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Quantum integrated nonlocal sensing of dynamic object

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In recent years, the application of quantum technology for imaging and information acquisition of objects has emerged as a prominent and extensively studied topic among researchers [1]. Several well-established technical solutions in this field include ghost imaging [2] utilizing parametric photon position correlation, as well as imaging with undetected photons [3] exploiting path identity. Spiral imaging is an efficient technique for extracting information about an object by analyzing its orbital angular momentum (OAM) spectrum. The fusion of spiral imaging with quantum methods has demonstrated its capability to compressively perceive the shape of symmetrical objects [4]. However, existing literature has not yet provided sufficient evidence to showcase the specific capabilities and advantages of this approach for asymmetric complex objects. Therefore, there is a need for further research to explore and elucidate the potential applications of this approach in the context of asymmetric complex objects.

Recently, a groundbreaking concept known as quantum nonlocal integrated sensing of dynamic object was recently proposed by researchers from Xi'an Jiaotong University [5]. This innovative approach leveraged a fusion of spiral imaging and correlated OAM states to facilitate the recognition of objects with arbitrary shapes. Moreover, they introduced a quantum correlated rotational Doppler effect to achieve nonlocal sensing of the rotational speed of a dynamic object. By analyzing the correlation OAM matrix between signal photons passing through the object and idle photons at the measurement end, they successfully identified sector apertures with varying opening sizes. Notably, their approach circumvented the requirement of measuring the photons passing through the object, providing a significant advantage for applications in challenging measurement scenarios. This achievement was accomplished by establishing a fitting relationship between experimental findings and theoretical simulations.

This study represents another successful application that utilizes the abundant information contained within the dimensionality of OAM, enabling the method to extract data at rates surpassing 1 bit per photon. Such a capability surpasses the limitations of conventional pixel-by-pixel imaging techniques and introduces a novel approach for information extraction. This study represents a crucial milestone in the pursuit of practical implementation of high-dimensional quantum nonlocality, offering significant potential to enhance the appeal of quantum technology for real-world applications.

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