Mechanical Rotation Generates Non-local Quantum Entanglement

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In recent years, advances in photonic technologies have enabled the investigation of quantum mechanical phenomena in non-inertial frames by combining Sagnac interferometer with two-photon sources. In this regard, mechanical rotation has been shown to modify quantum interference effect in a Hong-Ou-Mandel interferometer [1], transform the manifestation of entanglement by showing transformation from bosonic behaviour into fermionic behaviour and vice versa [2] and by revealing and concealing entanglement [3]. In this work, we propose a fibre based Sagnac interferometer scheme to generate a mechanical rotation induced non-local quantum entanglement between two independent single photons [4]. We quantify the degree of entanglement by calculating the Bell-CHSH inequality and we find that the degree of entanglement depends on the rotation frequency, reaching the maximal value of $2\sqrt{2}$ at specific frequencies (**Fig 1(b)**). Moreover, we find that even without any post-selection, the generated states violate the Bell-CHSH inequality for certain rotation frequencies reaching a maximal value of $1+\sqrt{2}$, indicating strong quantum non-locality (**Fig 1(b)**). The scheme is resilient to noise and imperfections, owing to the inherent nature of the Sagnac interferometer (**Fig 1(a)**). Furthermore, the required experimental parameters fall comfortably within the range of current photonic technologies, which makes the experimental implementation of the scheme feasible. So, in summary, we show that mechanical rotation can generate a tuneable source of quantum entanglement.

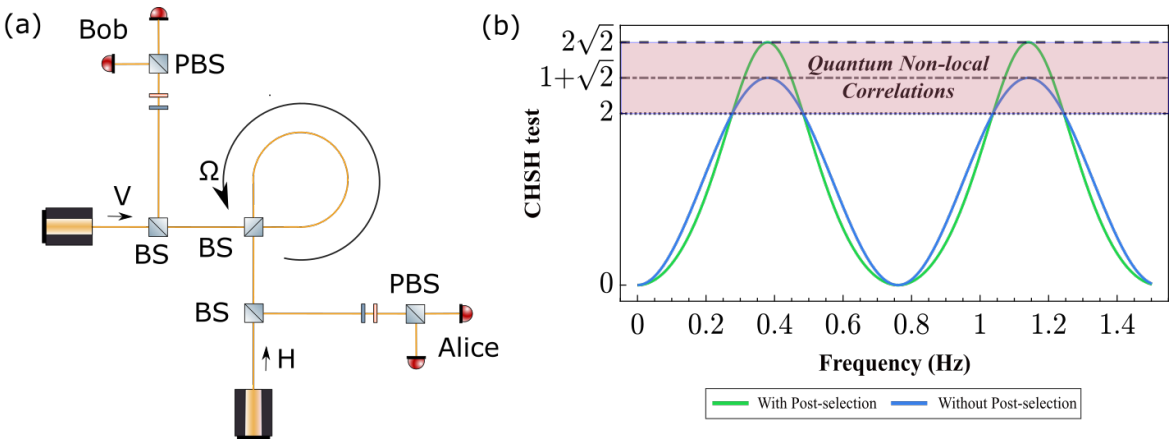

Fig. 1: ***a) Proposed photonic experimental setup to generate non-local entanglement b) Theoretical prediction of Bell–CHSH inequality violation as a function of rotational frequency.***

References

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