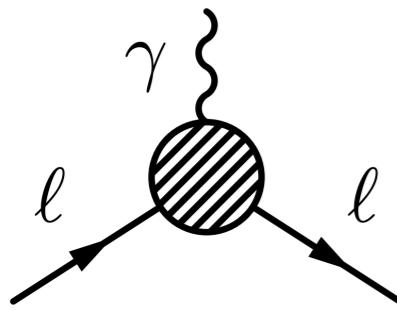


$(g - 2)_\mu$ and CLFV

Wouter Dekens, INT

In collaboration with
J. Aebischer, V. Cirigliano, J. de Vries, K. Fuyuto,
E. Jenkins, A. Manohar, E. Mereghetti,
R. Ruiz, D. Sengupta, P. Stoffer

Muon g-2



A Feynman diagram showing a muon loop with a virtual photon exchange. The loop consists of two muon lines meeting at a central vertex, which is connected to a wavy photon line labeled γ . The muon lines are labeled with the Greek letter ℓ .

$$\sim \Gamma^\mu(p, p') = \gamma^\mu F_E(k^2) + i \frac{\sigma^{\mu\nu} k_\nu}{2m_\ell} F_M(k^2) + \frac{\sigma^{\mu\nu} k_\nu}{2m_\ell} \gamma_5 F_D(k^2) + \frac{k^2 \gamma^\mu - k^\mu \not{k}}{m_\ell^2} \gamma_5 F_A(k^2)$$

$\sim \vec{\mu} \cdot \vec{B}$

$$a_\mu = \frac{g_\mu - 2}{2} = F_M(0) =$$

Muon g-2

γ

ℓ

ℓ

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In the SM

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Schwinger term

Leading term

Muon g-2

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Schwinger term Hadronic vacuum Polarization Hadronic light by light

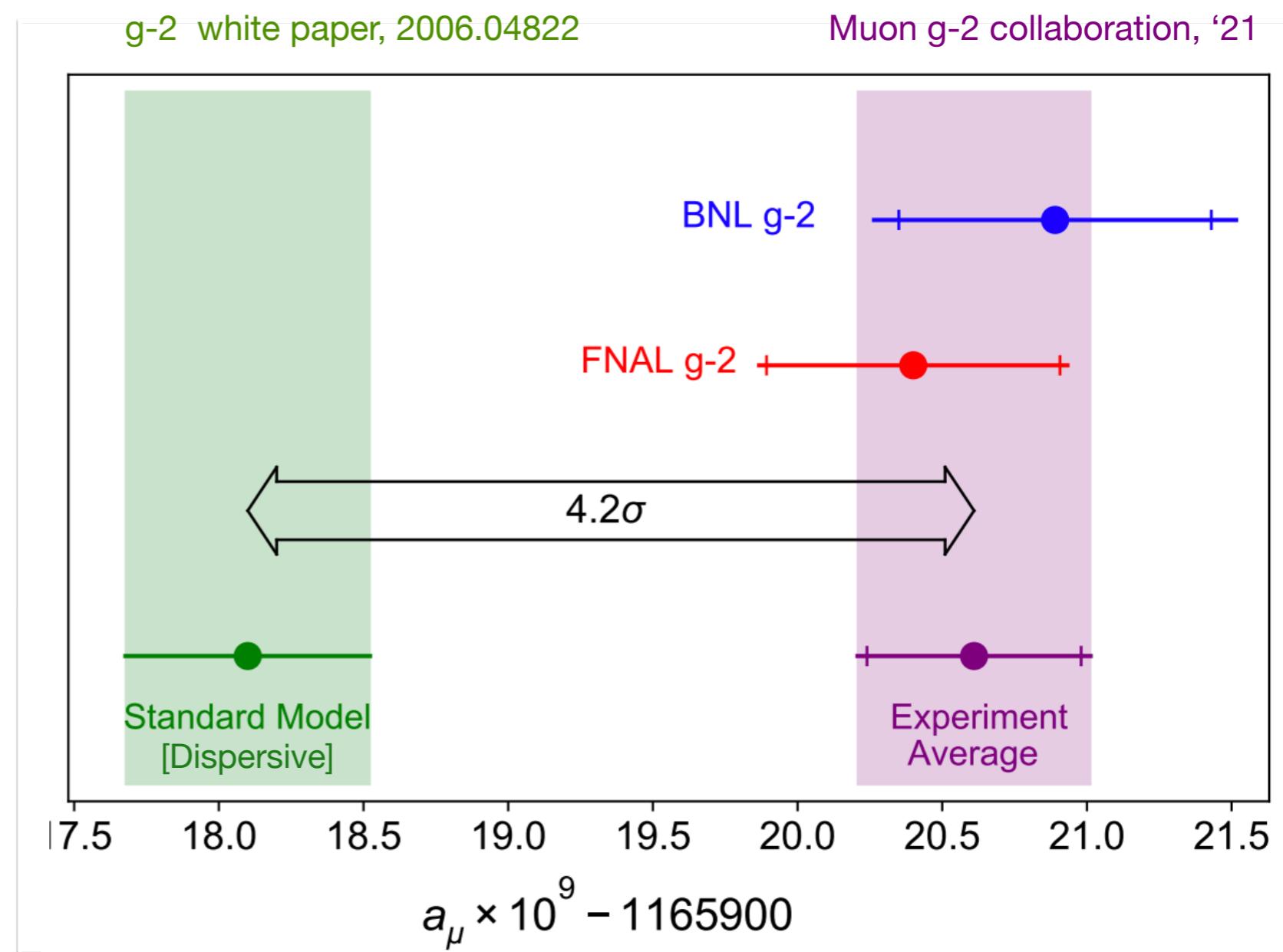
Leading term **Largest uncertainties**

Muon g-2

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- Dispersive approach
 - $\sim 4\sigma$ tension with SM



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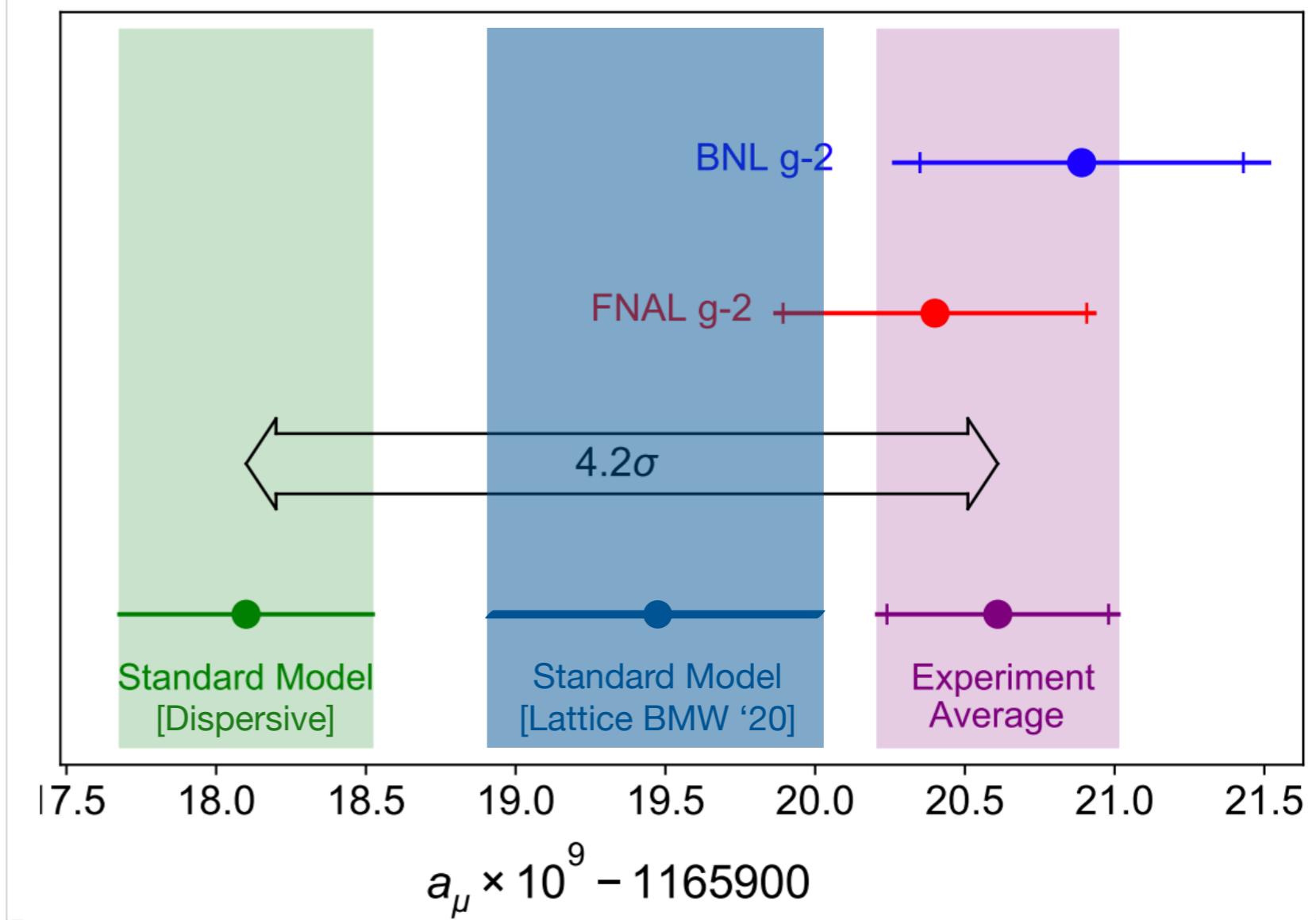
$\sim \vec{\mu} \cdot \vec{B}$

- Dispersive approach
 - $\sim 4\sigma$ tension with SM
- Lattice determination
 - Tension with EWPO, $\Delta\alpha_{\text{had}}$?

Crivellin, Hoferichter, Manzari, Montull, '20

g-2 white paper, 2006.04822

Muon g-2 collaboration, '21



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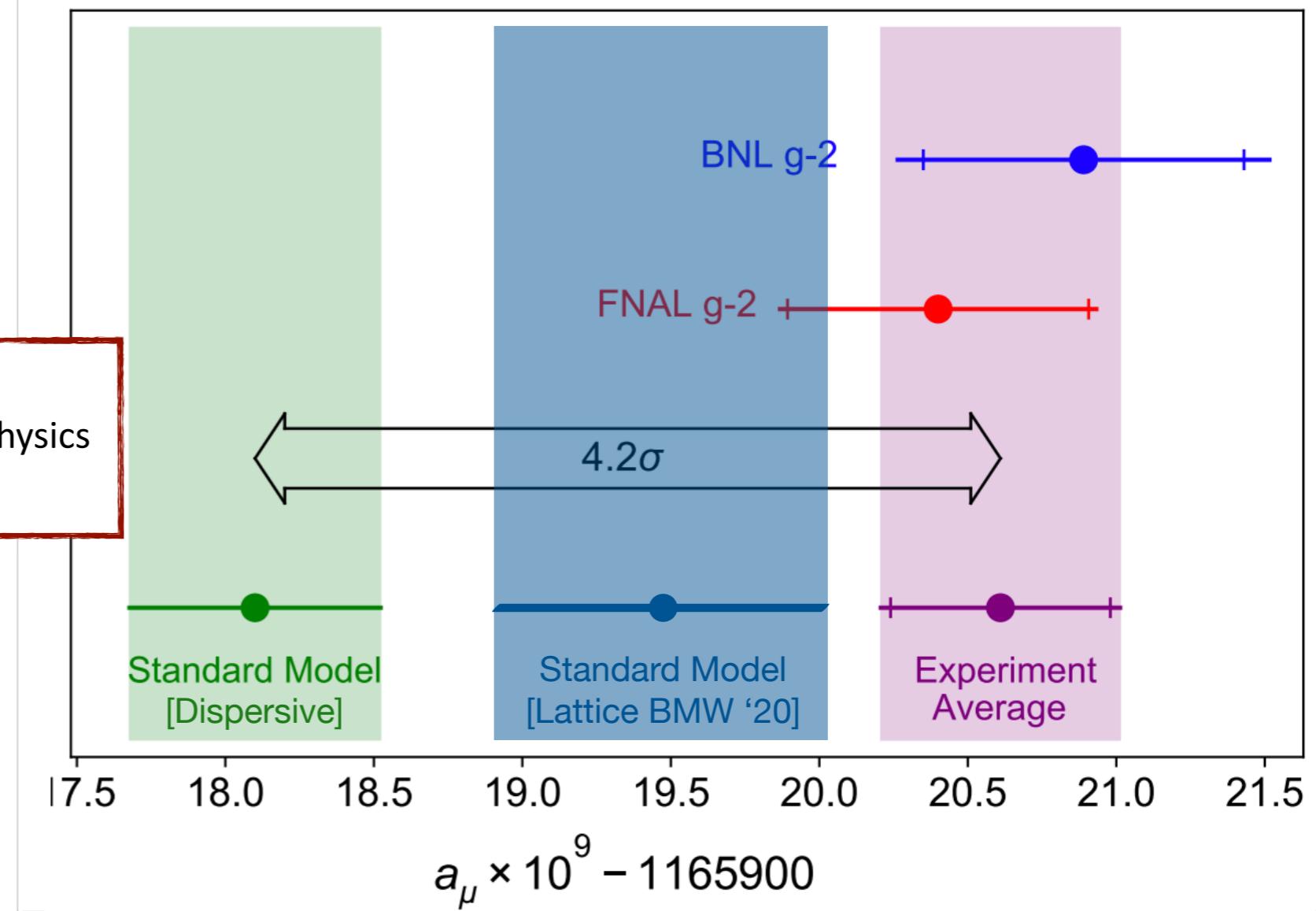
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Points to/stringently constrains BSM physics

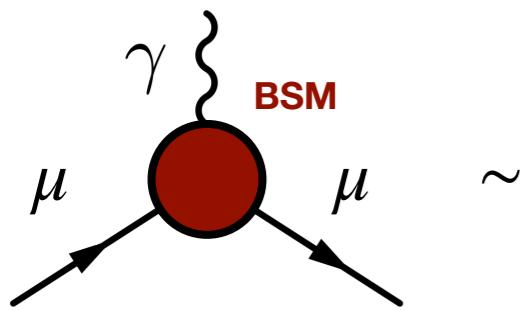
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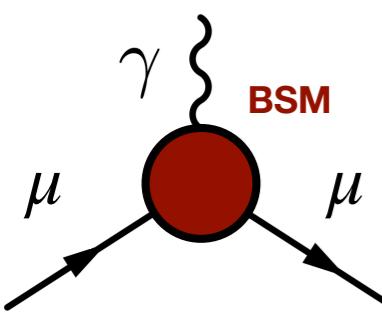
$g-2$ and CLFV

$(g - 2)_\mu$

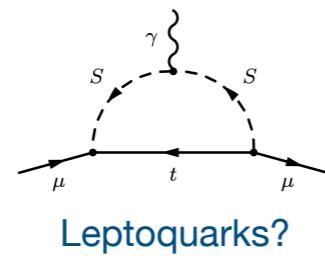


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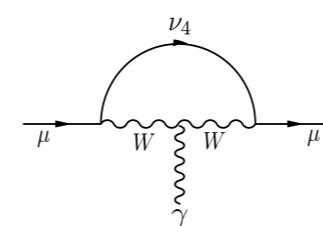
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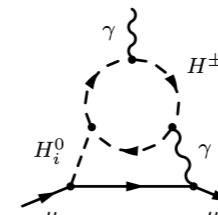
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New neutrinos/leptons?

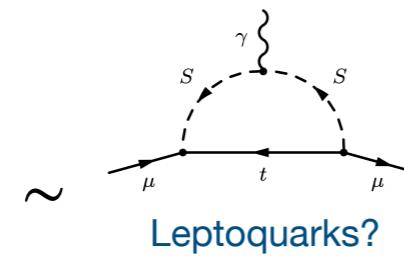
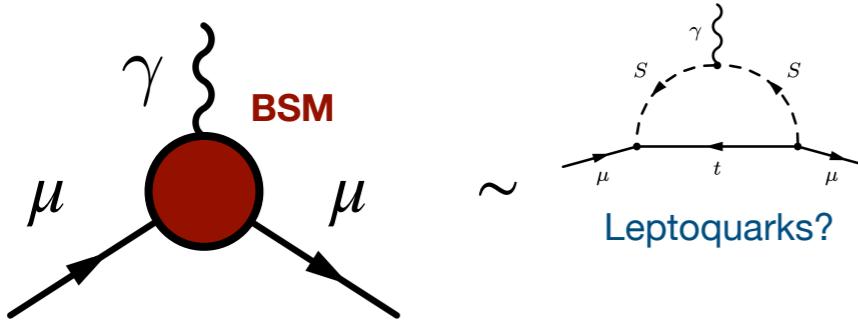


Two-Higgs doublet?

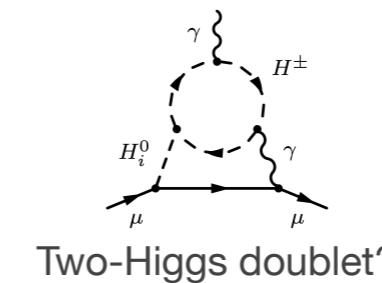
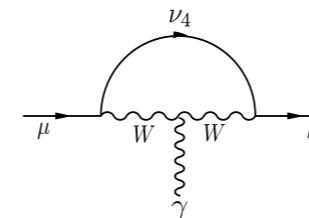


g-2 and CLFV

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New neutrinos/leptons?



+

SUSY?
GUTs?
Left-right model?
Vector-like leptons?
Dark Z's?
DM?
.....

Measurement of the Positive Muon Anomalous Magnetic Moment to 0.46 ppm

Muon g-2 Collaboration • B. Abi (Oxford U.) Show All(237)

Apr 7, 2021

11 pages

Published in: *Phys.Rev.Lett.* 126 (2021) 14, 141801

Published: Apr 8, 2021

e-Print: [2104.03281](https://arxiv.org/abs/2104.03281) [hep-ex]

DOI: [10.1103/PhysRevLett.126.141801](https://doi.org/10.1103/PhysRevLett.126.141801) (publication)

Report number: FERMILAB-PUB-21-132-E

Experiments: [FNAL-E-0989](#)

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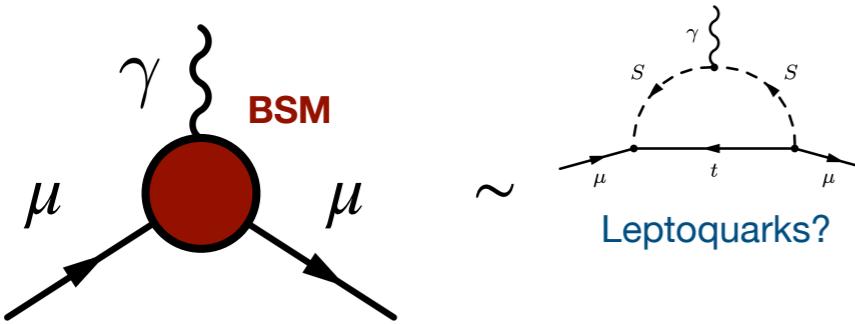
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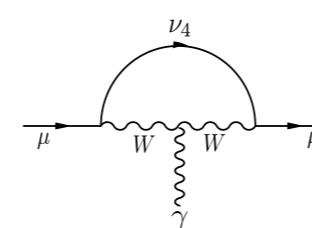
883 citations

g-2 and CLFV

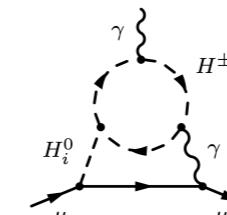
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MANY possible models
Describe them in an EFT framework

141801 (publication)
1-132-E

View in: [OSTI Information Bridge Server](#), [ADS Abstract Service](#)

pdf links cite

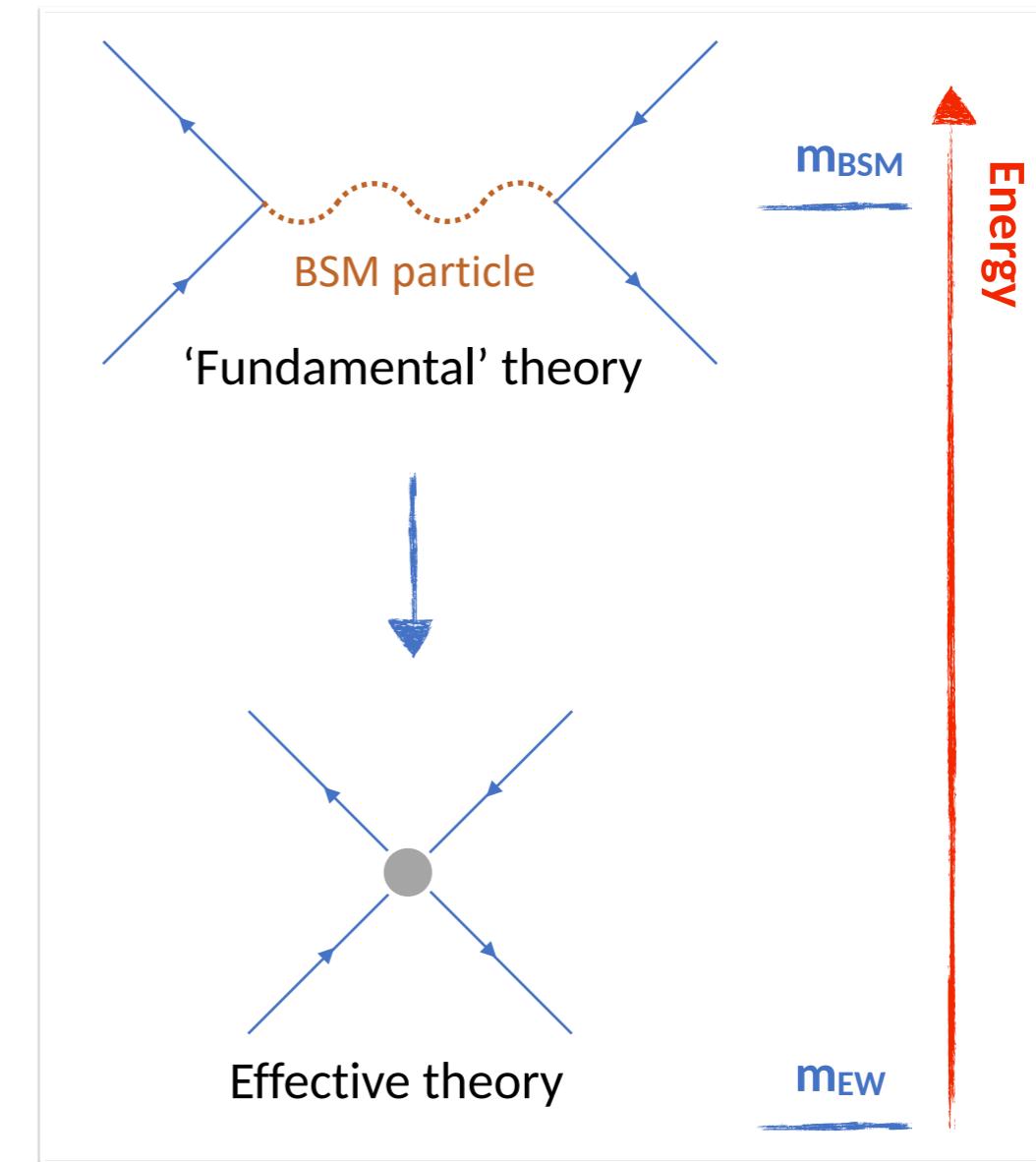
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Effective Field Theory

Assumptions

- No new light degrees of freedom (apart from ν_R)
- Assume high BSM scale, $m_{EW} \ll m_{BSM}$
- SM gauge group $SU(3) \times SU(2) \times U(1)$ is linearly realized (elementary scalar $SU(2)$ doublet)

$$\mathcal{L}_{UV} = ??$$



$$\mathcal{L}_{\text{EFT}} = \mathcal{L}_{SM} + \sum_i \frac{c_i}{\Lambda^2} O_i^{d=6}$$

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Dimension-six operators

- 59 of them involving only SM fields

X^3		φ^6 and $\varphi^4 D^2$		$\psi^2 \varphi^3$	
Q_G	$f^{ABC} G_\mu^{A\nu} G_\nu^{B\rho} G_\rho^{C\mu}$	Q_φ	$(\varphi^\dagger \varphi)^3$	$Q_{e\varphi}$	$(\varphi^\dagger \varphi) (\bar{l}_p e_r \varphi)$
$Q_{\tilde{G}}$	$f^{ABC} \tilde{G}_\mu^{A\nu} G_\nu^{B\rho} G_\rho^{C\mu}$	$Q_{\varphi \square}$	$(\varphi^\dagger \varphi) \square (\varphi^\dagger \varphi)$	$Q_{u\varphi}$	$(\varphi^\dagger \varphi) (\bar{q}_p u_r \tilde{\varphi})$
Q_W	$\varepsilon^{IJK} W_\mu^{I\nu} W_\nu^{J\rho} W_\rho^{K\mu}$	$Q_{\varphi D}$	$(\varphi^\dagger D^\mu \varphi)^* (\varphi^\dagger D_\mu \varphi)$	$Q_{d\varphi}$	$(\varphi^\dagger \varphi) (\bar{q}_p d_r \varphi)$
$Q_{\tilde{W}}$	$\varepsilon^{IJK} \tilde{W}_\mu^{I\nu} W_\nu^{J\rho} W_\rho^{K\mu}$				
$X^2 \varphi^2$		$\psi^2 X \varphi$		$\psi^2 \varphi^2 D$	
$Q_{\varphi G}$	$\varphi^\dagger \varphi G_{\mu\nu}^A G^{A\mu\nu}$	Q_{eW}	$(\bar{l}_p \sigma^{\mu\nu} e_r) \tau^I \varphi W_{\mu\nu}^I$	$Q_{\varphi l}^{(1)}$	$(\varphi^\dagger i \overleftrightarrow{D}_\mu \varphi) (\bar{l}_p \gamma^\mu l_r)$
$Q_{\varphi \tilde{G}}$	$\varphi^\dagger \varphi \tilde{G}_{\mu\nu}^A G^{A\mu\nu}$	Q_{eB}	$(\bar{l}_p \sigma^{\mu\nu} e_r) \varphi B_{\mu\nu}$	$Q_{\varphi l}^{(3)}$	$(\varphi^\dagger i \overleftrightarrow{D}_\mu^I \varphi) (\bar{l}_p \tau^I \gamma^\mu l_r)$
$Q_{\varphi W}$	$\varphi^\dagger \varphi W_{\mu\nu}^I W^{I\mu\nu}$	Q_{uG}	$(\bar{q}_p \sigma^{\mu\nu} T^A u_r) \tilde{\varphi} G_{\mu\nu}^A$	$Q_{\varphi e}$	$(\varphi^\dagger i \overleftrightarrow{D}_\mu \varphi) (\bar{e}_p \gamma^\mu e_r)$
$Q_{\varphi \tilde{W}}$	$\varphi^\dagger \varphi \tilde{W}_{\mu\nu}^I W^{I\mu\nu}$	Q_{uW}	$(\bar{q}_p \sigma^{\mu\nu} u_r) \tau^I \tilde{\varphi} W_{\mu\nu}^I$	$Q_{\varphi q}^{(1)}$	$(\varphi^\dagger i \overleftrightarrow{D}_\mu \varphi) (\bar{q}_p \gamma^\mu q_r)$
$Q_{\varphi B}$	$\varphi^\dagger \varphi B_{\mu\nu} B^{\mu\nu}$	Q_{uB}	$(\bar{q}_p \sigma^{\mu\nu} u_r) \tilde{\varphi} B_{\mu\nu}$	$Q_{\varphi q}^{(3)}$	$(\varphi^\dagger i \overleftrightarrow{D}_\mu^I \varphi) (\bar{q}_p \tau^I \gamma^\mu q_r)$
$Q_{\varphi \tilde{B}}$	$\varphi^\dagger \varphi \tilde{B}_{\mu\nu} B^{\mu\nu}$	Q_{dG}	$(\bar{q}_p \sigma^{\mu\nu} T^A d_r) \varphi G_{\mu\nu}^A$	$Q_{\varphi u}$	$(\varphi^\dagger i \overleftrightarrow{D}_\mu \varphi) (\bar{u}_p \gamma^\mu u_r)$
$Q_{\varphi WB}$	$\varphi^\dagger \tau^I \varphi W_{\mu\nu}^I B^{\mu\nu}$	Q_{dW}	$(\bar{q}_p \sigma^{\mu\nu} d_r) \tau^I \varphi W_{\mu\nu}^I$	$Q_{\varphi d}$	$(\varphi^\dagger i \overleftrightarrow{D}_\mu \varphi) (\bar{d}_p \gamma^\mu d_r)$
$Q_{\varphi \tilde{W} B}$	$\varphi^\dagger \tau^I \varphi \tilde{W}_{\mu\nu}^I B^{\mu\nu}$	Q_{dB}	$(\bar{q}_p \sigma^{\mu\nu} d_r) \varphi B_{\mu\nu}$	$Q_{\varphi ud}$	$i(\varphi^\dagger D_\mu \varphi) (\bar{u}_p \gamma^\mu d_r)$
				$Q_{ud}^{(1)}$	$(\bar{u}_p \gamma_\mu u_r) (\bar{d}_s \gamma^\mu d_t)$
				$Q_{ud}^{(8)}$	$(\bar{u}_p \gamma_\mu T^A u_r) (\bar{d}_s \gamma^\mu T^A d_t)$
				$Q_{qd}^{(1)}$	$(\bar{q}_p \gamma_\mu q_r) (\bar{d}_s \gamma^\mu d_t)$
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$(\bar{L}R)(\bar{R}L)$ and $(\bar{L}R)(\bar{L}R)$				B-violating	
Q_{ledq}	$(\bar{l}_p^j e_r) (\bar{d}_s q_t^j)$	Q_{duq}		$\varepsilon^{\alpha\beta\gamma} \varepsilon_{jk} [(d_p^\alpha)^T C u_r^\beta] [(q_s^\gamma)^T C l_t^k]$	
$Q_{quqd}^{(1)}$	$(\bar{q}_p^j u_r) \varepsilon_{jk} (\bar{q}_s^k d_t)$	Q_{qqu}		$\varepsilon^{\alpha\beta\gamma} \varepsilon_{jk} [(q_p^{\alpha j})^T C q_r^{\beta k}] [(u_s^\gamma)^T C e_t]$	
$Q_{quqd}^{(8)}$	$(\bar{q}_p^j T^A u_r) \varepsilon_{jk} (\bar{q}_s^k T^A d_t)$	$Q_{qqq}^{(1)}$		$\varepsilon^{\alpha\beta\gamma} \varepsilon_{jk} \varepsilon_{mn} [(q_p^{\alpha j})^T C q_r^{\beta k}] [(q_s^{\gamma m})^T C l_t^n]$	
$Q_{lequ}^{(1)}$	$(\bar{l}_p^j e_r) \varepsilon_{jk} (\bar{q}_s^k u_t)$	$Q_{qqq}^{(3)}$		$\varepsilon^{\alpha\beta\gamma} (\tau^I \varepsilon)_{jk} (\tau^I \varepsilon)_{mn} [(q_p^{\alpha j})^T C q_r^{\beta k}] [(q_s^{\gamma m})^T C l_t^n]$	
$Q_{lequ}^{(3)}$	$(\bar{l}_p^j \sigma_{\mu\nu} e_r) \varepsilon_{jk} (\bar{q}_s^k \sigma^{\mu\nu} u_t)$	Q_{duu}		$\varepsilon^{\alpha\beta\gamma} [(d_p^\alpha)^T C u_r^\beta] [(u_s^\gamma)^T C e_t]$	

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$Q_{\varphi W}$	$\varphi^\dagger \varphi W_{\mu\nu}^I W^{I\mu\nu}$	Q_{uG}	$(\bar{q}_p \sigma^{\mu\nu} T^A u_r) \tilde{\varphi} G_{\mu\nu}^A$	$Q_{\varphi e}$	$(\varphi^\dagger i \overset{\leftrightarrow}{D}_\mu \varphi) (\bar{e}_p \gamma^\mu e_r)$
$Q_{\varphi \tilde{W}}$	$\varphi^\dagger \varphi \tilde{W}_{\mu\nu}^I W^{I\mu\nu}$	Q_{uW}	$(\bar{q}_p \sigma^{\mu\nu} u_r) \tau^I \tilde{\varphi} W_{\mu\nu}^I$	$Q_{\varphi q}^{(1)}$	$(\varphi^\dagger i \overset{\leftrightarrow}{D}_\mu \varphi) (\bar{q}_p \gamma^\mu q_r)$
$Q_{\varphi B}$	$\varphi^\dagger \varphi B_{\mu\nu} B^{\mu\nu}$	Q_{uB}	$(\bar{q}_p \sigma^{\mu\nu} u_r) \tilde{\varphi} B_{\mu\nu}$	$Q_{\varphi q}^{(3)}$	$(\varphi^\dagger i \overset{\leftrightarrow}{D}_\mu^I \varphi) (\bar{q}_p \tau^I \gamma^\mu q_r)$
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$Q_{lequ}^{(1)}$	$(\bar{l}_p^j e_r) \varepsilon_{jk} (\bar{q}_s^k u_t)$	$Q_{qqq}^{(3)}$	$\varepsilon^{\alpha\beta\gamma} (\tau^I \varepsilon)_{jk} (\tau^I \varepsilon)_{mn} [(q_p^{\alpha j})^T C q_r^{\beta k}] [(q_s^{\gamma m})^T C l_t^n]$		
$Q_{lequ}^{(3)}$	$(\bar{l}_p^j \sigma_{\mu\nu} e_r) \varepsilon_{jk} (\bar{q}_s^k \sigma^{\mu\nu} u_t)$	Q_{duu}	$\varepsilon^{\alpha\beta\gamma} [(d_p^\alpha)^T C u_r^\beta] [(u_s^\gamma)^T C e_t]$		

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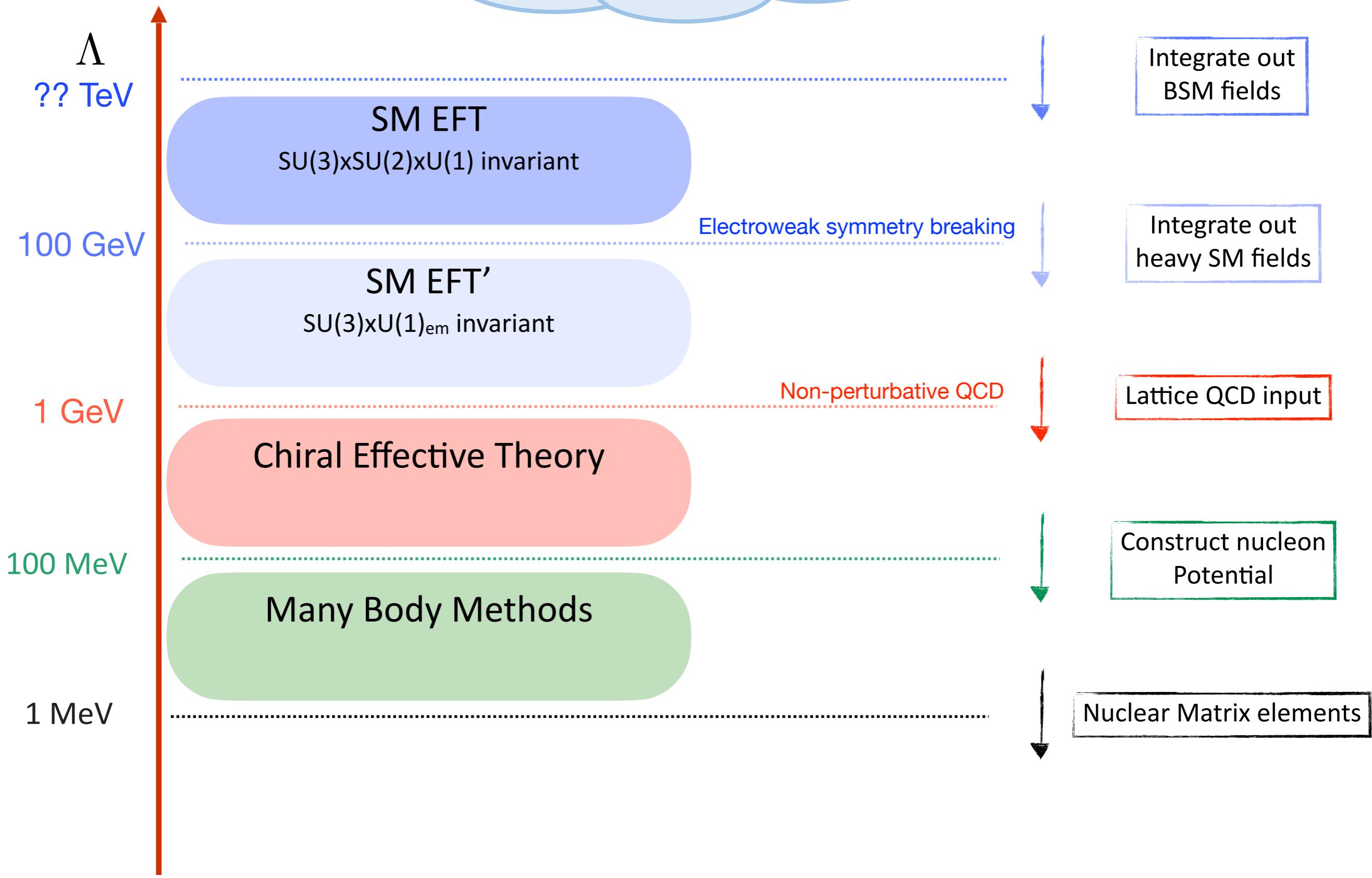
- Kinetic/mass terms

$$\mathcal{L}_{\nu_R} = \bar{\nu}_R [i\cancel{D} - m_{\nu_R}] \nu_R - \bar{l} Y_\nu H \nu_R$$

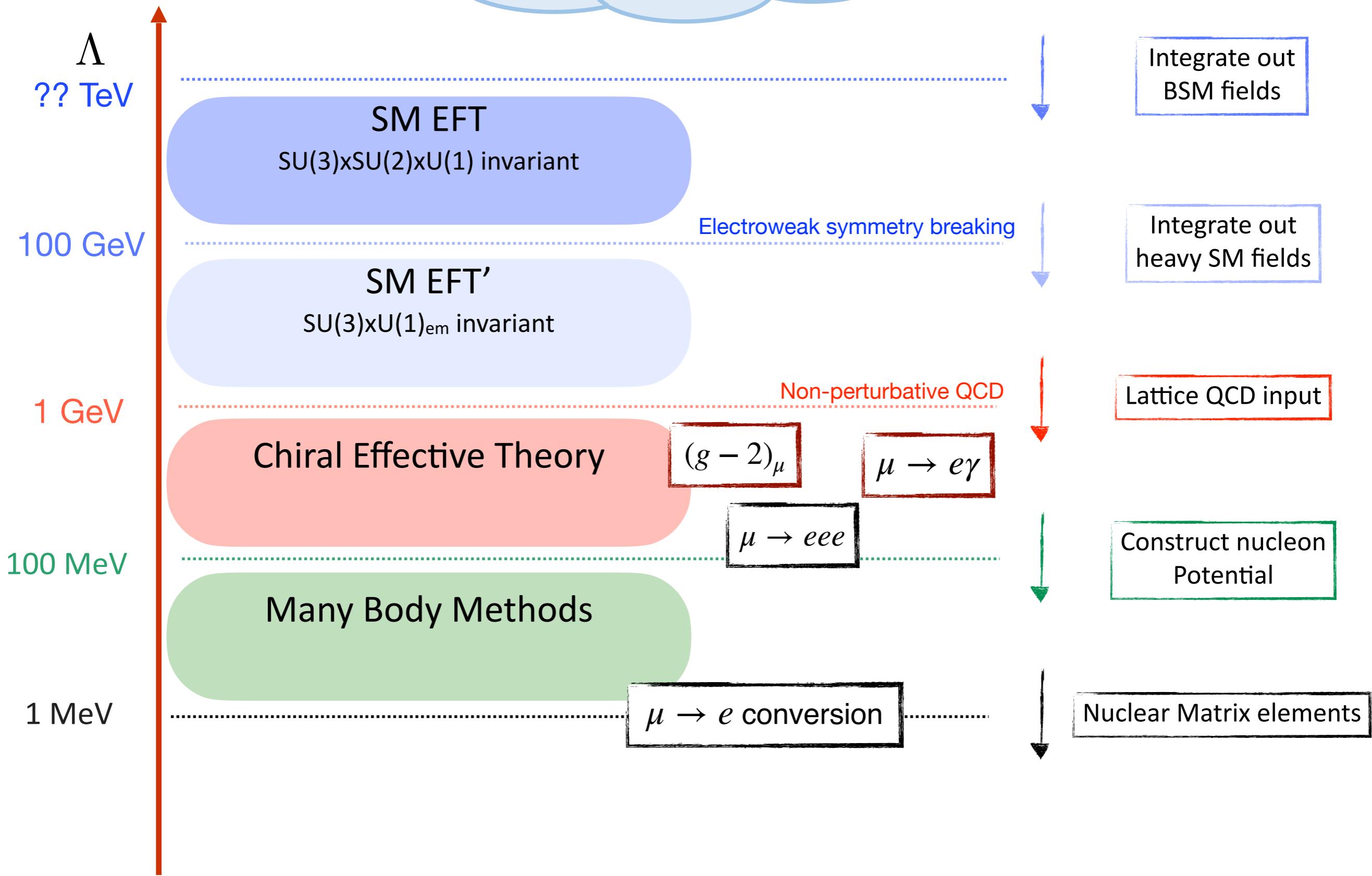
- 29 dim-6 operators when including ν_R

X^3		φ^6 and $\varphi^4 D^2$		$\psi^2 \varphi^3$	
Q_G	$f^{ABC} G_\mu^{A\nu} G_\nu^{B\rho} G_\rho^{C\mu}$	Q_φ	$(\varphi^\dagger \varphi)^3$	$Q_{e\varphi}$	$(\varphi^\dagger \varphi) (\bar{l}_p e_r \varphi)$
$Q_{\tilde{G}}$	$f^{ABC} \tilde{G}_\mu^{A\nu} G_\nu^{B\rho} G_\rho^{C\mu}$	$Q_{\varphi \square}$	$(\varphi^\dagger \varphi) \square (\varphi^\dagger \varphi)$	$Q_{u\varphi}$	$(\varphi^\dagger \varphi) (\bar{q}_p u_r \tilde{\varphi})$
Q_W	$\varepsilon^{IJK} W_\mu^{I\nu} W_\nu^{J\rho} W_\rho^{K\mu}$	$Q_{\varphi D}$	$(\varphi^\dagger D^\mu \varphi)^* (\varphi^\dagger D_\mu \varphi)$	$Q_{d\varphi}$	$(\varphi^\dagger \varphi) (\bar{q}_p d_r \varphi)$
$Q_{\tilde{W}}$	$\varepsilon^{IJK} \tilde{W}_\mu^{I\nu} W_\nu^{J\rho} W_\rho^{K\mu}$				
$X^2 \varphi^2$		$\psi^2 X \varphi$		$\psi^2 \varphi^2 D$	
$Q_{\varphi G}$	$\varphi^\dagger \varphi G_{\mu\nu}^A G^{A\mu\nu}$	Q_{eW}	$(\bar{l}_p \sigma^{\mu\nu} e_r) \tau^I \varphi W_{\mu\nu}^I$	$Q_{\varphi l}^{(1)}$	$(\varphi^\dagger i \overset{\leftrightarrow}{D}_\mu \varphi) (\bar{l}_p \gamma^\mu l_r)$
$Q_{\varphi \tilde{G}}$	$\varphi^\dagger \varphi \tilde{G}_{\mu\nu}^A G^{A\mu\nu}$	Q_{eB}	$(\bar{l}_p \sigma^{\mu\nu} e_r) \varphi B_{\mu\nu}$	$Q_{\varphi l}^{(3)}$	$(\varphi^\dagger i \overset{\leftrightarrow}{D}_\mu^I \varphi) (\bar{l}_p \tau^I \gamma^\mu l_r)$
$Q_{\varphi W}$	$\varphi^\dagger \varphi W_{\mu\nu}^I W^{I\mu\nu}$	Q_{uG}	$(\bar{q}_p \sigma^{\mu\nu} T^A u_r) \tilde{\varphi} G_{\mu\nu}^A$	$Q_{\varphi e}$	$(\varphi^\dagger i \overset{\leftrightarrow}{D}_\mu \varphi) (\bar{e}_p \gamma^\mu e_r)$
$Q_{\varphi \tilde{W}}$	$\varphi^\dagger \varphi \tilde{W}_{\mu\nu}^I W^{I\mu\nu}$	Q_{uW}	$(\bar{q}_p \sigma^{\mu\nu} u_r) \tau^I \tilde{\varphi} W_{\mu\nu}^I$	$Q_{\varphi q}^{(1)}$	$(\varphi^\dagger i \overset{\leftrightarrow}{D}_\mu \varphi) (\bar{q}_p \gamma^\mu q_r)$
$Q_{\varphi B}$	$\varphi^\dagger \varphi B_{\mu\nu} B^{\mu\nu}$	Q_{uB}	$(\bar{q}_p \sigma^{\mu\nu} u_r) \tilde{\varphi} B_{\mu\nu}$	$Q_{\varphi q}^{(3)}$	$(\varphi^\dagger i \overset{\leftrightarrow}{D}_\mu^I \varphi) (\bar{q}_p \tau^I \gamma^\mu q_r)$
$Q_{\varphi \tilde{B}}$	$\varphi^\dagger \varphi \tilde{B}_{\mu\nu} B^{\mu\nu}$	Q_{dG}	$(\bar{q}_p \sigma^{\mu\nu} T^A d_r) \varphi G_{\mu\nu}^A$	$Q_{\varphi u}$	$(\varphi^\dagger i \overset{\leftrightarrow}{D}_\mu \varphi) (\bar{u}_p \gamma^\mu u_r)$
$\psi^2 H^3$		$\psi^2 H^2 D$		$\psi^2 H X (+H.c.)$	
$\mathcal{O}_{L\nu H} (+H.c.)$	$(\bar{L}\nu_R) \tilde{H} (H^\dagger H)$	$\mathcal{O}_{H\nu}$	$(\bar{\nu}_R \gamma^\mu \nu_R) (H^\dagger i \overset{\leftrightarrow}{D}_\mu H)$	$\mathcal{O}_{\nu B}$	$(\bar{L}\sigma_{\mu\nu} \nu_R) \tilde{H} B^{\mu\nu}$
		$\mathcal{O}_{H\nu e} (+H.c.)$	$(\bar{\nu}_R \gamma^\mu e) (\tilde{H}^\dagger i D_\mu H)$	$\mathcal{O}_{\nu W}$	$(\bar{L}\sigma_{\mu\nu} \nu_R) \tau^I \tilde{H} W^I$
$(\bar{R}R)(\bar{R}R)$		$(\bar{L}L)(\bar{R}R)$		$(\bar{L}R)(\bar{L}R) (+H.c.)$	
$\mathcal{O}_{\nu\nu}$	$(\bar{\nu}_R \gamma^\mu \nu_R) (\bar{\nu}_R \gamma_\mu \nu_R)$	$\mathcal{O}_{L\nu}$	$(\bar{L}\gamma^\mu L) (\bar{\nu}_R \gamma_\mu \nu_R)$	$\mathcal{O}_{L\nu Le}$	$(\bar{L}\nu_R) \epsilon(\bar{L}e)$
$\mathcal{O}_{e\nu}$	$(\bar{e} \gamma^\mu e) (\bar{\nu}_R \gamma_\mu \nu_R)$	$\mathcal{O}_{Q\nu}$	$(\bar{Q} \gamma^\mu Q) (\bar{\nu}_R \gamma_\mu \nu_R)$	$\mathcal{O}_{L\nu Qd}$	$(\bar{L}\nu_R) \epsilon(\bar{Q}d)$
$\mathcal{O}_{u\nu}$	$(\bar{u} \gamma^\mu u) (\bar{\nu}_R \gamma_\mu \nu_R)$			$\mathcal{O}_{LdQ\nu}$	$(\bar{L}d) \epsilon(\bar{Q}\nu_R)$
$\mathcal{O}_{d\nu}$	$(\bar{d} \gamma^\mu d) (\bar{\nu}_R \gamma_\mu \nu_R)$				
$\mathcal{O}_{du\nu e} (+H.c.)$	$(\bar{d} \gamma^\mu u) (\bar{\nu}_R \gamma_\mu e)$				
$(\bar{L}R)(\bar{R}L)$		$(\bar{L} \cap B) (+H.c.)$		$(\bar{L} \cap \bar{B}) (+H.c.)$	
$\mathcal{O}_{Qu\nu L} (+H.c.)$	$(\bar{Q}u) (\bar{\nu}_R L)$	$\mathcal{O}_{\nu\nu\nu\nu}$	$(\bar{\nu}_R^c \nu_R) (\bar{\nu}_R^c \nu_R)$	$\mathcal{O}_{QQd\nu}$	$\epsilon_{ij} \epsilon_{\alpha\beta\sigma} (Q_\alpha^i C Q_\beta^j) (d_\sigma \bar{d})$
				$\mathcal{O}_{udd\nu}$	$\epsilon_{\alpha\beta\sigma} (u_\alpha C d_\beta) (d_\sigma \bar{d})$

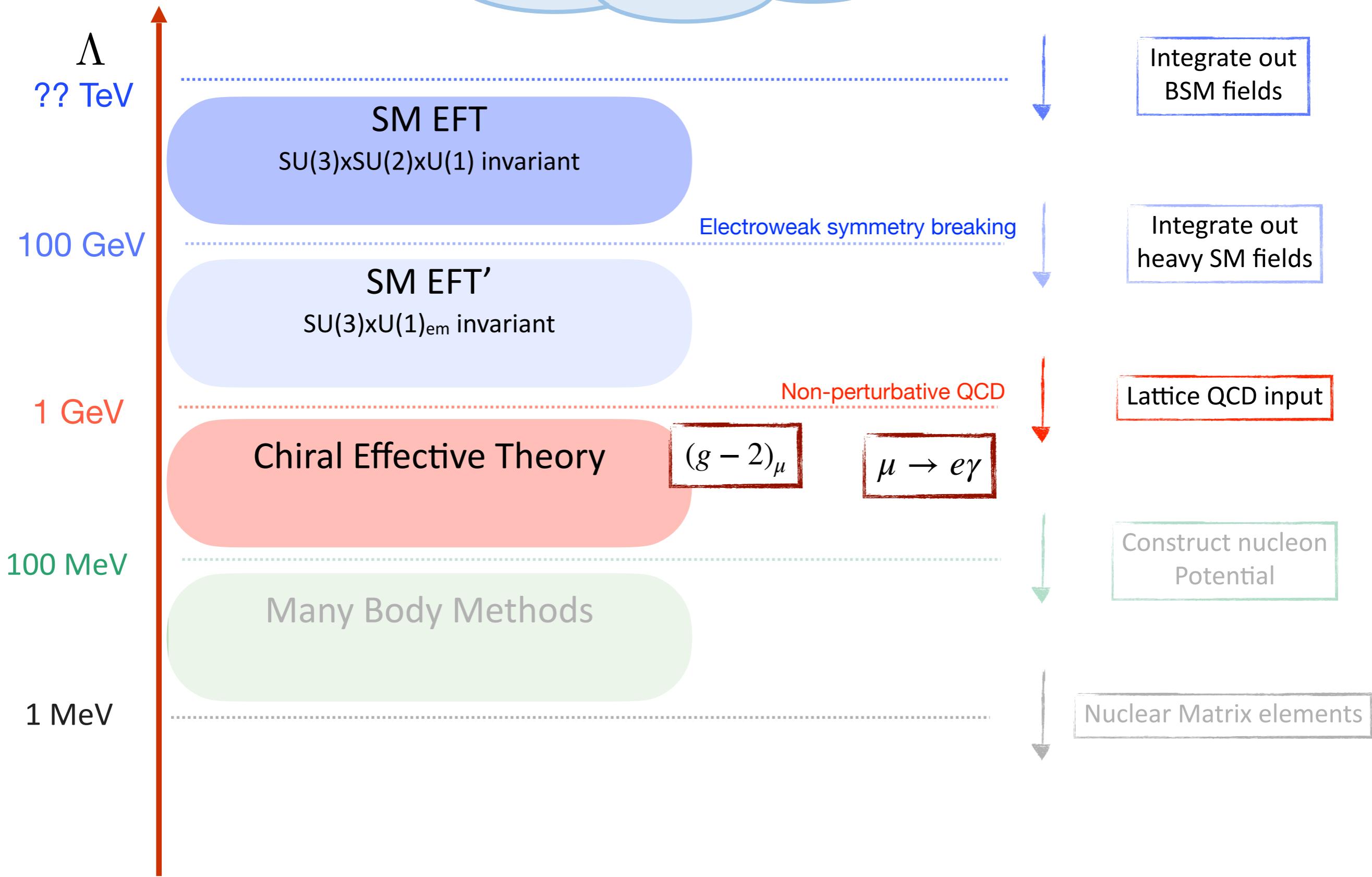
Outline



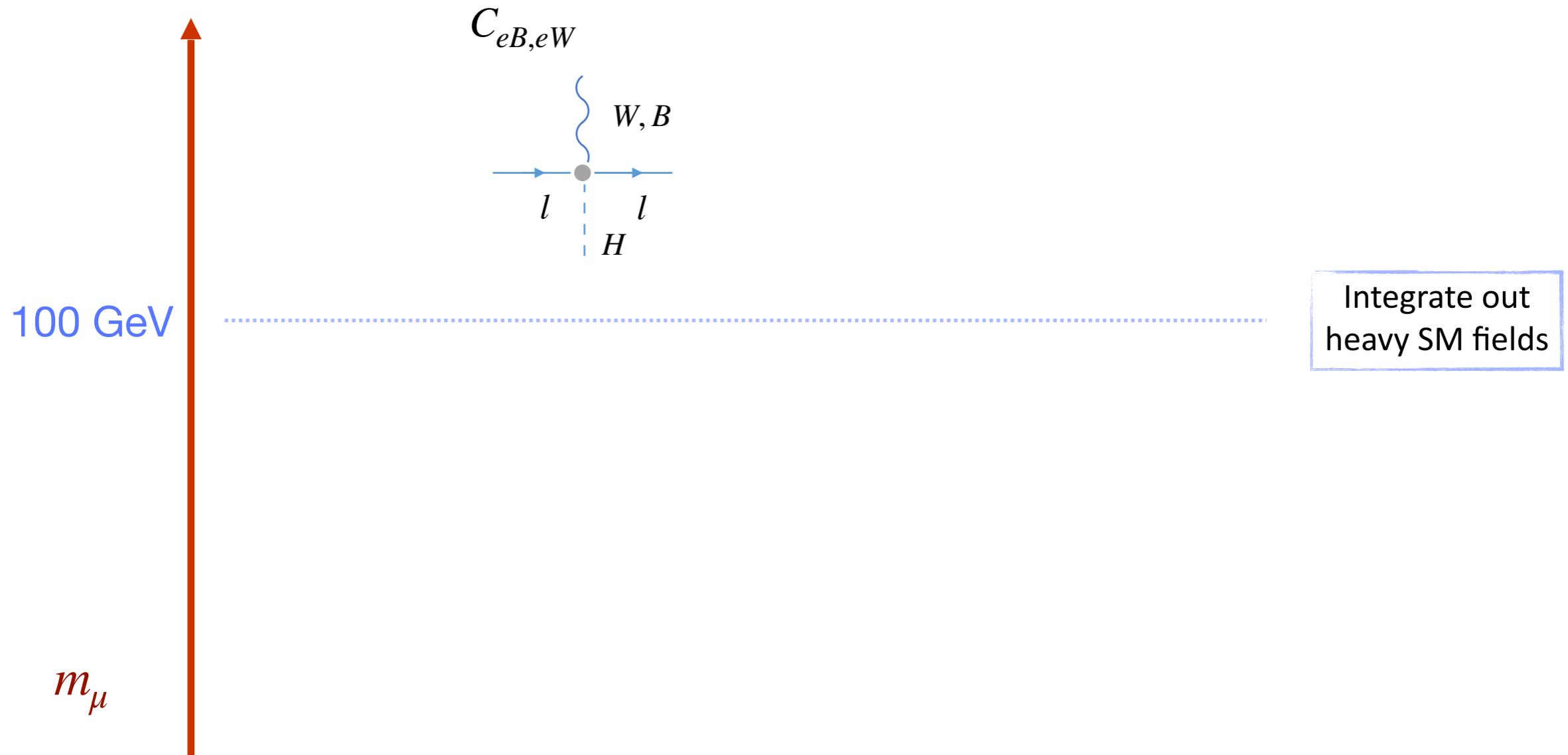
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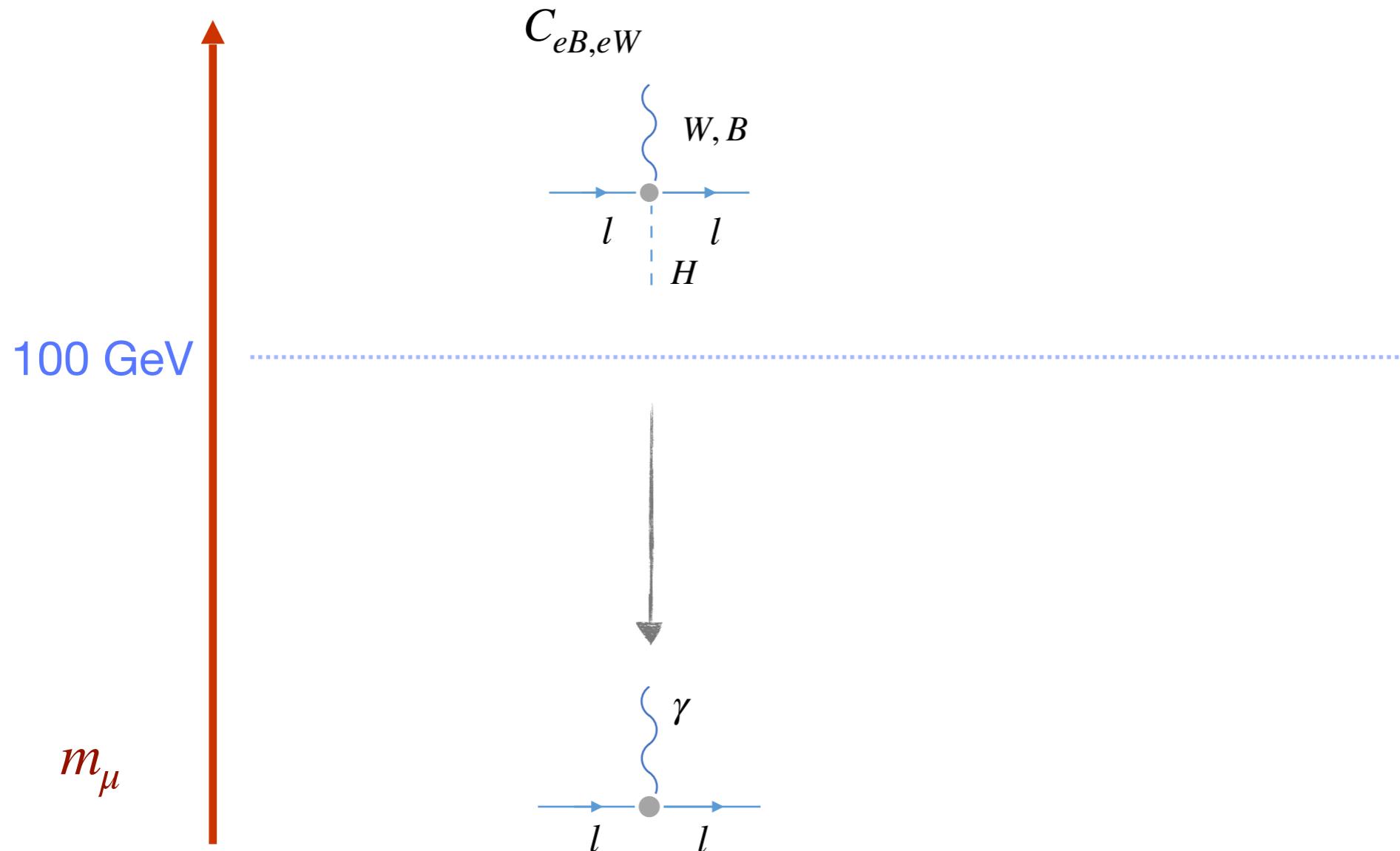
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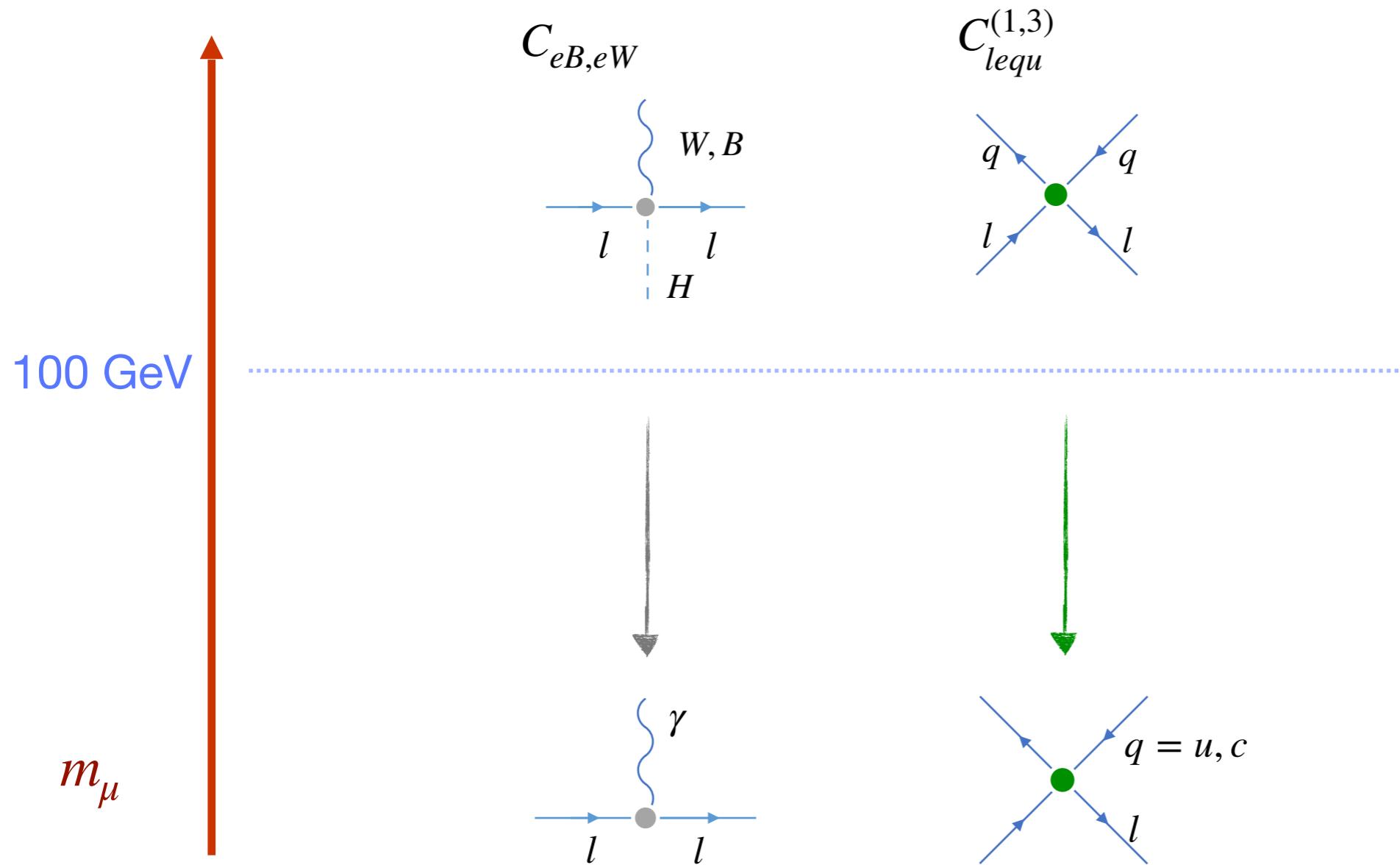
From Λ to m_μ : tree level



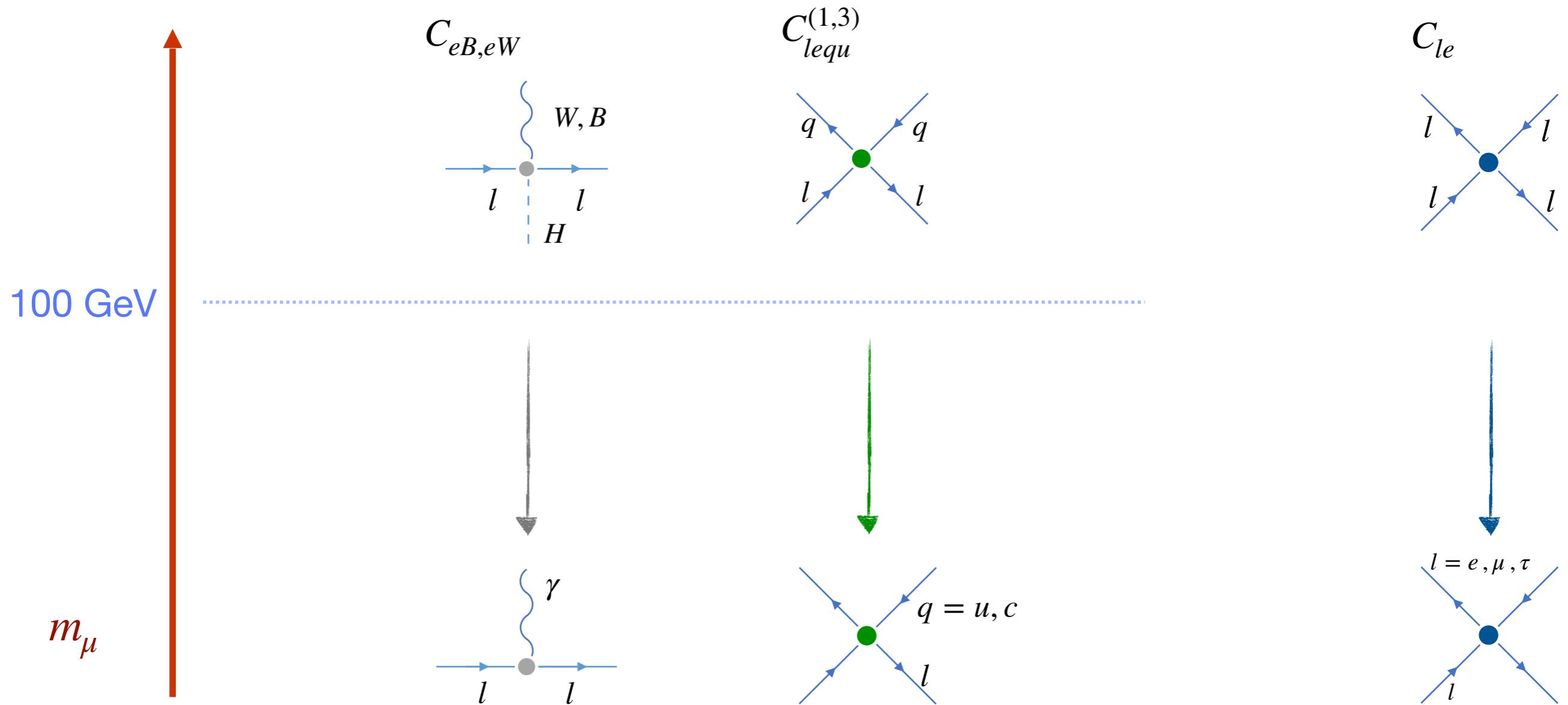
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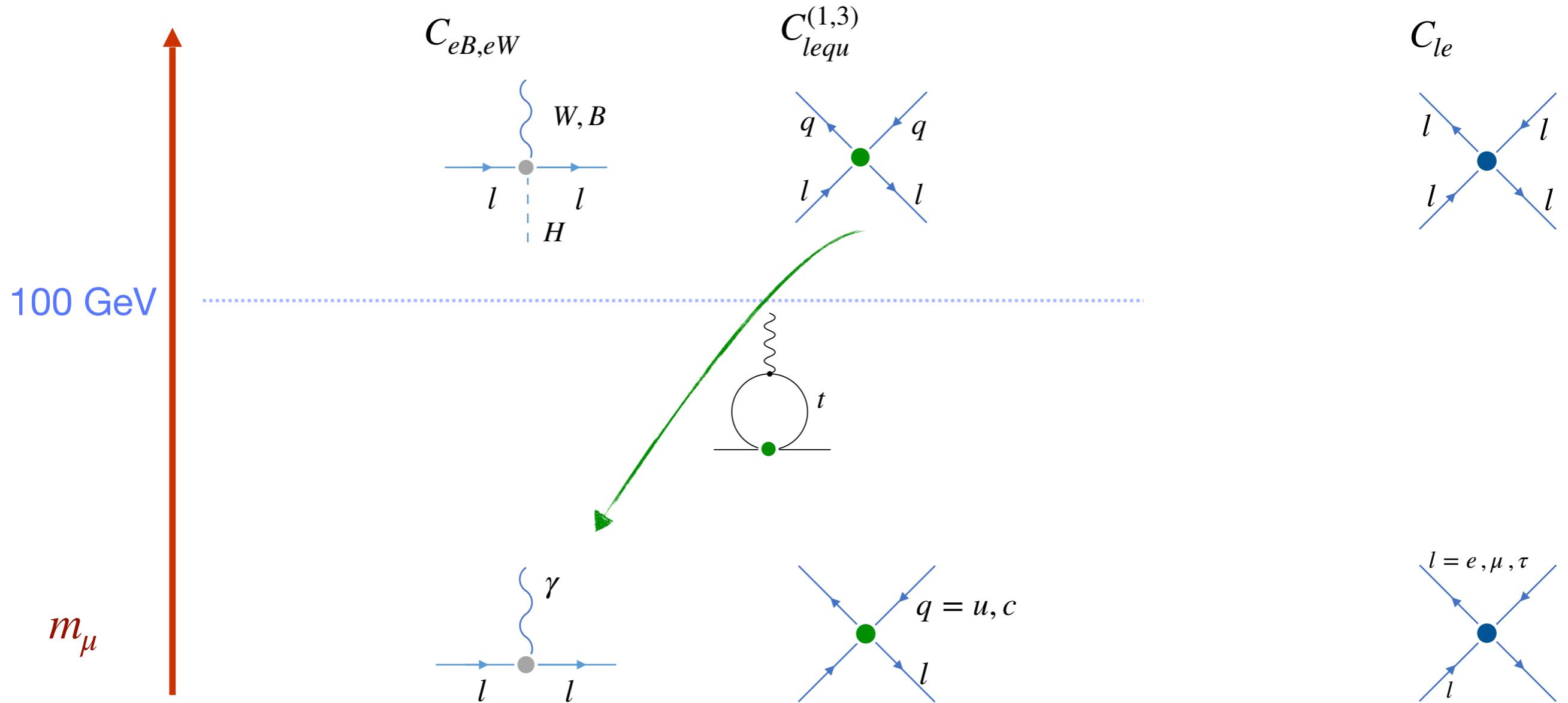
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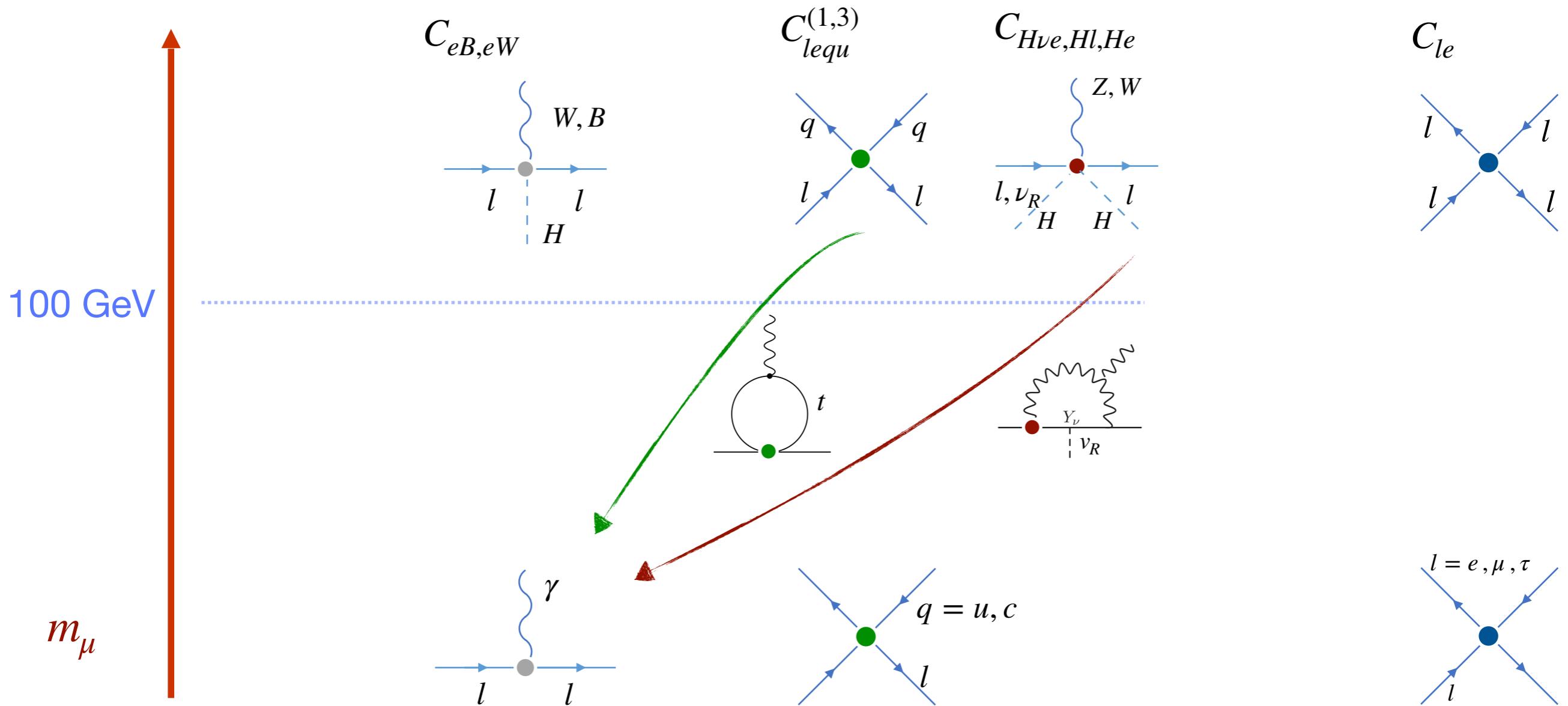
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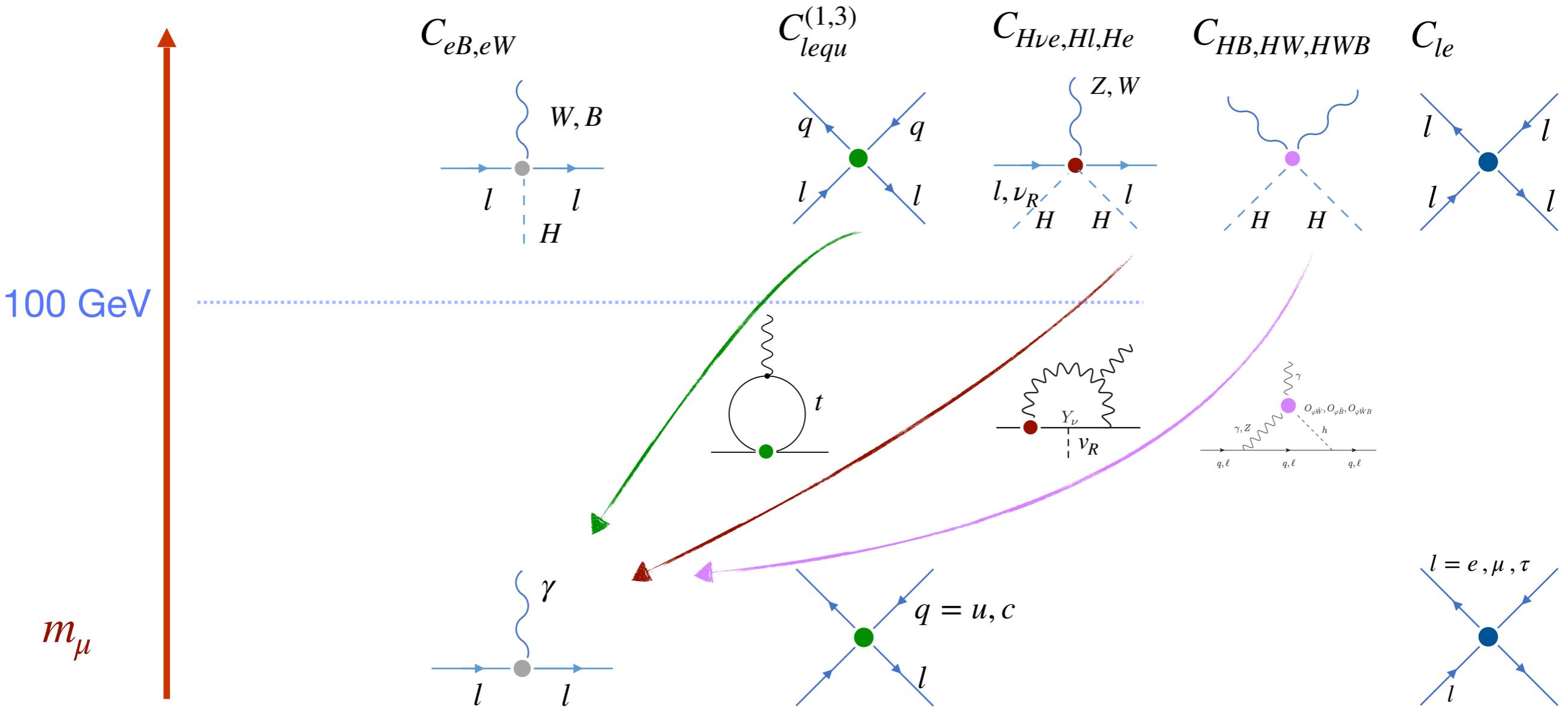
From Λ to m_μ : loops



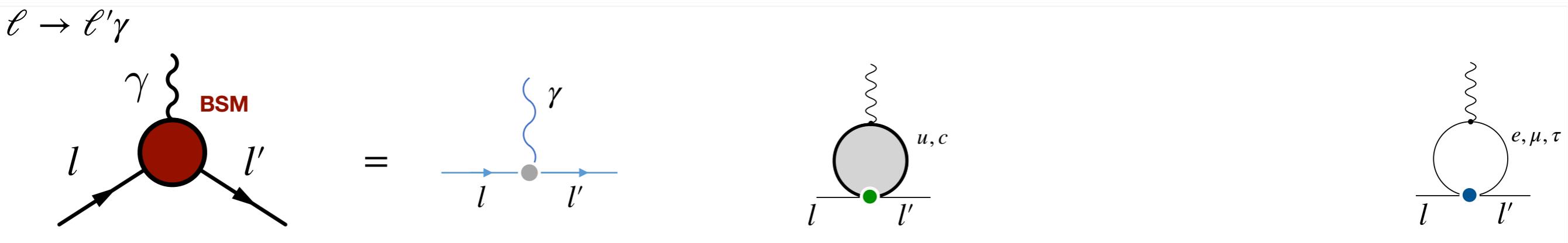
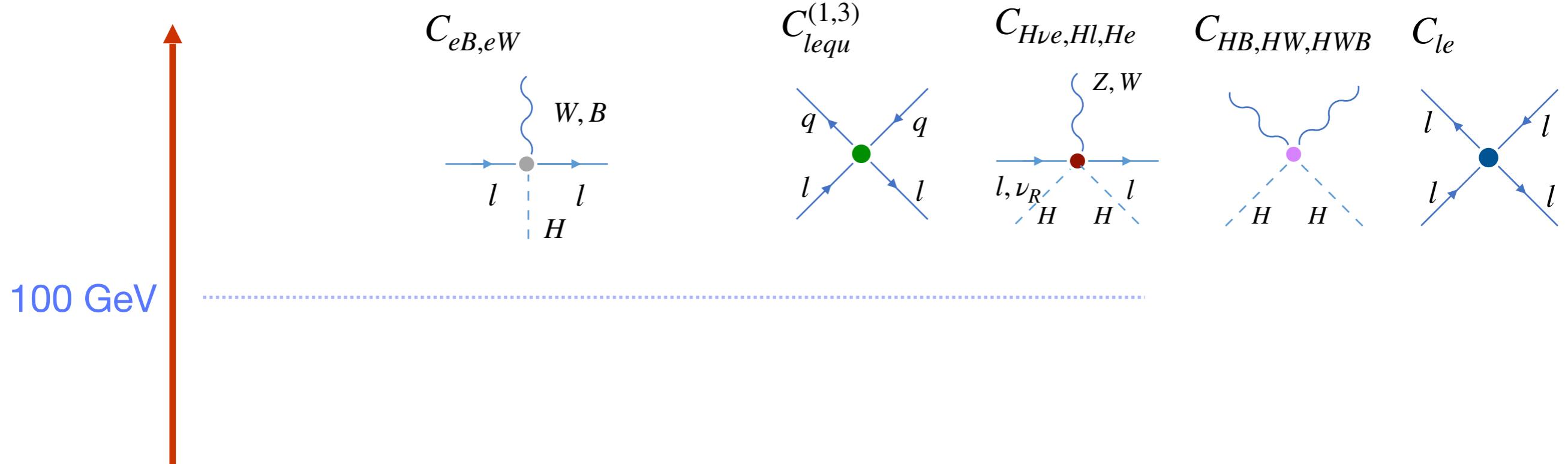
From Λ to m_μ : loops



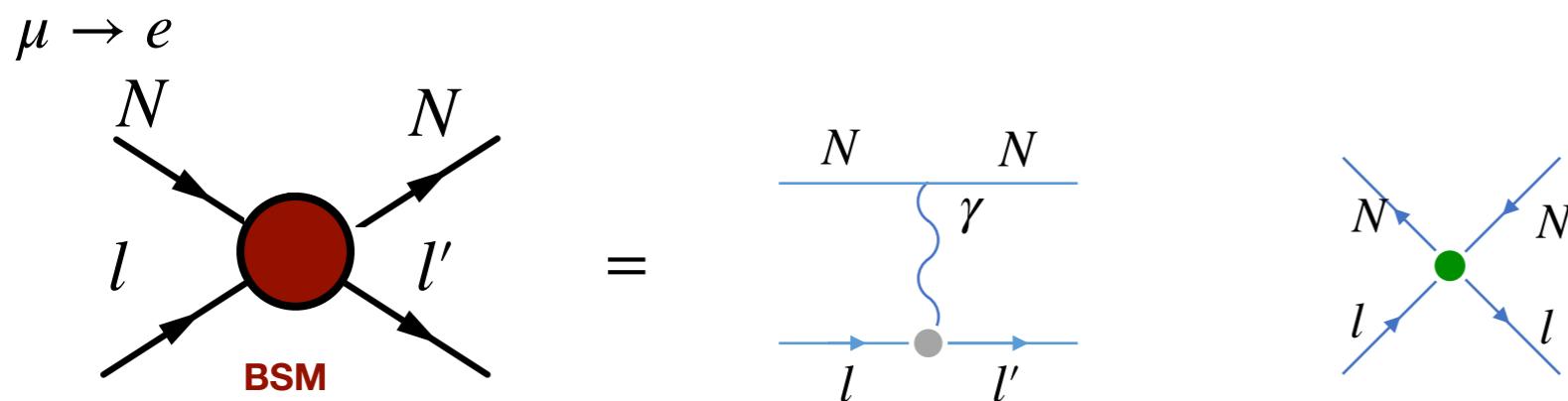
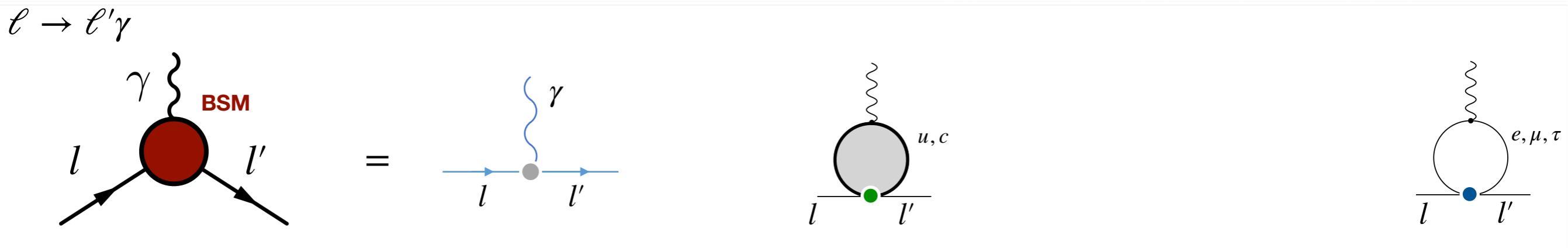
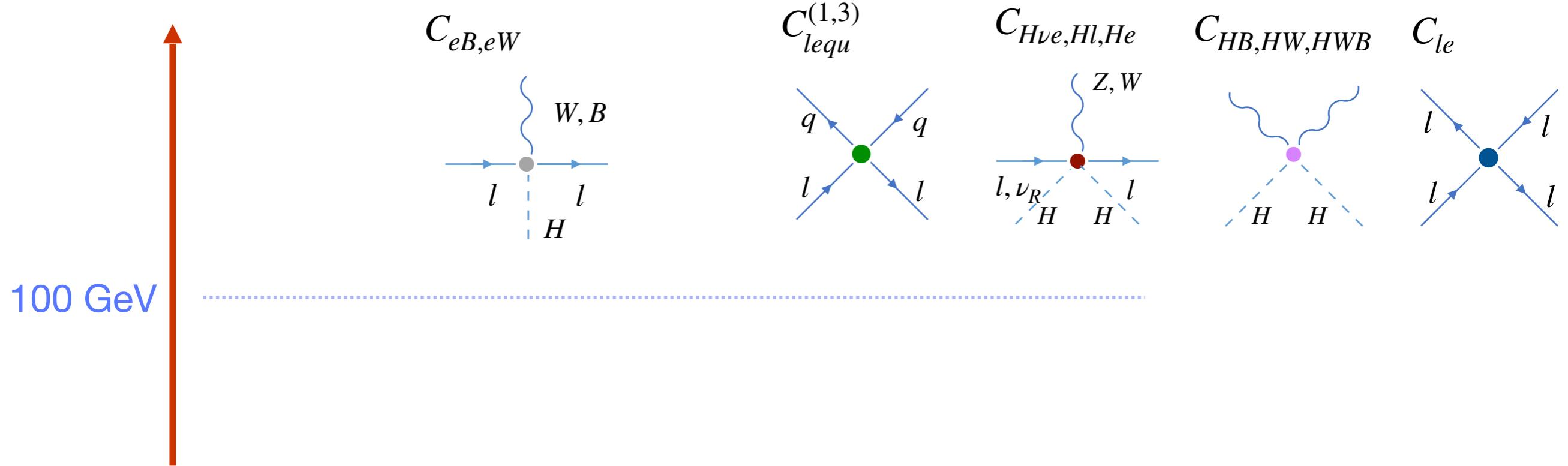
From Λ to m_μ : loops



From Λ to m_μ : observables

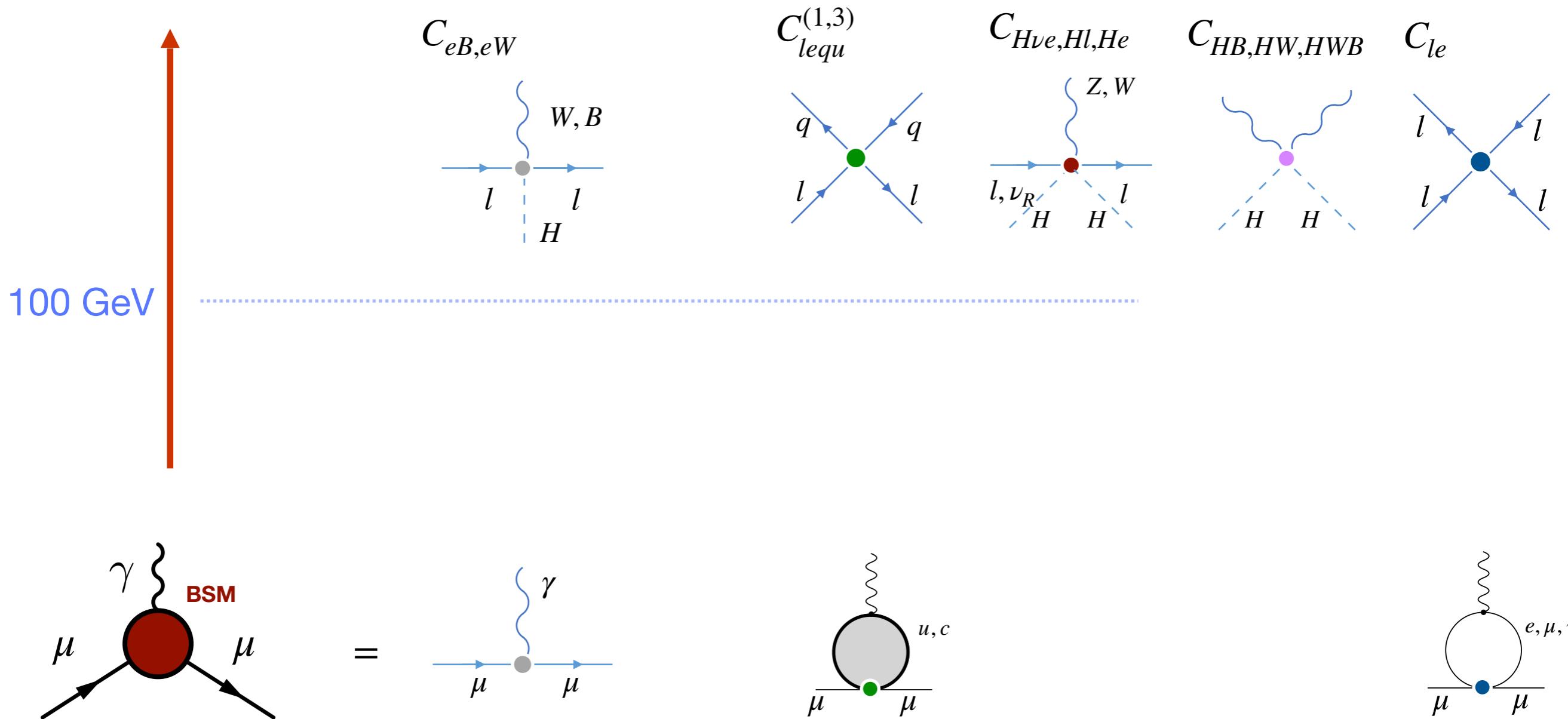


From Λ to m_μ : observables



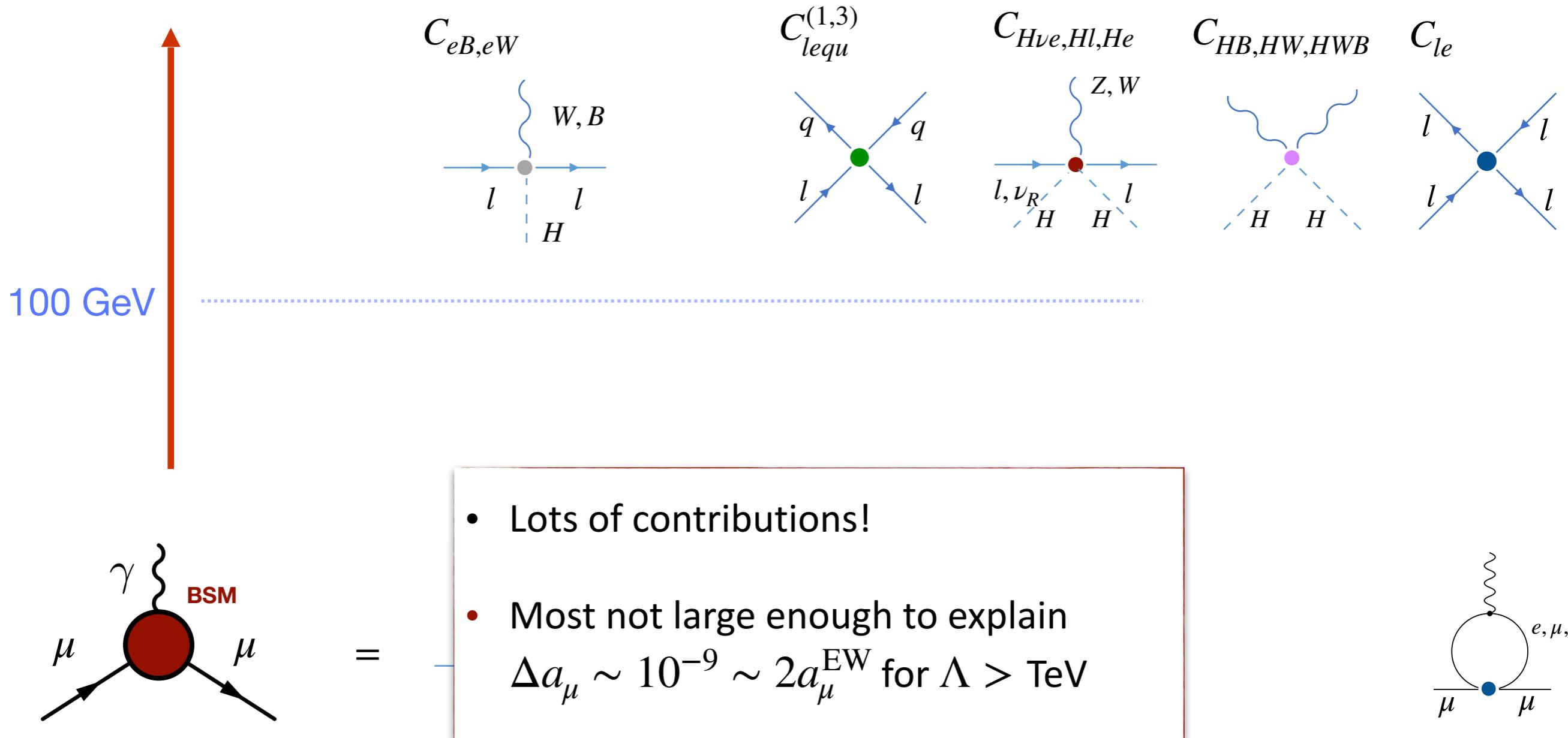
Crivellin, Davidson, Pruna, Signer, '16, '17;
Cirigliano, et al. '09

From Λ to m_μ : $g - 2$



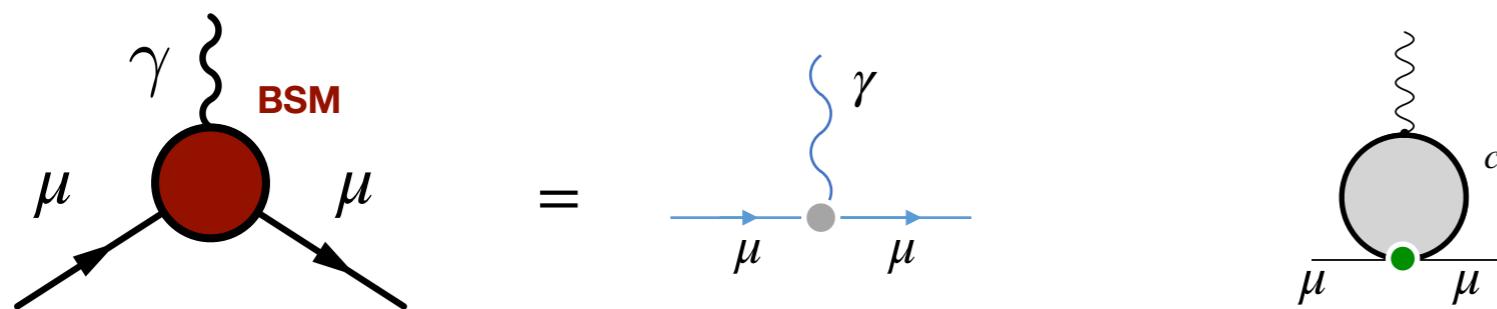
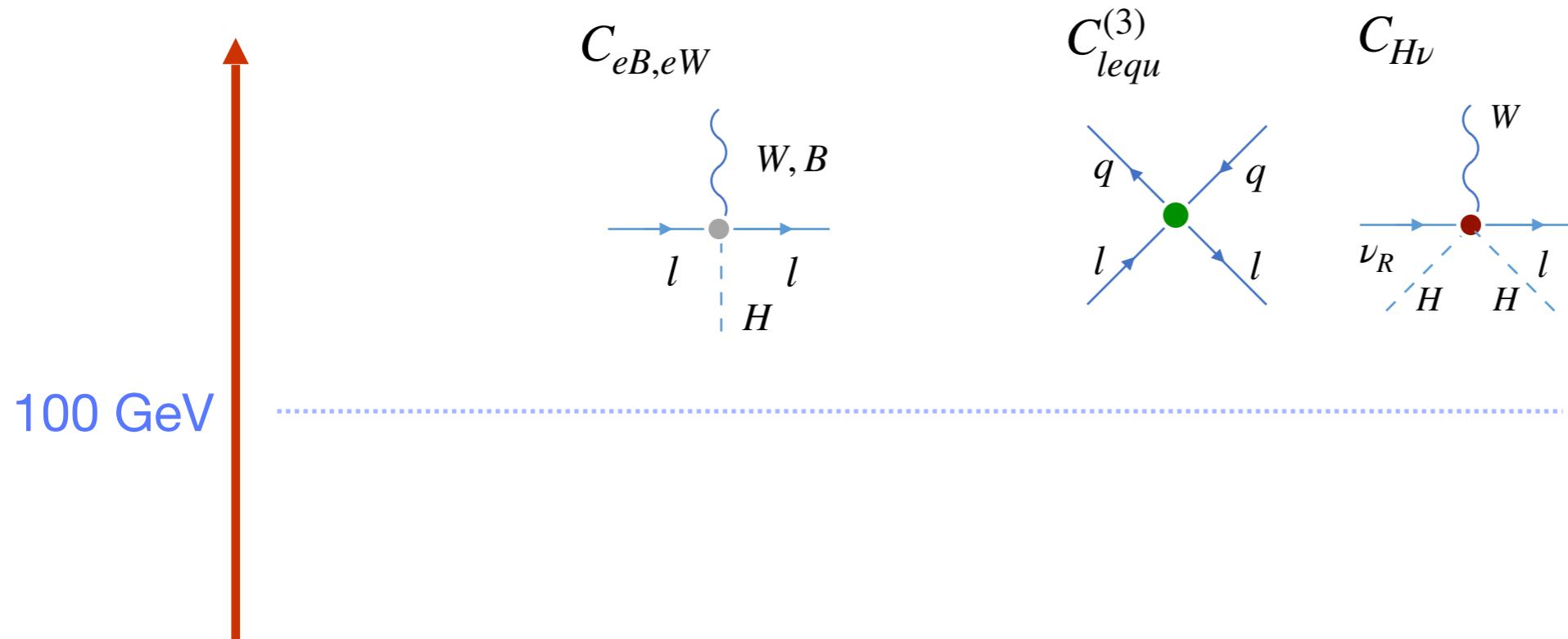
$$\begin{aligned} \Delta a_\ell^{250 \text{ GeV}} = & \frac{m_\ell}{m_\mu} \text{Re} \left[\frac{2.9_\mu}{2.8_e} \times 10^{-3} \tilde{C}_{\ell\ell}^{eB} - \frac{1.6_\mu}{1.5_e} \times 10^{-3} \tilde{C}_{\ell\ell}^{eW} - \frac{4.3_\mu}{4.1_e} \times 10^{-5} \tilde{C}_{\ell\ell33}^{lequ} - \left(2.6 + 0.37 c_T^{(c)} \right) \times 10^{-6} \tilde{C}_{\ell\ell22}^{lequ} - 7.9 \times 10^{-8} \tilde{C}_{\ell33\ell}^{\ell e} + \left(5.7 c_T - \frac{0.49_\mu}{0.48_e} \right) \times 10^{-8} \tilde{C}_{\ell\ell11}^{lequ} + 1.4 \times 10^{-8} \tilde{C}_{\ell\ell33}^{lequ} \right. \\ & + \left(\frac{10_\mu}{9.8_e} + 2.5 c_T^{(c)} \right) \times 10^{-9} \tilde{C}_{\ell\ell22}^{lequ} - \frac{4.6_\mu}{4.7_e} \times 10^{-9} \tilde{C}_{\ell22\ell}^{\ell e} + \frac{m_\ell}{m_\mu} \left\{ \frac{2.5_\mu}{2.4_e} \times 10^{-8} (\tilde{C}_{HWB} + i \tilde{C}_{H\tilde{W}B}) - \frac{1.8_\mu}{1.7_e} \times 10^{-8} (\tilde{C}_{HB} + i \tilde{C}_{H\tilde{B}}) + \frac{3.6_\mu}{3.3_e} \times 10^{-9} \tilde{C}_{\ell\ell}^{Hl} + \frac{1.8_\mu}{1.7_e} \times 10^{-9} \tilde{C}_{HD} + \frac{2.1_\mu}{2.0_e} \times 10^{-9} \tilde{C}_W \right. \\ & \left. - \frac{6.0_\mu}{5.7_e} \times 10^{-9} (\tilde{C}_{HW} + i \tilde{C}_{H\tilde{W}}) + 3.8 \times 10^{-9} \tilde{C}_{\ell\ell}^{He} - \frac{3.7_\mu}{3.6_e} \times 10^{-9} \tilde{C}_{\ell\ell}^{Hl} + 1.1 \times 10^{-9} i \tilde{C}_{\tilde{W}} \right\} \right] \end{aligned}$$

From Λ to m_μ : $g - 2$



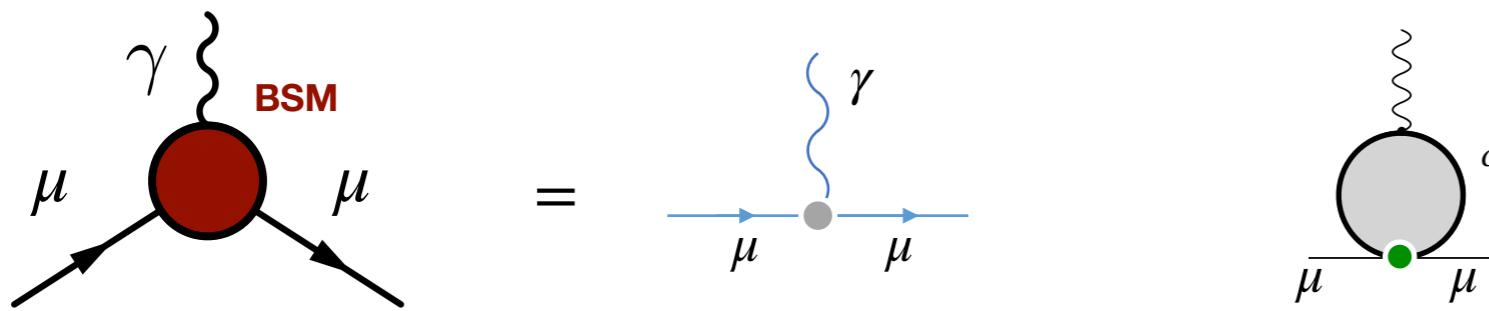
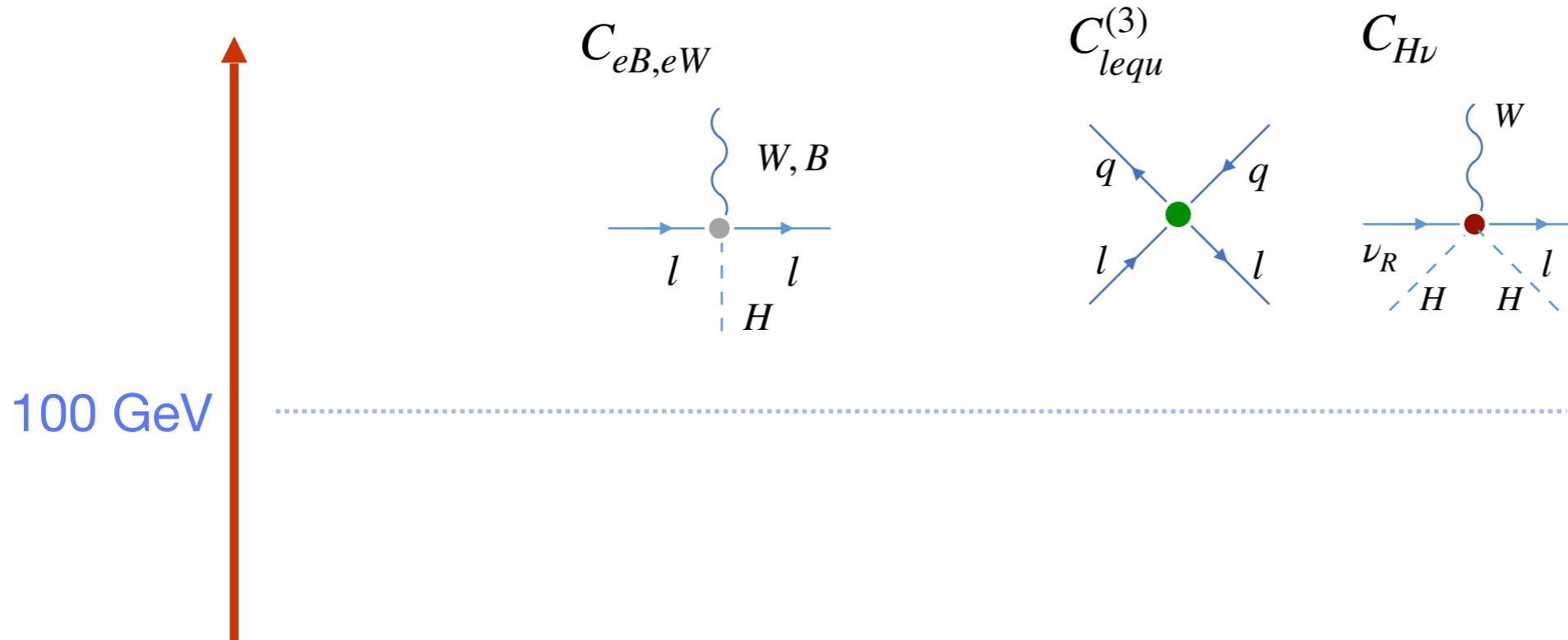
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From Λ to m_μ : $g - 2$



$$\Delta a_\ell^{10 \text{ TeV}} = \frac{m_\ell}{m_\mu} \text{Re} \left[1.7 \times 10^{-6} \tilde{C}_{\ell\ell}^{eB} - \frac{9.2\mu}{8.9e} \times 10^{-7} \tilde{C}_{\ell\ell}^{eW} - \frac{2.2\mu}{2.1e} \times 10^{-7} \tilde{C}_{\ell\ell33}^{(3)} - 2.1 \times 10^{-9} \frac{m_{\nu_R}}{m_W} \tilde{C}_{H\nu e} - \left(\frac{2.5\mu}{2.4e} + 0.22 c_T^{(c)} \right) \times 10^{-9} \tilde{C}_{\ell\ell22}^{(3)} \right]$$

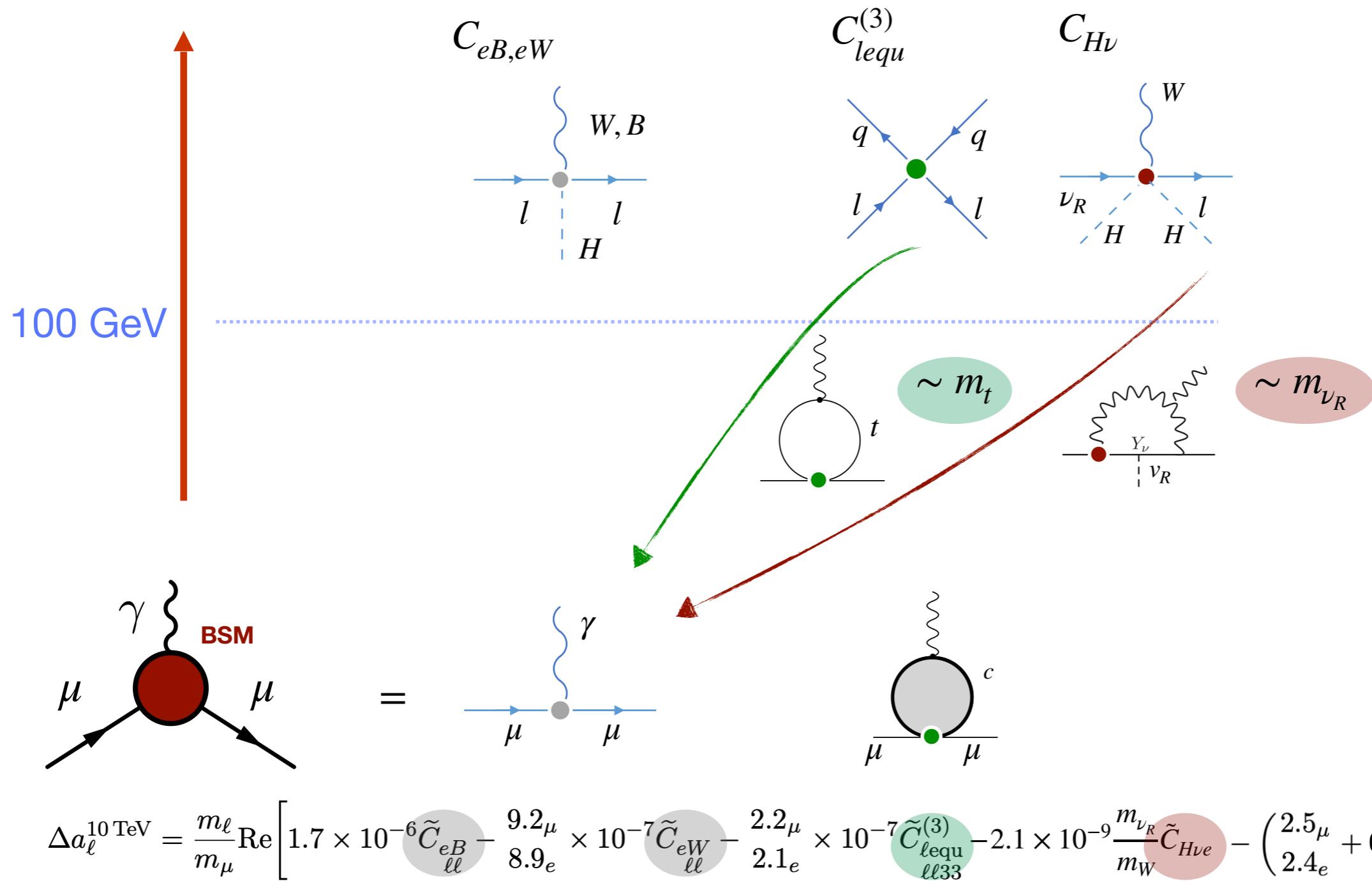
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- Only a few operators survive

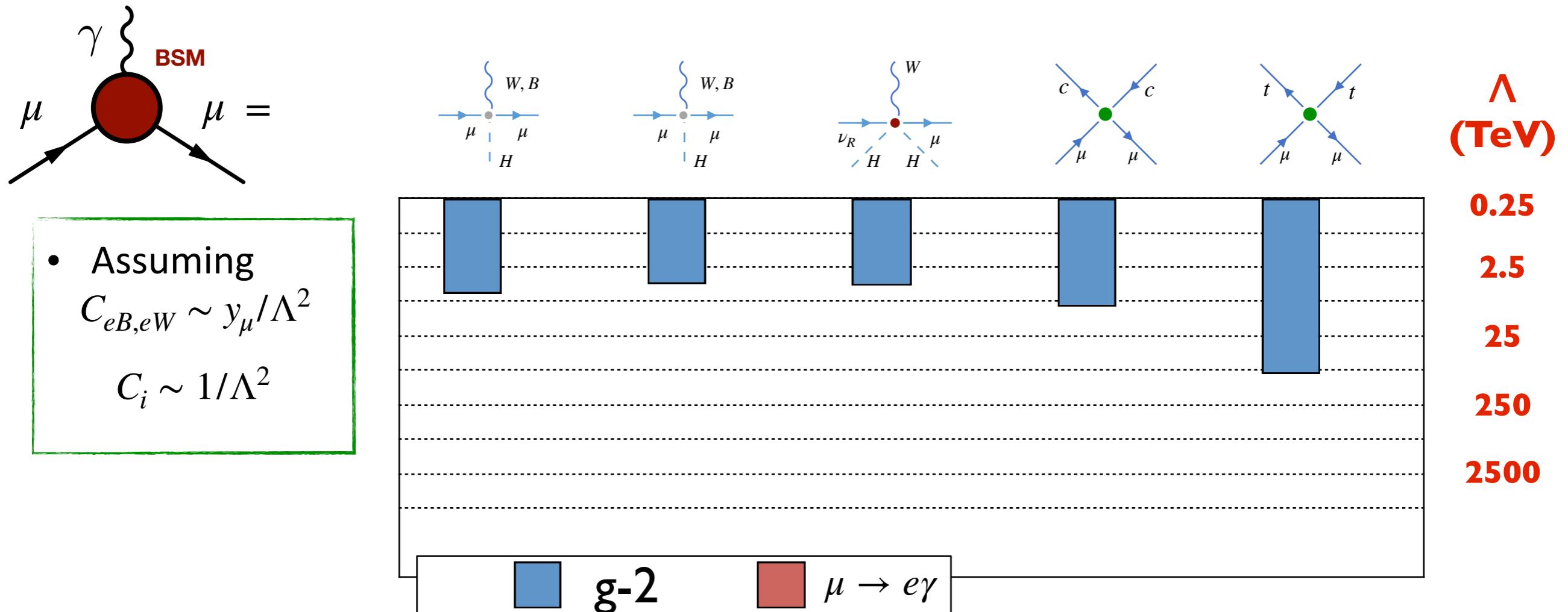
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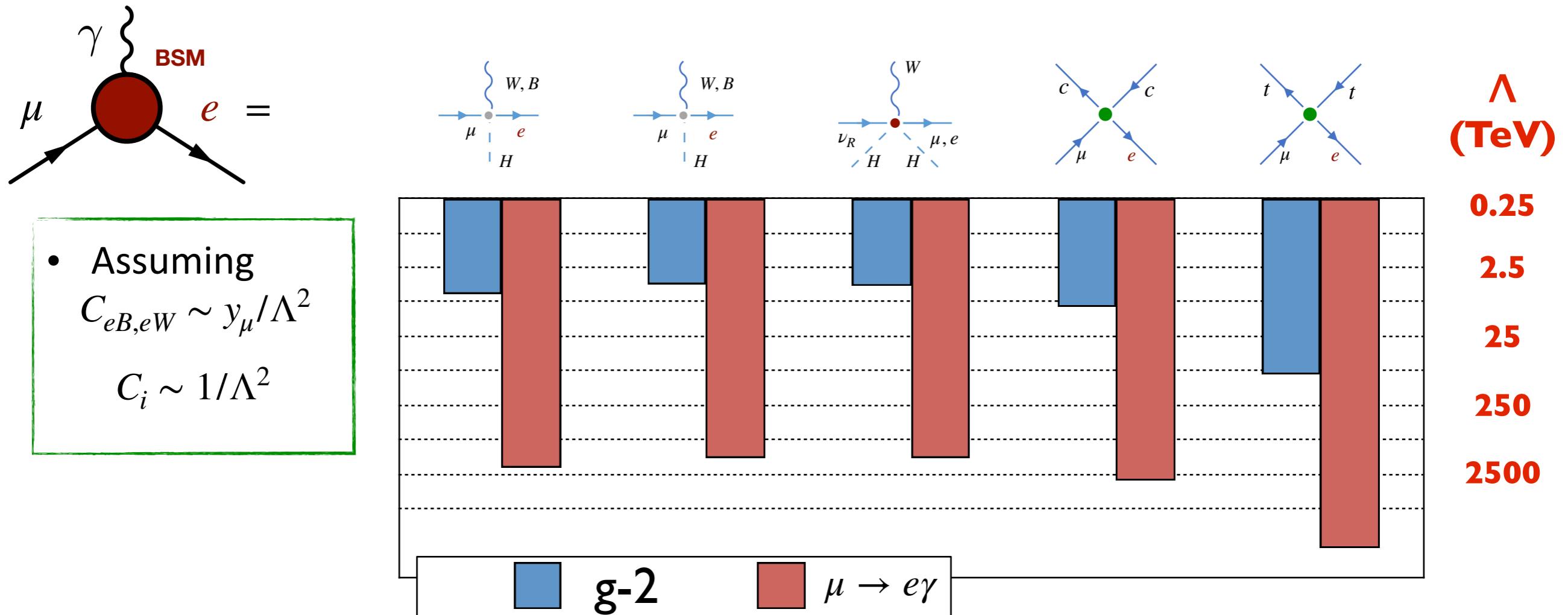
- Only a few operators survive
 - Need chiral enhanced contributions

$$\sim \frac{m_{c,t}}{m_\mu}, \frac{m_{\nu_R}}{m_\mu}$$

Connection to CLFV?

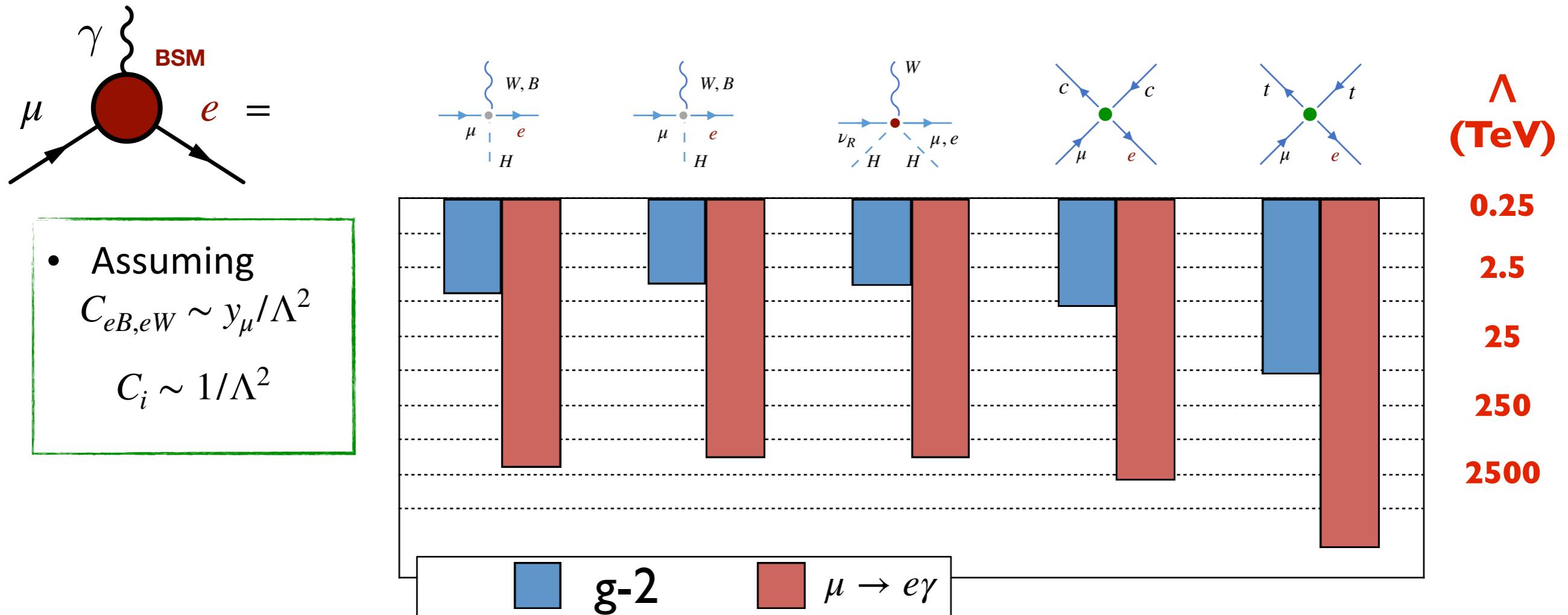


Connection to CLFV?



- $g - 2$ requires $\Lambda \sim \text{TeV}$
 - CLFV requires $\Lambda > 100\text{TeV}$
- Large hierarchy between similar interactions

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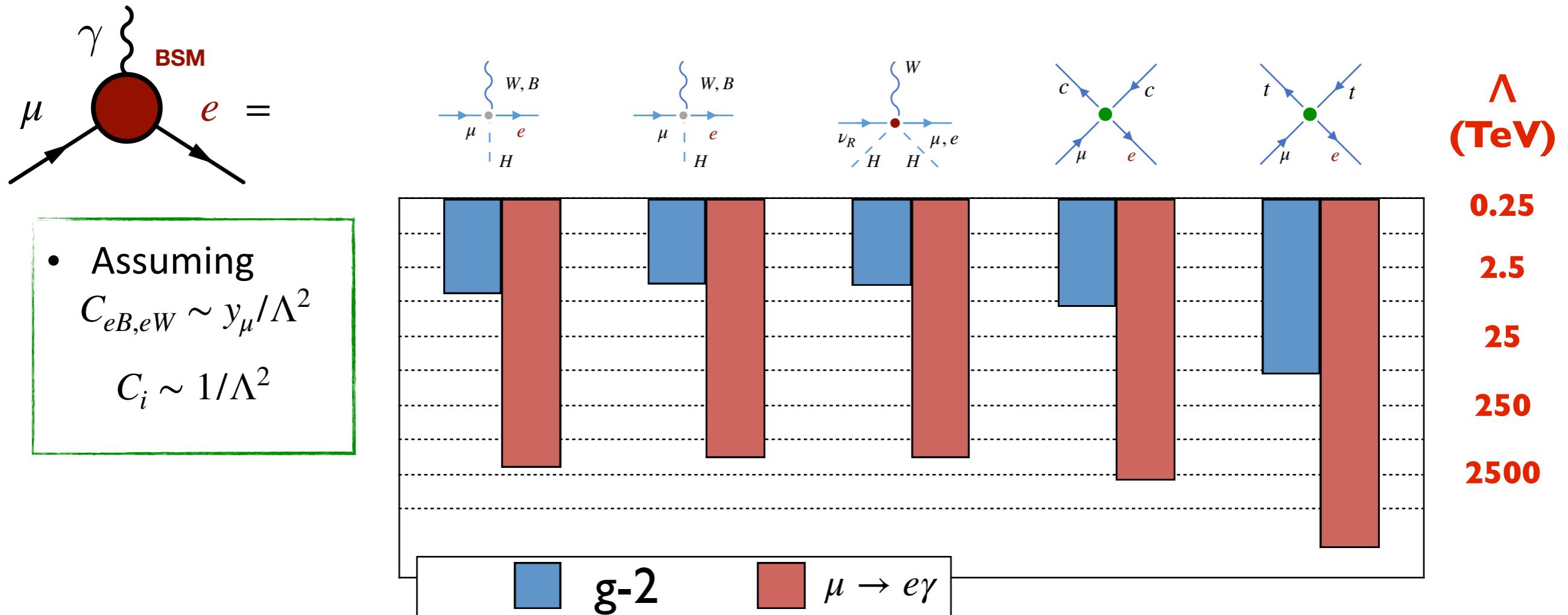


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- Connect by symmetries? Hierarchy not easily explained, unless assuming $L_{e,\mu,\tau}$

Large hierarchy between similar interactions

E.g.; Isidori, Pages, Wilsch, '22

Connection to CLFV?



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- CLFV requires $\Lambda > 100\text{TeV}$
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 - Connect by symmetries? Hierarchy not easily explained, unless assuming $L_{e,\mu,\tau}$
- $g - 2$ & CLFV can be related by other flavor dependent observations
 - neutrino masses, LFU in B anomalies, $(g - 2)_e$

E.g.; Isidori, Pages, Wilsch, '22

$(g - 2)_\mu \& (g - 2)_e$

- Not only $(g - 2)_\mu$ disagrees with the SM:

$$\Delta a_e^{\text{Cs}} = a_e^{\text{exp}} - a_e^{\text{SM, Cs}} = -(0.88 \pm 0.36) \cdot 10^{-12},$$

$$\Delta a_e^{\text{Rb}} = a_e^{\text{exp}} - a_e^{\text{SM, Rb}} = (0.48 \pm 0.30) \cdot 10^{-12}.$$

Depends on α determination

Parker et al. '18

Morel et al. '20

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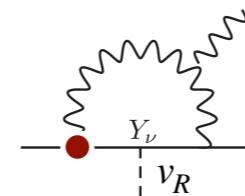
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Induced by:
Left-right model
Vector-Like Leptons

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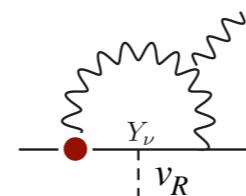
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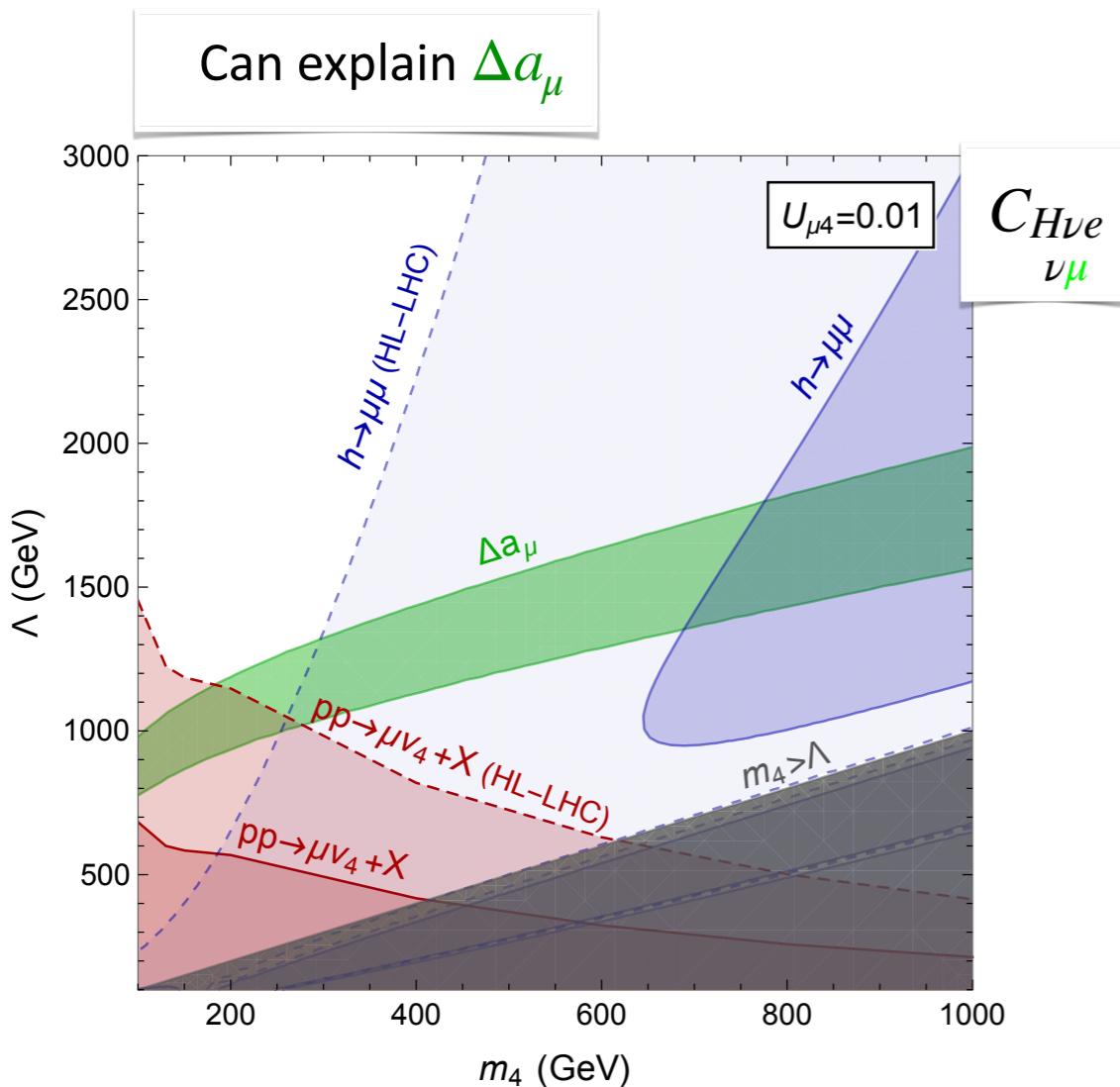
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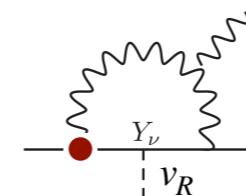
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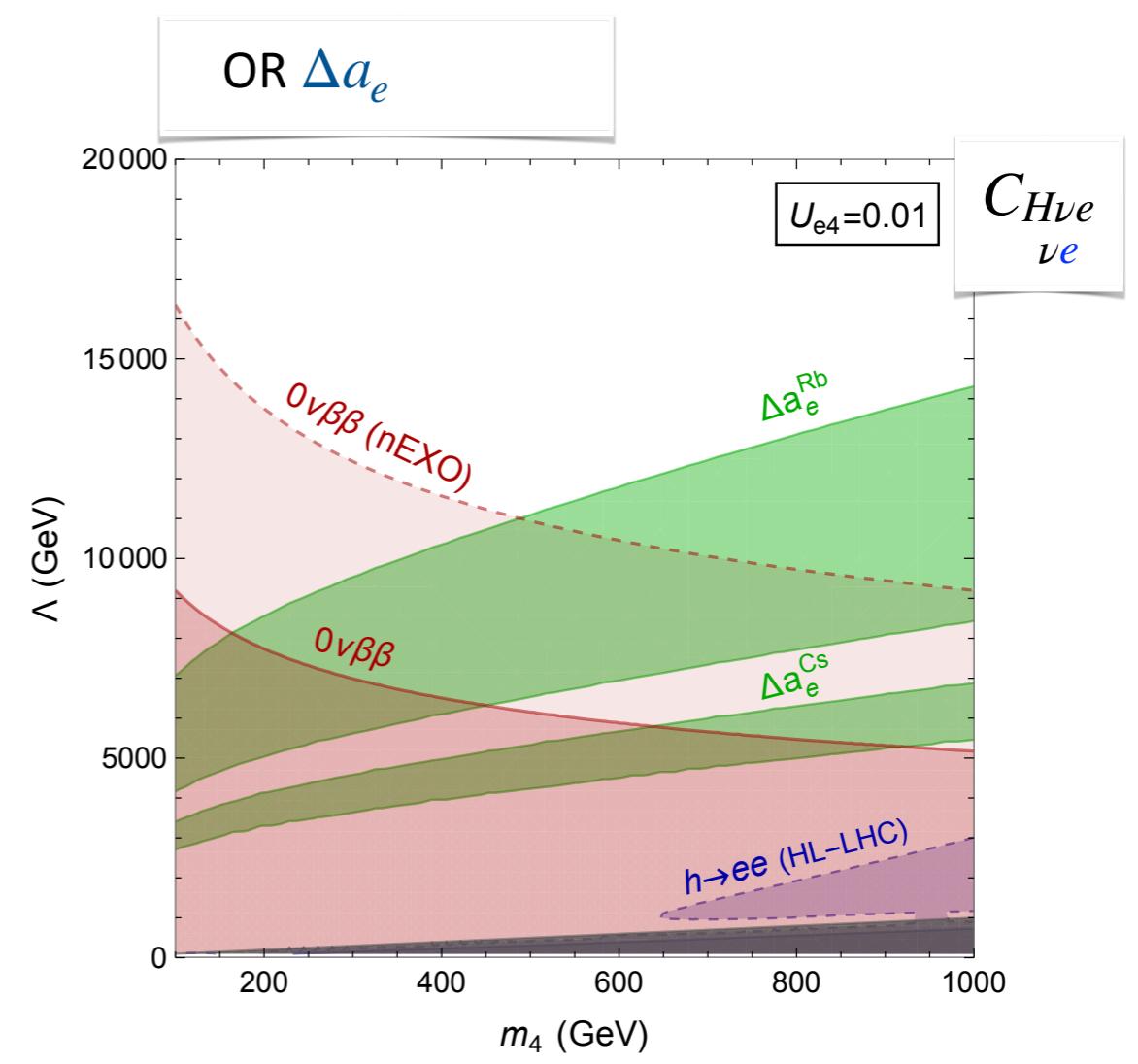
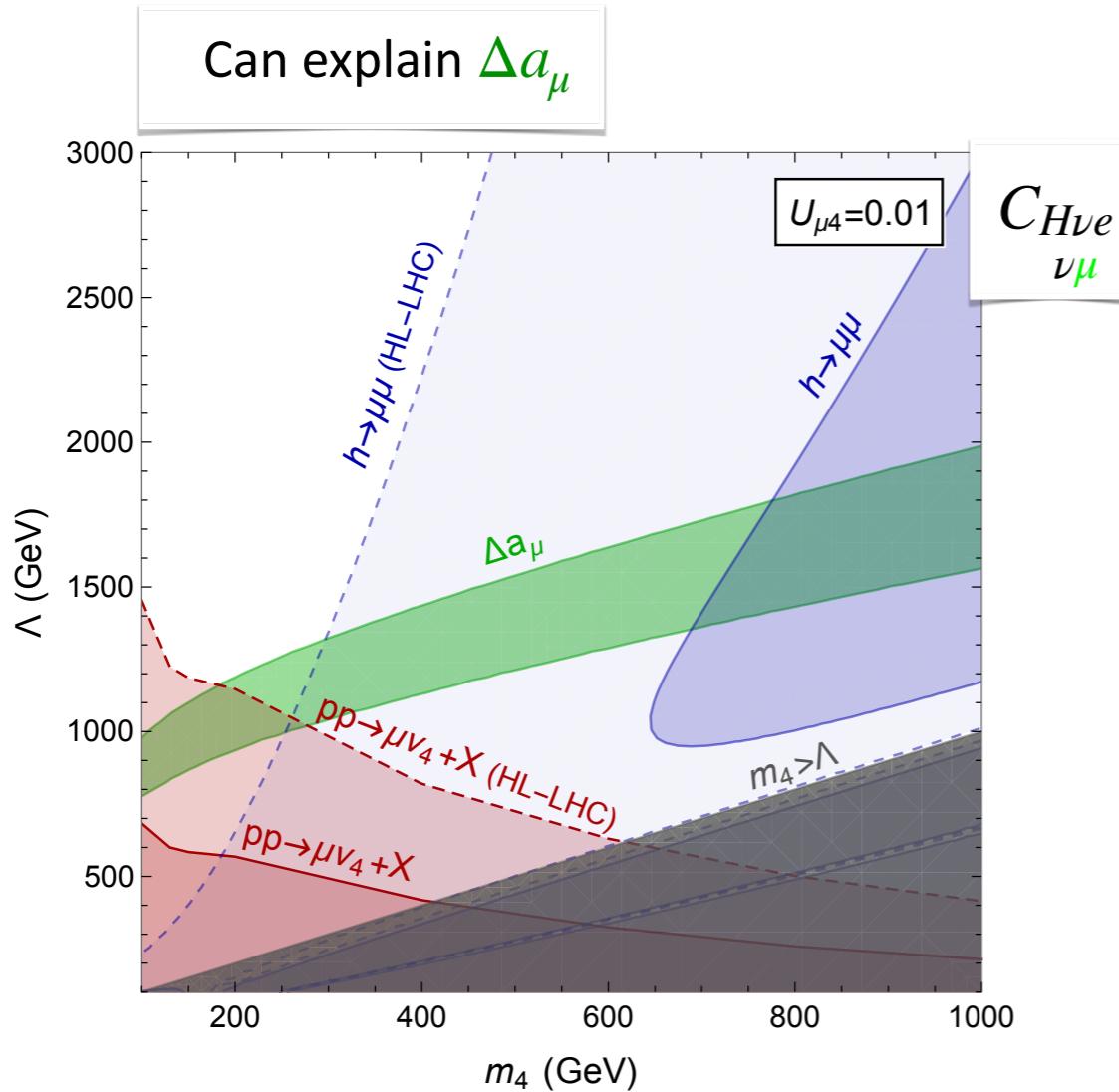
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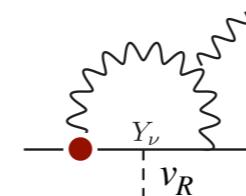
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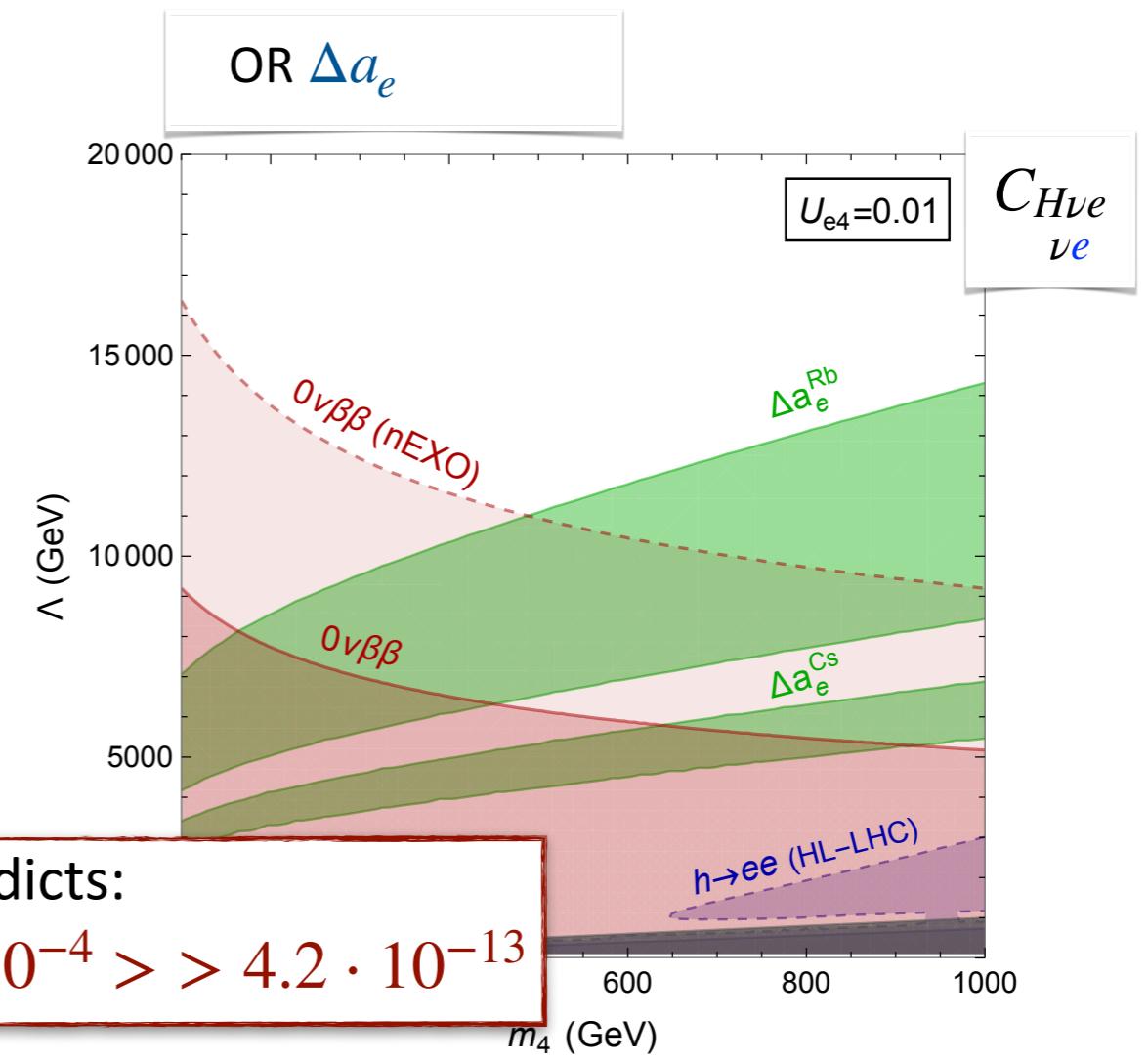
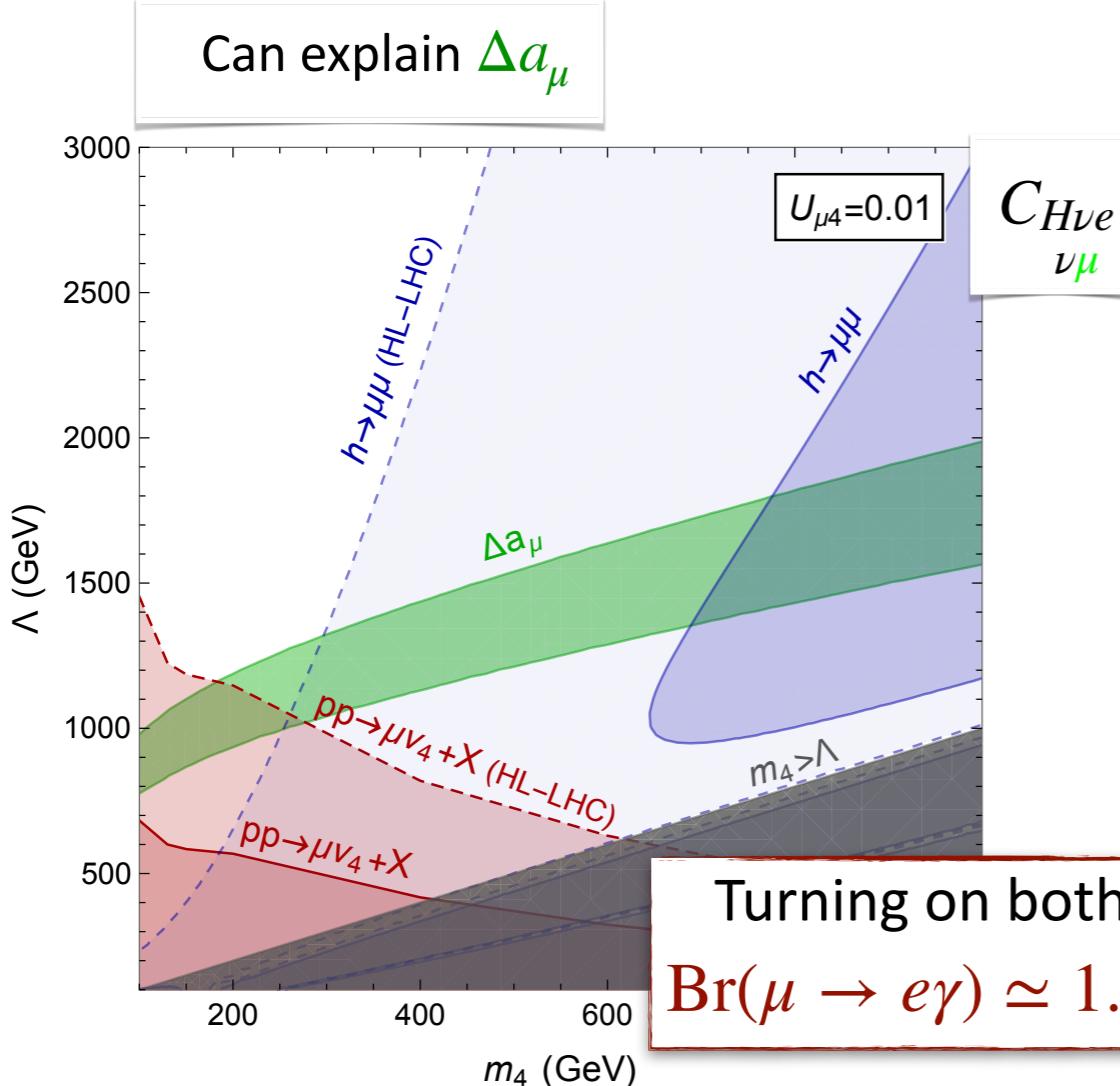
Depends on α determination

Parker et al. '18
Morel et al. '20

- Both $(g - 2)_{e,\mu}$ induced by EFT operator with 1 ν_R



Induced by:
Left-right model
Vector-Like Leptons



$(g - 2)_\mu$ & $(g - 2)_e$

- Not only $(g - 2)_\mu$ disagrees with the SM:

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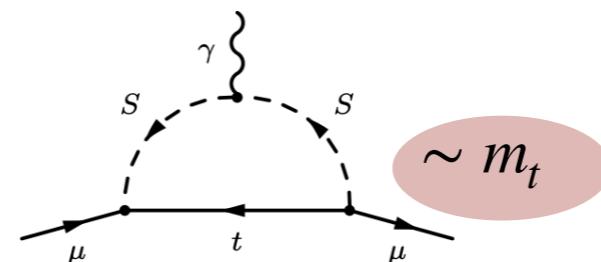
Parker et al. '18

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- Often happens when explaining $\Delta a_{e,\mu}$ with a single heavy particle:

$$\text{BR}(\mu \rightarrow e\gamma) \geq \frac{\tau_\mu \alpha m_\mu^3}{16} \left(\frac{\Delta a_e^2}{m_e^2 \xi^2} + \frac{\Delta a_\mu^2}{m_\mu^2} \xi^2 \right) \simeq 1.4 \cdot 10^{-4}.$$

- e.g. true for Leptoquarks models as well



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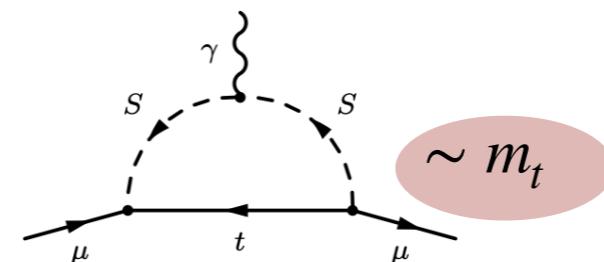
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- Can be fixed by introducing more fields & couplings
 - Requires significant cancellations

$$\sum_N U_{eN} m_N [C_{H\nu e}]_{N\textcolor{green}{e}} \sim \sum_N U_{\mu N} m_N [C_{H\nu e}]_{N\mu} \gg \sum_N U_{eN} m_N [C_{H\nu e}]_{N\mu}$$

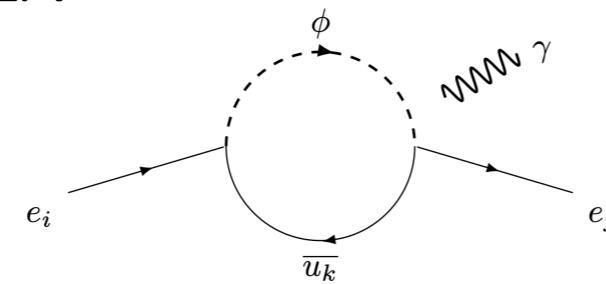
$(g - 2)_\mu$ & B anomalies $R(D^{(*)})$

Bigaran,Felk,Hagedorn,Schmidt, '22

- Model of a single leptoquark

$$\mathcal{L}_{\text{LQ}}^{\text{int}} = \hat{x}_{ij} \overline{L_i^c} \phi^\dagger Q_j + \hat{y}_{ij} \overline{e_{Ri}^c} \phi^\dagger u_{Rj} + \text{h.c.}$$

- Contributes to $(g - 2)_\mu$, CLFV



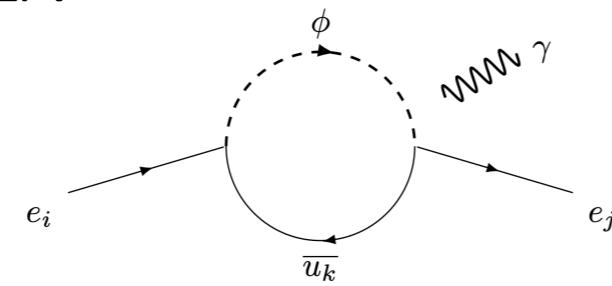
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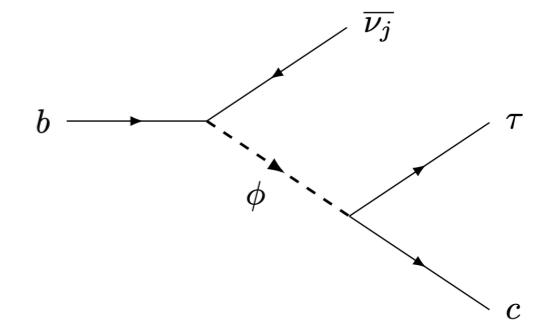
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$$R(D^{(*)}) = \frac{\Gamma(B \rightarrow D^{(*)}\tau\nu)}{\Gamma(B \rightarrow D^{(*)}\ell\nu)}$$

$2 - 3\sigma$ discrepancy



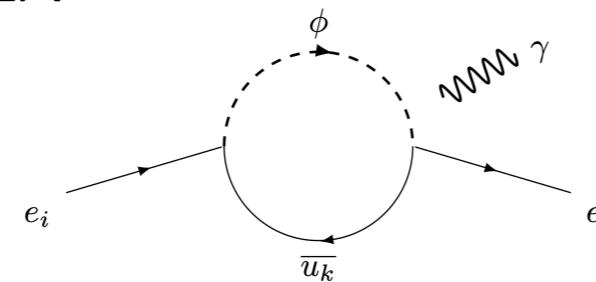
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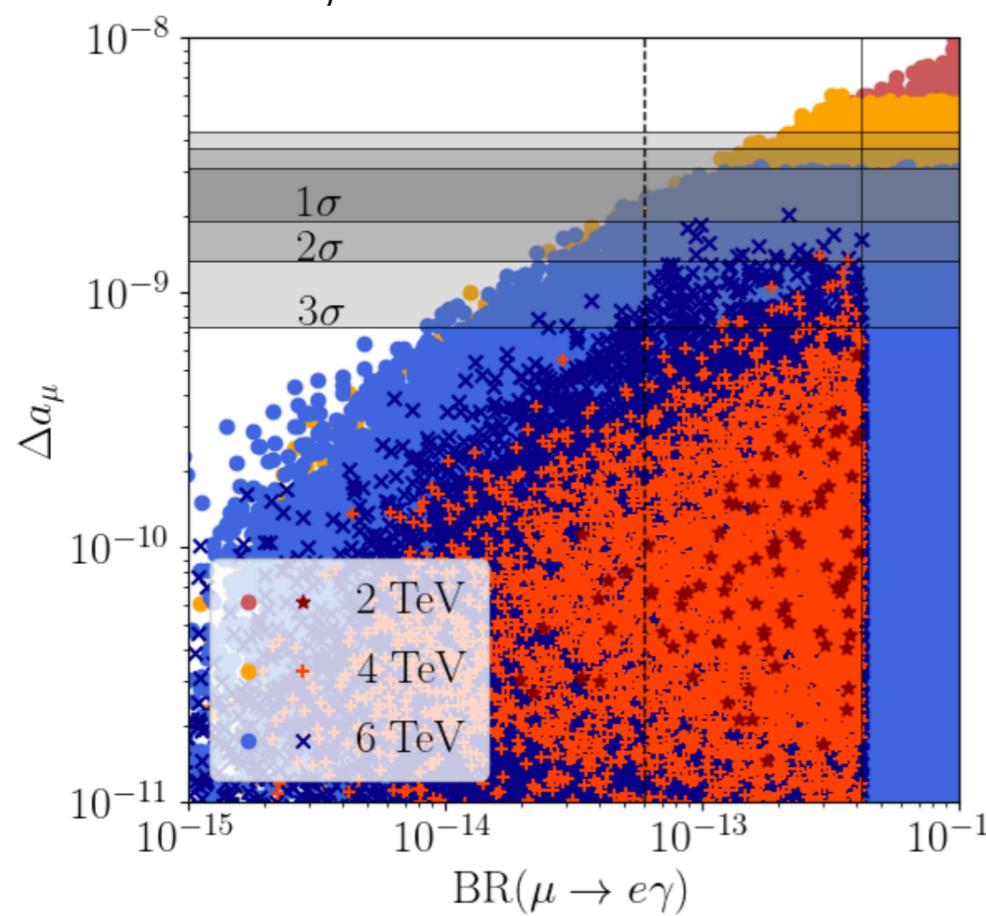
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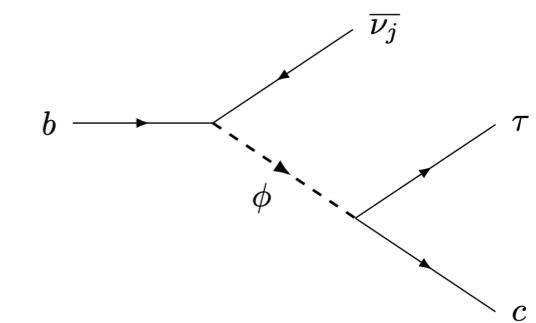
- Correlates $(g - 2)_\mu$ with CLFV



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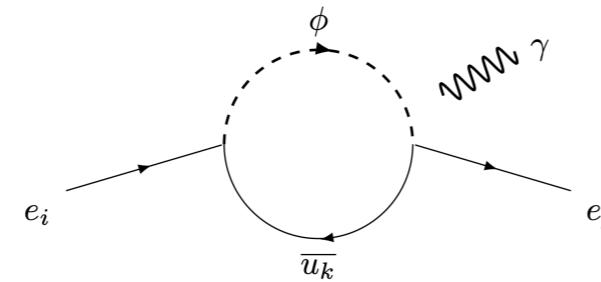
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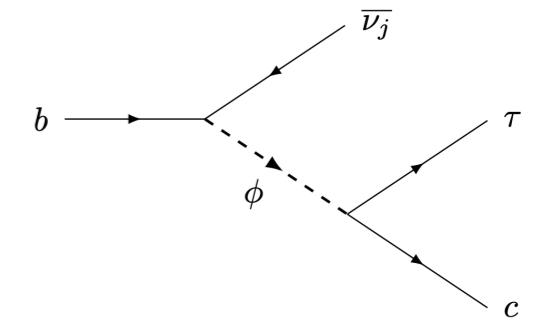
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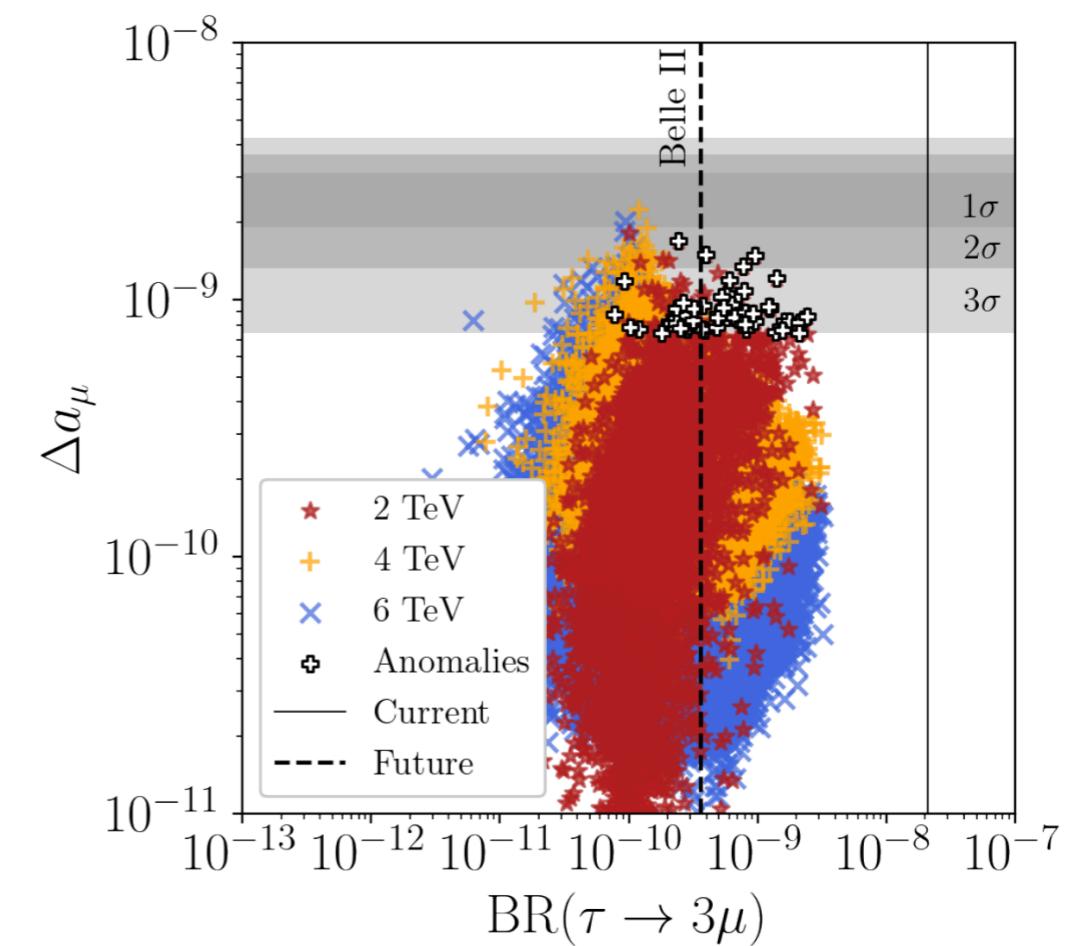
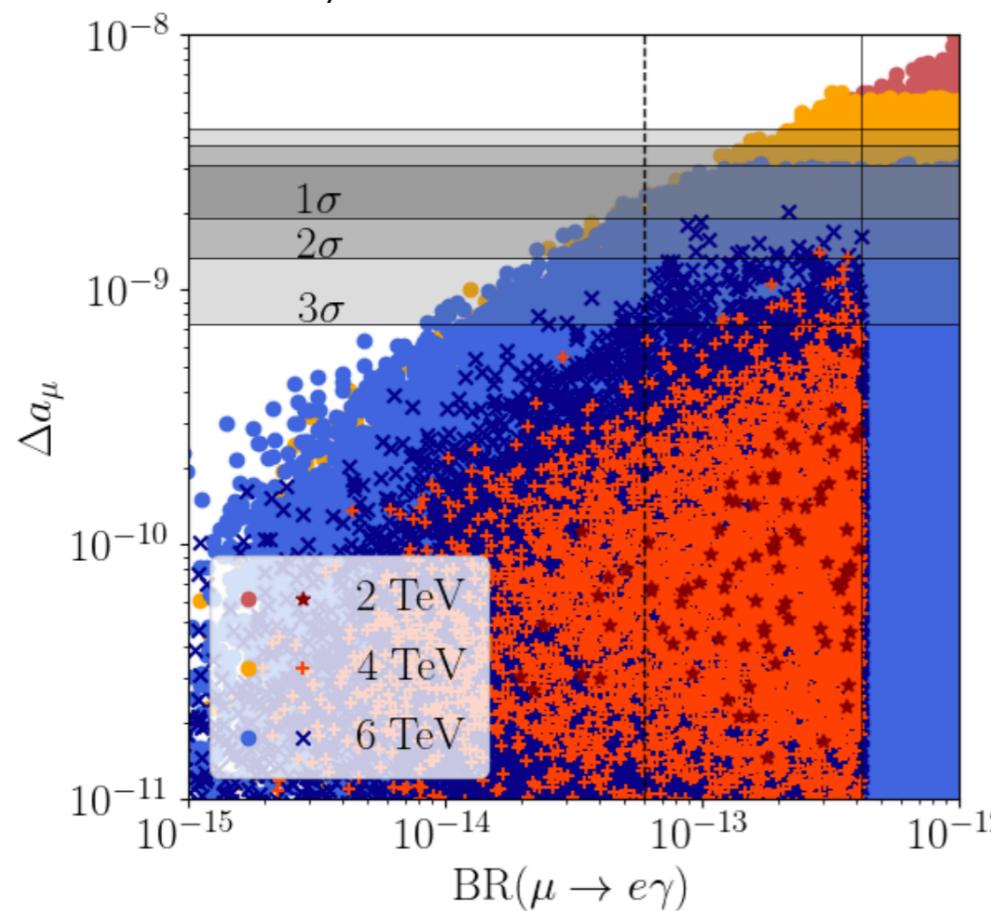
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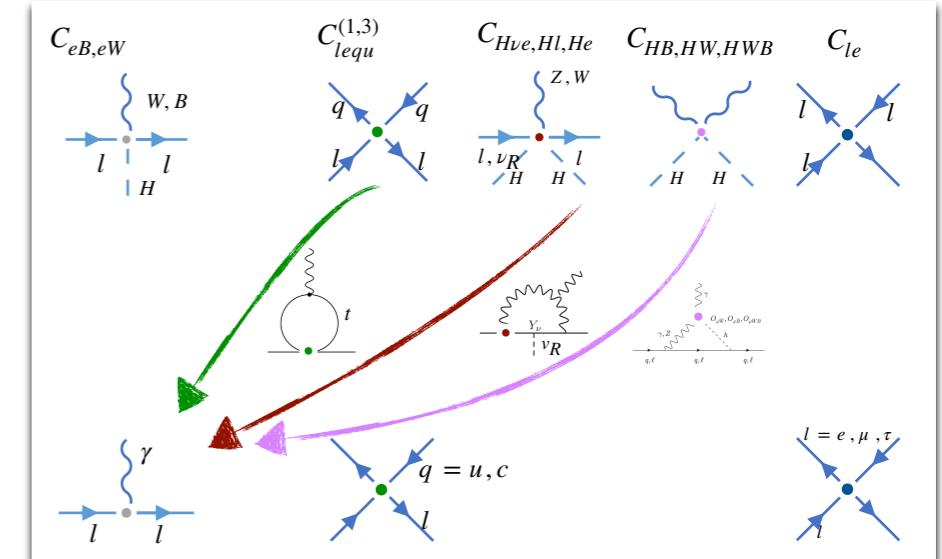


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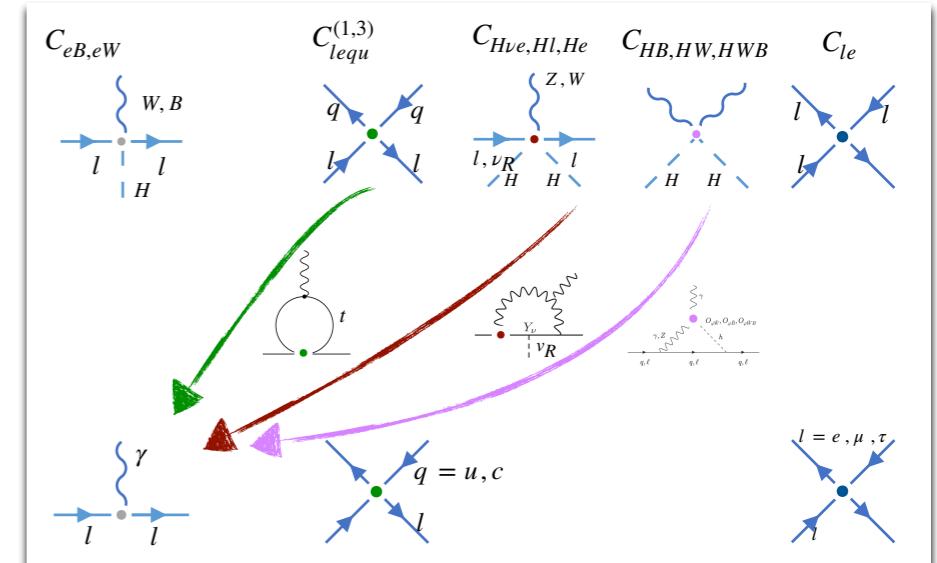
Summary

- EFTs are useful to organize contributions to
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 - CLFV: $\ell \rightarrow \ell' \gamma, \mu \rightarrow e, \mu \rightarrow eee,$

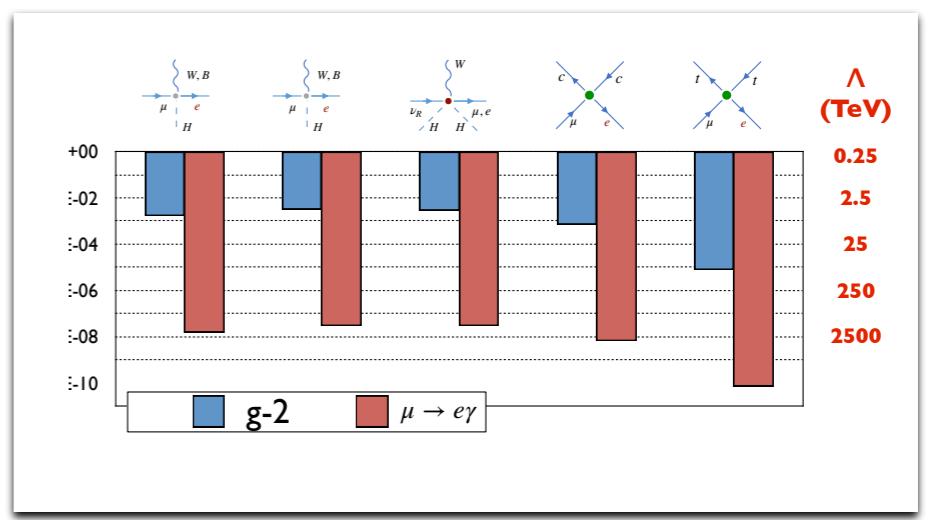


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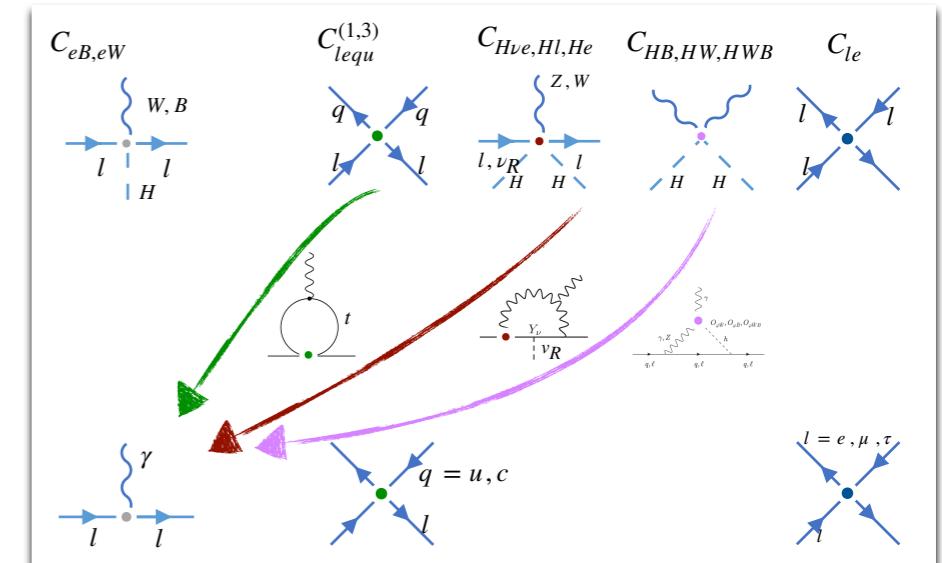


- The current value of Δa_μ would prefer $\Lambda \sim (1 - 10)\text{TeV}$
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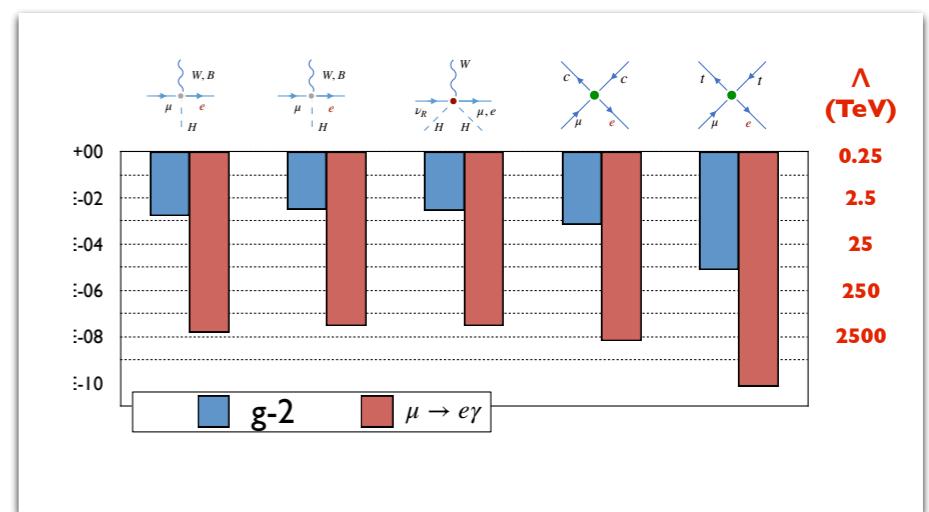


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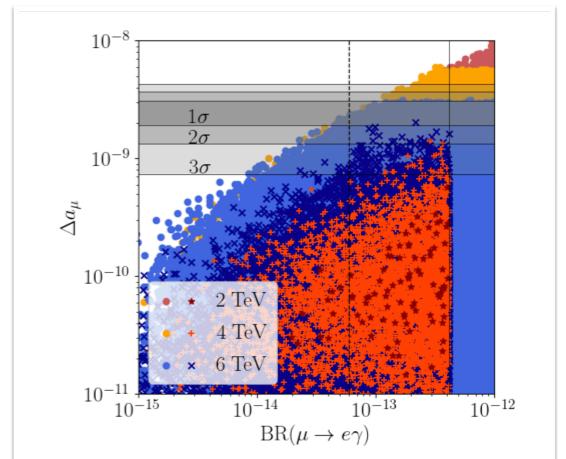
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- Other flavor dependent observables can correlate $(g - 2)_\mu$ & CLFV
 - Sensitive probe of models explaining multiple anomalies



Thank you
for your attention
