Contribution ID: **122** Type: **not specified**

Quantum computing to witness nonclassicality

Tuesday, 20 December 2022 18:55 (20 minutes)

We take the existence of a generalized-noncontextual model as a notion of classical explainability, an idea that has been previously shown to have solid foundational motivations (subsuming many other popular notions of classicality), broad applicability (unlike Bell's notion of locality), and a track record of being able to account for quantum-over-classical advantages in information processing. Through cloud quantum computing, we study quantum interference, one of the most characteristic features of quantum theory, to answer the question of which aspects resist explanation within the classical worldview. We found that, even though the basic phenomenology of quantum interference can be explained in a noncontextual model, we identify an aspect of interference that goes beyond the basic phenomenology and that can witness the failure of noncontextuality, namely, the functional form of wave-particle duality relation.
This, therefore, constitutes an aspect of interference that is nonclassical in a rigorous sense. Crucial for proving our result is to show that the wave-particle duality relations that we consider are an instance of uncertainty relations, thus establishing a connection with another main feature in quantum theory.

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Session Classification: Session 8