Muon g-2 and BSM Models

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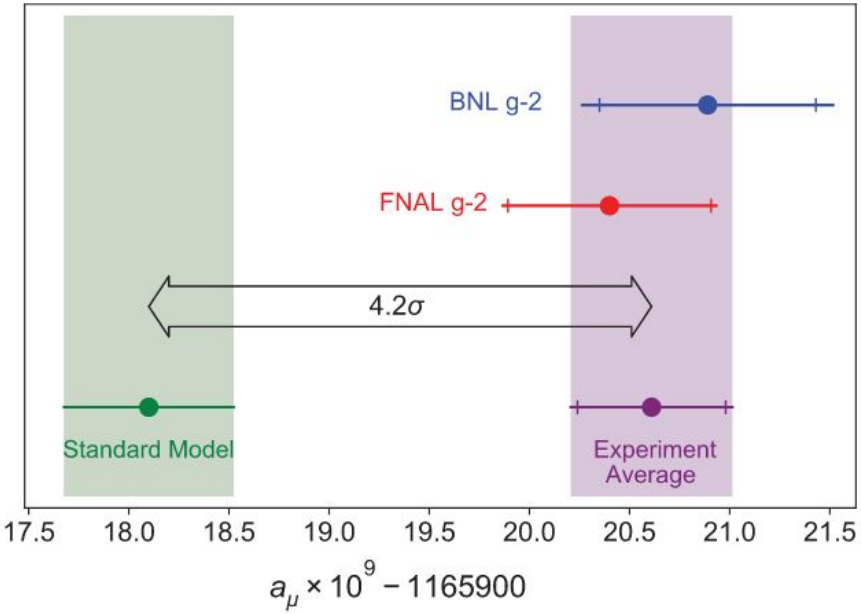
15 year after the BNL result, FNAL confirms the muon g-2 anomaly…

$$a_\mu \equiv (g_\mu - 2)/2$$

$$a_\mu^{\mathrm{SM}} = 116\ 591\ 810(43) \times 10^{-11}$$

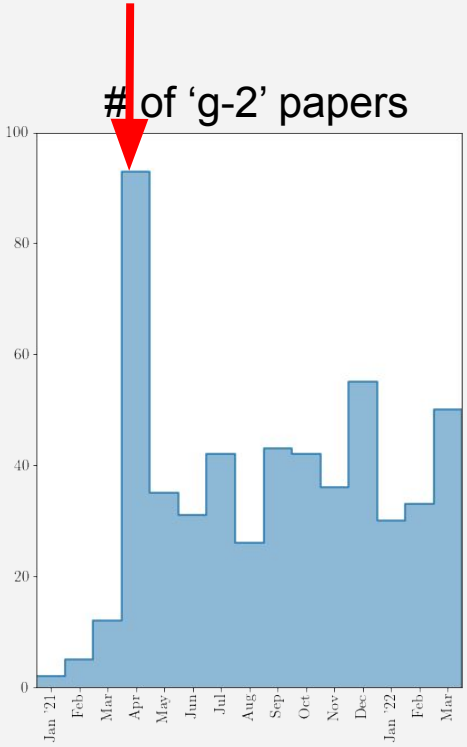
$$a_\mu^{\mathrm{exp}} = 116\ 592\ 061(41) \times 10^{-11}$$



PHYSICAL REVIEW LETTERS **126,** 141801 (2021)

Editors' Suggestion | Featured in Physics

Measurement of the Positive Muon Anomalous Magnetic Moment to 0.46 ppm



AMBULANCE

arXiv:2002.12347v3 [hep-lat] 22 Apr 2021

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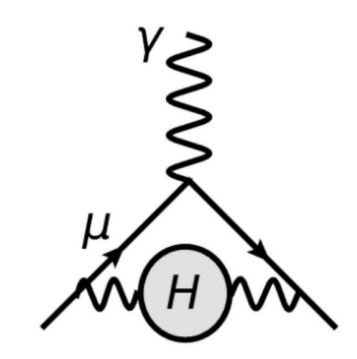
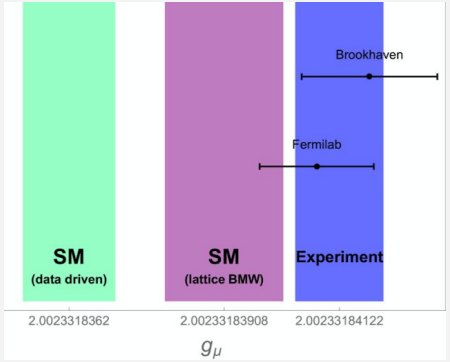
Article | Published: 07 April 2021

Leading hadronic contribution to the muon magnetic moment from lattice QCD

Sz. Borsanyi, Z. Fodor, J. N. Guenther, C. Hoelbling, S. D. Katz, L. Lellouch, T. Lippert, K. Miura, L. Parato, K. K. Szabo, F. Stokes, B. C. Toth, Cs. Torok & L. Varnhorst

Nature **593**, 51–55 (2021) | Cite this article





What if the anomaly is real?

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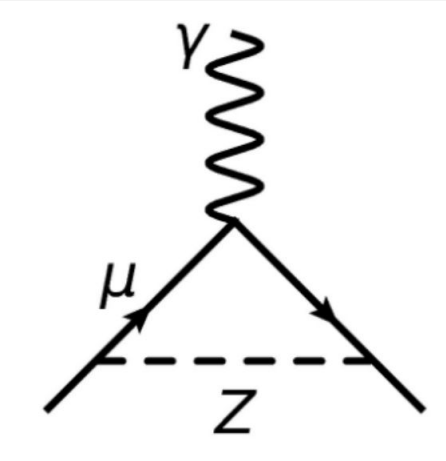
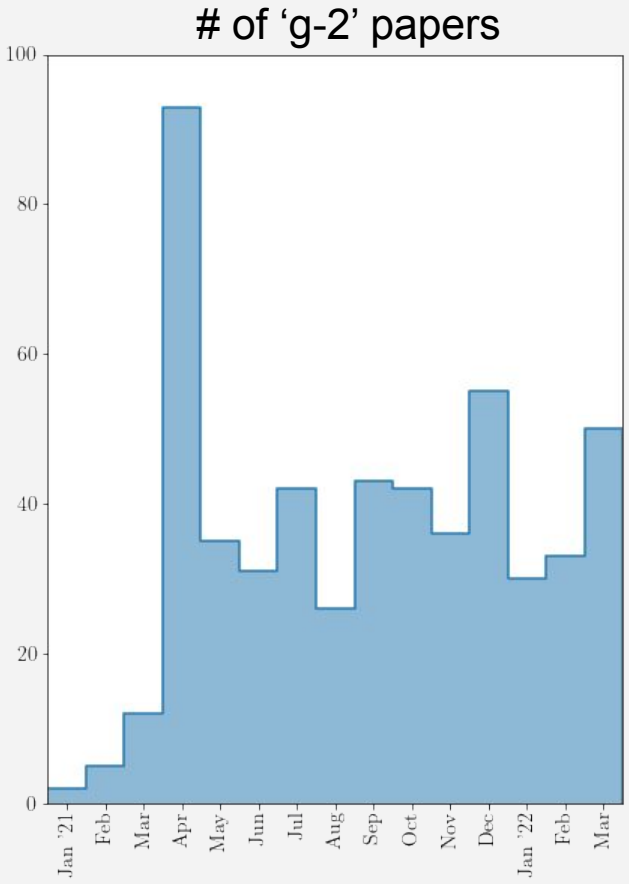


$$\Delta a_\mu \equiv (a_\mu^{\rm exp} - a_\mu^{\rm SM}) = (251 \pm 59) \times 10^{-11}$$

$$a_\mu^{\rm EW(1)} = \frac{G_{\rm F}}{\sqrt{2}} \frac{m_\mu^2}{8\pi^2} \left[\frac{5}{3} + \frac{1}{3}(1 - 4s_{\rm W}^2)^2 \right] = 194.79(1) \times 10^{-11}$$

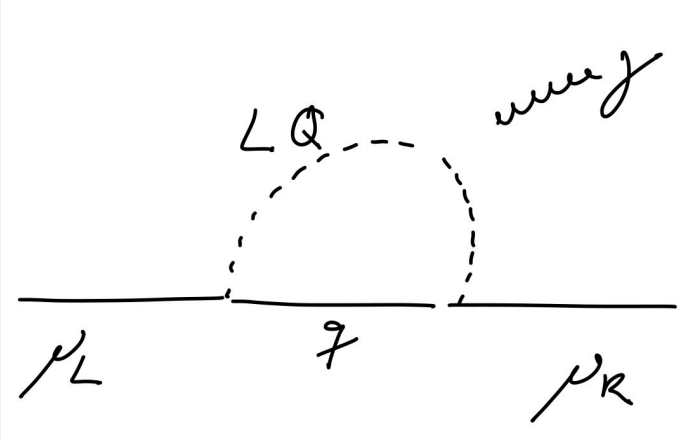
Many BSM possibilities…



+ 100s pre ‘21 FNAL result…

“Heavy”-solutions I: Leptoquarks

- Can be done with few-TeV masses
- Can be done with scalar and vector leptoquarks
- Need to carefully arrange flavor-structure of couplings



[Bauer&Neubert 1511.01900, Crivellin+ 2008.02643, Crivellin+ 2010.06593, Hiller+ 2103.12724, Nomura&Okada 2104.03248, Du+ 2104.05685, Ban+ 2104.06656, Perez+ 2104.11229, …]

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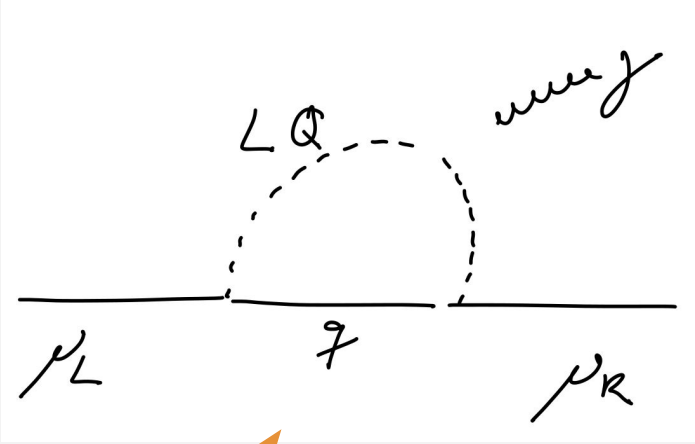

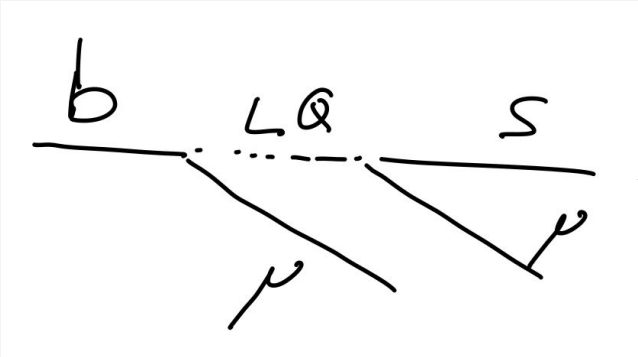

Bonus

Can address flavor anomalies!

1.01900, Crivellin+ 2008.02643, 3, Hiller+ 2103.12724, 4.03248, Du+ 2104.05685, erez+ 2104.11229, …]

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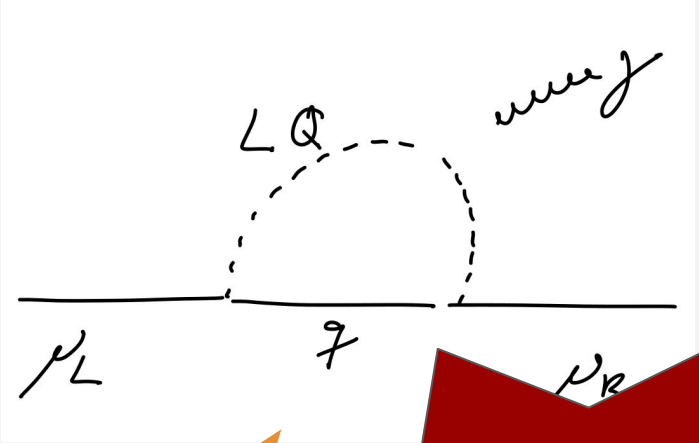
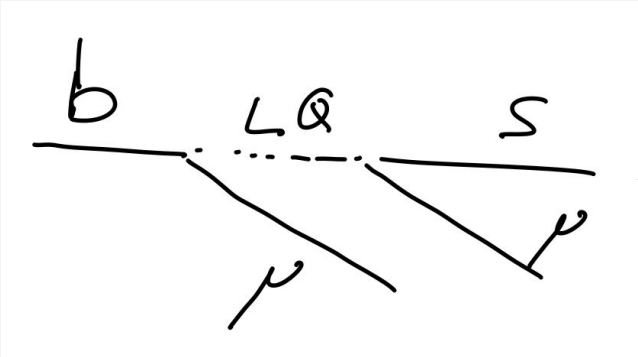




<u>Bonus</u>

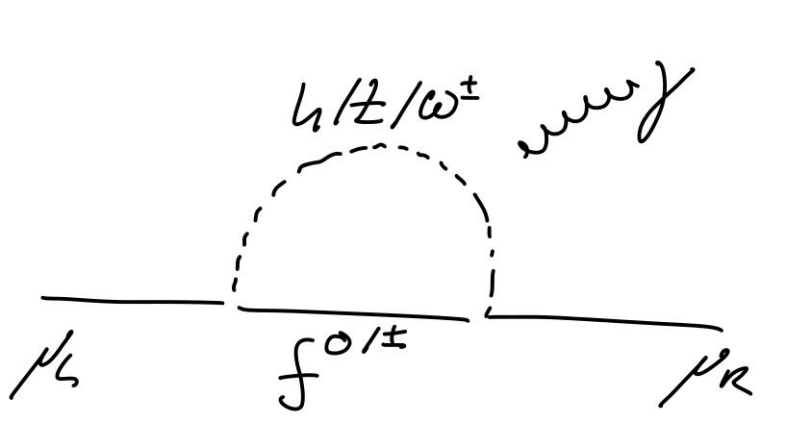
Can address flavor anomalies!

RPV SUSY!

[…008.02643, 3, Hiller+ …724, 4.03248, …2104.05685, …erez+ 210…1229, …]

“Heavy”-solutions II: Vector-like leptons

- Can be done with few-TeV masses
- Need to carefully arrange flavor-structure of couplings

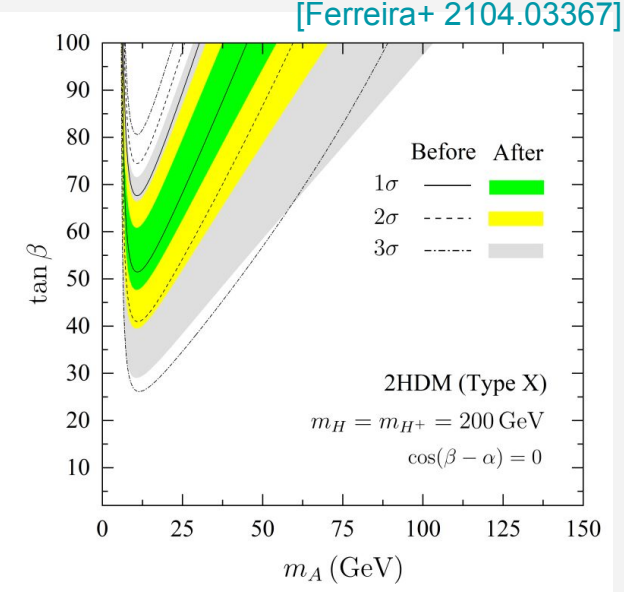


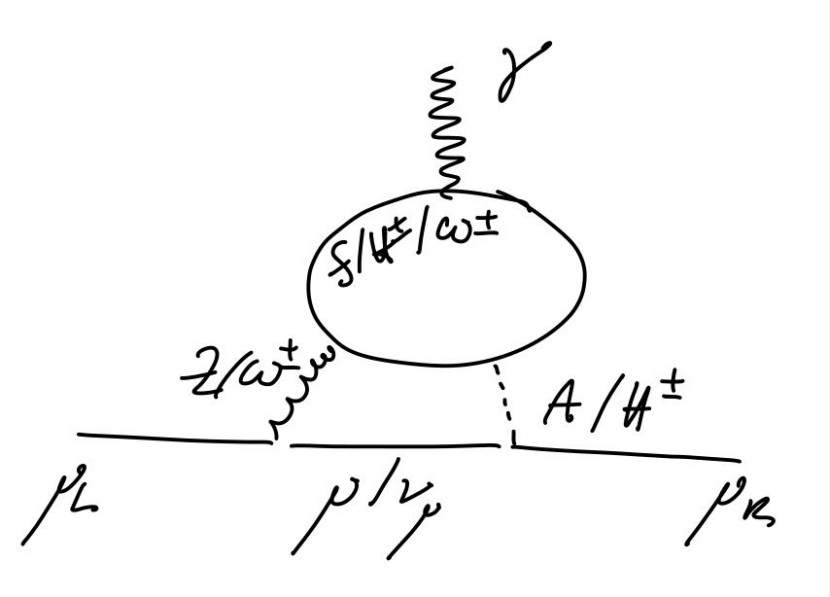
[Kannike+ 1111.2551, Dermisek&Raval 1305.3522, Dermisek+ 2103.05645, Arcadi+ 2104.03228, Lu+ 2104.04503, …]

“Heavy”-solutions III: 2 Higgs Doublet Models

- Seems possible with <u>leptophilic</u> 2HDM

[Ferreira+ 2104.03367]

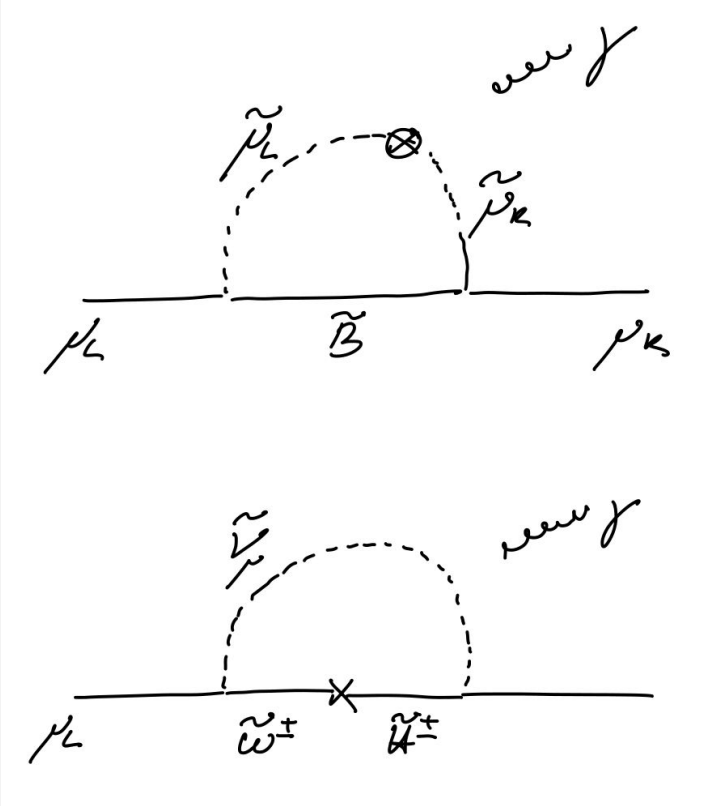




[Gunion 0808.2509, Wang+ 1809.05857, Han+ 2104.03227, Ferreira+ 2104.03367, Jueid+ 2104.10175, …]

“Heavy”-solutions IV: Supersymmetry

- Requires (some of) Higgsinos/Binos/sleptons in the few-hundred GeV range
- tan(β) enhanced chirality flips



[Barbieri&Maniani ‘82, Ellis+ ‘82, Kosower+ ‘83, Moroi+ ‘96, Carena+ ‘97, Feng&Matchev ‘01, Martin&Wells *01, …, Chakraborti+ 2006.15157, Chakraborti+ 2103.13403, **SB**+ 2104.03302, …]

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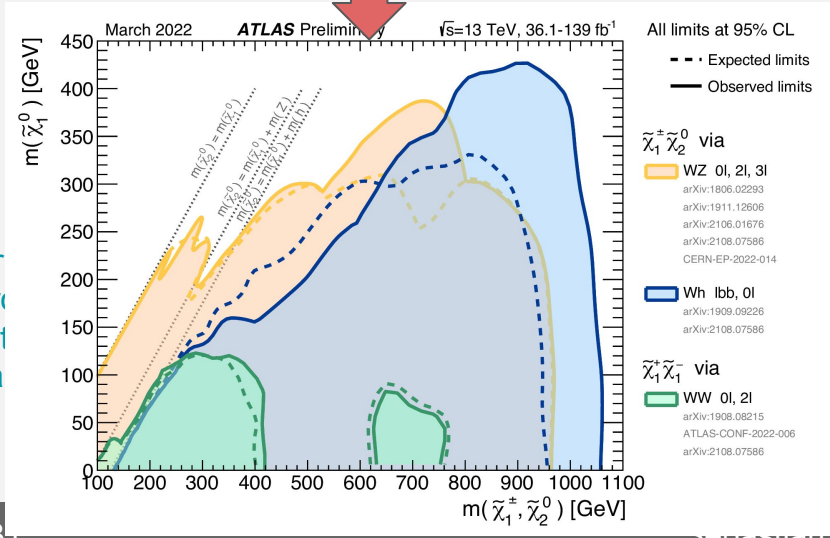
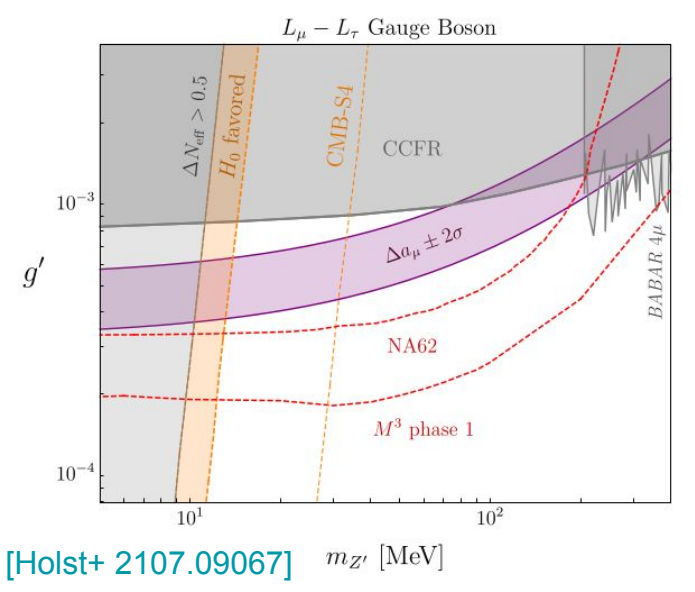


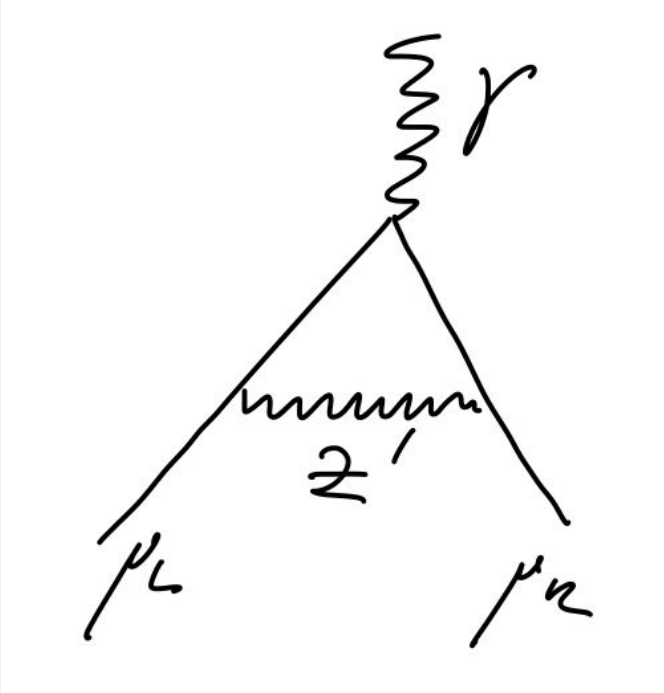
[Bar
Mor
Mart
Cha

“Light”-solutions I: *Z’*

- ~10 - 100 MeV masses, 10^{-3} couplings
- L_μ-L_τ is special!

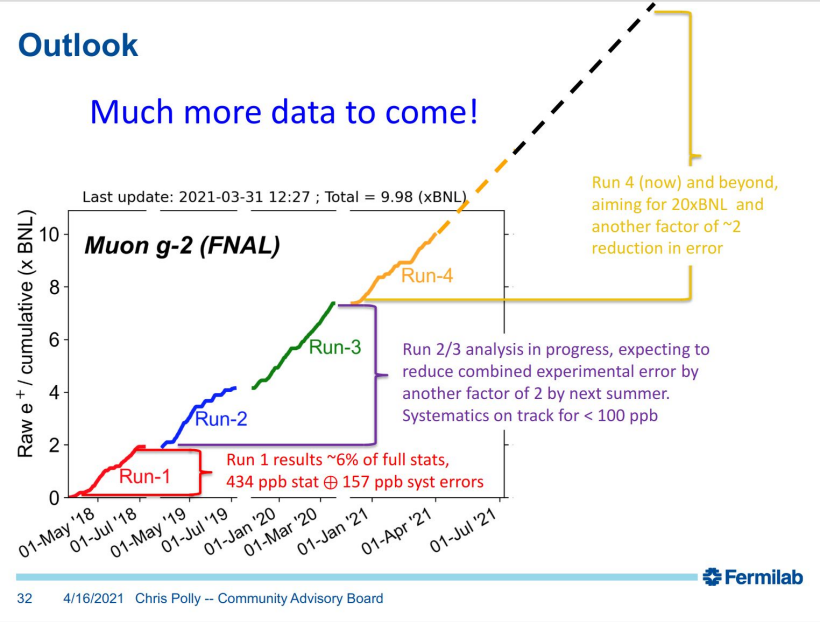


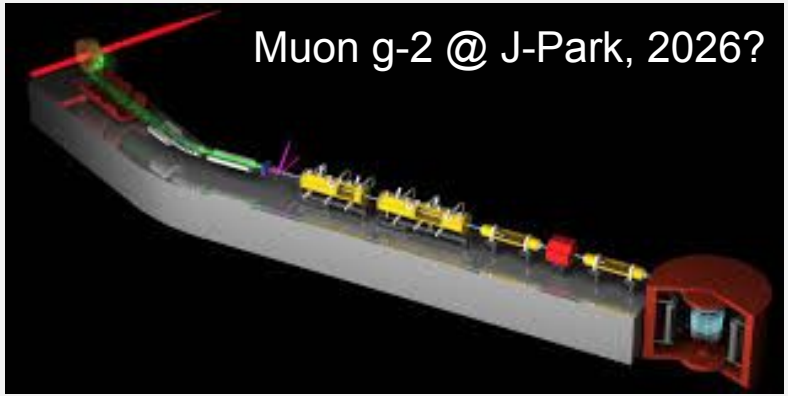
[Holst+ 2107.09067]



[Heeck&Rodejohann 1107.5238, Altmannshofer+ 1403.1269, Altmannshofer+ 1604.08221, Altmannshofer+ 1406.2332, Abdullah+ 1803.01224, Escudero+ 1901.02010, Amaral+ 2104.03297, Holst+ 2107.09067, Drees&Zhao 2107.14528, Greljo+ 2203.13731, …]

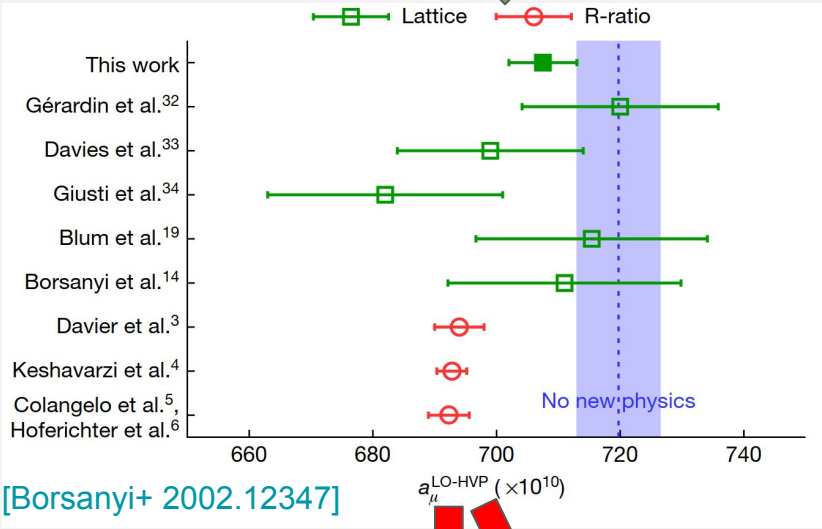
Will the fog clear soon?



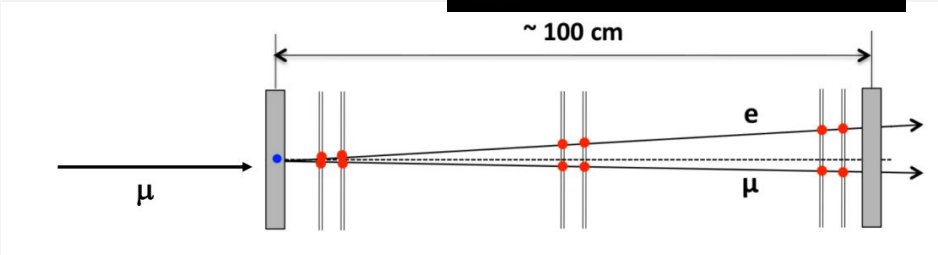


Will the fog clear soon?

2022?



[Borsanyi+ 2002.12347]

2022?

2026?