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## Physically-Motivated Guiding States for Local Hamiltonians

*Monday 1 December 2025 16:00 (1 hour)*

This work characterises families of guiding states for the *Guided Local Hamiltonian* problem, revealing new connections between physical constraints and computational complexity.

Focusing on states motivated by Quantum Chemistry and Hamiltonian Complexity, we extend prior **BQP**-hardness results beyond semi-classical subset states by demonstrating that broader state families preserve hardness while maintaining classical tractability under practical parameter regimes.

Crucially, we provide a constructive proof of **BQP** containment for the canonical problem, proving the problem is **BQP**-complete when provided with a polynomial-size classical description of the guiding state.

Our results show quantum advantage persists for physically meaningful state classes, and classical methods remain viable when guiding states admit appropriate descriptions.

We identify a *Goldilocks zone* of guiding states that are efficiently preparable, succinctly described, and sample-query accessible, allowing for a meaningful comparison between quantum and classical approaches.

Our work furthers the complexity landscape for ground state estimation problems, presenting steps toward experimentally relevant settings while clarifying the boundaries of quantum advantage.

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