Contribution ID : **31** Type : **Theoretical Lecture**

Linear Sigma Model Under Strong Magnetic Fields: Self-Consistent Masses, Screening Properties, and Effective Couplings.

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Content

Understanding the behavior of QCD matter under strong magnetic fields has become essential for interpreting heavy-ion collision results, modeling the early universe, and studying the physics of magnetars. In this lecture, I will present how the SU(2) Linear Sigma Model coupled to quarks (LSMq) can be used as an effective framework to explore the chiral phase transition and to construct an effective $T\breve{}|eB|$ phase diagram. I will start with a concise review of the LSMq in a magnetic background, emphasizing how the magnetic modification of fermionic and bosonic sectors interplay with spontaneous and explicit chiral symmetry breaking. The core of the lecture will focus on the computation of self-consistent thermomagnetic masses within the ring-improved effective potential, which allows one to determine the order and location of the chiral phase transition across the $T\breve{}|eB|$ plane. Based on these results, I will discuss how the model captures key qualitative features of QCD under magnetic fields, including magnetic catalysis at low temperatures and the onset of inverse magnetic catalysis near the transition region, as well as the emergence of a critical end point. Finally, I will outline how the self-consistent solutions can be used to infer the magnetic dependence of the effective parameters of the model, such as the quartic coupling λ, the Yukawa coupling g, and the squared mass parameter a^2, providing a systematic path toward building magnetically improved effective descriptions of QCD. The lecture aims to provide participants with conceptual and computational tools to employ the LSMq in studies of QCD matter under extreme electromagnetic conditions.

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