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Quantum Search for Gravitational Wave of Massive Black Hole Binaries

Matched filtering is a common method for detecting gravitational waves. However, the computational costs of searching large template banks limit the efficiency of classical algorithms when searching for massive black hole binary (MBHB) systems. In this work, a quantum matched filtering algorithm based on Grover's algorithm is applied to the MBHB signals. It is demonstrated that the quantum approach can reduce the computational complexity from $O(N)$ to $O(\sqrt{N})$ theoretically, where N is the size of the template bank. Simulated results indicate that the quantum-enhanced approach significantly reduces computational costs. However, it is also found that the performance can degrade in some cases due to instability of the algorithm. This highlights the need for more robust and stable quantum search strategies. This paper is accepted by PRD.

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