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Quantum Bosonic Codes and Finite Fields

In this talk, we explore the intersection of quantum error correction and finite field theory through the lens of quantum bosonic codes. As quantum systems, particularly those involving continuous variables, become increasingly relevant in quantum computing and communication, the development of robust error-correcting codes is essential for enhancing the reliability of quantum information processes. We begin by discussing bosonic codes, specifically designed to protect quantum information encoded in bosonic systems, such as photons and phonons. These codes leverage the mathematical properties of harmonic oscillators and are described using coherent state representations and lattice structures. We will explore the underlying mathematical framework of these codes, highlighting their connection to finite fields and the algebraic structures that aid in encoding and decoding processes. In particular, we will examine the construction of Gottesman-Kitaev-Preskill (GKP) codes, illustrating how finite fields enhance the design and optimization of these codes to improve their error correction capabilities.