

Pre- and post-selection paradoxes in quantum walks

Tomasz Kopyciuk, Mikołaj Lewandowski and Paweł Kurzyński

Faculty of Physics, Adam Mickiewicz University in Poznań,

*Uniwersytetu Poznaskiego 2, 61-614 Poznań, Poland**

Many features of single-partite quantum walks, such as ballistic spreading, can be simulated by classical light. In fact, classical light is often used in quantum walk experiments to test the setup before it is fed with single photons. Therefore, are single-partite quantum walks fundamentally classical? The answer would seem affirmative if such models were not used to construct quantum algorithms (see Grover-like search algorithms). So where is the quantumness? One way to look for it is to try to construct tests based on Bell-like inequalities and to show that quantum walk gives rise to natural measurements whose outcomes violate these inequalities. It was recently experimentally shown that some temporal sequences of measurements on a quantum walker violate temporal Bell-inequalities (Leggett-Garg inequalities). Here, we extend this observation and present pre- and post-selection scenarios in quantum walks leading to logical paradoxes. Such paradoxes were recently shown to be equivalent to proofs of contextuality, therefore we provide an additional argument for non-classicality of a quantum walk model.

References

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- [1] T. Kopyciuk, M. Lewandowski, P. Kurzyński, *New J. Phys.* **21**, 103054 (2019)

*Electronic address: pawel.kurzynski@amu.edu.pl