laboratory (LLNL) and the University of Trento on the development of near term quantum simulations for nuclear physics. The activity of the hired Ph.D. student is to develop the formalism, quantum algorithms and (classical) simulations software (Python scripts) for the co-processing of nuclear dynamics, and in particular the theory and mapping for direct, non-perturbative quantum simulations of neutron-proton scattering and possibly of three-nucleon systems. Calculations will be implemented on both on custom hardware developed at LLNL and in other US institutions (like for example the AQT at LBNL) and on standard quantum hardware. The activity will be carried out in strict contact with the LLNL research staff cooperating on the project. Besides weekly collaboration meetings, the student is supposed to spend substantial time at LLNL in order to work in close contact with the local group
Ideal candidate (skills and competencies)	The ideal candidate has a sound knowledge of basic quantum mechanics, and reasonable skills in standard programming. Some experience in quantum computing and/or nuclear physics during the M.Sc. curriculum might be considered as a preference, but are not strictly necessary

Scholarship C:

Topic	Theory of the electron-phonon interaction in magnetic systems with strong relativistic effects (in connection with the financing UE HE DELIGHT — ERC-2021-ADG), CUP: E63C22000860006 Teoria dell'interazione elettrone fonone in presenza di effetti magnetici e relativistici (nell'ambito del finanziamento UE HE DELIGHT — ERC-2021-ADG), CUP: E63C22000860006
Research group link	Materials theory group https://mattheory.physics.unitn.it/
Contacts	Matteo Calandra m.calandrabuonaura@unitn.it
Synthetic description of the activity and expected research outcome	In quantum mechanics we usually study that in a solid at rest the magnetic moment is due to the spin and orbital angular momentum of the electron (we do not consider the nuclear magnetic moments). However, our group has recently shown that the atoms, due to their vibrational motion, can carry a finite angular momentum that sums to the electron one, even if the solid is at rest. This can happen in magnetic systems with non collinear magnetism and strong relativistic effects due to the electron-phonon interaction. The theory of the electron-phonon interaction in metals and insulators in the presence of magnetism and strong relativistic effects has been only partially developed and applied to real materials. The goal of this PhD thesis is to develop the theory of the electron-phonon scattering in these conditions and to develop a practical calculation scheme to be applied to real materials
Ideal candidate (skills and competencies)	Curiosity and motivation. Excellent knowledge of quantum mechanics and solid state physics, basic knowledge of relativistic field theory. Excellent analytical and computational skills

Scholarship D:

Topic	Theory of Ultrafast phase transitions in quantum materials, (in connection with the financing) UE HE DELIGHT — ERC-2021-ADG), CUP: E63C22000860006 Teoria delle transizioni di fase ultrarapide in materiali con forti effetti quantistici s (nell’ambito del finanziamento UE HE DELIGHT — ERC-2021-ADG), CUP: E63C22000860006
Research group link	Materials theory group https://mattheory.physics.unitn.it/
Contacts	Matteo Calandra m.calandrabuonaura@unitn.it
Synthetic description of the activity and expected research outcome	Phase transitions and broken symmetry are interrelated and widespread in physics, mathematics, and engineering, fundamental to phenomena from superconductivity to the particle physics of the early universe. Broken symmetry with a phase transition means that the new state has a symmetry not shown by the system in its ground state. Ultrafast lasers can induce reversible and irreversible phase transitions but the theory to explain these phenomena is largely lacking. The candidate thesis plans to fill this knowledge gap, developing a theoretical strategy to predict and discover photoinduced phases in materials, building on top of previous achievements by our group. The results will guide future experiments and the rational development of novel materials and devices
Ideal candidate (skills and competencies)	Curiosity and motivation. Excellent knowledge of quantum mechanics and solid state physics. Excellent analytical and computational skills