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Study of the covariant Wigner function applied to the linear sigma model

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In this work we study the Wigner-Weyl formalism adequate for a theory with nucleons interacting through scalar and pseudoscalar fields, and for this we use the linear sigma model. Our goal is to understand the phenomena observed in experiments at laboratories such as the LHC or BNL, where a new state of matter is reached, the quark-gluon plasma. So we need to study chiral phase transitions, and the understanding of transport phenomena is crucial to this. Such experiments aim a better understanding of the fundamental structure of matter, from its formation in the primordial universe to its behavior in the most varied regimes.

An important application of effective models is the study of the chiral phase transitions in QCD under finite temperature and density conditions. Due to its simplicity compared to other models, the linear sigma model is a good candidate to this application. Another advantage is the fact that the model is renormalizable, unlike other models such as the Nambu–Jona-Lasinio or the nonlinear sigma model. However, since these phase transitions are out of equilibrium, we need a theory that can deal with dissipative phenomena. Then, we need a way to quantize the phase space. For this, we use the Wigner function, which is a quasi-probability distribution function. Since we are dealing with a relativistic model, we must adapt it to the formalism, and therefore we study the covariant Wigner function. We use the covariant Wigner function in the classical and semiclassical approximation in order to find a transport equation analogous to the Vlasov equation for the linear sigma model. Our formalism can be extended aiming the calculation of transport properties (viscosity, thermal conductivity) which are important to simulate heavy-ion collisions.

Summary

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