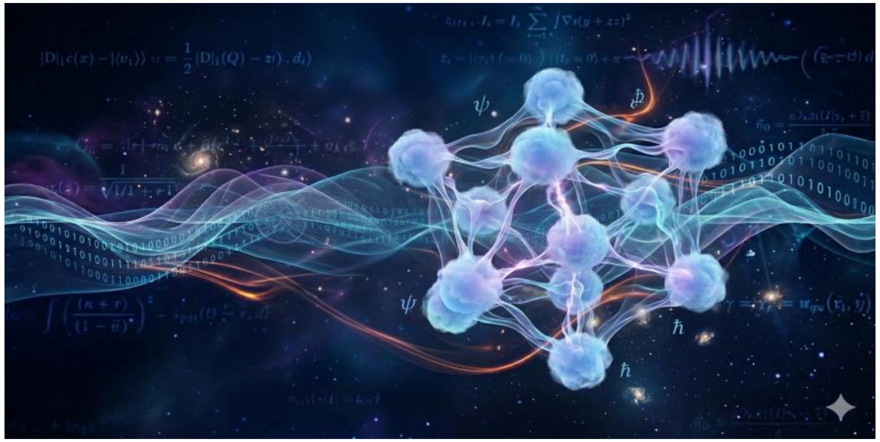
Technology Offer CSIC/JG/013

Quantum reduction of excited states spectra in Hamiltonians encoding combinatorial problems



Quantum method to suppress the spectrum of excited states in Hamiltonians associated to combinatorial problems, improving the identification of the ground state and supporting more efficient variational algorithms.

Intellectual Property

Priority patent application

Intended Collaboration

Licensing and/or co-development

Stage of development

Procedure validated analytically and through simulations using multiple topologies

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Market need

Combinatorial optimization problems often require mapping into Hamiltonians whose ground state encodes the solutions. These Hamiltonians typically exhibit dense excited-state spectra, making identifying the ground state challenging. Hybrid algorithms such as QAOA may require additional layers when the excited-state spectrum is dense, reducing efficiency and increasing computational overhead.

Proposed solution

Quantum method that integrates Boolean simplification, selective truncation of higher-order terms and the application of diffuser operators (Rx rotations) after time evolution under an auxiliary Hamiltonian. Analytical developments and simulations indicate that the approach significantly suppresses the spectrum of excited states while preserving all ground-state configurations. It has been tested in simulated scenarios using multiple graph topologies, showing substantial reduction in the spectrum of excited states and improving the efficiency of variational algorithms.

The new method can serve as an initialization (Warm-Start) for QAOA or similar algorithms, supporting faster convergence while preserving the underlying optimization problem.

Competitive advantages

- Significant suppression of the spectrum of excited states while retaining all ground-state solutions.
- Compatible with existing variational algorithms, including QAOA.
- It reduces the effective search space for classical optimizers.
- Improved behavior in problems with highly degenerate ground states.
- Potential to scale toward larger combinatorial problem instances.