Interests and current projects

Alberto Ramos

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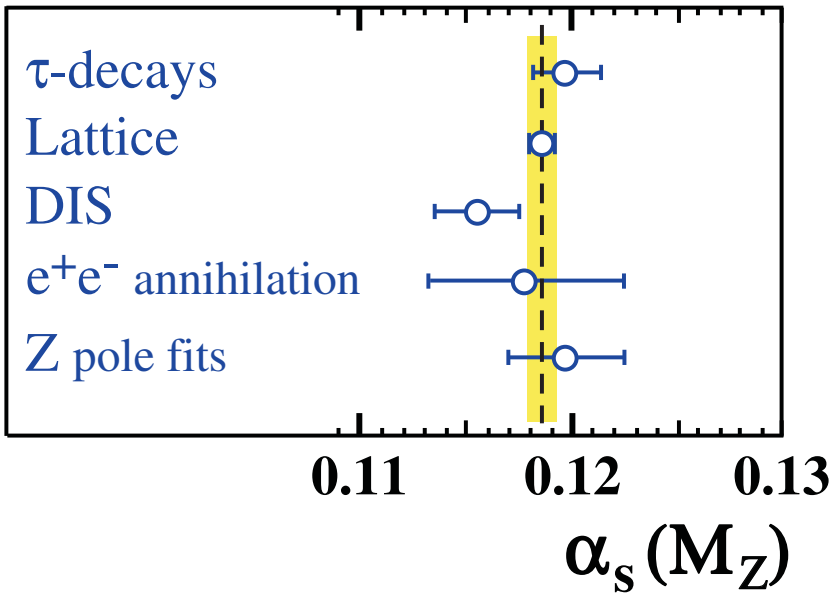
Determination of $\alpha_s(M_Z)$



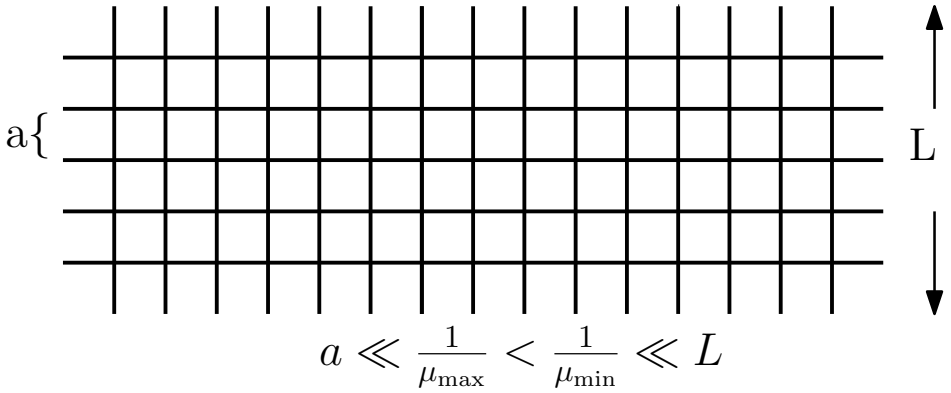
- PDG 2013 World average: $\alpha_s(M_Z) = 0.1185(6)$
- PDG 2013 Average without lattice: $\alpha_s(M_Z) = 0.1184(12)(\chi^2/\text{dof} \sim 2.9/3)$
- FLAG 2014 Lattice average: $\alpha_s(M_Z) = 0.1184(12)$

How to determine $\alpha_{\overline{\text{MS}}}(M_Z)$ on the lattice?

$O(\mu) \equiv$ Match observable at scale μ with PT

Huge computer resources

$L/a \sim 100 - 1000$.



Possibilities

- Lattice observable
- $q\bar{q}$ potential, vacuum polatization, 2-pt function,...
- Finite Volume renormalization scheme $\mu \sim 1/L$.

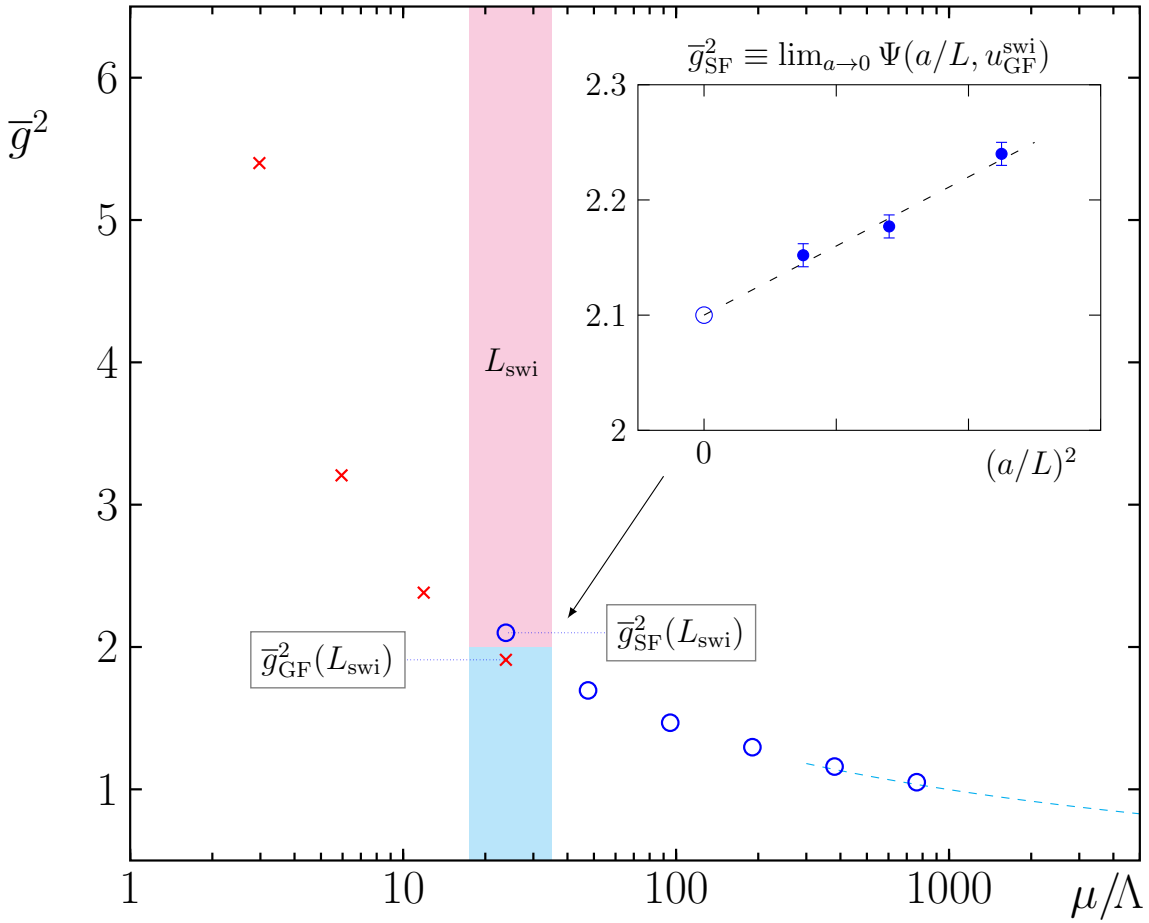
- μ large 2-loop (lattice) PT
- Continuum PT smaller μ; continuum extrapolation
- PT @$\mu \sim 100 GeV$ Dedicated simulations, statistical uncertainty

$\alpha_{\overline{\text{MS}}}(M_Z)$ ALPHA WAY. $N_f = 3$ [M. DALLA BRIDA, P. FRITZSCH, T. KORZEC, A. R., S. SINT, R.SOMMER, M. BRUNO, S. SCHAEFER, H. SIMMA]

Strategy

- Non-perturbative running of the coupling. Finite volume renormalization scheme.
  - $100GeV - 5GeV$ with $g^2_{\text{SF}}(L)$. DONE!
  - $5GeV - 300MeV$ with $g^2_{\text{GF}}(L)$. IN PROGRESS!
- Matching to physical scale using CLS ensambles

$\alpha_{\overline{\rm MS}}(M_Z)$ ALPHA way. $N_f = 3$ [M. Dalla Brida, P. Fritzsch, T. Korzec, A. R., S. Sint, R.Sommer, M. Bruno, S. Schaefer, H. Simma]



$\alpha_{\overline{\rm MS}}(M_Z)$ ALPHA way. $N_f = 3$ [M. Dalla Brida, P. Fritzsch, T. Korzec, A. R., S. Sint, R.Sommer, M. Bruno, S. Schaefer, H. Simma]

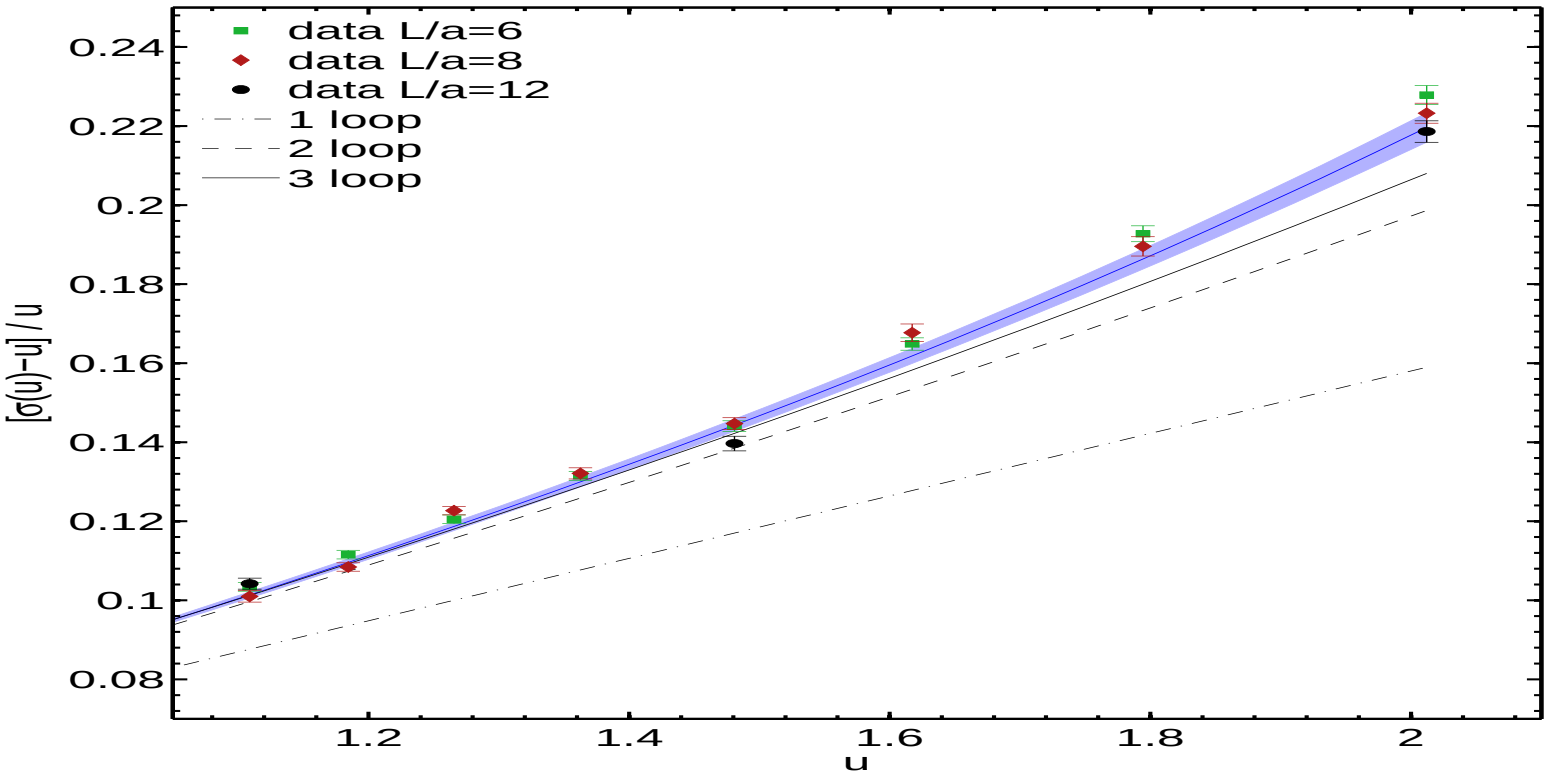


Figure: PRELIMINARY: $\sim 2\sigma$ discrepancy between 3-loop PT and NP running at $\alpha \sim 0.16 - 0.2$.

Very precise $\Lambda^{(3)}$. What about $\alpha_{\overline{\rm MS}}(M_Z)$?

$\Lambda^{(4)}/\Lambda^{(3)}$ has to be estimated with PT

- $M_c \sim 1GeV$
- M_c effect on hadronic quantities is very small
- PT seems well behaved, but...
- ...can PT be trusted at all?

Future: avoid it!

Lattice is mature enought for $N_f = 3 + 1$ running coupling.

Conclusions

Summary

- Main projects
  - $N_f = 3$ Running coupling
  - determination of quark masses

$$\mu \frac{\partial}{\partial \mu} m(\mu) = \tau(\mu)$$

  - Isospin breaking (QED) on the lattice
- Interesting to follow: $N_f = 3 + 1$, charm and isospin breaking on the lattice
- Also interested in
  - Reduction: $4D \rightarrow 2D$
  - "Some " BSM ($N_f = 12$)