Review of: "Constructing a Set of Kronecker-Pauli Matrices"

Shokhan M. Al-Barzinji[1]

1 University of Anbar, Iraq

Potential competing interests: No potential competing interests to declare.

This paper offers a significant contribution to quantum matrix theory by generalizing Kronecker-Pauli matrices to N×NN \times NN×N dimensions for prime NNN. However, its impact could be amplified by broadening the scope of results, simplifying the presentation, and connecting the findings to practical applications in quantum computing and related fields. Addressing these aspects would make the work more impactful and accessible to a wider audience. The abstract provides a concise overview of the paper's focus: extending the generalization of Kronecker-Pauli matrices (KPMs) from 2n2^n2n-dimensional systems to N×NN \times NN×N systems where NNN is a prime integer. The introduction sets the stage by explaining the importance of basis selection in quantum physics and the role of Kronecker-Pauli matrices in higher-dimensional systems. The results showcase the successful construction of 3×3 and 5×5 KPMs, satisfying the defined mathematical conditions. The paper proposes a framework for constructing N×NN \times NN×N-KPMs based on mathematical conditions (e.g., swap operator relation, Hermiticity, orthogonality).

Strengths:

1. Provides rigorous mathematical definitions and properties (SNS_NSN, Σi\Sigma_iΣi) that a valid set of N×NN \times NN×N-KPMs must satisfy.
2. Explains the role of phase factors and their connection to the Weyl-Heisenberg group in the context of 3×3 matrices.
3. Demonstrates the extension of these concepts to 5×5 matrices, showing feasibility for prime NNN.

Weaknesses:

1. Insufficient detail on the algorithmic process for constructing N×NN \times NN×N-KPMs for larger NNN.
2. Fails to address computational challenges or the scalability of the proposed method.
3. The methodology heavily relies on prior work without clearly distinguishing new contributions from existing results.