Schwinger-Unruh-Hawking radiation on manifolds

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Abstract

Based on arXiv:2303.11521, we discuss a basic method for understanding stationary radiation on manifolds by means of the Stokes phenomenon, for which the most famous examples are the Schwinger effect and Hawking radiation. The local Stokes phenomenon of the Schwinger effect is already known, but it cannot be used naively as an explanation for stationary radiation. The main difficulty of this problem lies in the convention of using asymptotic states to define the vacuum. More precisely, the "vacuum definition" here refers to the distinction between $\pm$ pairs of vacuum solutions that define the creation and annihilation operators. To address the problem of the vacuum definition and stationary radiation on manifolds, we show how to understand the "vacuum" of the Schwinger effect. Then we show that Hawking radiation should be understood by defining the vacuum for a local inertial frame, rather than for a local Lorentz frame. We show how this difference plays a crucial role in Hawking radiation. Unravelling the local nature of the Stokes phenomenon and discriminating similar phenomena will enable us to clearly distinguish between black holes and their analogues. Finally, we show that the Schwinger and Unruh effects can be observed simultaneously under a strong electric field, which can be verified experimentally.

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