Università di Genova

Andrea Amoretti

Fixed-term assistant professor

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Education and training

2016
PhD in Theoretical Physics
AdS/CFT correspondence and its applications - Excellent
University of Genoa - Genoa - IT

2012
Matser degree in Physics
3D Dynamics of 4D topological BF theory with boundary - 110/110 cum laude
University of Genoa - Genoa - IT

2010
Bachelor degree in Physics
Dyanamics of non-holonomic constraints - 110/110 cum laude
University of Genoa - Genoa - IT

Academic experience

2018 - ONGOING
Assistant professor (Ricercatore tempo determinato)
University of Genoa - Genoa - IT

2017 - 2018
Postdoctoral Research Associate
Universitè Libre de Bruxelles - Bruxelles - BE

2016
Postdoctoral Research Associate
University of Wuerzburg - Wuerzburg - DE

2015 - 2016
Postdoctoral research Associate
Univesity of Cambridge - Cambridge - GB

Language skills

English	French	Italian
Proficient	Independent	Mother tongue

Research interests

Strong field effects in BCS superconductors

The phenomenon of **superconductivity** has always been deeply connected with the study of elementary particle physics. In fact, the Anderson-Higgs mechanism, a cornerstone of the standard model, was originally proposed to describe the phase transition in a superconductor. The connection between superconductivity and particle physics is so deep that one can in principle map the superconductive dynamics in the dynamics of the Dirac equation describing Quantum Electrodynamics (QED). My interest in this respect is to characterize completely this not fully understood electrodynamics-superconductor analogy, and to use it to study how superconductivity is modified by the presence of a strong electric field, lifting the veil on the following unresolved questions: can a phenomenon analogous to the QED Schwinger effect (i.e. the creation from the vacuum of an electron-positron pair due to an intense electric field) be realized in superconductors? Can the presence of a strong electric field modify the superconductive behavior generating new physical phenomena? Can this new effects be used to project and build new technological devices?

Hydrodynamical description of strongly coupled materials

In modern language, **hydrodynamics** is an effective field theory in which the long lived foundamental degrees of freedom are (almost)-conserved currents, like the charge and the heat currents. This is the correct effective field theory to describe strongly coupled systems, in which there are no well defined microscopic particle-like degrees of freedom and the only long-lived modes are conserved currents dictated by the symmetries of the system. I use the powerful tools of hydrodynamic to build effective field theories useful to describe strongly coupled electronic materials, such as High Temperature superconductors.

Conformal field theories and their perturbations around the critical point

Conformal field theories are a very special class of Quantum Field Theories that are symmetric under scale transformations. In Statistical Physics they are particularly useful because they describe the critical point of second order phase transitions, where the correlation length of the system diverges restoring scale invariance. I use a combination of analytical methods, called **Conformal Perturbation Theory**, and numerical Montecarlo simulations to perturbe conformal field theories away from the conformal point and get insight in the behavior of physical systems in the vicinity of a second order phase transition.

Gauge/Gravity duality and strongly correlated systems

The Gauge/Gravity duality is a conjectured duality between certain strongly coupled regimes of ordinary quantum field theories and classical (i.e. weakly coupled) theories of gravity in at least one higher dimension. It is a new and extremely interesting tool to map difficult quantum field theory problems into easier classical gravitational ones. In particular my principal interest is to use this tool to analyse some states of condensed matter which are still not fully understood, such as **Unconventional Superconductors** and **Fractional Quantum Hall Effect**.

Topological Quantum Field Theories with boundary

Topological Quantum Field theories are Quantum Field Theories characterized by the nature of their observables. In fact, these peculiar theories have only global observables. In the past twenty years the study of these theories defined on a manifold with a boundary has gained a great physical relevance since they are used as effective field theories to model the behaviour of new and extremely interesting materials, whose phases cannot be described in terms of spontaneous symmetry breaking: **the topological states of matter**.

Grants

2020 - ONGOING

Curiosity driven Project

University of Genoa - IT

63000 euros - Pricipal investigator