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Complex Path Integral as a Fractional Fourier Transform

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Lately, it is becoming increasingly clear that extending the Feynman Path Integral into the Complex domain yields desirable properties. A first hint in support of such construction can be seen from the connection between SUSY Quantum Mechanics and the Langevin dynamics: analytically continuing the Langevin leads into different SUSY Quantum Mechanical systems (which share the same algebra of observables). Secondly, new results by E. Witten have brought forward new results in 3-dimensional Chern-Simons theory (in the form of Complex geometries) and Super Yang-Mills theory in four dimensions, as well as the relation between Khovanov homology and systems of branes.

Given a system of D0-branes, it is possible to understand it in terms of a Fourier Transform. As such, we can extend this system into the Complex plane, reinterpreting the Path Integral as a Fourier Transform over a certain integration cycle, which results in a Fractional Fourier Transform. This can be further understood in terms of the Phase Space of this system, where the Fractional Fourier Transform is related to the Wigner function. In this way, we realize that the label of our Fractional Fourier Transform, which is the Path Integral quantizing the system, acts as the parameter determining the vacuum state. Therefore, the allowed values of this label, for which the Path Integral converges, determine the quantum phases of the system. This can be immediately extended to Matrix models and Lie algebra-valued ones (known as Group Field Theory): the same results hold, so long as certain properties of the Action are satisfied, guaranteeing the convergence of the Path Integral.

These results can be dimensionally extended to systems of Dp-branes, showing some relations with the Geometric Langlands Duality and Mirror Symmetry. Furthermore, they can also be understood in terms of coherent state quantization, which opens a window into quantum tomography, and quantum chaos.

Summary

The Path Integral will be extended into the Complex plane and presented from the point of view of the Fractional Fourier Transform.

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