Finite volume effects in a_μ^{HVP} : 3-slide talks by

Harvey Meyer (Mainz):

The timelike pion form factor and finite-size corrections to the vector correlator

Laurent Lellouch (Marseille):

Correcting finite-size effects in the HVP contribution to the muon g-2 using large-volume lattice QCD simulations

Max Hansen (Edinburgh):

Finite-volume corrections to the vector correlator from space-like observables

Santi Peris (Barcelona):

FV effects in the EFT of a_{mu}^{HVP}

Christoph Lehner (Regensburg):

Finite-volume effects for the strong isospin-breaking contribution

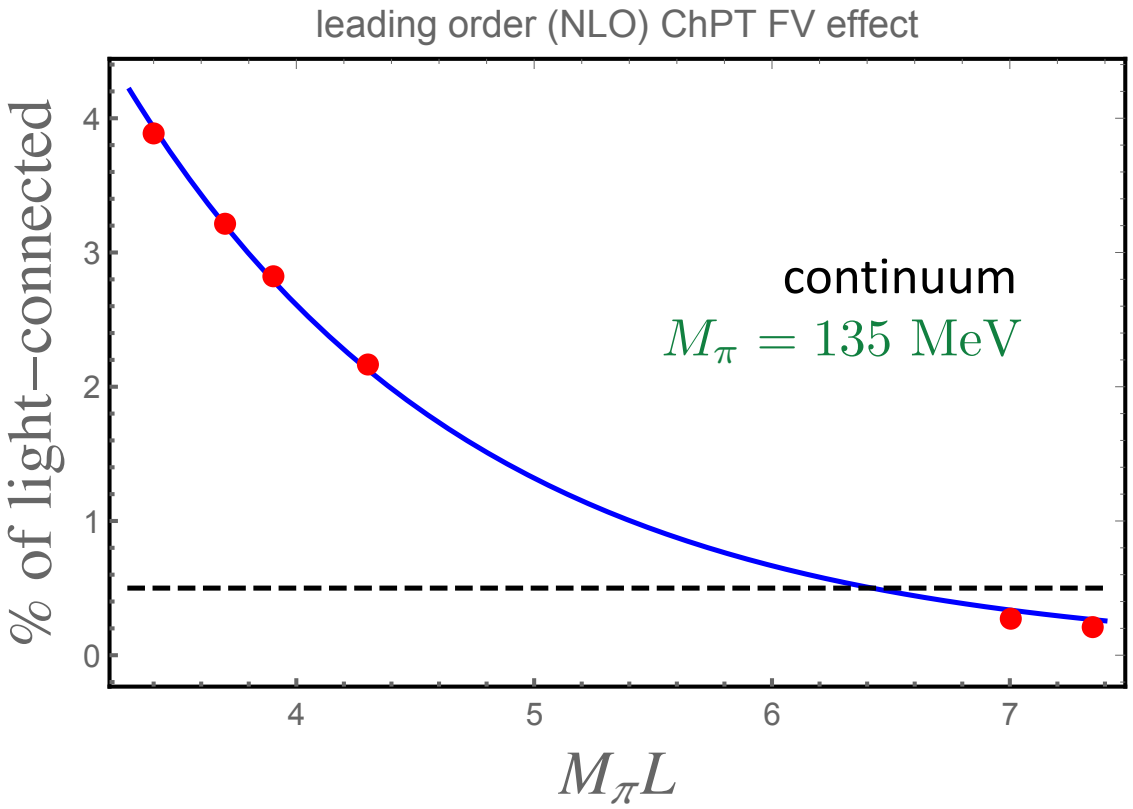
Antonin Portelli (Edinburg):

Electromagnetic finite-size effects on the two-pion contribution to the HVP

workshop "The hadronic vacuum polarization from lattice QCD at high precision"

November 16-20, 2020

Why is this important?



FV effects exponentially suppressed

NNLO ChPT corrections:

about 50 – 35% of NLO
In low-$M_\pi L$ region

$M_\pi L \lesssim 5$ computations need reliable correction

Need to prove that theory-based corrections are under good control!
Are simulations in large volumes ($L \gtrsim 10$ fm) needed to establish this?

BMW ‘20 finite-volume correction
(connected isospin-symmetric light-quark part):

(1) $$a_\mu(L_{\rm big}, T_{\rm big}) - a_\mu(L_{\rm ref}, T_{\rm ref}) = 18.1(2.0)_{\rm stat}(1.4)_{\rm cont}$$

(2) $$a_\mu(\infty, \infty) - a_\mu(L_{\rm big}, T_{\rm big}) = 0.6(0.3)_{\rm big}$$

$L_{\rm ref} = 6.272$ fm $L_{\rm big} = 10.752$ fm

(1) numerical; (2) NNLO ChPT

How big should $L_{\rm big}$ be?
Optimal balance between computation and theory?

Collaborations/methods

collab.	fermions	$M_{\pi,min}$	$(M_\pi L)_{max}@M_{\pi,min}$	this workshop
Mainz	$O(a)$-impr. Wilson	phys $-$ 421	4.1	Gérardin
PACS	$O(a)$-impr. Wilson	phys	7	
ETM	twisted-mass	223 $-$ 495	3.4	Giusti
RBC/UKQCD	domain wall	phys	3.7	A.Meyer
FHM	staggered (HISQ)	phys(NGB)	3.9	McNeile
Aubin *et al.*	staggered (HISQ)	phys(NGB)	3.9	Aubin
BMW	staggered(stout/HEX)	phys/average	4.3/7.3	Toth

- ChPT (two loop/NNLO) (Bijnens and Relefors '17, Aubin *et al.* '19, BMW '20)
- Pion EM form factor and Lellouch-Lüscher (Gounaris-Sakurai for FF) (Meyer '11, Mainz '13)
- Expansion in $\exp[-|\vec{n}|M_\pi L]$ up to $|\vec{n}| = \sqrt{3}$ (Hansen & Patella '20)
- Large volume studies on the lattice (PACS '19, BMW '20)

Further issues

- finite-volume corrections should be studied at the physical pion mass
  long extrapolation from 200 MeV pions – no EFT

- staggered meson masses & taste splitting: $M_{\pi,\mathrm{av}} \neq M_{\pi,\mathrm{NGB}}$
  example: NLO ChPT for $M_\pi L = 3.9$: $10^{10}\Delta a_\mu = 18.1$ @ $a = 0$
  $\Rightarrow\ 10^{10}\Delta a_\mu = \ \ 2.1$ @ $a = 0.12$ fm
  $M_{\pi,\mathrm{taste}} = 133 - 326$ MeV (HISQ)

  (SChPT@NNLO: BMW)
  lattice artifact: extrapolates away in the continuum limit, SChPT helps

- finite T: effects may not be negligible (BMW ‘20, Hansen&Patella ‘20)

- attention to FV effects in other contributions (disc., I = 0, IB, QED)