HLbL direct lattice calculation from BMW

Virtual spring meeting of the Muon g-2 Theory Initiative

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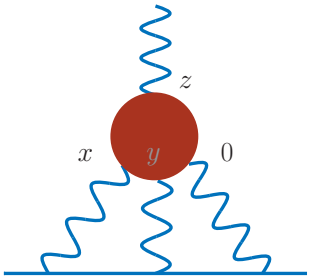
- Based on the coordinate-space approach developed by the Mainz group

$$a_\mu^{\mathrm{HLbL}} = \frac{me^6}{3} \int \mathrm{d}^4y \int \mathrm{d}^4x \, \mathcal{L}_{[\rho,\sigma],\mu\nu\lambda}(x,y) \, i\widehat{\Pi}_{\rho;\mu\nu\lambda\sigma}(x,y) \,,$$



with

$$i\widehat{\Pi}_{\rho;\mu\nu\lambda\sigma}(x,y) = -\int \mathrm{d}^4z \, z_\rho \langle j_\mu(x) j_\nu(y) j_\sigma(z) j_\lambda(0) \rangle$$

and $\mathcal{L}_{[\rho,\sigma],\mu\nu\lambda}(x,y)$ computed by Mainz group [JHEP 04 (2023) 040]

- Slightly different kernel compared to the Mainz calculation

  → motivation : simplification / otpimization of the code

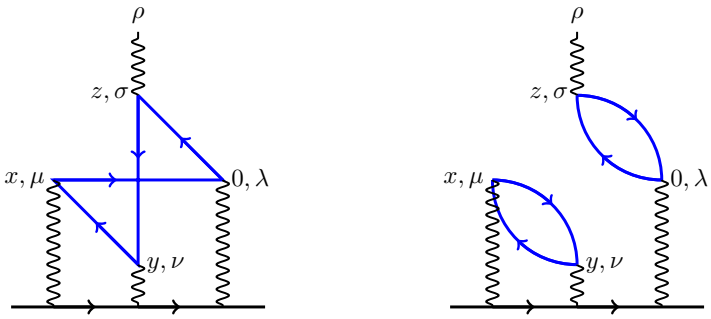
  → direct comparison at the level of the integrand not possible among groups

- Work at the physical pion mass

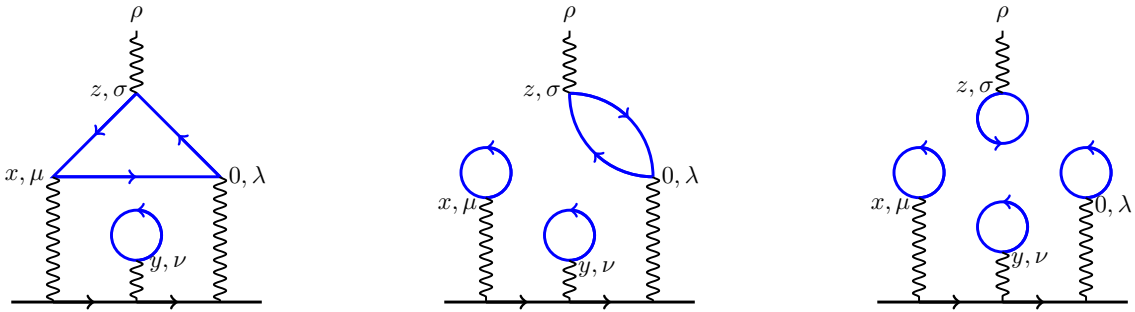
  → Challenge : bad signal / noise ratio at long distances.

- We focus on the connected and leading disconnected diagrams :

  → largest contribution - large cancellation between them



- Sub-leading diagrams : they are computed only on a subsets of ensembles

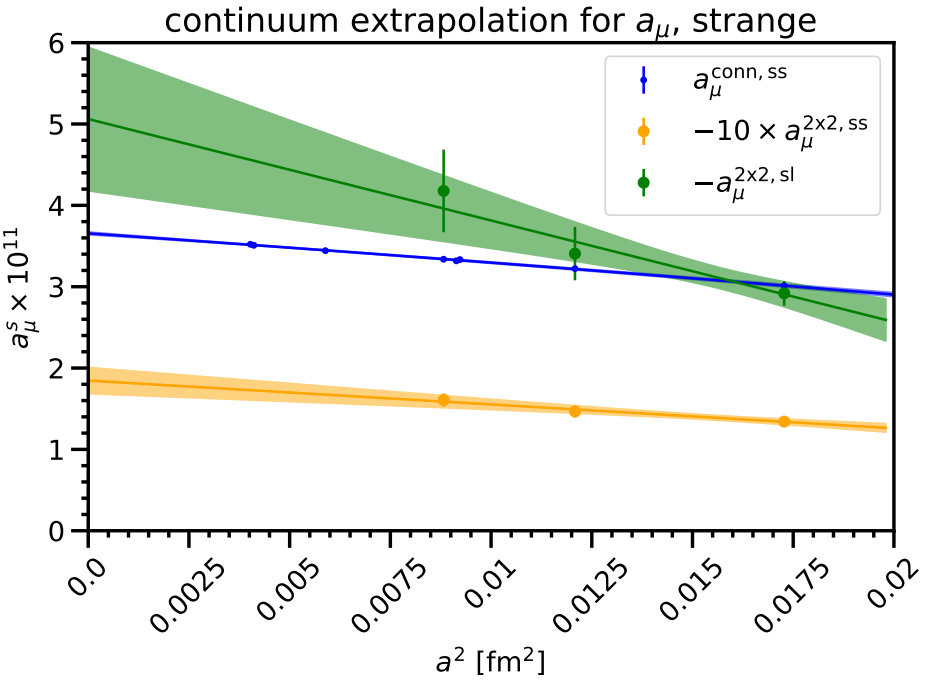


→ These contributions have been shown to be small by the Mainz group & RBC/UKQCD

Calculation based on Budapest-Marseille-Wuppertal (BMW) gauge ensembles

- Goldstone pion/kaon are tuned to their physical pion/kaon masses
  $\rightarrow$ $N_f = 2 + 1 + 1$ dynamical staggered fermions with four steps of stout smearing
- we have accumulated data at 3 values of the lattice spacing from 0.13 fm down to 0.09 fm
  $\rightarrow$ analysis on-going (preliminary results presented by C. Zimmermann @Lattice 23)
- 2 additional lattice spacings down to 0.065 fm for some contributions
  $\rightarrow$ connected strange (very precise data)
- use the π^0, η and η' transition form factors computed on the same set of ensembles
  $\rightarrow$ correct for finite-volume effects
  $\rightarrow$ better control on the tail of the integrand

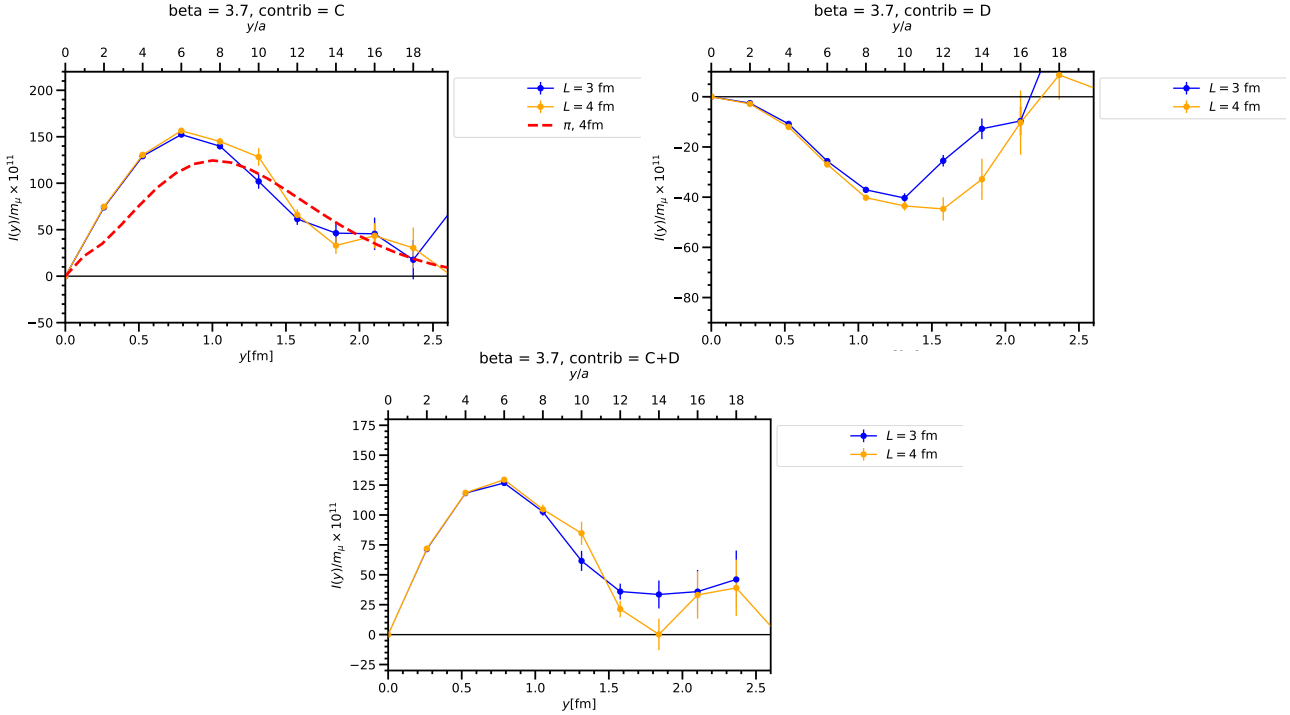
- Preliminary results presented by C. Zimmermann at Lattice 23
- Connected and 2+2 disconnected (preliminary)



- Individual contributions → cross-checks with other collaborations

- Connected and 2+2 disconnected (preliminary)

  → Results presented by C. Zimmermann @Lattice 23 ($a = 0.13$ fm)



→ Final results based on large-volume ensembles only

→ Current strategy : use the small volumes to test FSE correction.
then apply FSE on large volumes only.

- We have accumulated most of the statistics (3 lattice spacings).
- Analysis in on-going

  $\rightarrow$ focus on the dominant light-quark contribution (connected + leading disconnected)
- Use our calculation of the pseudoscalar transition form factors :

  $\rightarrow$ description of volume effects

  $\rightarrow$ tail of the integrand
- We expect first results by the end of the year