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Proposed Einstein-Correlation Experiment with a Timelike Separation of Detections.

O. COSTA DE BEAUREGARD

Laboratoire de Physique Théorique
Institut Henri Poincaré - 11 rue P. et M. Curie, 75005 Paris.

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What is paradoxical, with the Einstein (1) or EPR (2) correlation between measurements at P and Q upon subsystems with a previous common origin at S, is that, due to Born's rule of adding partial amplitudes rather than probabilities, it is definitely not at S « when shaken in the cup », but at P and Q « when they stop rolling on the table », that « the dice are cast », *and* that nevertheless they are correlated! This entails that, between the measurements at P and Q, there exists not only a « telediction » as was the case with the classical probability calculus, but also some sort of paradoxical « teleaction » (3).

In all of the experiments that have been devoted to the problem up to now the separation between the measurements at P and Q was spacelike. It is necessarily such with two freely flying photons (4), but it could (in principle) be made timelike with massive particles, as in the Saclay experiment (5). Also in this case, quantum mechanics predicts the existence of an Einstein correlation, and it is no less paradoxical than in the usual case because, the correlation being symmetric in P and Q, some sort of « retroaction » of the later measurement (say Q) upon the earlier one (say P) is then implied.

It would certainly be interesting to test experimentally this point. This may not be too easy in the form just mentioned, but, as it seems, there is a way out of the difficulty.

Coming back (fig. 1) to the case of correlated photons leaving the source S in opposite directions in the laboratory frame, one of the two beams may be folded back by means of a mirror, so that the two detectors are side by side. Denoting ΔL the dif-

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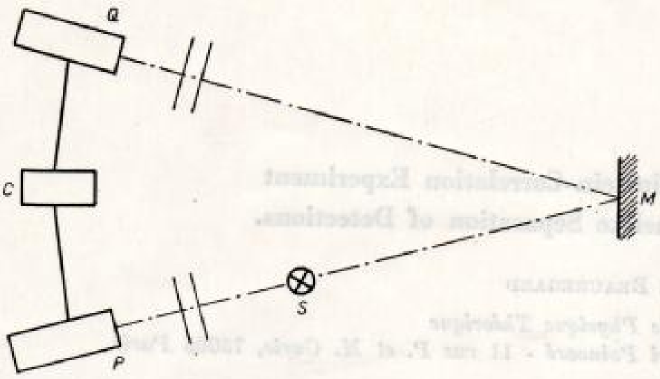

Fig. 1. – Sketch of the correlation experiment with a timelike separation between the detection events: S: source of cascading atoms; M: mirror folding back one of the two beams; P, Q: detecting devices (linear polarizer and photomultiplier); C: coincidence counter with an adjustable time delay.

ference in lengths of the two beams (between source and detectors) and l the spatial straight distance between the detectors, the condition that the two detection events have a timelike separation is obviously $l < \Delta L$—which is easily feasible.

For obvious reasons, the linear polarization of the folded beam would be chosen either parallel or perpendicular to the incidence plane upon the mirror, while that of the straight beam could be arbitrarily chosen. Also, the time delay ΔT between the two coincidence counters could be arbitrarily adjusted, so as to display the transition between the old probability law (addition of partial probabilities) when $\Delta T \neq \Delta L/c$, towards the new one (addition of partial amplitudes) when $\Delta T = \Delta L/c$.

If the quantum mechanical prediction is again vindicated under these conditions, the *law of invariance of the correlation by arbitrary translations of the two measuring devices along the beams*, already well substantiated experimentally (6), will be extended through the light cone. This would strengthen the already existing argument against the various hypotheses or *direct* interaction put forward by D'ESPAGNAT (7), VIGIER and CUFARO-PETRONI (8), but in favour of my hypothesis (9) and Stapp's (10) of indirect interaction via in a Feynman zigzag, which I have recently expressed in the S-matrix formalism (11).

An adaptation of Aspect's (12) experimental procedure tantamount to turning a polarizer while the photon is flying could also be considered, this being then done at Q rather than at P.

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