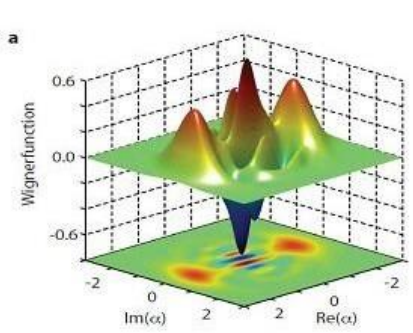
Proposta di Tesi Magistrale in Matematica

Indirizzo Applicativo

Relatore Prof. Omar MORANDI
Possibili collaboratori esterni: Dr. Giovanni MANFREDI (CNRS Strasburgo, Francia), Prof. Alfio BORZI (Università di Würzburg, Germania)
E-mail : omar.morandi@unifi.it

Title: Controlling quantum evolutions in the phase space



The precise control of a quantum state plays a central role in the development of new devices based on the quantum properties of matter. This research activity is stimulated by its potential applications to quantum computing and the design of new magnetic materials. One of the main technological challenges in this field concerns the possibility to address and control the quantum states of a magnetic nanomaterial.

Due to the complexity of the dynamics in a system of many interacting particles, it is useful to develop simple quantum models that capture the main physical properties of the system. Among the various possibilities, the descriptions provided by Wigner's phase-space representation and by Bohm's approach based on the pilot-wave mechanism, offer the possibility to interpret the quantum mechanics in a classical-like framework. Both approaches are promising to achieve control of the quantum dynamics.

In recent years, the research group at DIMAI and its two partners at Strasbourg and Würzburg universities, have obtained encouraging results in this area. The theoretical models will be solved numerically, and the results analysed in view of potential applications. Optimal control techniques constitute a well-established mathematical tool which has been successfully applied to the study of various physical models. However, little is known on the use of optimal control techniques to the Wigner and Bohm frameworks. The present internship will be a first step into this unexplored territory.

The long-term objective of this research is to compare the numerical results to experimental findings, with the aim of designing realistic devices in the fields of the quantum computation and spintronics.

In case of interest, the Thesis may be developed in partnership (cotutela) with the Universities of Würzburg or Strasbourg (CNRS), and a stage in such Institutes may be considered.

References

Omar Morandi, *On the connection between the Wigner and the Bohm quantum formalism*, Physics Letters A **443**, 128223 (2022).

J. Hurst, P.-A. Hervieux, G. Manfredi, *Phase-space methods for the spin dynamics in condensed matter systems*, Phil. Trans. Royal Soc. A **375**(2092), 20160199 (2017).

A Thomann, A Borzì, *Stability and accuracy of a pseudospectral scheme for the Wigner function equation*, Numerical Methods for Partial Differential Equations **33** (1), 62-87 (2017).