Bures and Sjöqvist metrics over thermal state manifolds for spin qubits and superconducting flux qubits

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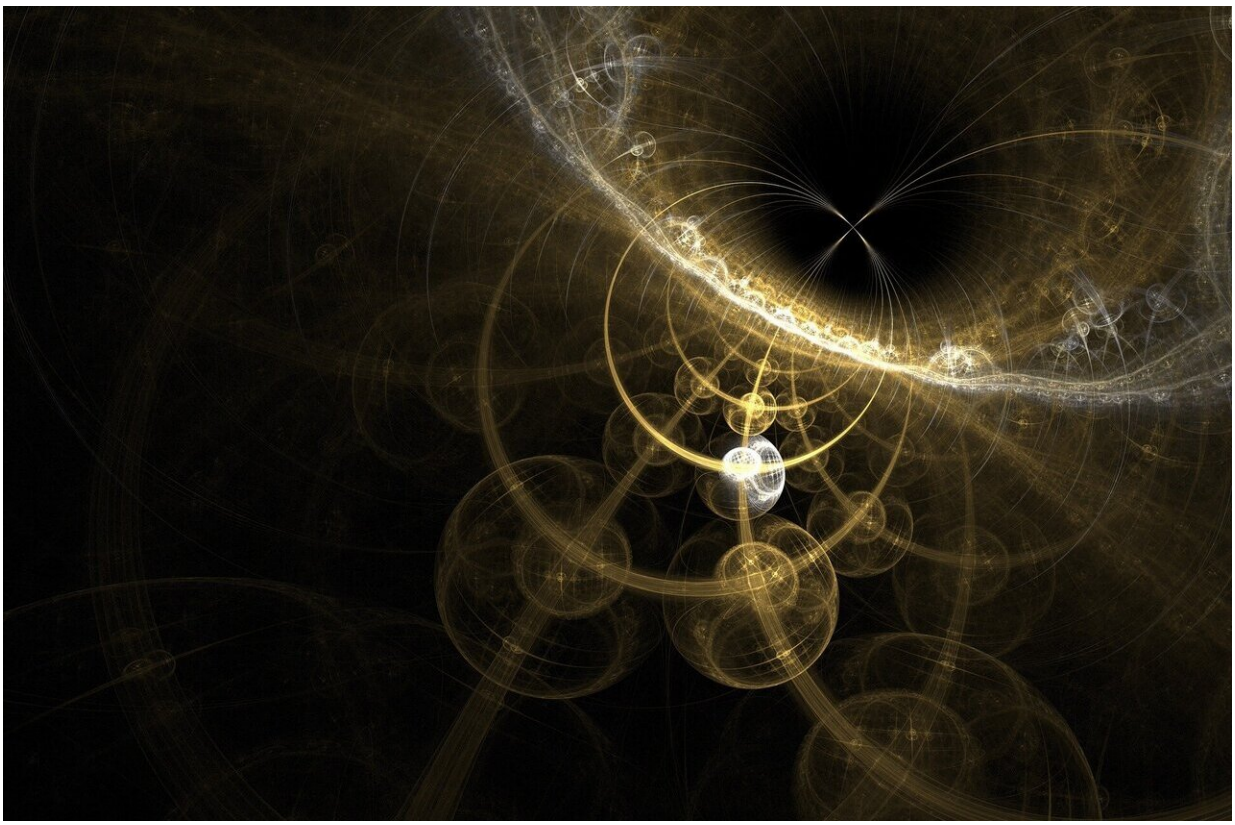

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Dr. Carlo Cafaro, SUNY Poly faculty in the Department of Mathematics and Physics, has collaborated with Dr. Paul M. Alsing, Principal

Research Physicist at the Air Force Research Laboratory in Rome, NY, on work published in *The European Physical Journal Plus*.

The tutorial paper, titled, "Bures and Sjöqvist Metrics over Thermal State Manifolds for Spin Qubits and Superconducting Flux Qubits," in which Cafaro is lead author, is a useful and relatively simple theoretical piece of work. It combines concepts of quantum physics with elements of differential geometry to clarify in simple terms the differences between two important metrics for mixed quantum states of great use in quantum information science.

The interplay among differential geometry, statistical physics, and quantum information science has been increasingly gaining theoretical interest in recent years.

In this paper, Cafaro and Alsing present an explicit analysis of the Bures and Sjöqvist metrics over the manifolds of thermal states for specific spin qubit and the superconducting flux qubit Hamiltonian models. While the two metrics equally reduce to the Fubini-Study metric in the asymptotic limiting case of the inverse temperature approaching infinity for both Hamiltonian models, they observe that the two metrics are generally different when departing from the zero-temperature limit.

Cafaro and Alsing discuss this discrepancy in the case of the superconducting flux Hamiltonian model.

They conclude the two metrics differ in the presence of a non-classical behavior specified by the noncommutativity of neighboring mixed quantum states. Such a noncommutativity, in turn, is quantified by the two metrics in different manners. Finally, Cafaro and Alsing briefly discuss possible observable consequences of this discrepancy between the two metrics when using them to predict critical and/or complex behavior of physical systems of interest in quantum information science.

More information: Carlo Cafaro et al, Bures and Sjöqvist metrics over thermal state manifolds for spin qubits and superconducting flux qubits, *The European Physical Journal Plus* (2023). DOI: 10.1140/epjp/s13360-023-04267-9

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