Project: Self Testing

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Self-testing is a procedure used in quantum cryptographic protocols to obtain a certification of quantum states without having to trust the measuring apparatus—a so-called device-independent certification. All devices involved in the experiment are treated as black boxes, and self-testing aims to recover the form of the state providing certain measurement correlations. A condition for self-testing quantum states can be the maximal violation of some Bell inequalities, or reproduction of a full set of measurement correlations. Hypothesis is that every set of measurement correlations which self-tests some quantum state also maximally violates some Bell inequality.

The aim is of the project to find relation between these two self-testing conditions, i.e. to find Bell inequalities which are maximally violated by measurement correlations which self-test a corresponding quantum states. In particular, the aim is to relate the Mayers–Yao self-testing condition to some Bell inequality.

When this is done, the students could look for a way to generalise Mayers–Yao self-testing condition to larger classes of entangled states. The student are expected to use semidefinite programming (SDP) techniques

Bibliography:

- On self-testing in general:
  Ivan Šupić and J. Bowles, "Self-testing of quantum systems: a review", *Quantum* **4** 337, 2020. arXiv:1904.1004

- On Mayers–Yao's self-testing:
  Dominic Mayers and Andrew Yao, "Self testing quantum apparatus", Quantum Info. Comput., 4:273, 2004. arXiv:quant-ph/0307205

- On Bell inequalities:
  N. Brunner, D. Cavalcanti, S. Pironio, V. Scarani, and S. Wehner, "Bell nonlocality." *Rev. Mod. Phys.* **86** p. 419, Apr 2014. arXiv:1303.2849