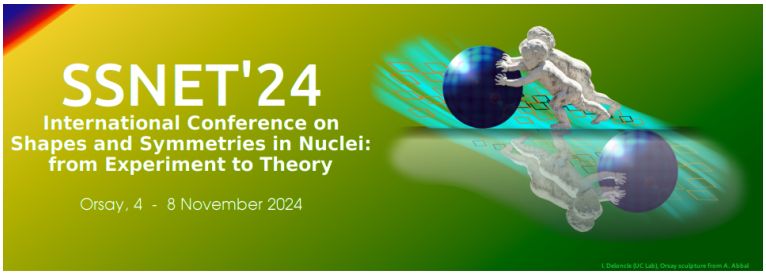

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The extended Lipkin model: implementation in a quantum platform and machine learning analysis of its phase diagram

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We investigate the Extended Lipkin Model (ELM), whose phase diagram mirrors that of the Interacting Boson Approximation (IBA) model. Our goal is to implement the ELM on a quantum platform, leveraging Machine Learning techniques to identify its quantum phase transitions and critical lines. To achieve this, we offer: i) ground state energy calculations using a variational quantum eigensolver; ii) a detailed formulation for ELM dynamics within quantum computing, facilitating experimental exploration of the IBA phase diagram; and iii) a phase diagram determination using various Machine Learning methods. We successfully replicate the ELM ground-state energy using the Adaptive Derivative-Assembled Pseudo-Trotter ansatz Variational Quantum Eigensolver (ADAPT-VQE) algorithm across the entire phase space. Our framework ensures ELM implementation on quantum platforms with controlled errors. Lastly, our ML predictions yield a meaningful phase diagram for the model.

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