Amplification

Many associate quantum measurements with an act of amplification. For example, if one intends to measure a single photon that is registered in the classical domain in a macroscopic manner, amplification is often used. Devices that might be hypothesized to be bona fide measurement devices include, for example, a photographic film or a photo-avalanche detector, both of which utilize methods of amplification when a single photon impinges on the device. Hence it is a reasonable question as to whether or not amplification is a necessary and sufficient condition for measurement.

Discerning Amplification

A fundamental tool in the experimental area of quantum information is the use of a non-linear quantum optical phenomenon known as spontaneous parametric down conversion (SPDC). This is achieved by using a crystal to split a single photon from a pump beam into two photons commonly referred to as the signal and idler in a manner that conserves energy and momentum. SPDC can be considered a simple form of amplification in which a single photon is input and two photons are output. Such down conversion has been demonstrated to be in agreement with the unitary prediction in numerous experiments. Many experiments akin to amplification have been conducted. For example, in the paper [200] two photons were produced by parametric down conversion and one of these photons impinged on a metal plate. The photon that was absorbed by the plate created a number of surface plasmons that propagated to the other side of the plate at which time they recombined to release a photon. It was found that it was possible that the photon that was re-emitted was found to exhibit a Bell correlation and therefore entanglement with the original photon. This shows that such conversion to a number of plasmons and subsequent re-emission was not enough to measure the photon.

Due to the numerous experiments that have been conducted using SPDC and the verification of the unitary prediction which violates Bell's inequalities, it can be considered to be a scientifically validated conclusion that there exist amplification mechanisms that are not measurement devices. Hence amplification does not appear to be a sufficient condition for measurement. Whether or not amplification is a necessary condition for measurement is unknown at this time.