Minimally Disturbing Measurement

Minimally disturbing measurement, back-action evading measurement (BAE), non-disturbing measurement, and non-demolition measurement, are all classes of measurements that are designed to minimize in some manner the disturbance of the measurement.

As noted previously, a POVM given by elements $E_k \equiv {M_k}^\dagger M_k$ also could have the same elements as a second POVM E_k but of the form $E_k = {\widehat{M}_k}^\dagger \widehat{M}_k$where $\widehat{M}_k \neq M_k$. That is, it is possible that the measurement instruments are different corresponding to the idea that there exist multiple ways of performing a measurement with the same POVM elements.

Consider a generalized Lüder's implementation $\mathcal{E}_k^L(\varrho)$ whereby $M_k = {E_k}^{1/2}$. In such a case $E_k = {M_k}^\dagger M_k = {\widehat{M}_k}^\dagger \widehat{M}_k$. Wiseman et al. [186] refers to the generalized Lüder's measurement as a minimally disturbing measurement since one can always decompose an arbitrary operator $\widehat{M}_k$ via the polar decomposition theorem according to $\widehat{M}_k = U({\widehat{M}_k}^\dagger \widehat{M}_k)^{1/2}$, whereby $({\widehat{M}_k}^\dagger \widehat{M}_k)^{1/2}$ is unique. Hence $\widehat{M}_k = UM_k$ .The fidelity between the initial state and final average state is also found to be maximized when $M_k = {E_k}^{1/2}$ [663]. $\widehat{M}_k$ requires an operation *U* that, provides additional back-action beyond that required to implement ${E_k}^{1/2}$.