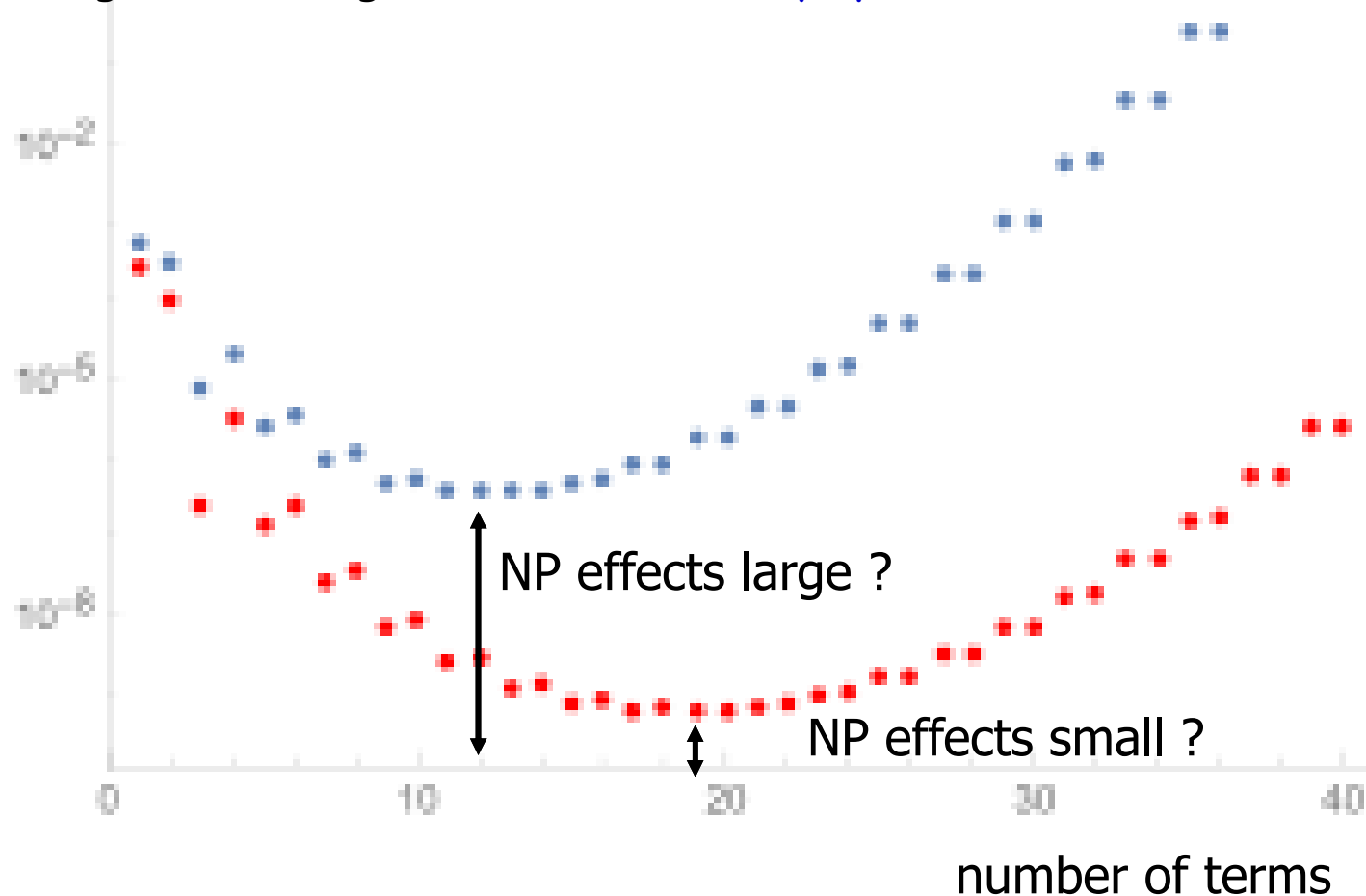


# Correlation between size of instanton contribution and uncertainty of asymptotic perturbative (Borel) series?

In most cases, instanton contributions are evaluated on top of a “perturbative background”.

In general, do nonperturbative (NP) effects (renormalons, instantons, ...) contribute to spoiling the convergence of the **QCD asymptotic series**?



# Instantons and perturbative uncertainty

- arxiv:1206.6272 by Marcos Mariño, which discusses the issue generically for gauge theories. In particular, on page 24:

"An important effect of the Borel resummation technique is a **relationship between the asymptotic behavior of the coefficients of a perturbative series and the first instanton or transseries solution.**"

- arxiv:1411.3585 by Daniele Dorigoni, on asymptotic series, p. 4:

"The **"strength" of these ambiguities is related to terms that cannot be possibly captured by an expansion of the form (1.1), precisely the non-perturbative (NP) physics.**

Furthermore, even in cases when the Borel sum of the perturbative series alone would give rise to an unambiguous analytic continuation, this might not be the exact answer [12]. We have to investigate the analytic properties of the Borel transform in the entire complex Borel plane. We stress that, in general, we do not have a complete argument for why the poles of the Borel transform of the perturbative expansion should all be associated with new NP physics so it is perhaps surprising that, **in all the cases analysed in the literature, it is always possible to find a suitable weak coupling regime in which these poles can be interpreted as particular non-perturbative objects of the underlying microscopic theory, i.e. instantons, D-branes, quasi-normal modes [13] etc."**

# Uncertainties: problem of principle?

- Assumption 1: Instanton-related cross sections are calculable  
-> let's just take this for granted (trusting theory colleagues)
- Assumption 2, in practice so far: Instanton-related cross section is an add-on to a baseline perturbative cross section with NP corrections, and can be distinguished from it.  
-> uncertainty of perturbative baseline must be smaller than the value of the "pure instanton" prediction!  
Is this true?
- If not: need to resort to final states for which the perturbative prediction vanishes to all orders?  
-> lepton/baryon number violation for EW instantons/sphalerons  
-> chirality number violation for QCD instantons  
(e.g. use  $\Lambda, \Lambda_c, \Lambda_b$  as chirality analyzers)