

**PhD research topic proposal**  
**BME, Doctoral School of Mathematics and Computer Science**

**Name of supervisor :**

Orsolya Kálmán

**Degree:**

PhD

**Title of the topic:**

Nonlinear protocols for quantum information processing

**Short description:**

Quantum information processing is a promising field for applications for computation, simulation as well as communication, where the quantum mechanical evolution provides a clear advantage over classical methods. The usual assumption in quantum information theory is that the time evolution of the physical systems is linear. If this constraint is relieved, and a nonlinear equation governs the dynamics of the system, then – in principle – one could design quantum protocols, which could efficiently solve problems that are hard even for usual quantum algorithms. The linearity of the evolution may be changed if one considers quantum measurements and selection from an ensemble according to the result. Then, the effective time evolution will be described by complex rational functions, and thus, the dynamics will possess convergent and chaotic regimes. Elements of such nonlinear protocols have successfully been tested in photonic experiments. They might also be implemented on existing quantum computer platforms.

In the proposed PhD topic we aim at studying how such nonlinear quantum dynamics could be harnessed for quantum information processing tasks, algorithms, and computations due to their inherent sensitivity to the initial conditions, and their possible tolerance to initial noise. The research will involve the mathematical analysis of complex rational functions and classical numerical/quantum simulations of iterative nonlinear quantum evolution .

**Requirements:**

linear algebra, coding in a scientific programming language, prior knowledge in quantum theory is an advantage

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**Place of work:**

Dept. of Quantum Optics and Quantum Information, Wigner Research Centre for Physics

**Statement:** *The conditions of the research above are satisfied, the theme is confirmed by the Head of the Department/Institute*