BELL'S THEOREM AND THE DEMONSTRATION OF QUANTUM NONLOCALITY IN NOISY ENVIRONMENTS

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Paraphrasing N. D. Mermin, contemporary physicists come in two varieties: either they are bothered by EPR and Bell's theorem, or they missed the point [1]. In my Bachelor Thesis, *Bell's theorem and the demonstration of Quantum Nonlocality in noisy environments* (supervised by Julio de Vicente), we studied the effects of simple noise models on the violation of the CHSH inequality by maximally entangled states.

Different noise models affecting both the state or the measurement were studied and the violation of the CHSH inequality was evaluated using the result derived in [2]. In the case only our state is affected by noise, we discuss what measurements maximize the violation as a function of the noise parameters and the possible strategies to increase the parameter range in which we witness the violation. We find that, in the cases we studied, all measurement strategies will give the expected value of the Bell operator as linear functions of the noise parameter, limiting the cases in which we can find a strategy demonstrating nonlocality in the whole range where it would be achievable.

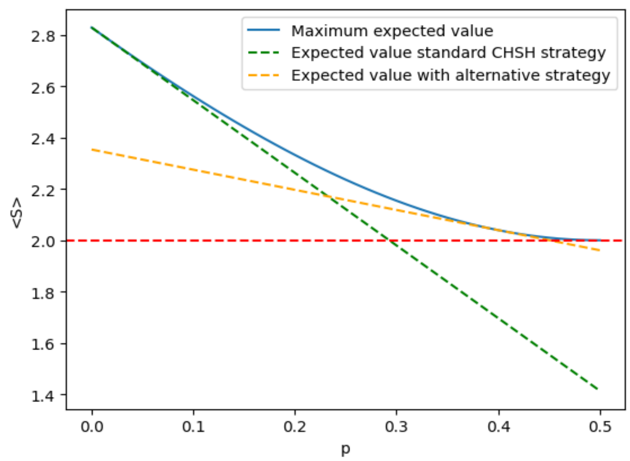

Figure 1 – Expected value of the CHSH Bell operator for a maximally entangled two-qubit system affected by the bit flip channel. The different curves show the maximum possible expected value and the one obtained using different measurement strategies as a function of the noise parameter p.

References:

[1] Mermin, N. D., 1985. Is the moon there when nobody looks? Reality and the quantum theory. Physics Today 38(4), pp.38–47.
[2] Horodecki, R., Horodecki, P. and Horodecki, M., 1995. Violating Bell inequality by mixed spin-12 states: necessary and sufficient condition. Physics Letters A, 200(5), pp.340–344.