Strong coupling asymptotics of the β-function in ϕ^4 theory and QED

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Abstract

The well-known algorithm for summing of divergent series is based on the Borel transformation in combination with the conformal mapping (Le Guillou and Zinn-Justin, 1977). Modification of this algorithm allows to determine a strong coupling asymptotics of the sum of the series through the values of the expansion coefficients. Application of the algorithm to the β-function of φ^4 theory leads to the asymptotics $\beta(g) = \beta_\infty g^\alpha$ at $g \to \infty$, where $\alpha \approx 1$ for space dimensions $d = 2, 3, 4$. The natural hypothesis arises, that asymptotic behavior is $\beta(g) \sim g$ for all d. Consideration of the "toy" zero-dimensional model confirms the hypothesis and reveals the origin of this result: it is related with a zero of a certain functional integral. Generalization of this mechanism to the arbitrary space dimensionality leads to the linear asymptotics of $\beta(g)$ for all d. The same idea can be applied for QED and gives asymptotics $\beta(g) = g$, where g is the running fine structure constant. Relation to the "zero charge" problem is discussed.