The ambiguities in the determination of field correlators represented by asymptotic perturbation series*

Irinel Caprini[1], Jan Fischer[2], Ivo Vrkoc[3]

[1] *National Institute of Physics and Nuclear Engineering, Bucharest POB MG-6, R-077125 Romania*
email: caprini@theory.nipne.ro

[2] *Institute of Physics, Academy of Sciences of the Czech Republic, CZ-182 21 Prague 8, Czech Republic*
email: fischer@fzu.cz

[3] *Mathematical Institute, Academy of Sciences of the Czech Republic, CZ-115 67 Prague 1, Czech Republic*
email: vrkoc@math.cas.cz

Abstract

Starting from the divergence pattern of perturbation expansions in Quantum Field Theory and the (assumed) asymptotic character of the series, we address the problem of ambiguity of a function determined by the perturbation expansion. We consider functions represented by an integral of the Laplace-Borel type along a general contour in the Borel complex plane. Proving a modified form of the Watson lemma (called Lemma 2 in the following), we obtain a large class of functions having the same asymptotic perturbation expansion, differing from each other by the angle of validity of the expansion. Remarkable correlations between the strength of the bounds on the remainder and the size of the angles of validity are obtained. Imposing weak conditions both on the Borel transform $B(u)$ of the expanded function and on the integration contour, our Lemma 2 reveals a great ambiguity of the resummation procedures having the same asymptotic expansion. The form and length of the contour do not affect the expansion, contributing only to the exponentially suppressed remainder. Applications to perturbative QCD are discussed, using the particular case of the Adler function.

*Work supported by CNCSIS in the frame of the Program Idei, Contract Nr. 464/2009, and by the Projects No. LA08015 of the Ministry of Education and AV0Z-10100502 of the Academy of Sciences of the Czech Republic.
12.38.Bx, 12.38.Cy