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Title: Pseudo-Hermitian Operators in Quantum Information Theory and Quantum Chemistry

Abstract: In this talk, we will present an argument regarding quantum superposition in a non-orthogonal system. Specifically, we will examine how quantum superposition can be contained between the basis states or locally inside their overlaps. The portion of quantum superposition contained within overlaps is associated with a type of quantum indistinguishability, which can also generate quantum correlations. We will demonstrate how the concepts of pseudohermiticity and biorthogonality provide a unified framework for inter-basis quantum superposition and quantum indistinguishability. We will refer to this unified framework as genuine quantum superposition. Additionally, we will introduce measures of quantum indistinguishability and genuine quantum superposition. We will discuss potential applications and extensions of our theory to the field of quantum chemistry. Specifically, we will focus on the concept of aromaticity, which was first introduced to explain structural symmetry, energetic stability, and chemical reactivity of benzene and its derivatives, but still lacks a comprehensive and conventional definition. We will show that the amount of genuine quantum superposition shared between biorthogonal orbitals can effectively capture the aromaticity order of some archetypical aromatic molecules, comparable to the most successful measures of aromaticity used in the literature.