Project title:

Dynamical Resource for Multipartite Quantum Systems

Position:

PhD Student – scholarship

Number of positions: 1

City: Toruń

Website: https://www.fizyka.umk.pl/en

Requirements

Candidates must hold a Master's degree in physics, mathematics, or a related field, with a solid background in quantum mechanics and basic knowledge of quantum information theory. Good knowledge of linear algebra and familiarity with operator methods are expected. Basic knowledge of open quantum systems and experience with scientific programming (e.g., Python, Julia, or MATLAB) are desirable. Candidates should demonstrate analytical thinking, motivation for theoretical research, willingness to develop new mathematical and computational skills, and the ability to work both independently and as part of an international research team. Good communication skills in English are required.

Description of duties

The PhD student will conduct theoretical and numerical research on the dynamics of multipartite entanglement in open quantum systems. The work will focus on understanding how entanglement evolves under noise, how long it remains useful for quantum communication, and how it can be detected through algebraic invariants and temporal correlations.

The student will initially develop the necessary theoretical background and contribute to the study of entanglement criteria for quantum states and channels. Subsequently, the student will investigate selected Markovian and non-Markovian noise models, implement numerical simulations, and analyse the evolution of entanglement. In the later stages, the student will contribute to the development and numerical testing of dynamical entanglement witnesses based on multi-time correlations.

The research will be carried out under the supervision of the Principal Investigator, in collaboration with the postdoctoral researcher and senior co-investigators. The student will also participate in scientific meetings, prepare research publications, present results at conferences.

Tasks

1. Assessment of entanglement criteria and dynamical quantum models. Study algebraic invariants, entanglement distillability, and representative quantum channels, identifying suitable mathematical tools and physical models for the project.
2. Implementation of numerical methods for open quantum systems. Develop and test computational routines for simulating multipartite quantum dynamics and evaluating entanglement indicators under local and collective noise.
3. Analysis of dynamical entanglement and temporal correlations. Investigate entanglement lifetimes, noise-induced decay and revivals, and the relationship between algebraic invariants and multi-time quantum correlations.
4. Verification of dynamical entanglement witnesses. Numerically test selected entanglement criteria and temporal witnesses, evaluate their performance under realistic noise conditions, and contribute to the interpretation and publication of the results.

Competition type: SONATA 21

Field of science: ST

Application deadline: 20.12.2026 23:59

Application form: email to giosca@umk.pl

Employment conditions:

A scholarship in the amount of PLN 3000 per month.
Planned period of employment: 12 months from 01.02.2027, to 31.01.2028

Additional information:

The scholarship is awarded in accordance with the rules set out in the Regulations on the Award of Research Scholarships of the National Science Centre, adopted by Resolution No. 72/2025 of the Council of the National Science Centre dated 11 September 2025.

Required documents (send zip file to : giovanni.scala@umk.pl with annotation "SONATA21_PhD_NameSurname" :

- Cover letter
- CV
- Copies of obtained diplomas and certificates (if any)
- Copy or scan of candidate's publications (if any)
- Information about scientific awards, scholarships and other distinctions (if any)

- Description of current research activity (if applicable)
- Consent to the processing of personal data
  (EN):https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fwww.umk.pl%2Fen%2Fjobs%2Fdocs%2Fen_os4.docx&wdOrigin=BROWSELINK
  PL: https://www.fizyka.umk.pl/panel/wp-content/uploads/Zalacznik-bez-tytulu-00016.pdf
- Certificate of PhD student

Applicants will be evaluated by a selection committee appointed by the Dean of the Faculty of Physics, Astronomy and Informatics. The committee will recommend the awarding (or rejection) of the scholarship no later than 28.12.2026 r.
Candidates will be notified of the outcome of the competition by e-mail.
In the event of resignation of the selected candidate, the right to indicate the next candidate from the ranking list is reserved.
All documents should contain the candidate's signature or its scan.
Language of application: Polish or English.