Poster

Measurement Induced Enhancement in Ergotropy

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Advancements in quantum thermodynamics and quantum information have driven the exploration of quantum batteries, aiming to harness quantum effects for enhanced energy storage and extraction [1,2]. Ergotropy, which quantifies the maximum extractable work from a quantum system, plays a central role in this endeavor [3,4]. In this study, we investigate measurement-assisted work extraction protocols, specifically focusing on the role of generalized measurements (POVMs) in enhancing ergotropy under certain conditions [5,6]. While POVMs can, in principle, maximize

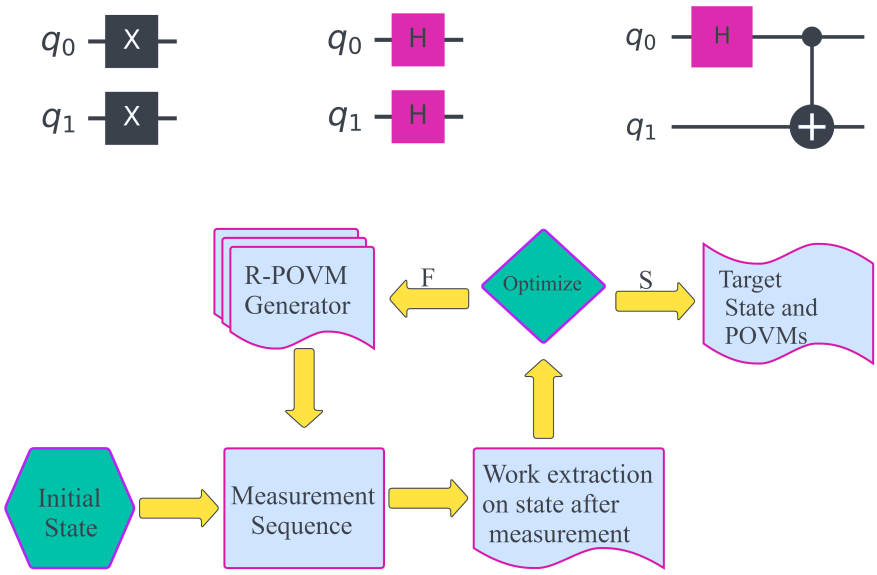

Figure 15: (Top) Circuit implementation of 3 cases of initial states considered for the protocol. (Bottom) Schematic diagram of POVM protocol to optimize gain.

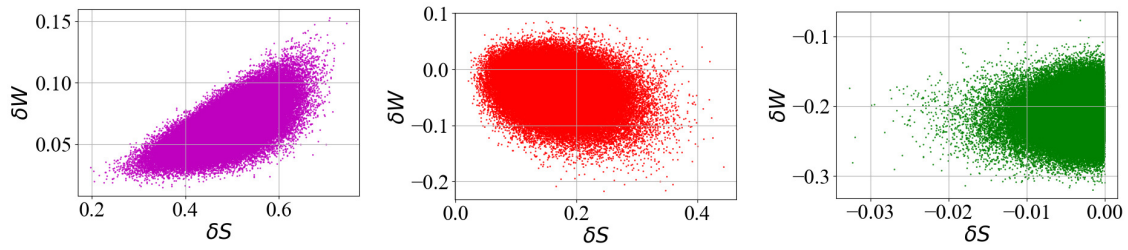

Figure 16: Scatter plot of δW vs δS (change in entropy after POVM protocol) for XX case (magenta), HH case (red), and Bell state (green).

work extraction, identifying an optimal measurement strategy for a given system remains a significant challenge. Additionally, depending on the initial state, some

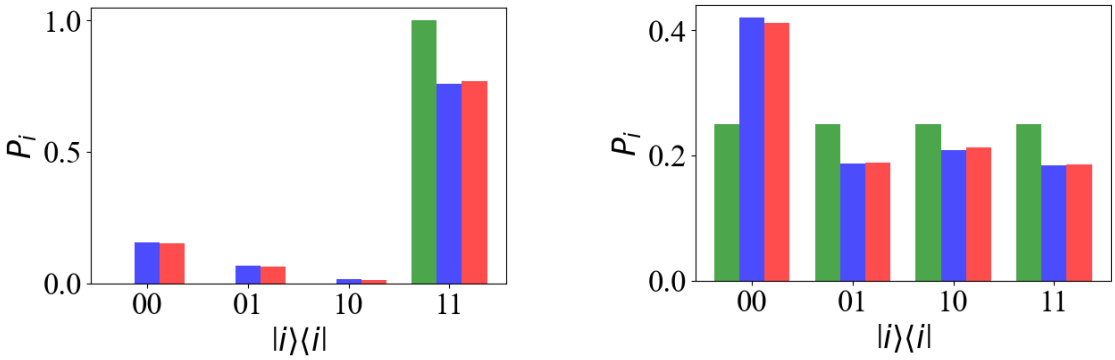

Figure 17: Occupational probability in the computational basis of state without optimization (green) and with optimized POVM protocol (theory-blue, simulations-red) for XX (left) and HH cases.

systems may not exhibit any improvement through measurement-based protocols. To address this, we introduce a Randomized POVM protocol, which enables the identification of an optimal set of generalized measurements tailored to a specific system. Our results indicate that the relationship between correlations and gain or loss in ergotropy is highly dependent on the choice of the initial state. By optimizing for maximum enhancement in ergotropy, we determine the most effective measurement strategy. Finally, we implement the optimized protocol using Qiskit backend simulators, analyzing the population dynamics of energy states with and without optimization. Future work will extend this approach to a broader class of quantum states with ancilla-assisted protocols and implementations in existing quantum hardware.

References

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