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EXPERIMENTS PERFORMED AT THE LAWRENCE BERKELEY LABORATORY BEARING RELATION TO BELL'S INEQUALITY

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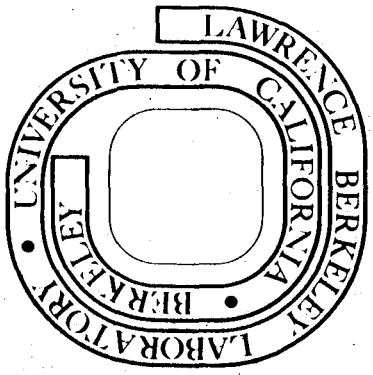

DISCLAIMER

EXPERIMENTS PERFORMED AT THE LAWRENCE BERKELEY LABORATORY BEARING RELATION TO BELL'S INEQUALITY†

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This paper described a series of experiments performed at the Lawrence Berkeley Laboratory. Kocher and Commins, here performed the first polarization correlation measurement using optical photons.[1] In it they measured the polarization correlation with relative polarizer orientations at 0^{o} and 90^{o}, and used inefficient polarizers. As a result, this experiment gave no evidence concerning the predictions made by Bell's Theorem.[2] However, the experiment was useful in two respects. (1) It developed technology for subsequent experiments, and (2) its results refuted Furry's hypothesis.[3]

The second experiment described was that of Freedman and Clauser.[4] It measured the polarization correlation in the same J=0-1-0 cascade of calcium as that of Kocher and Commins, but used efficient pile-of-plates polarizers with relative orientations other than 0^{o} and 90^{o}. Indeed, the experiment was specifically performed to test the predictions made by Bell's Theorem.[2] To a high degree of statistical accuracy it refuted these,[5] while simultaneously confirming the quantum-mechanical predictions for this two-photon system.

The next experiment described was one performed by Clauser.[6] It used the Hg cascade of Holt and Pipkin,[7] and attempted to observe the anomalous results observed by them. Contrary to their findings, however, good agreement with quantum mechanics and a strong violation of the Bell's Theorem prediction was observed.[5]

In a further experiment[8] the same apparatus was used to measure the simultaneous circular-polarization correlation of these photons. To do this, quarter-wave plates were installed (with axes perpendicular to the exciting electron beam) ahead of the

polarizers. Reasonable agreement with the quantum mechanical predictions was obtained. Unfortunately, the marginal quality of these quarter-wave plates prevented the results from violating Bell's inequality. None the less, the results did violate a new inequality by Garuccio and Selleri[9] which holds for systems described by "state vectors of the first kind" (and/or Furry's hypothesis).

The last experiment described was one which was performed as an indirect test of whether or not photons act in a manner consistent with the notion that they propagate as localized objects.[10] The results give further credibility to the mild assumptions needed for the cascade-optical-photon experiments. Surprisingly, this was the first experiment capable of telling whether or not a single photon is split at a beam splitter. That is, can it produce only one photoionization on one side or the other of the splitter, but never on both sides at once? To implement this, the Cauchy-Schwarz inequality was used to constrain coincidence rates between four photomultiplier tubes. These viewed an atomic cascade through two beam splitters.

The results indicate that the notion of localized "particle-like" photons is consistent with experiment, and that such entities evidently do not split, at least with regard to their detectability.

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