Stirring the false vacuum via interacting quantized bubbles on a 5,564-qubit quantum annealer

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Our recently published work in *Nature Physics* [1] addresses the phenomenon of false vacuum decay—the transition from a metastable quantum state to a true vacuum state—that plays an important role in quantum field theory and non-equilibrium phenomena such as phase transitions and dynamical metastability. The non-perturbative nature of false vacuum decay and the limited experimental access to this process make it challenging to study, leaving several open questions regarding how true vacuum bubbles form, move and interact. Here we observe quantized bubble formation in real time, a key feature of false vacuum decay dynamics, using a quantum annealer with 5,564 superconducting flux qubits. We develop an effective model that captures both initial bubble creation and subsequent interactions, and remains accurate under dissipation. The annealer reveals coherent scaling laws in the driven many-body dynamics for more than 1,000 intrinsic qubit time units. This work provides a method for investigating false vacuum dynamics of large quantum systems in quantum annealers.

References

[1] Vodeb, J., Desaules, JY., Hallam, A. et al. Stirring the false vacuum via interacting quantized bubbles on a 5,564-qubit quantum annealer. Nat. Phys. (2025). https://doi.org/10.1038/s41567-024-02765-w

Figures

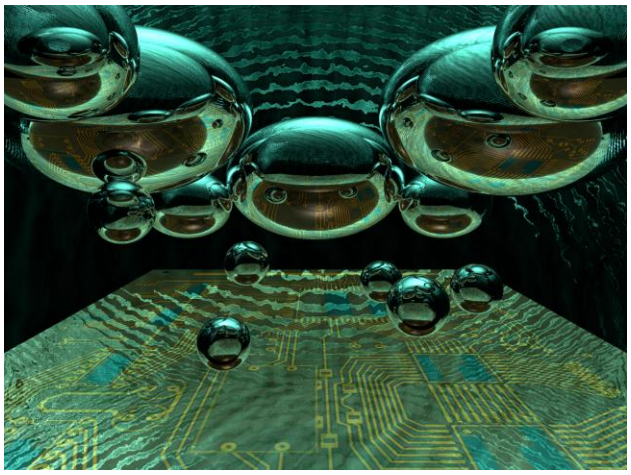

Figure 1: Artistic rendition of true vacuum bubbles forming in the background of the false vacuum on a quantum chip. Copyright: University of Leeds / Zlatko Papić.