Test of Bell/CHSH

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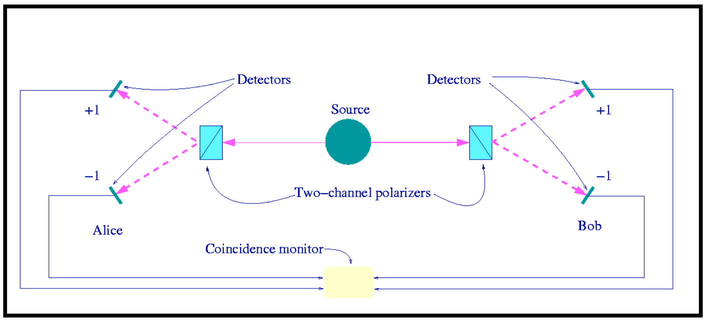
In the "Experiment: Classical fields masquerade as quanta", the Bell/CHSH inequality was violated with classical fields, which until then was considered an indicator for a successful QM experiment. The false positive result raises questions.

In the current paper, the Bell/CHSH mathematics is tested with artificially generated classical and quantum data, respectively.

1. Introduction

Typical QM experiments with photons are often based on a two-part topology.



The source generates photons with random polarization angles which fly to the left to an arbitrarily distant laboratory ("Alice"). At the same time, the source generates photons with an orthogonal polarization angle and sends them to the right, equally distant laboratory ("Bob").

The rest (polarizers, detectors, coincidence monitor including Bell/CHSH statistics) is to compare the polarization angles of these photons arriving simultaneously at "Alice" and "Bob" and distinguish quantum from classical correlations.

In the paper "Experiment: Classical fields masquerade as quanta" [Stu23] it was shown that false positives can also be generated with classical fields. In this paper the reason for this is searched.

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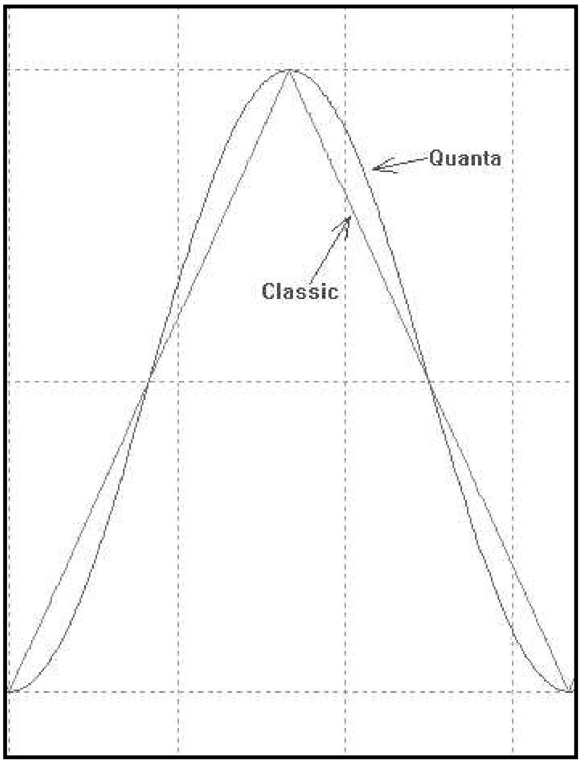
2. Principle of the test



There are several ways to generate photons with fixed differences of polarization angles.

One can split a laser beam and rotate it with polarizers. The angular comparison of the photons generated in this way can at best give the linear "classic" curve.

In quantum mechanics, one can generate twin photons with a nonlinear crystal. Their angular comparison ideally yields the nonlinear „quanta“ curve.

With the exception of the source, all elements of the experiment are combined as an electronic simulation. This system is fed with artificially generated angular differences. The angle differences are converted into normalized voltages according to the two functions "classic" and "quanta".

The simulation calculates S-values from this. The test of the system is successful if it can distinguish classical and quanta data.

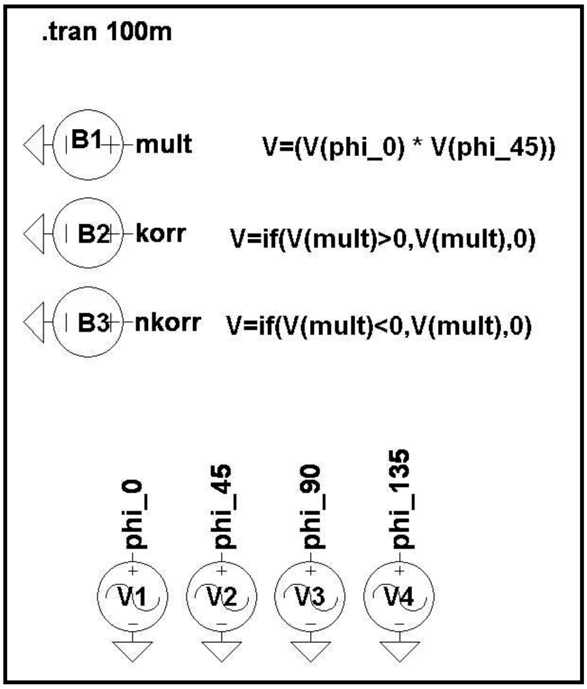
3. *Development of the simulation*

The basis for the new simulation can be found in [Stu23] . One needs the CHSH formulas:

$$E(\alpha,\beta) = \frac{C(\alpha,\beta) - C(\alpha^{\perp},\beta) - C(\alpha,\beta^{\perp}) + C(\alpha^{\perp},\beta^{\perp})}{C(\alpha,\beta) + C(\alpha^{\perp},\beta) + C(\alpha,\beta^{\perp}) + C(\alpha^{\perp},\beta^{\perp})}$$

$$S = E(\alpha,\beta) - E(\alpha,\beta') + E(\alpha',\beta) + E(\alpha',\beta')$$

And the simulation to determine an expected value:

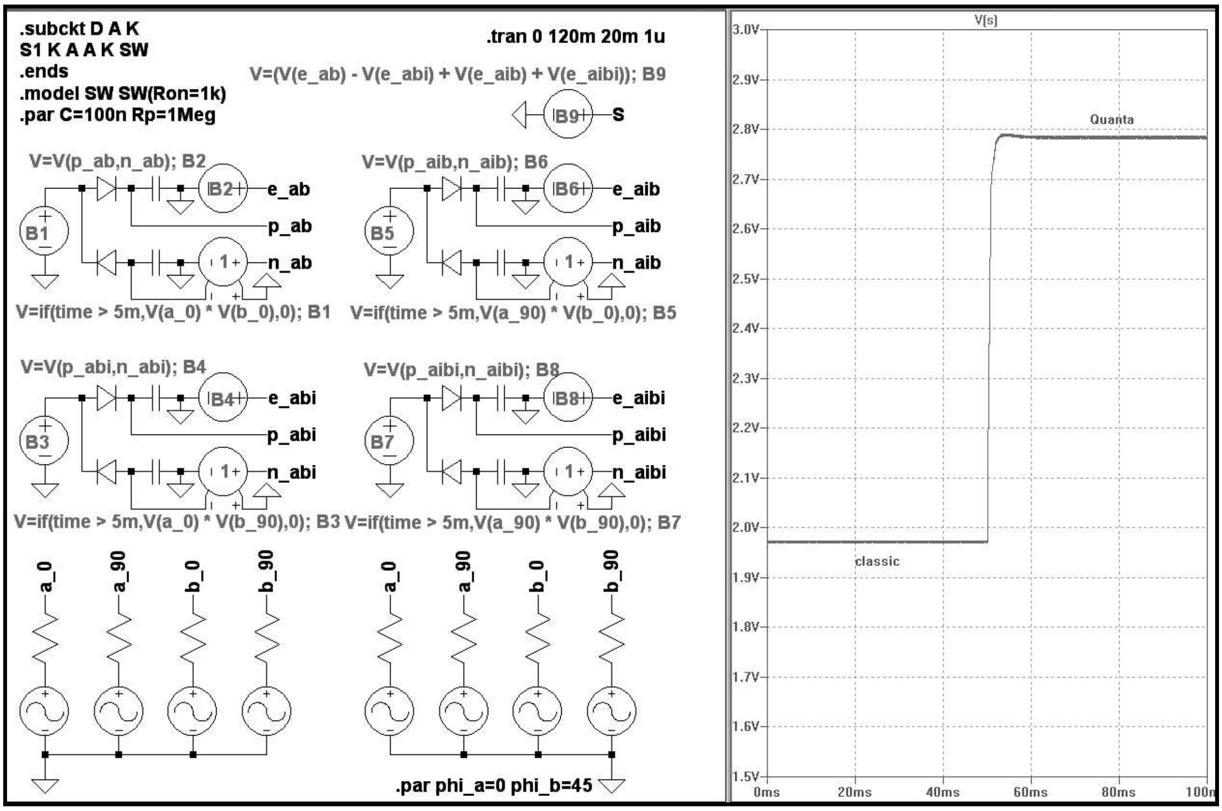


The simulation requires the following extensions:

- Additionally four linear correlation functions as data sources.
- Automatic switching between classical and QM input data
- Calculation of all four expected values
- Calculation of the S-value

4. Test of Bell/CHSH

In the simulation, the S values are plotted on the right as a function of the input data. With classical correlations the result is S < 2. And with quantum correlations the result is S > 2.



5. Conclusion

The successful test proves that Bell/CHS statistics works perfectly. And it proves in reverse that everything was applied and simulated correctly.

Obviously, in the real experiment with classical fields [Stu23] correlations were generated which are not different from quantum correlations.

The whole principle of such entanglement experiments is therefore to be questioned.

[Stu23] Wolfgang Sturm: Experiment: Classical fields masquerade as quanta 2023, https://vixra.org/abs/2302.0109