

Detail check of EFT power counting

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Bound states and resonances in Effective Field Theories and Lattice QCD calculations
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Road Map for the future

(for any power counting of NN interaction)

RG-invariant



Check/arrange the power counting
in detail (Lepage plot?).

(Pin down the difference of various version of pc.)

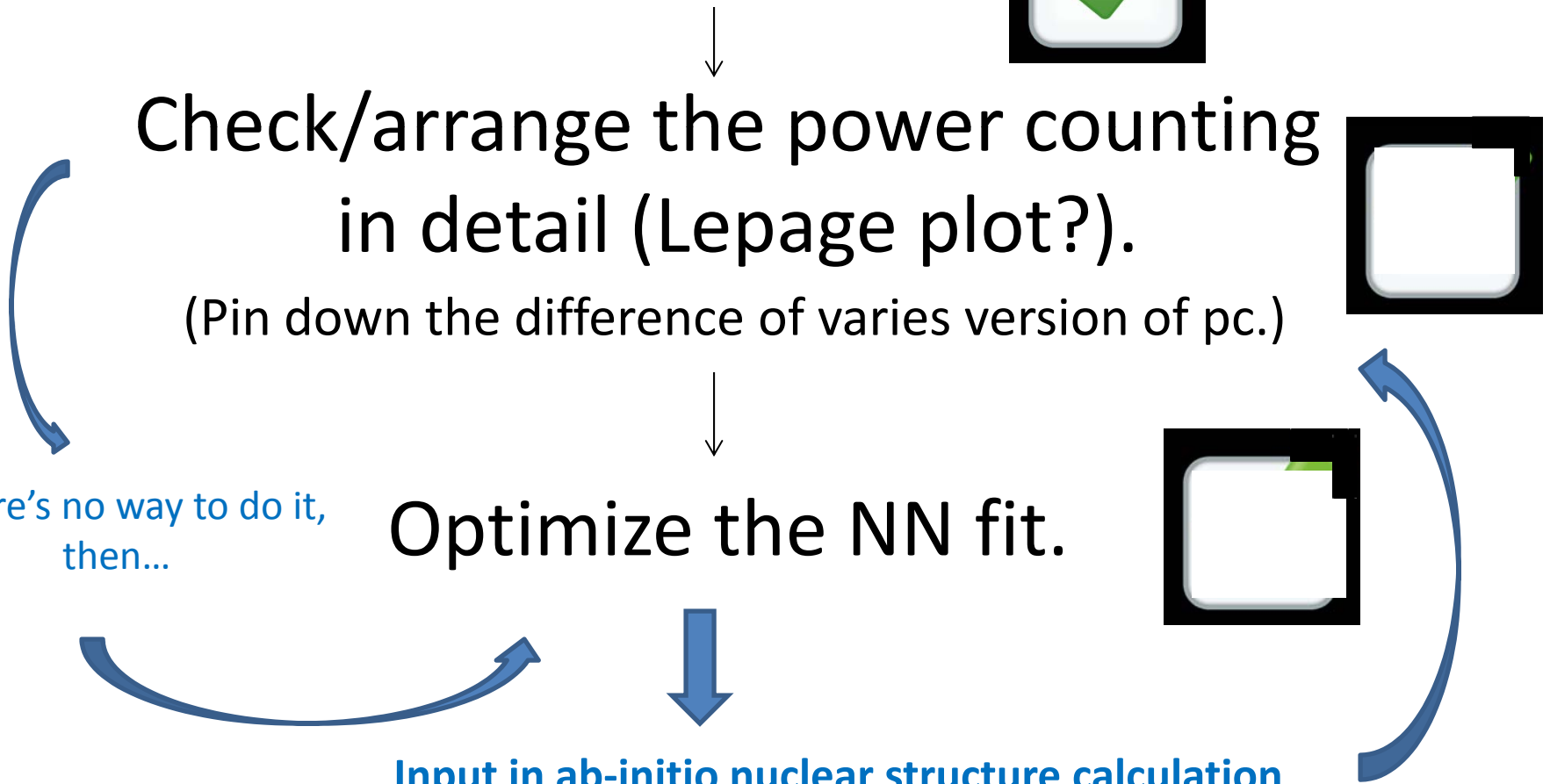


If there's no way to do it,
then...

Optimize the NN fit.



Input in ab-initio nuclear structure calculation.



How to build/check power counting ?

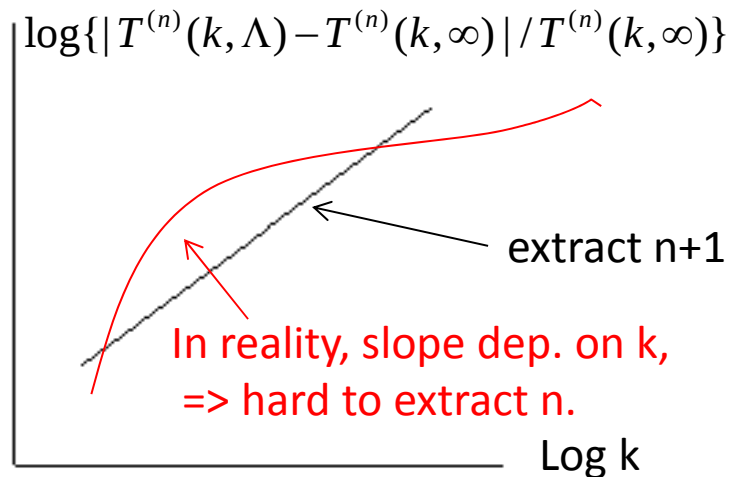
Old way:

Lepage plot

Residue cutoff-dependence:

$$|T^{(n)}(k, \Lambda) - T^{(n)}(k, \infty)| \approx \left(\frac{k}{\Lambda}\right)^{n+1} \text{ (or to higher power if the next correction is absent)}$$

Dominates by the next term haven't included



Alternative way:

α -rescaling

Consider in more detail, has $\Lambda_{NN} = \frac{16\pi f_\pi^2}{g_A^2 M}$,

$$V_{LO} G V_{LO} G V_{LO} / V_{LO} G V_{LO} \approx V_{LO} G V_{LO} / V_{LO} \approx Q / \Lambda_{NN}.$$

Power counting of $T^{(n)} \sim O\left\{\left(\frac{Q^n}{M_{hi}^n}\right) F\left(\frac{Q}{\Lambda_{NN}}\right)\right\}$.

$Q \in (k, m_\pi)$, F is some function from the loops.

$\Rightarrow$ Rescale $(k, m_\pi) \rightarrow (\alpha k, \alpha m_\pi)$.

Plot **residue** versus $\text{Log } \alpha$ (at chosen k)

$\Rightarrow$ Could determine relative PC between each order.

Allow PC-analysis at each k .

***Need to go to high enough Λ (in practice, ~ 2 GeV).**

Difficulty

- Pre-assumption: power counting of counter terms doesn't change too much w.r.t. α .
- For $\alpha \neq 1$, no real physical data to perform the renormalization.

=> limit range of α to be: $0.7 < \alpha < 1.3$.

=> choose to fit LEC's to low-E (physical) data.

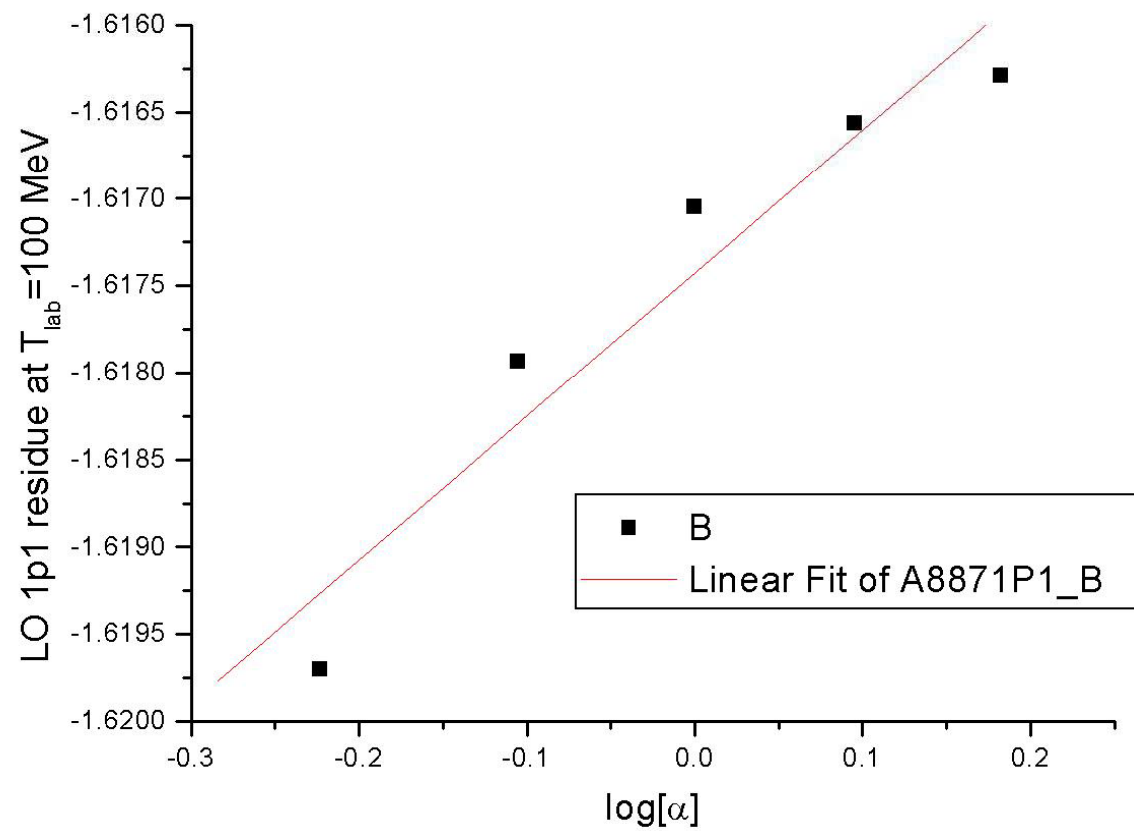
Results for the new scheme (work in progress)

Residue	LO		NLO(Q ²)	NNLO(Q ³)	
1S0	Q ⁰ $\frac{p^{-1}}{M_{hi}^{-1}}$	Q ¹ $\frac{p^{-1}}{M_{hi}^{-1}}$	$\frac{Q^{-0.2}}{M_{hi}^{-0.2}}$		!
1P1	$\frac{Q^0}{M_{hi}^0}$		$\frac{Q^{1.6}}{M_{hi}^{1.6}}$	$\frac{Q^{2.7}}{M_{hi}^{2.7}}$	
3P0	$\frac{Q^{0.6}}{M_{hi}^{0.6}}$		$\frac{Q^0}{M_{hi}^0}$	$\frac{Q^{0\sim-1}}{M_{hi}^{0\sim-1}}$	!?
3P1	$\frac{Q^0}{M_{hi}^0}$		$\frac{Q^0}{M_{hi}^0}$	$\frac{Q^{0\sim-1}}{M_{hi}^{0\sim-1}}$	!?

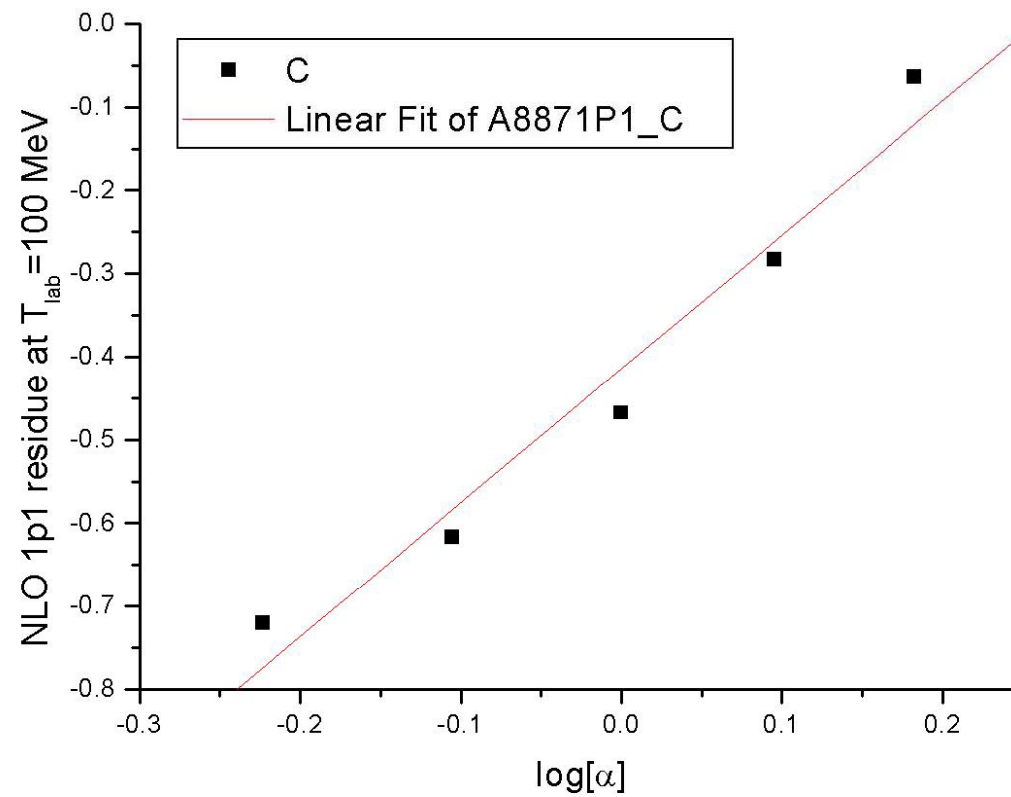
* Analyzed at k corresponds to T_{lab}=100 MeV.

Thank you!

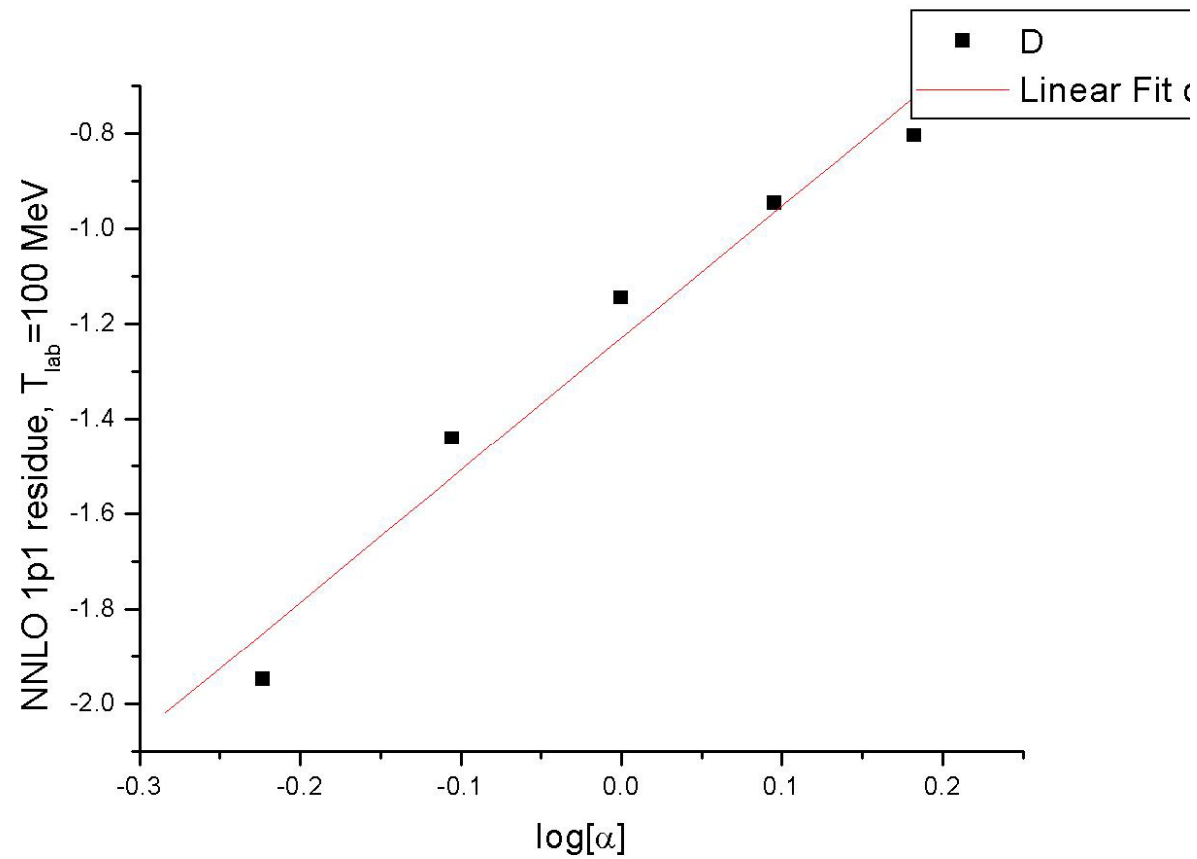
LO 1P1



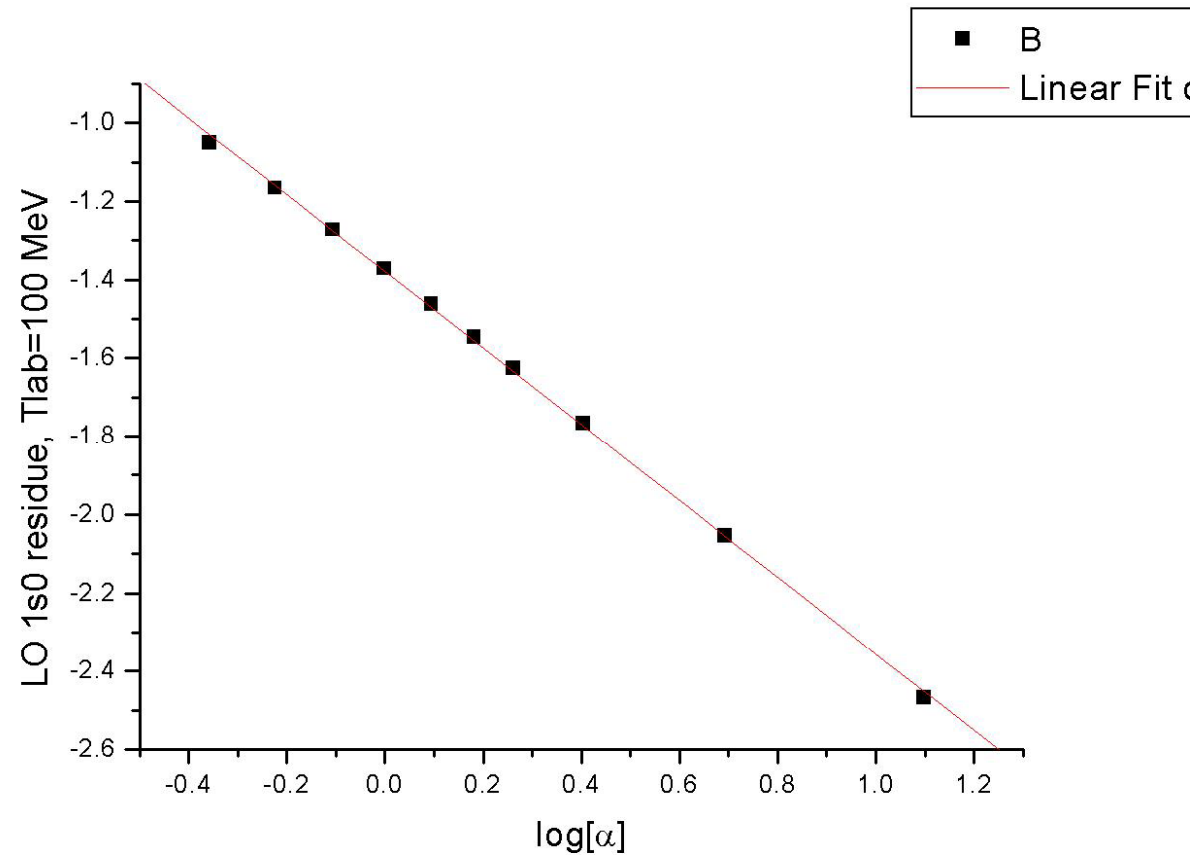
NLO 1P1



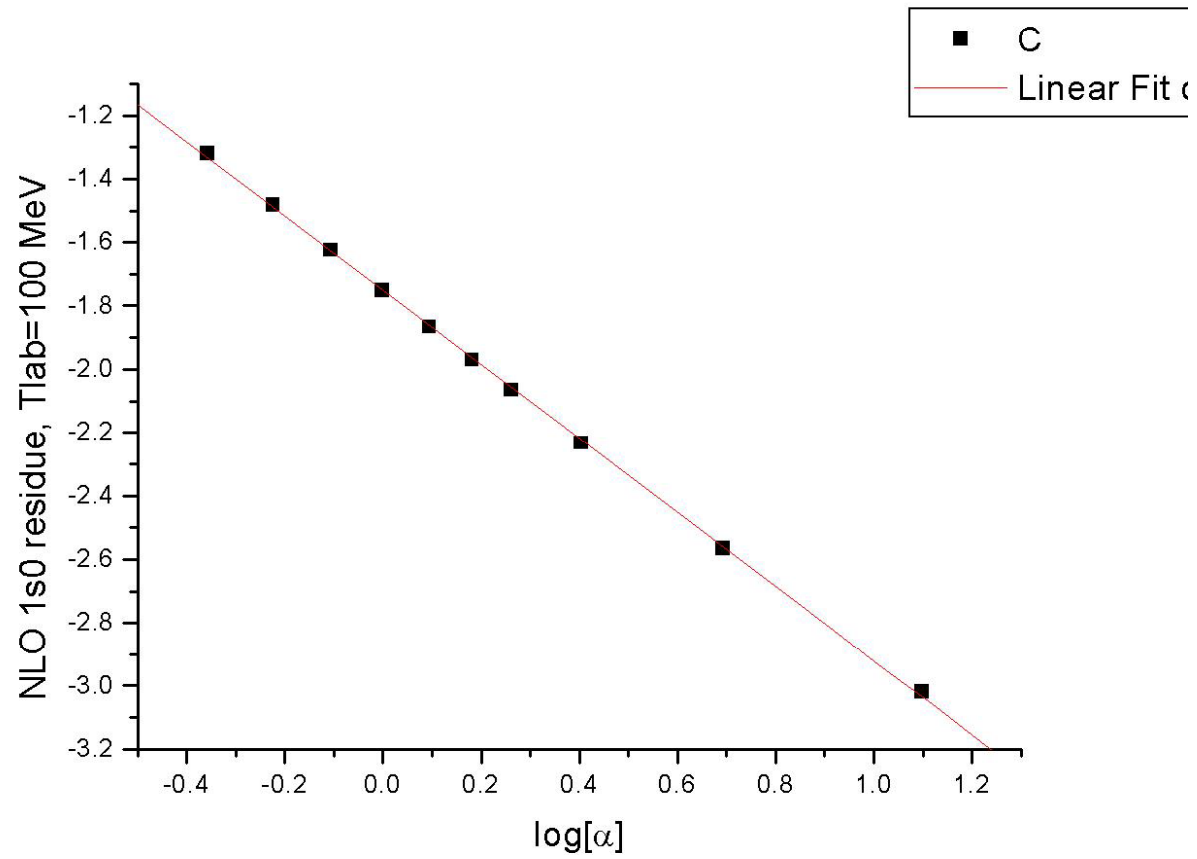
NNLO 1P1



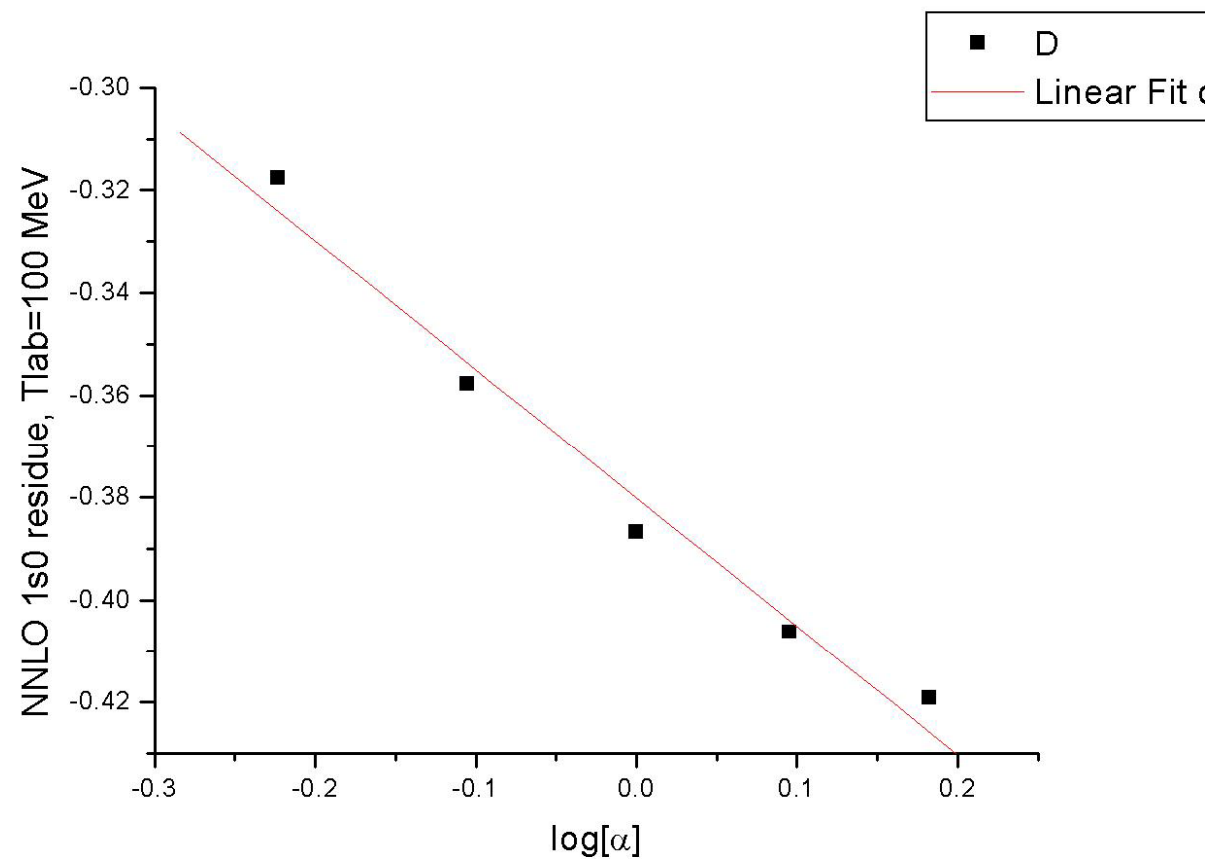
LO 1s0



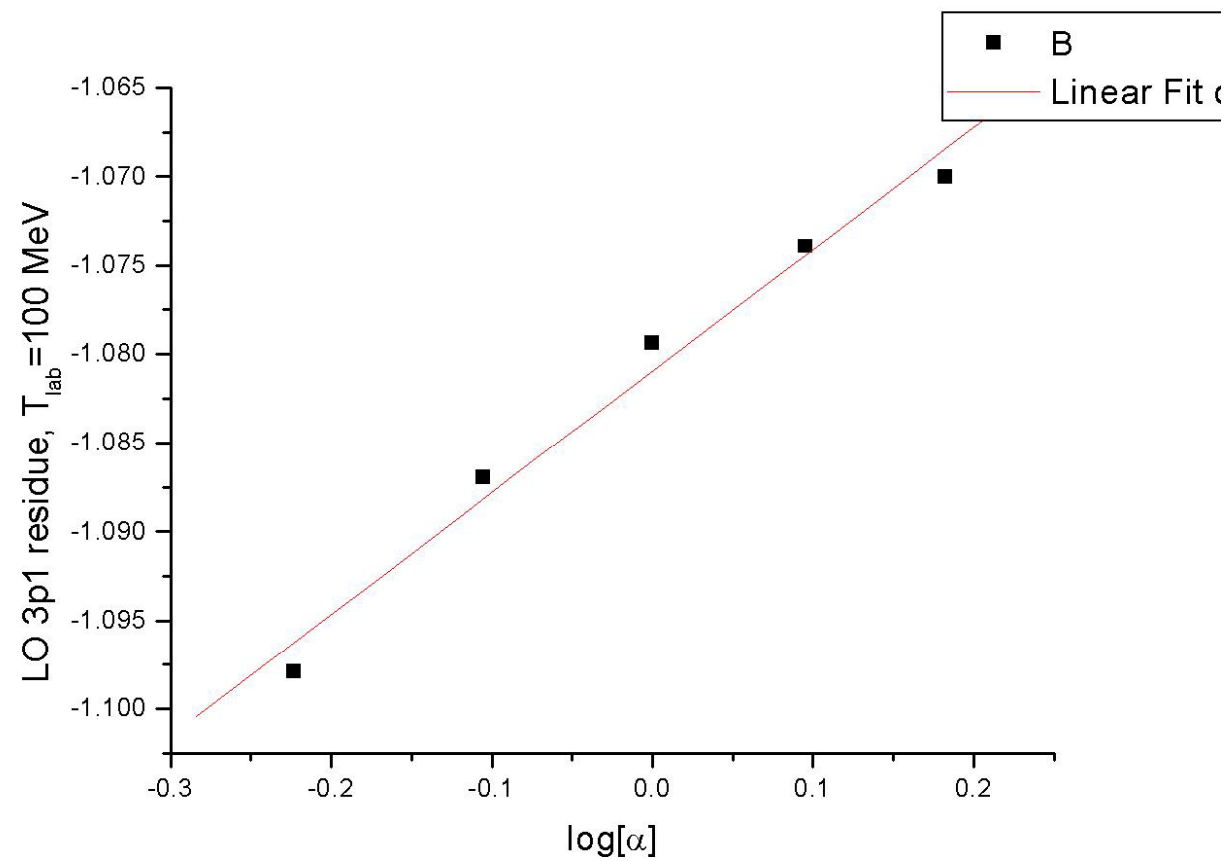
NLO 1s0



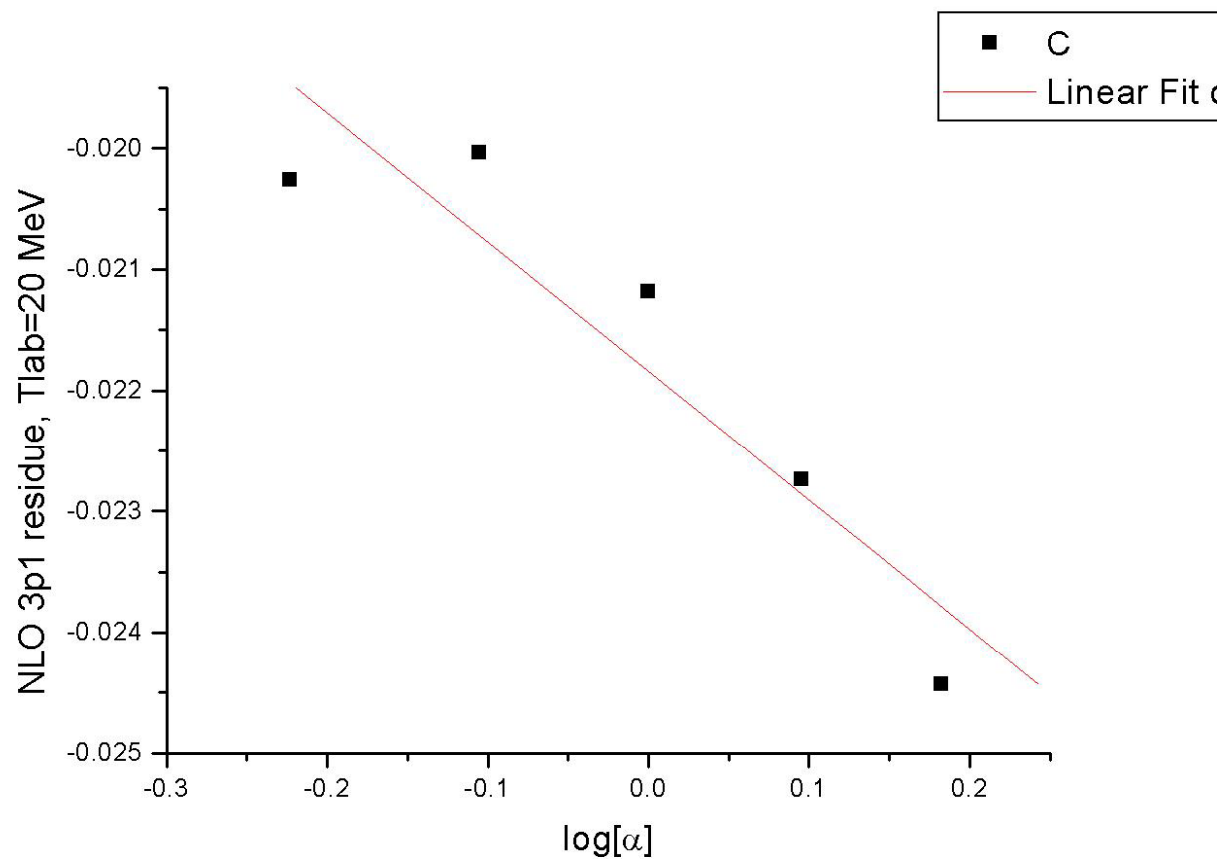
NNLO 1s0



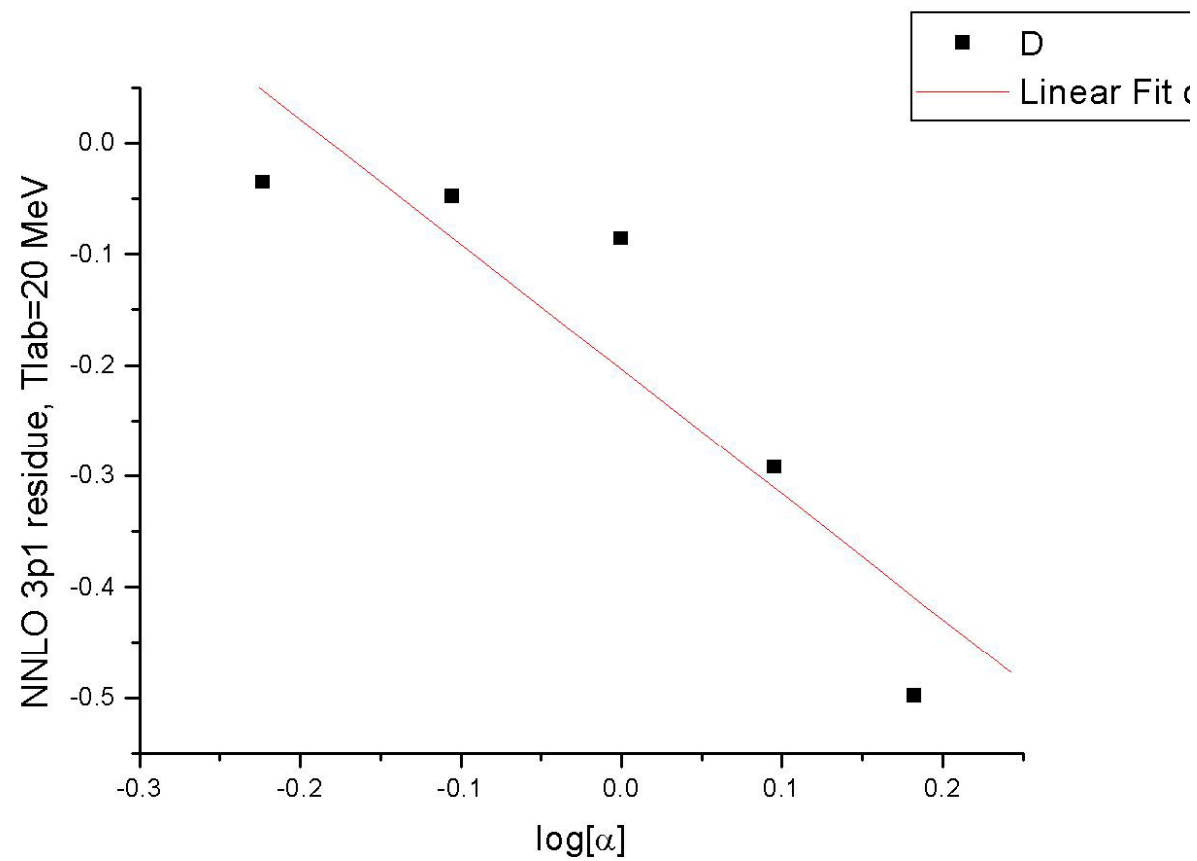
LO 3p1



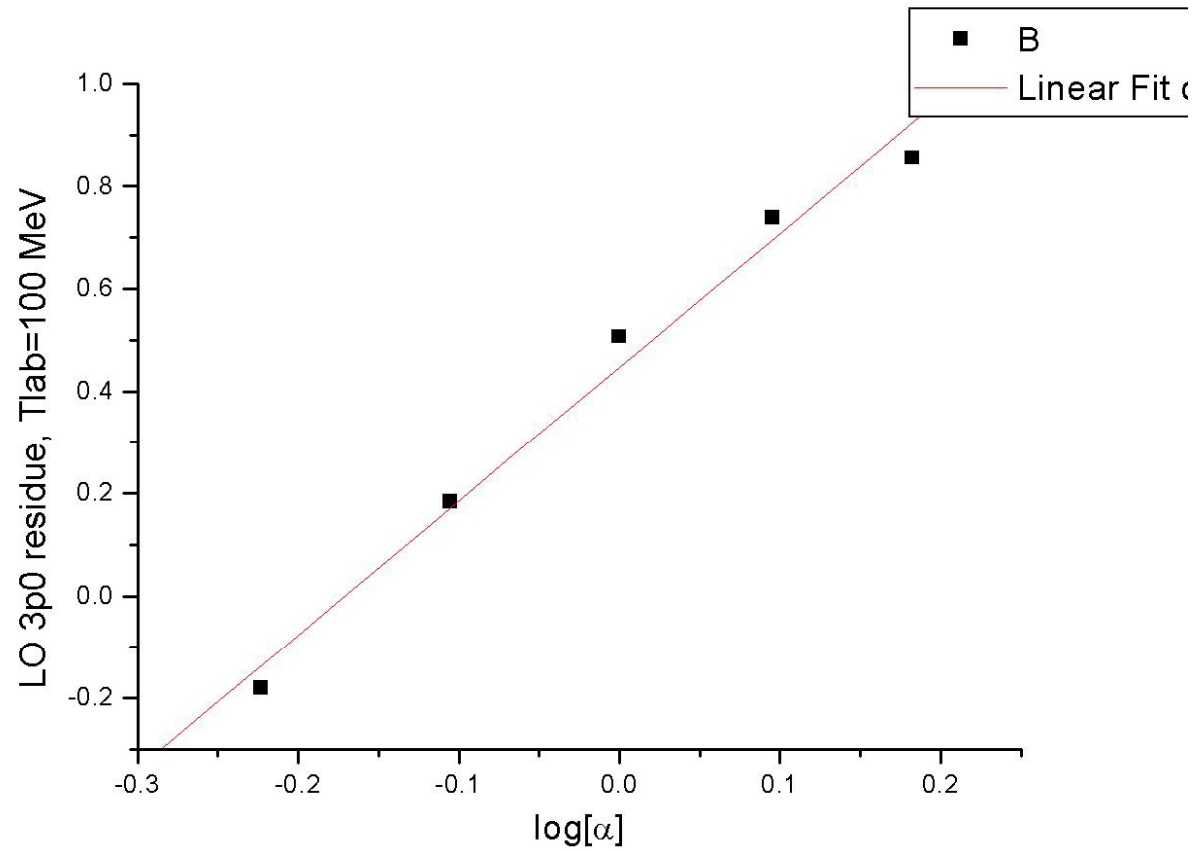
NLO 3p1



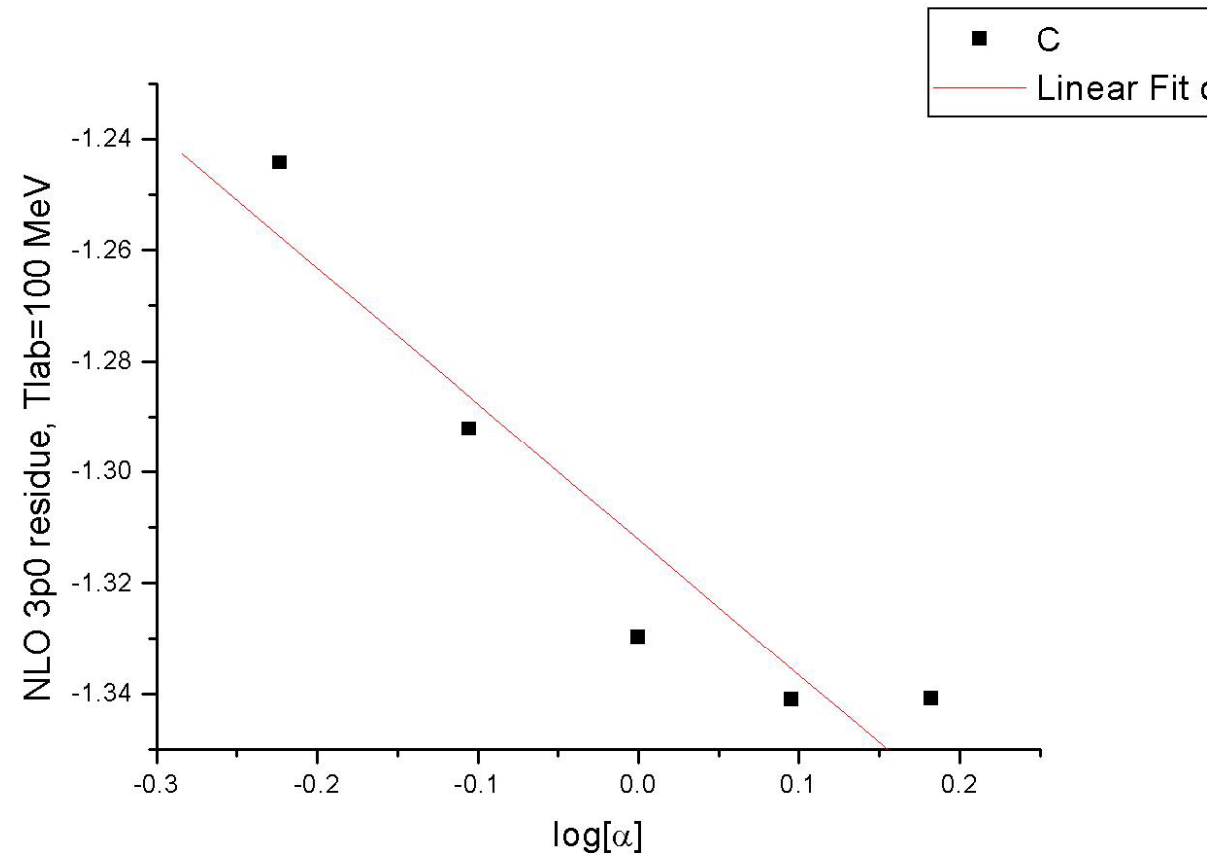
NNLO 3p1



LO 3p0



NLO 3p0



NNLO 3p0

