UNIVERSITY OF LIVERPOOL

Re-Evaluation of the HVP Contribution to the Anomalous Magnetic Moment of the Muon

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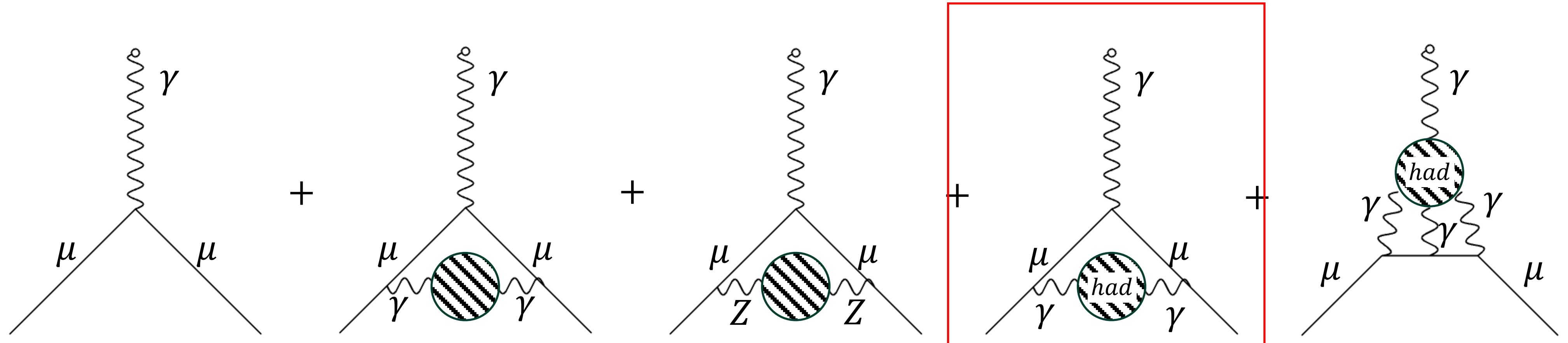
The Anomalous Magnetic Moment & $g - 2$

- Dirac: $g = 2$, QFT: $g = 2 + a_\mu$ (bottom)
- Largest theory uncertainty: hadronic contribution due to QCD non-perturbativity.
- Hadronic contribution can be calculated using lattice QCD or dispersive methods (this presentation).
- Dispersive result is in strong tension with recent results of the $g - 2$ experiment.

$g =$



Dirac: 2

a_μ^{QED, N^4LO}: 116 584 718.931(104) $\times 10^{-11}$

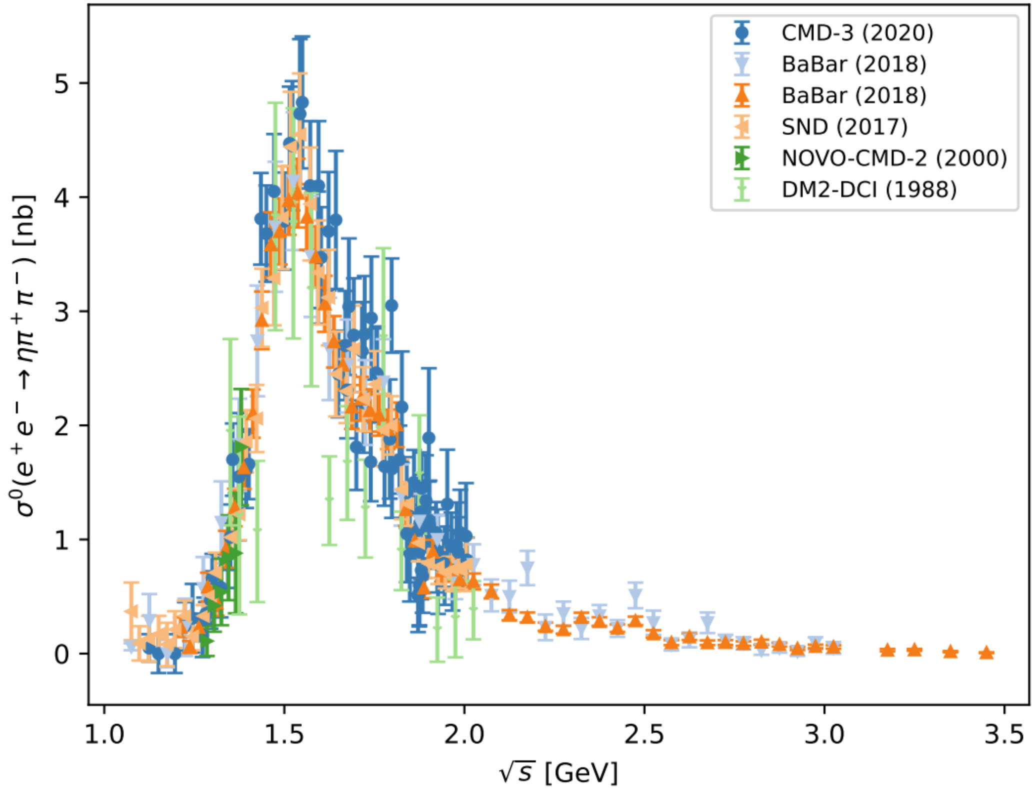
$a_\mu^{EW, NNLO}$: 153.6(1.0)$\times 10^{-11}$

$a_\mu^{HVP, NNLO, disp.}$: 6845(40)$\times 10^{-11}$

$a_\mu^{HLbL, NLO}$: 92(18)$\times 10^{-11}$

Dispersive a_μ^{HVP}

- Take experimental inputs of $e^+e^- \to hadrons$ in non-perturbative region and integrate cross section σ with a known kernel $K(s)$.
- Complicated by:
  - Multiple hadronic final states
  - Tension between e^+e^- datasets (CMD-3 $\pi^+\pi^-$)
  - Radiative corrections
  - Data combination
- (Right) Plot of σ vs. $\sqrt{s}$ in the $\eta\pi^+\pi^-$ channel.



Database Introduction and Structure

- Previous FORTRAN code read in data from saved .txt files.
- New Python3 code uses a relational SQL database which is then used to construct objects.
- (Right) Structure of the database:
  Channels → Datasets → Data → Covariances
- Dataset object inherits channel attributes and contains its data.

channel_id	channel_name	num_sets	radcorr_1	radcorr_2	...
0	Inclusive data HIGH	19	-	Y	...
1	Inclusive data LOW	6	-	Y	...
2	#eta#pi^+#pi^-	7	-	Y	...
3	K^+K^-	17	N	Y	...
4	K^+K^-#pi^0	4	-	Y	...

dataset_id	channel_id	use	num_data_points	experiment	year	...
0	0	y	14	BES-III	2021.0	...
1	0	y	22	KEDR-VEPP4M	2019.0	...
2	0	y	122	BaBar	2009.0	...
3	0	y	3	BES-II	2009.0	...
5	0	y	7	CLEO	2007.0	...
...	...	..	...	...	...	...

data_id	channel_id	dataset_id	energy_min	energy_max	cross_section	...
0	0	0	2.2324	2.2324	2.286	...
1	0	0	2.4000	2.4000	2.260	...
2	0	0	2.8000	2.8000	2.233	...
3	0	0	3.0500	3.0500	2.252	...
4	0	0	3.0600	3.0600	2.255	...
...	...	...	...	...	...	...

data_id1	data_id2	stat0_or_syst1	value
14	14	0	0.019321
14	15	0	0.000000
14	16	0	0.000000
14	17	0	0.000000
14	18	0	0.000000
...	...	...	...

Blinding

- Previous analysis was not blinded.
- New analysis should be.
- Blind using seeds $\{s1, s2, s3, s4, s5\}$:
  - Channel number (s5: $\mathrm{c} \to \mathrm{c}' = (c + s5) \bmod 100$)
  - Sign: $a = \pm 1$
  - Scale: b in $0.1 \to 0.9$ or $1.1 \to 10$
  - Offset: s_0 in $-0.01\ \mathrm{GeV}^2 \ \to 1.00\ \mathrm{GeV}^2$
  - Power: p with $0.01 \leq |p| \leq 0.05$

  (Sign, Scale, Offset, Power) $\Rightarrow B(s) = a \cdot b(s + s_0)^p$
- Blinding variables $\{a, b, s_0, p\}$ use concatenations of c' and $\{s1, s2, s3, s4\}$.

  e.g.: $s1 = 1,\ \mathrm{c}' = 63 \ \Longrightarrow \mathrm{sign\_seed} = \mathrm{python.random.seed}(163)$