# Nonclassical superposed coherent state as a pointer state in postselected weak measurements

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Aharonov, Albert, and Vaidman [1] proposed the weak measurement theory which is the generalized form of the von Neumann quantum measurement theory. Weak measurement has several applications in the field of observation of very small effects such as beam deflection, frequency shifts, phase shifts, angular shifts, velocity shifts and temperature shifts. Weak value is a complex number leading to the weak measurements as an ideal method to test the fundamental aspects of the quantum physics [2] like quantum paradoxes, quantum correlation and quantum dynamics, quantum state tomography, violation of the generalized Leggett-Gard inequalities and violation of the initial Heisenberg measurement-disturbance relationships [2]. Turek et. al [3] investigated the advantages of non-classical pointer states over semi-classical ones for the coherent, squeezed vacuum and Schrodinger cat states. We investigate the advantage of ‘superposition of Fock state, $|\mathrm{n}\rangle$, with the Schrodinger cat states’ (abbreviated as SFSCS), taken in the form $|\psi\rangle = \mathrm{N}\left(|\alpha\rangle + \left|e^{i\theta}\alpha\right\rangle + \gamma|\mathrm{n}\rangle\right)$ where, $\gamma$ is a superposition constant, N is the normalization constant with $\mathrm{N}^2 = 1/\left(2 + 2\exp(|\alpha|^2(\cos\theta - 1))\cos(|\alpha|^2\sin\theta) + 2(\gamma\exp(-|\alpha|^2/2)|\alpha|^{\mathrm{n}}/\sqrt{\mathrm{n}!})(\cos \mathrm{n}\varphi + \cos n(\varphi + \theta)) + |\gamma|^2\right)$. The coherent state, $|\alpha\rangle$, is the eigenstate of the annihilation operator ($\hat{a}$): $\hat{a}|\alpha\rangle = \alpha|\alpha\rangle$ with $\alpha = |\alpha|e^{i\varphi}$. We utilize this state as a pointer state for the system operator $\hat{\mathrm{A}}$ with $\hat{\mathrm{A}}^2 = \hat{I}$, where $\hat{I}$ represents the identity operator, and we calculate the ratio between the signal-to-noise ratio (SNR) of non-postselected and postselected weak measurements. We focus on the postselected weak measurement process to calculate the quantum Fisher information in which we find that the postselected weak measurement scheme for our proposed state is superior under some conditions of $\gamma$. Therefore, the proposed SFSCS state can improve the precision of a measurement process.

**References:**

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