

Critical Dynamics of Multiplicative Systems

Wednesday 8 December 2021 15:15 (10 minutes)

In this study we analyze the critical dynamics of a real scalar field in 2D near a continuous phase transition. We have computed and solved Dynamical Renormalization Group (DRG) equations to two loops order. We have found that, different from the case $d < 4$, characterized by a Wilson-Fisher fixed point with $z = 2 + O(\epsilon^2)$, the critical dynamics is dominated by a novel multiplicative fixed point.

The interest in critical dynamics is rapidly growing up in part due to the wide range of multidisciplinary applications deeply impacted by the use of criticality. For instance, the collective behavior of biological systems displays critical behavior with space-time correlation functions with non-trivial scaling laws[1].

The standart approach to deal with dynamics is the Dynamical Renormalization Group[2]. We assume that the evolution of the system near the critical point is governed by a dissipative process. Then we use the *Martin-Siggia-Rose-Janssen-DeDominicis* formalism[3] to transform the dynamical equation in to a functional generator.

On top of that, one can add two Grassmann fields $\bar{\xi}, \xi$ in the functional generator in order to increase the supersymmetric formulation for the dynamics[4,5]. This supersymmetric formalism enables the choice of a specific stochastic evolution.

In this work, we begin with the dynamical ϕ^4 . We adopted the so called Generalized Stratonovich prescription parametrized by a real number $0 \leq \alpha \leq 1$ and present here the calculations for the Itô ($\alpha = 0$) prescription. % For instance, $\alpha = 0$ is the Itô prescription, $\alpha = 1/2$ is the Stratonovich while $\alpha = 1$ is the Hangii-Klimontovich or anti-Itô prescription.

We use the functional generator to compute the dynamical correlation functions. We perform a diagrammatic perturbation theory up to 2-loops and obtain the DRG equations. We fully calculated up to 2-loop corrections for the flux equations using an "Wilsonian approach". Here we are presenting only the 1-loop corrections since the analysis for the 2-loop equations is still ongoing.

The 1-loop DRG equations has fixed points, depending essentially on dimensionality. For $d > 4$, the Gaussian fixed point, with $z = 2$ correctly describes the phase

transitions. However, for $d < 4$, a Wilson-Fisher fixed point[6] shows up. At this level of approximation, g is an irrelevant variable and the dynamics is driven by a usual additive noise stochastic process recovering the results from Ref. [2]. However, at $d = 2$ the dynamical behavior changes and the former Wilson-Fischer point is transferred to a relevant multiplicative fix point with $g \neq 0$. Thus creating a critical plane for the transition. We also notice, in 1-loop, the appearance of an anomalous dimension originatad from the multiplicative interaction.

We thank the financial support from CAPES and CNPq.

[1] A. Cavagna, D. Conti, C. Creato, L. Del Castello, I. Giardina, T. S. Grigera, S. Melillo, L. Parisi, and M. Viale, Nature Physics \textbf{13}, 914 (2017).\

[2] P. C. Hohenberg and B. I. Halperin, Rev. Mod. Phys. \textbf{49}, 435 (1977).\

[3] P. C. Martin, E. D. Siggia, and H. A. Rose, Phys. Rev. A\textbf{8}, 423 (1973).\

[4] Z. G. Arenas and D. G. Barci, Phys. Rev. E \textbf{85}, 041122 (2012).\

[5] Z. G. Arenas and D. G. Barci, Jour. of Stati. Mech.: Theory and Experiment \textbf{2012}, P12005 (2012).\

[6] K. G. Wilson and M. E. Fisher, Phys. Rev. Lett. \textbf{28}, 240 (1972).

Authors: DE OLIVEIRA SILVANO, Nathan (Rio de Janeiro State University - UERJ); Dr G. BARCI, Daniel (UERJ)

Presenter: DE OLIVEIRA SILVANO, Nathan (Rio de Janeiro State University - UERJ)

Session Classification: Apresentações de vídeo-pôsteres