Project 5.3. Practical and theoretical aspects of near-term quantum computers

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WWW: https://nisq.eu/ , group manager page: http://quantin.pl/

Background:

In recent years, we have witnessed extremely rapid technological development in the field of quantum computing. Until recently, quantum computing was mainly the domain of theoretical considerations, relatively distant from practical applications. However, with the increased involvement of the industry (IBM, Google, Rigetti and many others), it has become possible to build prototypes of quantum computers consisting of up to several dozens of qubuts. However, these machines intrinsically consist of non-ideal elements and traditional error correction techniques cannot be implemented there to mitigate the errors. It is then a huge challenge is to understand the computational capabilities and potential practical applications of such devices and prototypes of quantum computers that will be available in the near future.
The "Quantum computers of the near future: challenges, optimal implementations and applications" project implemented under the Team-Net grant awarded by the Foundation for Polish Science, aims to tackle exactly with these problems The project will be realized by four closely cooperating research groups from Warsaw (CPT PAN), Gliwice (IITiS PAN) and Kraków (Faculty of Physics, Jagiellonian University). Proposed doctoral positions will be implemented in a research group led by dr Michał Oszmaniec in CTP PAN.

Aim:

Depending on the qualifications and competences of the candidates, we propose the following topics of doctoral projects:
- certification and characterization of prototypes of quantum computers in order to develop effective methods of reducing errors on these devices.
- application of generalized quantum measurements (POVMs) in new quantum algorithms and development of methods for their effective implementation on prototypes of quantum computers.
- mathematical foundations of quantum computing (effective compilation of quantum gates, universal quantum computation, new quantum supremacy schemes, classical simulation of noisy quantum computations)

Requirements:

- interest in the practical or mathematical aspects of quantum computers
- at least basic knowledge in the field of quantum information theory and quantum computing
- optionally (not all skills are required at the same time):
    - programming experience (C ++, Python or Matlab),
    - experience in programming on quantum computers (Qiskit, Forest)
    - basic knowledge of mathematical physics (e.g. representation theory of Lie groups and Lie algebras, operator theory)
- a M.Sc degree in physics or other field related to the scope of the project
- interest in the subject and motivation for academic work.