3.3 A general approach to quantum inspired amplification using strange weak values

A recent development involves the exploitation of weak measurements as a new method of amplification.

Amplification is a recurring theme in all of science and communication and is immensely important for security and military application. Signals are often classically enhanced by having the detector in a meta-stable state such that small external perturbations trigger a large detectable response. This is not our object of study here nor the resonant amplification of signal within a known frequency band by properly tuned circuits/devices.

Consider again the impossibly- large-spin experiment. From one perspective, it raises a question about the spins true value. But one can also regard it as an amplification effect. For all the particles in the pre-and post-selected ensemble, the pointer of the measuring device moves much further than in a conventional measurement.

In 2008, Onur Hosten and Paul Kwiat used that technique to amplify the displacement of a laser beam by a factor of ten thousand. That allowed them to measure displacements of 0.1 nm and thus confirm the existence of the quantum Hall effect for light. And last year, Ben Dixon, Andrew Jordan, John Howell and coworkers, using a Sagnac ring interferometer, were able to detect mirror displacements on the order of the order of 10 fm. The main point of the amplification method is that it offers a new kind of compromise between amplification and noise that may prove useful in many applications.

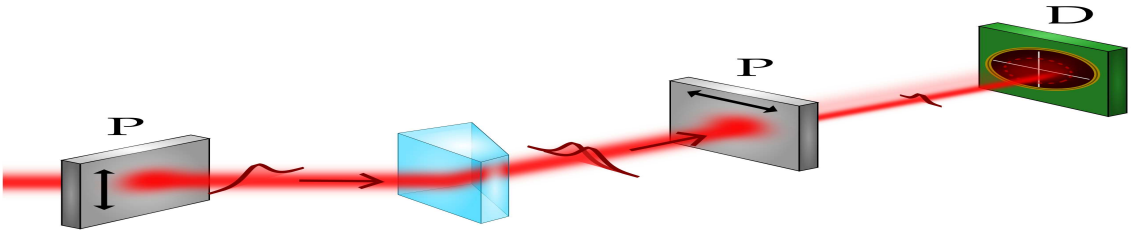

Figure 9: Amplifying the quantum Hall effect for light by weak measurement with pre- and post-selection. The QHE produces a tiny lateral displacement of the light beam whose direction depends on the whether the light is left- or right-circularly. The beam undergoes the displacement while traversing the prism sandwiched between two polarizers. The polarizers, almost but not completely crossed, perform the pre- and post-selection. As a result of those selections, the detector sees a beam thats much fainter but has a much greater QHE displacement.