（様式６号）「課程博士用」

学 位 論 文 の 要 旨

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学位論文題目　Stationary quantum entanglement and the method of flow equations

（英訳又は和訳　定常量子エンタングルメントとフロー方程式の方法 ）

This dissertation includes three obtained results of the research.

Firstly, we discuss stationary quantum entanglement between light and matter, which plays a key role for realizing robust quantum information processing. Here, we apply the method of flow equations introduced by Wegner to the Jaynes-Cummings model, which describes a two-level atom interacting with a monochromatic radiation field. The exact stationary entangled state is obtained as a flow of an "initial" product state of the atom and radiation field. To evaluate the degree of correlation, we also analyze the flow of the entanglement entropy.

Secondly, we discuss a possibility of using the method of flow equations in quantum state engineering in the general context. In particular, we examine how such an approach can possess a certain advantageous point for realizing stationary states. For this purpose, we develop a new theory that generalizes Wegner's method itself. Then, through such a generalization, we find a condition, under which the flow of a quantum state becomes geodesic in a submanifold of the projective Hilbert space. Thus, it is shown that the method can provide quantum state engineering with the geometrically optimal strategy for realizing stationary states. Some physical examples are employed in order to show that the flows are in fact geodesic.

Finally, we notice that in exactly solvable systems there always exist invariant quantities with respect to the flow equations. We study this structure in analogy with Noether's theorem, which connects a profound relation between the existence of invariants and underlying continuous symmetries in a system under consideration.

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