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Chiral kinetic theory in curved spacetime

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Many-body systems with chiral fermions exhibit anomalous transport phenomena originated from quantum anomalies. Based on quantum field theory, we derive the kinetic theory for chiral fermions interacting with an external electromagnetic field and a background curved geometry. The resultant framework respects the covariance under the U(1) gauge, local Lorentz, and diffeomorphic transformations. It is particularly useful to study the gravitational or non-inertial effects for chiral systems. As the first application, we study the chiral dynamics in a rotating coordinate and clarify the roles of the Coriolis force and spin-vorticity coupling in generating the chiral vortical effect (CVE). We also show that the CVE is an intrinsic phenomenon of a rotating chiral fluid, and thus independent of observer's frame.

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