Electric field fluctuations in a self interacting scalar theory

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Motivation

- Our task is to study the impact and effects of electromagnetic (EM) fields and temperature in hadronic matter.
- Particularly, in this project, we study the effects of a weak, noisy electric field on the physical parameters of complex scalar fields ($\lambda\phi^4$ theory).
- We want to compare the effects of the self interaction with the effects of electric field fluctuations.

Physical scenario

- The physical scenario correspond to asymmetric heavy-ion collisions.
- In asymmetric collisions a dipole-like electric field is induced on the collision plane.
- The properties of this field is similar to the magnetic fields, (strength and short lifetime).

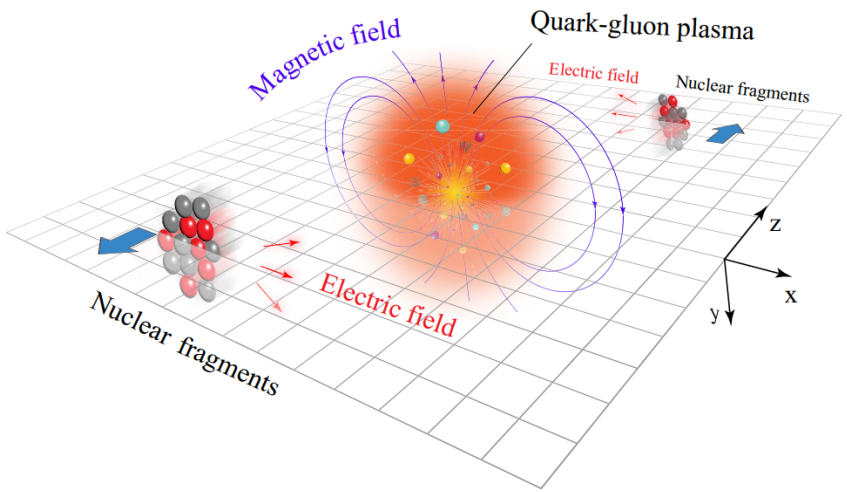

Fig. 1: Sketch of a heavy-ion collision at the lab frame (STAR collaboration, 2024).

The model

- We use Schwinger's propagator as the "free“ theory propagator.
- We introduce the fluctuations through the covariant derivative, modeled as white noise.
- We use the replica method to find $\overline{\ln(Z)}$.

Computations

- We find the two point (self energy) and four point functions (vertex correction), dressed by the noisy electric field.
- We study the spectral density of the dressed propagator.
- We study the β functions of the theory.

Results

- We found that the self interaction shifts the pole mass of the field.
- We found that quasi-particle states emerge from the electric field fluctuations.
- We found that the noise works as a damping factor for the self interaction strength.