THERMAL PROPERTIES OF THE DIRAC OSCILLATOR IN NONCOMMUTATIVE PHASE SPACE

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Abstract

This study investigates the Dirac oscillator within a deformed noncommutative phase space framework, emphasizing its thermal properties. By employing the canonical ensemble approach and utilizing the Euler–Maclaurin formula, we derive the partition function and compute key thermodynamic quantities, including Helmholtz free energy, entropy, mean energy, and heat capacity. Our analysis reveals that the noncommutative deformation introduces significant modifications to these properties compared to their commutative counterparts. Notably, we observe the emergence of re-entrant phase transitions in the heat capacity as a function of temperature, indicating complex thermal behaviors influenced by the underlying noncommutative geometry. These findings provide deeper insights into the interplay between quantum mechanics, spacetime structure, and thermal dynamics, with potential implications for high-energy physics and cosmology.

References

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