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Analysis of a recent experiment seemingly favouring local realism against quantum mechanics

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Abstract. A recent experiment by Brida et al. [Eur. Phys. J. D **44**, 547 (2007)] is analyzed with the conclusion that the results disagree with standard quantum predictions but fit a simple local hidden variables model. New experiments are proposed which might throw new light on the anomaly.

PACS. 42.50.-p Quantum optics – 03.65.Ud Entanglement and quantum nonlocality (e.g. EPR paradox, Bell's inequalities, GHZ states, etc.)

1 Introduction

A recent experiment by Brida et al. [1] has shown a violation of an inequality which I derived [2] for a restricted, but sensible, family of local hidden variables (LHV) theories. The empirical results, however, also violate the quantum predictions. Thus it is worth studying more carefully the implications of the experiment, which is the purpose of the present paper.

As is well-known, many experiments have been performed in the attempt to discriminate between quantum mechanics and LHV theories via tests of Bell's inequalities [3]. The experiments have agreed with quantum mechanics in general, but none of them has provided a conclusive, loophole-free, refutation of the whole family of LHV theories. This is due to the fact that genuine Bell inequalities, derived from locality and realism alone, are extremely difficult to test [4]. Actually all Bell-type experiments performed till now have tested inequalities derived from local realism plus some additional assumptions. Thus the violation of the inequalities has refuted restricted families of LHV theories, namely those fulfilling the auxiliary hypotheses. In the early experiments the additional assumption was "no enhancement" [6], and the experiments provided a clear empirical refutation of that family. Later on, for about 25 years beginning with the Aspect experiments [7], the most popular assumption has been "fair sampling". LHV theories with fair sampling have been clearly refuted by many experiments. For instance Brida et al. [1] report a violation by 48 standard deviations (see their Eq. (15)). However the fair sampling assumption excludes a priori all sensible LHV theories [4] and it has been empirically refuted [5]. Therefore the rebuttal of those LHV theories has not too much relevance. For this reason I have started [2] the search for Bell type inequalities derived from local realism plus some assumptions more reasonable than fair sampling able to provide tests of restricted, but sensible, families of LHV theories.

I shall consider specifically experiments measuring polarization correlation of optical photon pairs like the one performed by Brida et al. [1]. In the experiment a source produces photon pairs, each member of the pair traveling along one of two possible paths, each path ending in an analyzer-detector system (named Alice and Bob, respectively). If the polarization planes of the analyzers are determined by the angles ϕ_1 and ϕ_2, respectively, the results of the experiment may be summarized in two single rates, $R_1(\phi_1)$ and $R_2(\phi_2)$, and a coincidence rate $R_{12}(\phi_1,\phi_2)$. The detection rates divided by the production rate, R_0, not measurable in the experiment, are the detection probabilities that is

$$p_j(\phi_j)=\frac{R_1(\phi_1)}{R_0},\qquad p_{12}(\phi_1,\phi_2)=\frac{R_{12}(\phi_1,\phi_2)}{R_0},\tag{1}$$

which are the quantities to be calculated from the theory, either a LHV model or quantum mechanics. Following Bell, a LHV model consists of three functions, $\rho(\lambda), P_1(\lambda,\phi_1), P_2(\lambda,\phi_2)$, where λ stands for one or several hidden variables, such that the detection probabilities could be obtained by means of the integrals

$$p_j(\phi_j)=\int\rho(\lambda)P_j(\lambda,\phi_j)d\lambda,$$
$$p_{12}(\phi_1,\phi_2)=\int\rho(\lambda)P_1(\lambda,\phi_1)P_2(\lambda,\phi_2)d\lambda.\tag{2}$$

The essential requirements of realism and locality imply that the said functions fulfil the conditions

$$\rho(\lambda)\geq 0,\qquad \int\rho(\lambda)d\lambda=1,\qquad 0\leq P_j(\lambda,\phi_j)\leq 1.\tag{3}$$

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The experiment is compatible with local realism if there exists a LHV model reproducing the results of the experiment, that is if one may find three functions ρ, P_1, P_2 and a rate, R_0, such that the results, R_1, R_2 and R_{12} are reproduced by equations (1) and (2). In particular, for the proof of compatibility it is not necessary to make any analysis of the source or the analyzer-detectors systems, which may be taken as "black boxes". Also we should not make any assumptions about the signals produced in the source, the word "photon" being here just a short for "signal of whatever nature produced in the source and able to propagate, until its arrival to Alice or Bob, with velocity not higher than that of light". For later convenience I shall label $LHV0$ the whole family of local hidden variables theories (in Bell's sense, i.e. defined by Eqs. (1)–(3)).

2 A simple, but sensible, family of local hidden variables theories

The restricted family of theories which I have proposed elsewhere [2] reduces λ to a set of just two angular hidden variables, that is $\lambda \equiv \{\chi_1, \chi_2\}$, where χ_1 (χ_2) is a polarization angle of the first (second) photon of a pair, thus χ_j and $\chi_j + \pi$ representing the same polarization. In addition I assume a specific dependence of $\rho(\chi_1, \chi_2)$ and $p_j(\chi_1, \phi_j)$ so that Bell's equations (2) and (3) become

$$p_{12}(\phi) = \int \rho(\chi_1 - \chi_2) P(\chi_1 - \phi_1) P(\chi_2 - \phi_2) d\chi_1 d\chi_2, \tag{4}$$

$$p_j = \int \rho(\chi_1 - \chi_2) P(\chi_j - \phi_j) d\chi_1 d\chi_2, \; j = 1, 2, \tag{5}$$

$$\rho(x) = \rho(-x) \geq 0, \quad \int \rho(x) dx = 1/\pi, \\ 0 \leq P(x) = P(-x) \leq 1. \tag{6}$$

(The normalization of ρ fulfils Eq. (3) if we integrate over both hidden variables, χ_1 and χ_2.) I shall label $LHV1$ the restricted family defined by equations (4)–(6). Thus $LHV1 \subset LHV0$.

The main inequality derived for the family $LHV1$ is [2]

$$\Delta_{\exp} \equiv \left\{ \frac{1}{n} \sum_{k=1}^{n} \left[\frac{R_{12}(\phi_k)}{\langle R_{12} \rangle} - 1 - V \cos 2\phi_k \right]^2 \right\}^{1/2} \geq D(\eta, V), \tag{7}$$

where $\phi_k = \pi k/n$, $k = 1, 2...n$, stands now for the difference between the polarization angles ϕ_1 and ϕ_2, of Alice and Bob respectively. The detection efficiency η enters in the model as the ratio between twice the coincidence detection rate, $R_{12}(\phi)$, averaged over angles, and the single rate $R_1 \simeq R_2$ or their mean if $R_1 \neq R_2$ (assuming that the single rates do not depend on the angles ϕ_j, as is usual) and V is the visibility of the cosinus curve predicted by quantum mechanics for the function $R_{12}(\phi)$. The function $D(\eta, V)$ provides a lower bound for the deviation between the local models of the family $LHV1$ and quantum mechanics. It has the dependence

$$D(\eta, V) = \frac{8\sqrt{2}}{3\pi} \sqrt{\frac{2}{3\eta} - \frac{1}{2} - \frac{\sin^4(\pi\eta/2)}{(\pi\eta/2)^4}} \varepsilon^3 + O(\varepsilon^4), \\ \varepsilon \simeq \frac{1}{\sqrt{2}} \left(V - \frac{\sin^2(\pi\eta/2)}{(\pi\eta/2)^2} \right)_+^{1/2} \quad \text{if } \varepsilon \ll 1 \tag{8}$$

where $(.)_+$ means putting zero if the quantity inside the bracket is negative. In practice V may be obtained from the best cosinus fit to the empirical coincidence detection rates, that is

$$\langle R_{12} \rangle = \frac{1}{n} \sum_{k=1}^{n} R_{12}(\phi_k), \qquad \eta = \frac{4 \langle R_{12} \rangle}{R_1 + R_2}, \\ V = 2 \frac{\sum_{k=1}^{n} R_{12}(\phi_k) \cos 2\phi_k}{n \langle R_{12} \rangle}, \tag{9}$$

the latter equality defining "best fit" in the commented paper [2].

Equations (7) and (8) are valid for $\varepsilon \ll 1$ but the exact equations (31), (34) and (38) of my paper [2] should be used, rather than the approximation to lowest order in ε, if ε is not small. That is ε should be obtained from the following exact equation

$$\frac{\pi - 2\varepsilon + \sin(2\varepsilon)\cos(2\varepsilon)}{\cos(2\varepsilon)\left[\pi - 2\varepsilon + \tan(2\varepsilon)\right]} = V \frac{(\pi\eta/2)^2}{\sin^2(\pi\eta/2)}. \tag{10}$$

Also if ε is not small the expression of $D(\eta, V)$, equation (8), is not valid but an accurate lower bound exists of the form

$$D(\eta, V) \geq \frac{\sqrt{2}\sin^3(2\varepsilon)}{3\left[(\pi - 2\varepsilon)\cos(2\varepsilon) + \sin(2\varepsilon)\right]} \frac{\sin^2(\pi\eta)}{(\pi\eta)^2}. \tag{11}$$

(See Eq. (39) of my paper [2].) It is interesting that the bound is not accurate if $\varepsilon \ll 1$, so that equation (8) is more appropriate in that case.

According to equation (9) the quantity η corresponds to the overall detection efficiency, taking into account all kinds of losses in lenses, polarizers, etc. But in typical experiments, including the one by Brida et al. [1], the quantity η so defined is rather small, with the consequence that the inequality (7) is very well fulfilled. Thus in typical experiments there are models of the family $LHV1$ which are compatible with quantum mechanics so that, in order to get reliable tests, I propose a more restricted family which I shall label $LHV2$. It is defined by equations (4)–(6) plus a "partial fair sampling" assumption which applies to lenses, filters, etc. *but neither to polarizers nor to detectors* (see my paper [2], the non-idealities of polarizers will be studied in the Discussion section). This means that the quantity η to be used in the inequality (7) should be the one given by equation (9) divided by the product $f_1 f_2 ..... f_s$, where 1, 2, ...s correspond to the different devices inserted between the source and the detectors, like lenses, filters or even the medium which transmits the photons, and f_l is the fraction of photons that are *not* absorbed in the corresponding device. In practice this procedure is equivalent to using for η the quantum efficiency of the detectors themselves, to be measured in auxiliary experiments. (Actually we should use for η the product of the quantum efficiency times the parameter a introduced in Eq. (21) below, but I may take $a = 1$ here.) Obviously the new family includes a restriction with respect to the one defined by equations (4)–(6), that is $LHV2 \subset LHV1$.

3 Analysis of the results of the experiment by Brida et al.

Now I shall study the specific experiment by Brida et al. [1]. The results of the experiment are summarized in Table 1 (not published in the report of the experiment; I acknowledge the authors for providing me with this valuable information).

From these data, using a detection efficiency $\eta = 0.62$ and equation (8), the authors [1] report a violation of the inequality (7) by 3.3σ. But, as said above, the expression equation (8) is valid only for relatively low efficiency. (I apologize for not having made this point more clear in my article [2].) In the experiment of Brida et al. ε is not small and, consequently, equations (10) and (11) should be used whence I obtain $\varepsilon = 0.578$ which, for $\eta = 0.62$ and the value equation (16) for V, leads to $D \geq 0.048$. This value gives rise a violation of the inequality (7) even stronger than the one reported [1].

However the value 0.62 for the parameter η may be questioned by the following reasons. The commented experiment [1] belongs to a class where half of the photons produced in the source are excluded by a post-selection procedure. In fact the two photons of every pair outgoing from a non-linear crystal are collinear and a non-polarizing beam splitter is inserted in order to produce two different beams. With this procedure only half the photon pairs are used for the measurement of the polarization correlation, namely those such that the two photons of the pair travel in different beams. Experiments of this kind have been performed since long ago [9] but there has been some controversy about whether they actually allow tests of Bell's inequalities [10]. Indeed by the nature of the source only half the photons produced belong to pairs going to different detectors (that is one to Alice and the other one to Bob) so that the effective overall detection efficiency cannot be larger than 50%, that is much lower than the minimum required for the violation of a (genuine) Bell inequality [4]. Actually experiments of this type *do allow* Bell tests, but only if a two-channel analyzer followed by two detectors is used by Alice and similarly by Bob, so that all photons might in principle be detected [11]. In the experiment by Brida et al. [1] Alice and Bob possess only one detector each so that the compatibility with local models like the one defined by equations (4) and (5), must be studied using a parameter η with a value just *half the quantum efficiency of the actual detectors*. Indeed the ratio between twice the average coincidence rate and the single rate would be half the quantum efficiency at most, the maximum taking place if there were no losses between the source and the detectors. Thus the tests of the family $LHV2$ for the said experiment [1] via equation (7) should be studied using $\eta = 0.31$.

Alternatively the experiment might be interpreted by assuming that photons are particles and that the effect of the beam splitter is to divide the ensemble of photon pairs arriving at it (coming from the non-linear crystal) into three subensembles consisting respectively of photon pairs going: (1) both photons to Alice, (2) both to Bob, (3) one of them to Alice and the other one to Bob. Within this (corpuscular) model of light it is appropriate to ignore the single rates due to photons such that both members of the pair go to Alice or both to Bob, which are precisely half of the photon pairs produced in the source. Thus we might consider LHV models involving only the photon pairs of the third subensemble. The subfamily of local models included in $LHV2$ with the additional restriction that photons are treated as particles, in the sense above explained, will be labelled $LHV3$. For the tests of this family we should use an efficiency $\eta = 0.62$ in the inequality (7) to be compared with the efficiency $\eta = 0.31$ for the tests of the wider family $LHV2$.

A subfamily of $LHV3$ may be obtained using, in equations (4) and (5), a specific distribution, $\rho(\chi_1 - \chi_2)$, for the two hidden variables of the models. A possibility is the function

$$\rho(x) = \frac{1}{\pi^2}\left[1 + (1+\gamma)\cos(2x) + \gamma\cos(4x)\right], \gamma \in \left[0, \frac{1}{3}\right], \tag{12}$$

which was studied elsewhere [8]. I shall label $LHV4$ the subfamily of $LHV3$ which involves the distribution equation (12). In summary I have defined a hierarchy of families of local models

$$LHV0 \supset LHV1 \supset LHV2 \supset LHV3 \supset LHV4. \tag{13}$$

Tests of the family $LHV0$ require the so-called loophole-free experiments, which seem far in the future. The family $LHV1$ cannot be tested without the knowledge of the single detection rates, but we may safely claim that it is not refuted by the experiment of Brida et al. Indeed the value of η derived from equation (9) would be very small. In contrast the family $LHV4$ has been clearly refuted. In fact, an inequality derived from equation (12) [8] has been violated by more than 11σ [1]. Also the family $LHV3$ has been refuted by more than 3.3σ, as said above. It remains the question whether the family $LHV2$ has been refuted, which requires a more careful analysis made in the following.

If we use an effective efficiency $\eta = 0.31$ (appropriate for the test of the family $LHV2$ via inequality (7)), the function $D(\eta, V)$ may be obtained from equation (8) because the parameter ε has the value $\varepsilon = 0.1820$, which is low enough for the approximations involved being valid. Indeed the exact equation (10) gives $\varepsilon = 0.1825$. (These values of ε are obtained using $V = 0.9897$ got from

Table 1. Coincidence rates vs. angle amongst polarizers.

ϕ (deg)	0	22.5	45	67.5	90	112.5	135	157.5
R_{12} (ϕ)	9906.2	8439.6	4936.6	1454.1	108.0	1481.3	4983.5	8499.2
ΔR_{12}	21.0	18.6	13.6	9.0	8.2	11.9	14.1	19.0

Eq. (9).) Thus equation (8) leads to

$$D = 0.0065 < \Delta_{\text{exp}} = 0.0074, \tag{14}$$

that is the inequality (7) of the family $LHV2$ is fulfilled. (The exact lower bound equation (11) is now $D \geq 0.0052$, also smaller than Δ_{exp}) However the fact that the inequality (7) is not violated does not guarantee that the experimental results of Table 1 are compatible with models of the family $LHV2$. An explicit proof of compatibility would require that the data of Table 1 may be fitted to a particular model of the family, which is made in the following. For comparison I shall check firstly whether the data fit the quantum-mechanical predictions.

Quantum mechanics predicts a cosinus curve of the form

$$R_{12}(\phi_j) = \langle R_{12} \rangle \left[1 + V \cos(2\phi_j + \psi)\right], \tag{15}$$

where the phase ψ is included in order to take account of any possible error in the measurement of the angle between polarizers. A chi-squared fit to the results of Table 1 gives

$$\langle R_{12} \rangle = 4973, \quad V = 0.9872, \quad \psi = 0.31(\text{deg}), \tag{16}$$

with $\chi^2 = 63.2$. The quantum prediction, equation (15), contains 3 free parameters, but ψ is so small that almost not change is produced using the ideal value 0. Thus we may consider just 2 free parameters, whence the fit may be considered to have 6 degrees of freedom. In any case the value of χ^2 is so high that we may safely claim that the data of Table 1 are incompatible with the curve equation (15). *This shows a clear disagreement with the quantum predictions*, which may be also seen from the value

$$\begin{aligned} \frac{V_B}{V_A} &= 1.0205 \pm 0.0048, \\ V_A &\equiv \frac{R_{12}(0^\circ) - R_{12}(90^\circ)}{R_{12}(0^\circ) + R_{12}(90^\circ)}, \\ V_B &\equiv \sqrt{2}\frac{R_{12}(22.5^\circ) - R_{12}(67.5^\circ)}{R_{12}(22.5^\circ) + R_{12}(67.5^\circ)}, \end{aligned} \tag{17}$$

reported by Brida et al. [1]. It violates the standard quantum prediction $V_A = V_B$, derived from equation (15), by more than 4σ. In the final section I shall discuss whether the disagreement might be interpreted as a true violation of quantum mechanics. It is interesting to point out that the main deviation of the data from the cosinus curve equation (15) comes from a too high value of the coincidence detection rate at $\phi = 90^\circ$, that is when the polarization planes of the analyzers are perpendicular.

The model of the family $LHV2$ which is most close to the quantum prediction, equation (15), gives a deviation from the best cosinus fit of the form (see Eqs. (32) and (37) of my paper [2])

$$\begin{aligned} \delta(\phi) &= \langle R_{12} \rangle \alpha \left[\beta \cos(2\phi) - 1\right] + \langle R_{12} \rangle \gamma(\phi), \\ \alpha &\equiv \frac{8\varepsilon^3}{3\pi}, \quad \beta \equiv 2\frac{\sin^2(\pi\eta/2)}{(\pi\eta/2)^2}, \\ \gamma(\phi) &= \frac{2\alpha}{\eta^2}\left(\eta + \frac{2}{\pi}|\phi| - 1\right)_+, \end{aligned} \tag{18}$$

where ε was defined in equation (8), $\phi \in \left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$ and $()_+$ means putting 0 if the quantity inside brackets is negative. It is easy to see that the deviation with respect to the quantum prediction, equation (18), corresponds precisely to an increase of the coincidence detection rates when the polarization planes of the analyzers are at angles close to 90°. As said above with $\eta = 0.31$ the parameter ε is small enough to allow working at order $O(\varepsilon^3)$ and the sum of the cosinus curve equation (15) plus the correction equation (18) may be rewritten

$$R_{12}(\phi_j) = \langle R_{12} \rangle \left[1 + V\cos(2\phi_j) + \frac{16\varepsilon^3}{3\pi\eta^2}\left(\eta + \frac{2}{\pi}|\phi| - 1\right)_+\right], \tag{19}$$

where the first term of equation (18) is absorbed in new values of $\langle R_{12} \rangle$ and V, slightly different from the ones used in the quantum equation (15). This is the prediction of a local model of the family $LHV2$ which contains 2 adjustable parameters, V and $\langle R_{12} \rangle$, ε being related to V and η by equation (8). A chi-squared fit of equation (19) to the data of Table 1 gives

$$\langle R_{12} \rangle = 4945, \quad V = 1.0087, \tag{20}$$

with $\chi^2 = 10.8$. This value of χ^2 for 6 degrees of freedom is low enough to allow claiming that *the results of Table 1 are compatible with the family LHV2* of local hidden variables models.

4 Discussion

In summary the results of the experiment by Brida et al. [1], shown in Table 1, are compatible with a simple family of local models but not compatible with the standard predictions of quantum mechanics. The latter conclusion is so striking that it deserves further discussion.

The main question is whether the disagreement with quantum predictions is real or it is due to errors in the experiment. The latter possibility seems supported by the fact that many performed Bell-type experiments have confirmed quantum mechanics. Consequently I must study whether the experiment by Brida et al. is peculiar, in the sense of being specially suited for the discrimination between quantum mechanics and local realism. The truth is that indeed the experiment is special because it has achieved for the first time a value of the parameter V_B, equation (17), extremely close to unity combined with a relatively high quantum efficiency, η, of the detectors.

In order to make the comparison with other optical tests of Bell's inequalities, I begin looking at the non-idealities of polarization analyzers. In fact a high value of V_B may be obtained only using analyzers with very low transmittance for light polarized perpendicular. It is well-known that when a plane polarized beam of light arrives at an analyzer the fraction of intensity transmitted depends on the angle, ϕ, between the polarization planes of light and analyzer according to Malus law

$$\frac{I_{out}}{I_{in}} = (a-b)\cos^2\phi + b, \qquad 0 \lesssim b \ll a \lesssim 1, \tag{21}$$

where a and b are the transmittances for light parallel and perpendicular, respectively. If two photons maximally entangled in polarization arrive at two similar analyzers followed by one detector each, the quantum prediction for the joint coincidence detection probability has the form of equation (15) (with $\psi = 0$) the visibility V being [12]

$$V = \left(\frac{a-b}{a+b}\right)^2 \simeq 1 - 4b, \tag{22}$$

and the parameter V_B, equation (17), is equal to V. The value of b is usually not smaller than 0.01 in typical polarization analyzers and, in addition, there are depolarizing effects which tend to diminish the parameter V_B. As a consequence the value of V_B in standard experiments lies between 0.85 [6] and about 0.95 [13] (actually the quoted papers do not report V_B as defined in Eq. (17) and the values which I give derive from the reported data assuming the validity of Eq. (15)).

The relevance of high values of V_B for the discrimination between quantum mechanics and the family of local models $LHV2$ may be illustrated with the following simple example. I will compare the predictions of the quantum equation (15) and the local model equation (19) for the probabilities of coincidence detection at the angles 22.5°, 67.5° and 90°. If we consider detection efficiencies $\eta \leq 0.25$ the calculations become quite simple because the last term of equation (19) is zero for the angles 22.5° and 67.5° so that $V = V_B$. In addition the approximate expression equation (8) may be used for ε, which may also be written to order $O(\eta^2)$, that is

$$\varepsilon \simeq \frac{1}{\sqrt{2}}\left(V_B - 1 + \frac{\pi^2\eta^2}{12}\right)^{1/2}. \tag{23}$$

Thus the quantum and LHV predictions corresponding to the angle $\phi = 90°$ are

$$r_Q \equiv \left[\frac{R_{12}\,(90°)}{\langle R_{12}\rangle}\right]_Q = 1 - V_B,$$
$$r_{LHV} \equiv \left[\frac{R_{12}\,(90°)}{\langle R_{12}\rangle}\right]_{LHV} \simeq 1 - V_B + \frac{0.60}{\eta}\left[\left(V_B - 1 + 0.82\eta^2\right)_+\right]^{3/2}. \tag{24}$$

Discrimination between quantum mechanics and the family $LHV2$ requires $r_{LHV} \neq r_Q$, that is

$$V_B + 0.82\eta^2 > 1. \tag{25}$$

This inequality has been derived for a detection efficiency $\eta \leq 0.25$ but we may plausibly extrapolate it until $\eta = 0.31$, which is the value appropriate for the commented experiment [1]. For that η a value $V_B > 0.92$ is needed, but even with $V_B \simeq 0.95$ the discrimination would be difficult, because $r_{LHV} - r_Q \ll r_Q$. In contrast for the commented experiment [1], where $V_B = 0.9985$, the LHV prediction, r_{LHV}, is as high as 30 times the quantum one, r_Q, making the discrimination easy. We conclude that rather stringent conditions are needed in order to distinguish between quantum mechanics and the family of local models $LHV2$, e.g. values of η and V_B fulfilling the inequality (25) when $\eta < 0.25$. In particular the use of analyzers with very small transmittance for perpendicular polarizer light, parameter b in equation (21), is necessary. These conditions had never been achieved until the recent experiment by Brida et al. Indeed as far as I know only one polarization correlation experiment has ever been performed with analyzers possessing very small transmittance for perpendicular polarized light, namely the old experiment by Holt and Pipkin [12] where $b < 0.0001$. The results of that experiment also violated quantum mechanics.

These facts support the view that the experiment by Brida et al. [1] has been the first one to allow a real discrimination between quantum mechanics and a sensible family of local hidden variables theories. The results of the experiment favour local realism against quantum mechanics, but the conclusion might be flawed if there are errors in the interpretation of the data. For instance a mistake in the background subtraction of accidental coincidences might produce an increase or decrease in the rates of Table 1. The change could be negligible for all rates in the table except $R_{12}(90°)$ which, being rather small, may suffer a most important modification.

I conclude that, in order to discard or confirm the seemingly violation of quantum predictions, new experiments are needed which should combine a relatively high detection efficiency with the use of polarization analyzers possessing an extremely small transmittance for light polarized perpendicular.

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