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Effect of magnetic fluctuations on the renormalons of a Self-Interacting scalar theory

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Content

The impact of magnetic fluctuations on the $\lambda\phi^4$ theory is analyzed by modeling these fluctuations as white noise following the theory from [1] and examining their averaged effect in the weak field regime ($|eB| \ll m^2$). This way, it is found that the first-order contribution of order $\Delta_B e^2$ to the two-point correlation function manifests as a self-energy correction, leading to an extra term in the weak field expansion of the propagator which depends on the auto-correlation function of the fluctuations. When examining the renormalon diagrams of this theory in the deep Euclidean region, it is observed that the expression for the k-\textit{bubble} chain diagram is proportional to $k!$. As a result, the sum over k of this set of diagrams diverges, similar to the results found in the literature on vacuum and uniform magnetic field renormalons, among others [2,3,4]. In order to give meaning to this divergent result, the Borel prescription [5] is used. However, when applied in Ref.[2], the inverse Borel tranform is undefined due to the appearance of real and positive poles on the Borel plane, which spoils the technique completely. In regards to our case, the possibility of Borel summability arises because of the mentioned new term of the propagator including the effect of the fluctuations, which of course, is the building block of the renormalon diagram. This new term confers a finite imaginary part to the poles in the Borel plane, which in turn, would make the sum Borel summable. This is currently under examination by us. Magnetic noise, present in various systems including Heavy-Ion collisions (HIC) [1] and experiments aiming to maintain uniform magnetic fields, when accounted for rather than neglected, could render a previously non-Borel summable series Borel summable. This enhances the value of including fluctuations along with the Borel technique, especially since many instances (e.g., [2,3,4,6]) encounter undefined inverse Borel transforms arising from the real and positive singularities in the Borel plane.

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