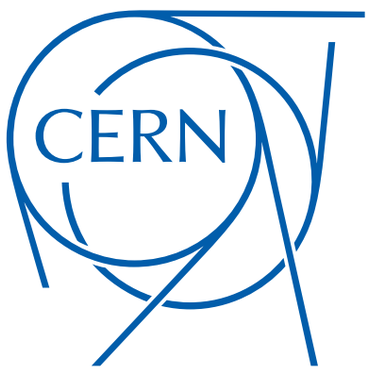
New proposals for the space-like experimental measurements of HVP and the lattice QCD data

Marina Krstić Marinković



First Workshop of the Muon *g* – 2 Theory Initiative

Fermilab, 2017, June 3-6

Proposals for new experimental measurements of a_μ^{HVP}

- Goal precision for HVP contribution to is <1%

➡ New proposals for the **space-like** experimental measurements of HVP

  ➡ [**Phys.Lett. B746 (2015) 325-329 by Carloni, Passera,Trentadue, Venanzoni**] **@KLOE2**

  ➡ [**Eur.Phys.J. C77 (2017) XYZ-YYY by Abbiendi et al.**] **@CERN**

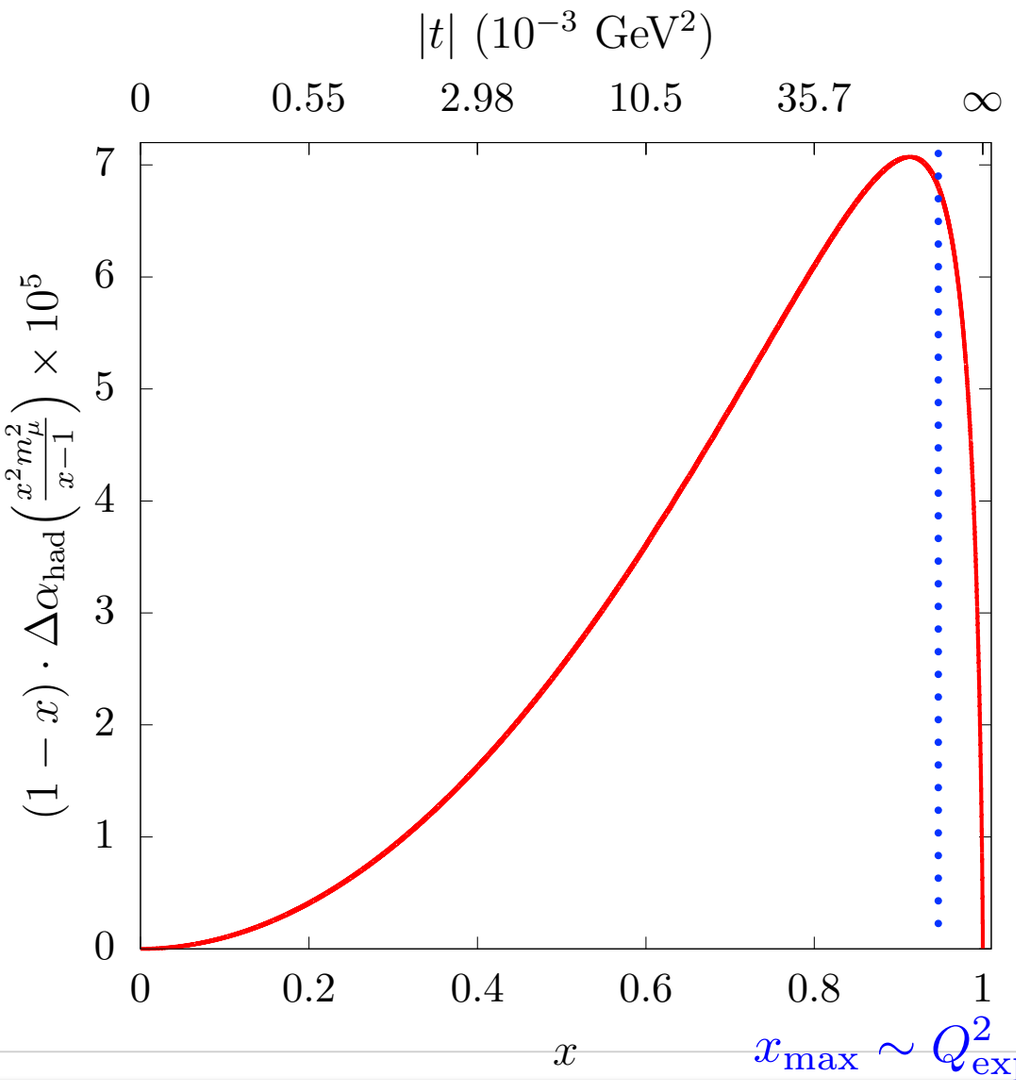
- Estimated precision for the HVP from the **μe scattering** experiment is **0.3%** **[see slides by G. Venanzoni]**

- **Relevance for lattice QCD determinations of HVP:**

  1. "hybrid method" [**Phys. Rev. D 90, 074508 (2014) Golterman,Maltman,Peris**] with experimental+lattice QCD data
     a) to complete the exp. result
     b) to cross-check lattice data
  2. continuum limit of $\Pi(Q^2)$ at fixed **Q^2**
  3. help in choosing the parametrization for $\Pi(Q^2)$ with less FV/cutoff effects

Hybrid method: a_μ^{HVP} **from experimental + lattice QCD data**

- Estimated precision for the HVP from the **μe** exp. is **0.3%** in **[0,0.138]GeV²** **[see slides by G. Venanzoni]**
- Due to the experimental constraints: region **[0.138, ∞] GeV²** cannot be covered by this exp.
  - ➡ complementary to the lattice QCD data



- ➡ $x_{\rm max} = 0.93$
- ➡ $Q^2 = \dfrac{x^2 m_\mu^2}{1-x}$
- ➡ $Q^2_{\rm exp,max} = 0.138{\rm GeV}^2$

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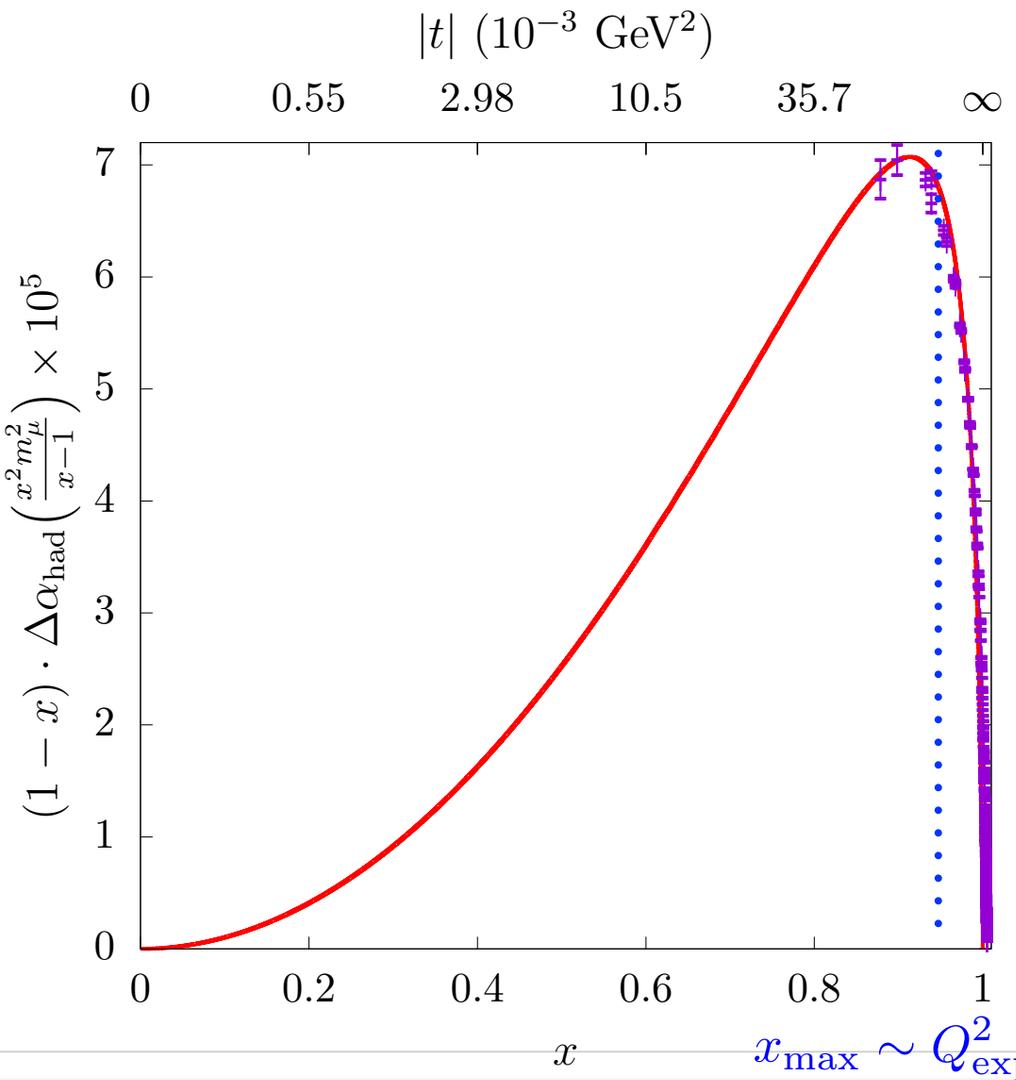

$x_{\max} \sim Q^2_{\text{exp,max}}$

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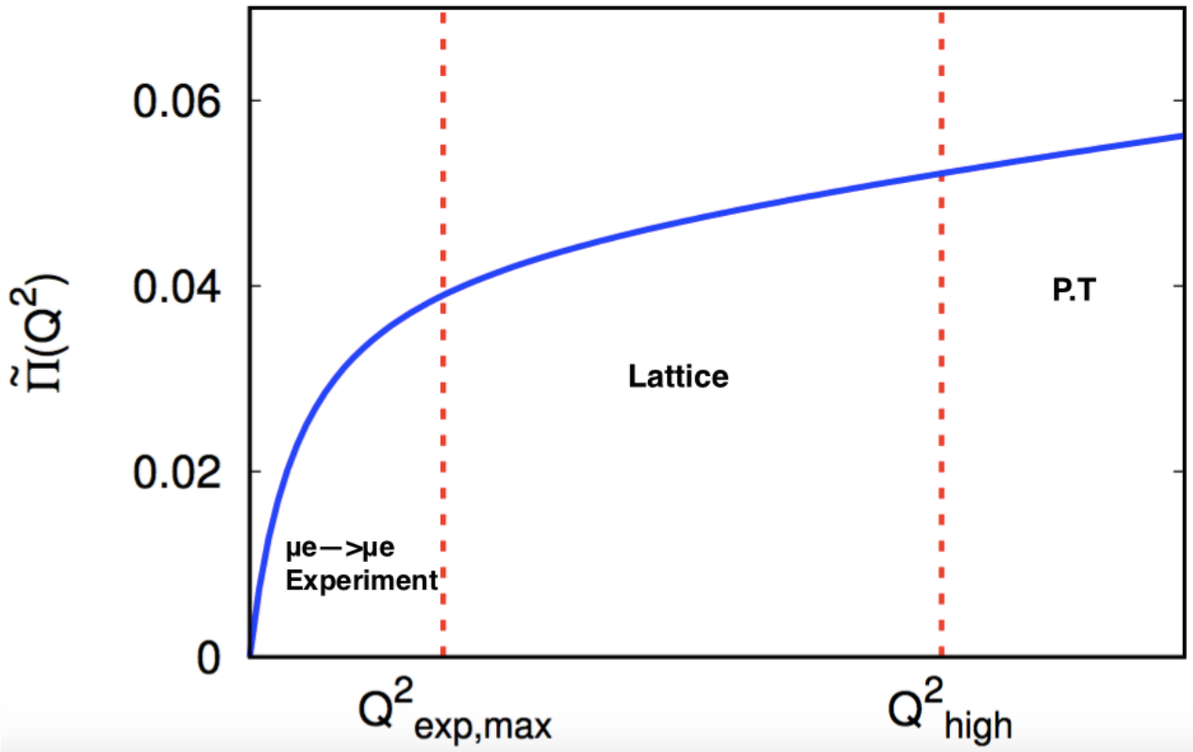

- ➡ Nf=2, E5, L/a=32 (CLS), $m_\pi \approx 440$MeV
- ➡ Pade [1,1]
- ➡ $a_\mu^{HVP,uds} = 3.61(10) \times 10^{-8}$
- ➡ $[0,Q^2_{exp,max}]$ —>87% of total $a_\mu^{HVP,uds}$
- ➡ $[Q^2_{exp,max},Q^2_{high}]$—>12% total $a_\mu^{HVP,uds}$
- ➡ $[Q^2_{high},\infty]$ —> <1% of total $a_\mu^{HVP,uds}$

- ABGP Pade approximants [**Aubin,Blum,Golterman,Peris, Phys.Rev. D86 (2012) 054509**]:
  - ➡ guaranteed to converge on the interval **$[Q^2_{exp,max},Q^2_{high}]$**
  - ➡ possible to combine with the numerical integration

Cross-check experimental $\Pi(Q^2)$ vs. continuum limit from the lattice

- Take individual $\Pi(Q^2)$values **[0,0.108]GeV²**
- Continuum limit at fixed Q² (previously extrapolated or measured at $\mathbf{m_{\pi,phys}}$)
- Compare to the slope and curvature for HVP function [**see arXiv:1612.02364 and talk by L. Lellouch**]

- **For the continuum limit of $\Pi(Q^2)$ at fixed Q²:**
  - ➡ twisted bc's / SCI
  - ➡ interpolate between the values measured by conventional methods

1. The HVP integral on a range [Q^2_{min},Q^2_{max}] has continuum&FV limit:

$$a_\mu^{HVP} = \left(\frac{\alpha}{\pi}\right)^2 \int_{Q^2_{exp,max}}^{\infty} dQ^2 \; f(Q^2) \times \tilde{\Pi}(Q^2)$$

- ➡ isospin breaking effects not expected to be relevant (≈ 1‰)
- ➡ cutoff effects need to be assessed systematically

2. Please go back to your data sets, look in the momentum range [0.138, ∞]GeV²

- ➡ Ideally, perform continuum limit (&infinite volume limit)
- ➡ Help us put together yet another estimate for a_μ^{HVP} joining th. and exp. efforts

QED+QCD simulations with C* bc's

- Generating configurations for N_f=2+1 O(a) improved Wilson fermions (QCD, QCD+QED)
- Next 1-2 years, expect to have first results on a_μ^{HVP} and a_μ^{HLbL}
- Particularly convenient for computing isospin breaking effects
  - ➡ local formulation of QED+QCD
  - ➡ different (smaller and better controlled?) F.V. effects

- **RC* collaboration:** P.Fritzsch, I.Campos, M.Hansen, B.Lucini, M.K.M, M.Papinutto, A. Patella, A. Ramos, N.Tantalo, …
- [**A.Patella, M.K.M @ Lattice 2017**] openQCD code —> added C* bc's and dynamical SU(3)+U(1)
- [**M. Hansen @ Lattice 2017**] —> first physics results with C* bc's