

Author: Jakub Jan Borkała

Supervisor: Dr hab. Marcin Pawłowski

Applications of Quantum Random Access Codes in Quantum Information.

In recent years, Random Access Code (RAC) has become an important research tool in the field of quantum information theory. This protocol is used for a wide range of applications such as quantum key-distribution, quantum randomness certification, self-testing, tests of nonclassicality and many others. Some of them will be discussed in detail in this dissertation and references will be found for many others. RAC is also a useful tool for studying the foundations of quantum mechanics from the perspective of information processing with the use of quantum resources. Information and the laws that govern it are inscribed in the basic structure of nature. Therefore, a better understanding of the information processing, what is possible in this process and what is not, may be classified as research in the field of foundations of quantum mechanics. The goal of this doctoral dissertation is to familiarize the reader with the details of the RAC protocol in various contexts of the quantum information and to sketch future development opportunities. In the presented work, we also introduce a few mathematical tools that are arranged in such a way that it may be helpful to start working with a topic of RAC. This work also aspires for being a review source about RACs, that might give a reader a general landscape of possible applications of that protocol. The main results discussed in detail in this dissertation are the issue of searching for Mutually Unbiased Bases in dimension 6, self-testing of unsharp measurements in dimension 2 and generalization of the RAC protocol for to arbitrary number of parties. In all these results, Random Access Code is a key element.

References

- [1] Edgar A. Aguilar, Jakub J. Borkała, Piotr Mironowicz, Marcin Pawłowski; *Connections between Mutually Unbiased Bases and Quantum Random Access Codes*. Phys. Rev. Lett.; 121,5 2018
- [2] Nikolai Miklin, Jakub J. Borkała, Marcin Pawłowski; *Self-testing of unsharp measurements*. arXiv: 10903.12533; 2019
- [3] Debashis Saha and Jakub J. Borkała; *Multiparty Random Access Codes* European Physical Society: G41725/B19913