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Resurgence and self-completion in renormalized gauge theories

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Under certain assumptions and independent of the instantons, we show that the logarithm expansion of dimensional regularization in quantum field theory needs a nonperturbative completion to have a renormalization-group flow valid at all energies. Then, we show that such nonperturbative completion has the analytic properties of the renormalons, which we find with no reference to diagrammatic calculations. We demonstrate that renormalon corrections necessarily lead to analyzable functions, namely, resurgent transseries. A detailed analysis of the resurgent properties of the renormalons is provided. The self-consistency of the theory requires these nonperturbative contributions to render the running coupling well-defined at any energy, thus with no Landau pole. We illustrate the point within the case of QED. This way, we explicitly realize the correspondence between the nonperturbative Landau pole scale and the renormalons. What is seen as a Landau pole in perturbation theory is cured by the nonperturbative, resurgent contributions.

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