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Nonlinear Chiral Kinetic Theory

The chiral kinetic theory (CKT) is a great theoretical framework for the transport phenomena of massless degrees of freedom. In spite of various developments, the nonlinear order quantum correction to the CKT is less understood. In this talk, employing the Wigner function, I develop the off-equilibrium CKT including the nonlinear quantum correction at $O(\hbar^2)$. This nonlinear CKT involves not only the nonlinear order effects of background electromagnetic fields and fluid vortical fields, but also arbitrary spacetime dependence of the background fields. The equilibrium Wigner function is identified via the kinetic equation with the help of the frame-independence of the Wigner function. Then, the nonlinear CKT verifies the nondissipativeness of the magneto-vortical transport of chiral fermions, which is originally derived by Hattori-Yin. Besides, I reveal that the nonlinear CKT is consistent with the Euler-Heisenberg effective Lagrangian, including the logarithmic ultraviolet behavior, which is associated with the QED β-function. This consistency is an indirect evidence of the trace anomaly in the context of the kinetic theory. I also pose a potential issue of the regularization in the CKT.

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