

Bell Tests with Photons

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The idea that the random nature of quantum mechanics might be determined by some unknown or “hidden” variables was shattered by Bell’s inequality. This inequality constrains all such theories, provided they obey Einstein-locality and give the possibility to calculate the state of a system at all times. The theory of quantum mechanics violates Bell’s inequality, and thus many experiments were conducted with the purpose of disproving hidden-variable-theories and measuring violations of Bell’s inequality. According to quantum mechanical predictions, polarization-entangled photon pairs are a good experimental instrument to obtain a strong violation. In the experiments, two detectors measure the polarization of each of the photons in several different measurement angles to each other. The sum of the correlations of these polarization measurements is expected to violate Bell’s inequality. The yet conducted experiments left two loopholes for hidden-variable-theories open due to the lack of efficiency and space-like separation of the detectors which are needed quantities to achieve a violation of the Bell Inequality. Nonetheless, both loopholes have been closed in experiments, and recent developments promise a simultaneous closing soon.