Evanescent Operators in (SM)EFT Matching

Anders Eller Thomsen

Based on [2211.09144] w/ J. Fuentes-Martín, M. König, J. Pagès, and F. Wilsch

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University of Basel

MATCHETE

EFTs in BSM Physics

The role of EFT matching

Effective field theory

High-energy physics manifests as contact interactions in EFTs

UV Physics

$$\mathcal{L}_{\text{(SM)EFT}}(\phi) = \mathcal{L}_{d=4}(\phi) + \sum_{d=5}^{\infty} \sum_{k} \frac{C_{d,k}}{\Lambda^{d-4}} \mathcal{O}_{d,k}(\phi)$$

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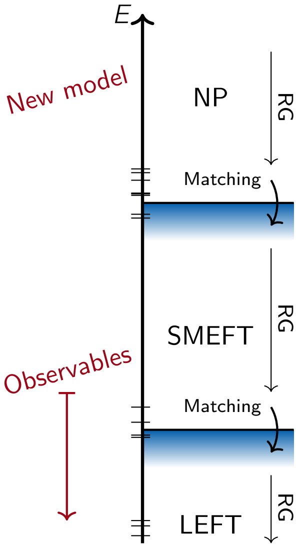
- **Bottom–up:**
  - The use of EFTs allows for a **model-comprehensive** ("model-independent") analysis of deviations from the SM, quantifying possible deviations as an expansion in E/Λ
- **Top–down:**
  - **Precision computations** necessitate the use of EFTs to separate the large scales introduced in BSM physics and avoid large logs
  - Many BSM models result in the same EFT, ensuring that computations are **reusable**: you only need to compute once in the EFT

Top–down EFT workflow



Jenkins, Manohar, Trott [1308.2627]
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Top–down EFT workflow

Included in codes
wilson and **DsixTools**
Aebischer, Kumar, Straub [1804.05033]
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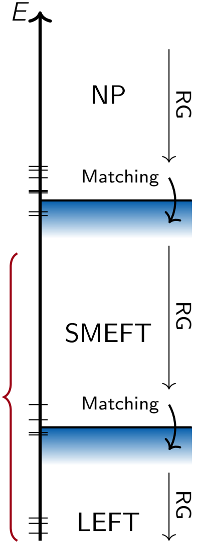

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The repetitive nature of EFT computations calls for **automated tools!**

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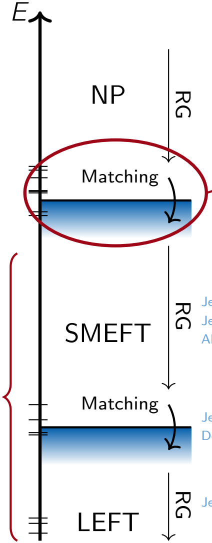

Carmona *et al.* [2112.10787]; Fuentes-Martín, König, Pagès, AET, Wilsch [2212.04510]

*Talk by Julie Pagès

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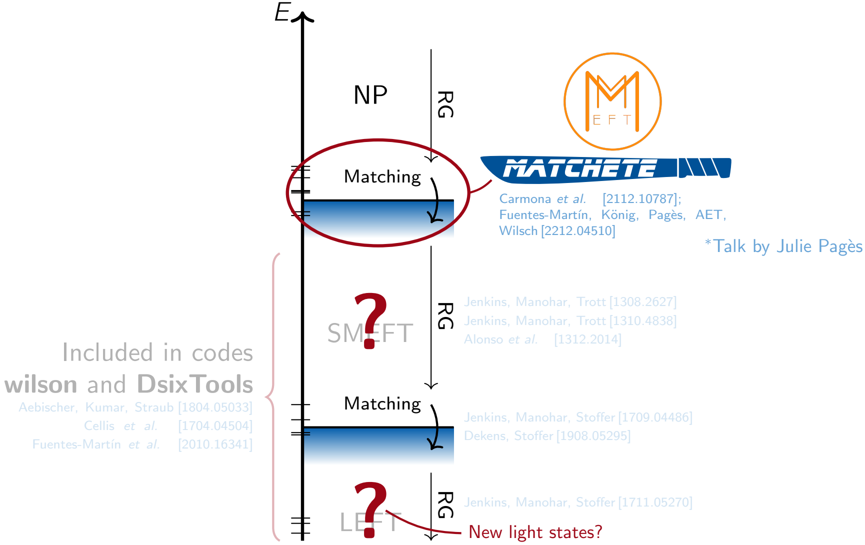

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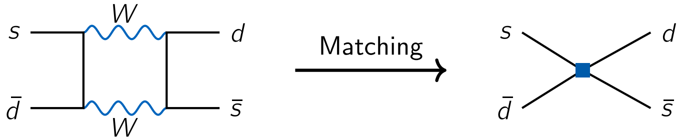
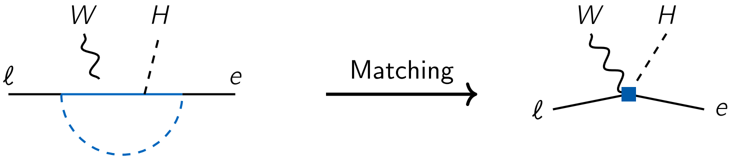
EFTs beyond tree level

1-loop effects are often the **leading contributions** from high-scale physics

- FCNCs in the SM



- In BSM models: dipoles, FCNCs, EW precision, ...



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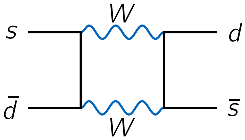

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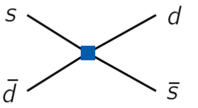

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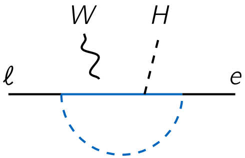

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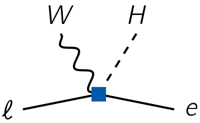

We better do it right!

Evanescent Operators

Why can't QFT just play nice?

EFT from a 2HDM

Example: SM + leptophilic Higgs, $\Phi \sim (\mathbf{1},\, \mathbf{2})_{1/2}$:

$$\mathcal{L} \supset \mathcal{L}_{\text{SM}} + D_\mu \Phi^\dagger D^\mu \Phi - M_\Phi^2\, \Phi^\dagger \Phi - \left(y_{\Phi e}^{pr}\, \bar{\ell}_p \Phi e_r + \text{h.c.} \right) + \ldots$$

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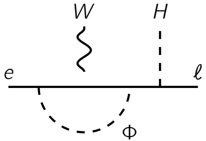

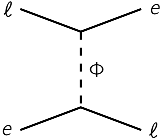

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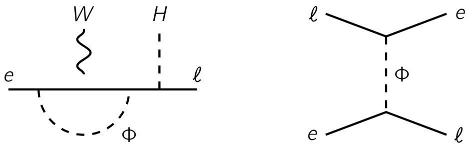

Below the scale $M_\Phi \gg v_{\text{EW}}$

$$\mathcal{L}_{\text{EFT}} \supset C_{eW}^{pr} Q_{eW}^{pr} + C_{\ell e}^{prst} R_{\ell e}^{prst}$$

But the tree-level operator **$R_{\ell e}$ is not part of the Warsaw basis**

Changing basis in an EFT

In $d = 4$ dimensions, $\mathcal{L}_{\text{EFT}} = \widetilde{\mathcal{L}}_{\text{EFT}}$, where

$$\mathcal{L}_{\text{EFT}} \supset C_{eW}^{pr} Q_{eW}^{pr} + C_{\ell e}^{prst} R_{\ell e}^{prst} \qquad R_{\ell e}^{prst} = (\bar{\ell}_p e_r)(\bar{e}_s \ell_t)$$

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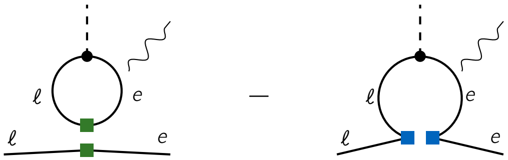
But the 1-loop EFT **amplitudes are different!**

$$i\big(\mathcal{A}_{eH\to\ell W} - \widetilde{\mathcal{A}}_{eH\to\ell W}\big) = \frac{g_2}{64\pi^2} [C_{\ell e}]^{prst} y_e^{ts} \big(\bar{u}\tau^I \sigma_{\mu\nu} P_R u\big) q^\mu \varepsilon^{*\nu}$$



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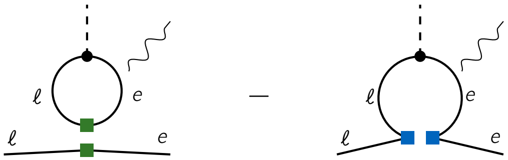

For $d \neq 4$, there is an **evanescent operator:**

$$R_{\ell e}^{prst} = -\tfrac{1}{2} Q_{\ell e}^{ptsr} + E_{\ell e}^{prst}, \qquad E_{\ell e}^{prst} \xrightarrow{d\to 4} 0$$

Evanescent operators

An **evanescent operator** E is an operator satisfying

$$\text{rank}(E) = \epsilon \xrightarrow{d \to 4} 0$$

Evanescent contributions have long been accounted for in the LEFT (Weak Effective Hamiltonian). Not so much in BSM context

Buras, Weisz '90; Dugan, Grinstein '91; Herrlich, Nierste [hep-ph/9412375];...

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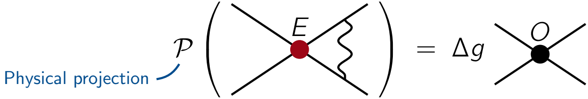
The physical contributions from evanescent operators are **finite and local**



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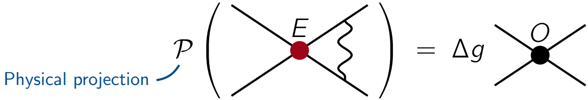

e.g., in the 2HDM example

$$E_{\ell e}^{prst} \longrightarrow -\frac{g_L y_e^{ts}}{128\pi^2} Q_{eW}^{pr} + [\text{many other contributions}]$$

The physical projector

The **physical projector** $\mathcal{P}$ is defined through a choice of identities:

$$O_d = \underbrace{\mathcal{P}\, O_d}_{\text{phys. part}} + \underbrace{\overbrace{\mathcal{E}_{\mathcal{P}}}^{\text{id} - \mathcal{P}}\, O_d}_{\text{ev. part}}$$

- Reduction of Dirac structures for 4-fermion operators, e.g.,

$$(\gamma^{\mu}\gamma^{\nu}\gamma^{\lambda}P_{\text{L}}) \otimes [\gamma_{\lambda}\gamma_{\nu}\gamma_{\mu}P_{\text{L}}] = 4(1 - \overbrace{2\epsilon}^{\text{Compatibility with NDR}})\,(\gamma^{\mu}P_{\text{L}}) \otimes [\gamma_{\mu}P_{\text{L}}] + E_{LL}^{[3]}$$

- Fierz identities for 4-fermion operators, e.g.,

$$(P_{\text{R}}) \otimes [P_{\text{L}}] = -\tfrac{1}{2}(\gamma_{\mu}P_{\text{L}}] \otimes [\gamma_{\mu}P_{\text{R}}) + E_{\text{Fierz}}(P_{\text{R}}, P_{\text{L}})$$

- Other identities involving γ_5 and/or the Levi-Civita tensor, e.g.,

$$\varepsilon_{\mu\nu\rho\sigma}\sigma^{\rho\sigma} = 2i\sigma_{\mu\nu}\gamma_5 + E_{\mu\nu}^{(\varepsilon\cdot\sigma)}$$

Evanescence-free schemes

For an EFT Lagrangian $\mathcal{L} = \bar{g}_a O^a + \bar{\eta}_i E^i$, the 1-loop effective action is

$$\Gamma = \int_x \left(\bar{g}_a O^a + \bar{\eta}_i E^i \right) + \overline{\Gamma}(g, \eta).$$

1-loop diagrams, tree-level couplings

bare couplings

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Scheme	$\overline{\text{MS}}$
Action: $\mathcal{P} : O^a$ $\mathcal{E}_{\mathcal{P}} : E^i$	$\bar{g}_a = g_a + \delta g_a$ $\bar{\eta}_i = \eta_i + \delta \eta_i$
Phys. eff. action $\mathcal{P}\Gamma$	$\int_x \bar{g}_a O^a + \mathcal{P}\overline{\Gamma}(g, \eta)$

Loops involve Ev. couplings!

What is used in the calculation of physical amplitudes.

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Action $\mathcal{E}_{\mathcal{P}} : E^i$	$\bar{\eta}_i = \eta_i + \delta\eta_i$	$\delta\eta_i + \eta_i$
Phys. eff. action $\mathcal{P}\Gamma$	$\int_x \bar{g}_a O^a + \mathcal{P}\overline{\Gamma}(g, \eta)$	$\int_x (\bar{g}_a + \Delta g_a) O^a + \mathcal{P}\overline{\Gamma}(g, \eta) - \int_x \Delta g_a O^a$

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The evanescent contribution is defined by

local, finite

$$\int_x \Delta g_a O^a \equiv \mathcal{P}\left[\overline{\Gamma}(g, \eta) - \overline{\Gamma}(g, 0)\right]$$

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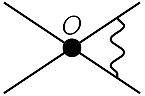
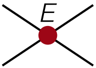
Handling evanescent contributions means computing $\boldsymbol{\Delta g}$

RG in evanescent schemes

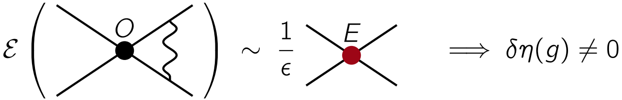
$\mathcal{E}\Big($ 

$\Big) \sim \frac{1}{\epsilon}$ 

$\implies \delta\eta(g) \neq 0$

Evanescent counterterms implies evanescent contributions in RG running

RG in evanescent schemes



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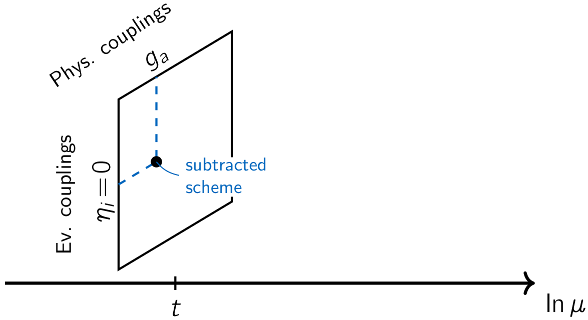

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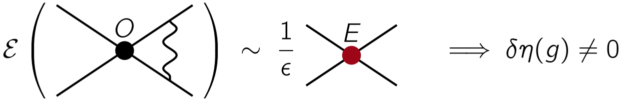

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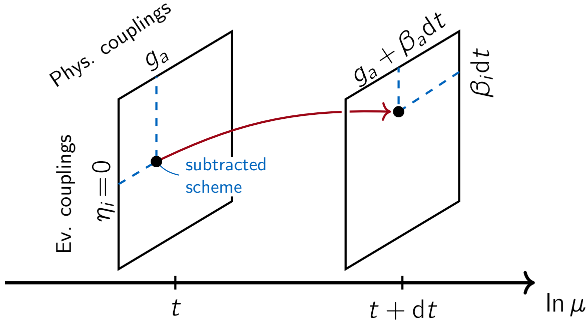
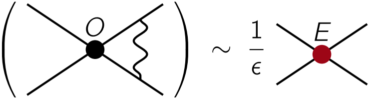
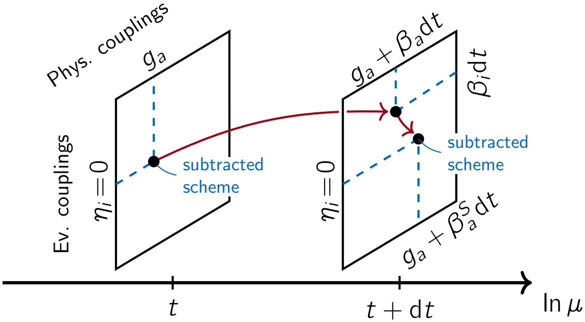


RG in evanescent schemes

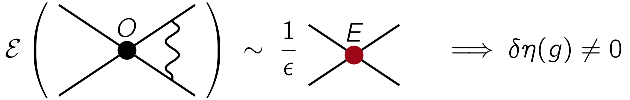


$$\mathcal{E}\left(\;\cdots\;\right) \sim \frac{1}{\epsilon}\;\cdots \quad\Longrightarrow\quad \delta\eta(g)\neq 0$$

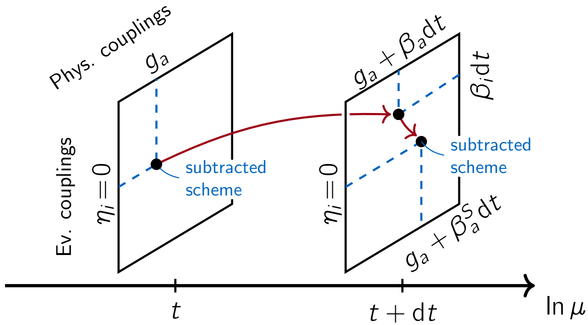
Evanescent counterterms implies evanescent contributions in RG running



RG in evanescent schemes



Evanescent counterterms implies evanescent contributions in RG running



In the subtracted evanescent scheme

$$\frac{\mathrm{d}g_a}{\mathrm{d}t} = \beta_a^S = \beta_a + \overbrace{\beta_i \, \frac{\partial \Delta g_a}{\partial \eta_i}}^{\text{2-loop}}\Bigg|_{\eta=0}$$

Application to the SMEFT

Reduction to the Warsaw basis

SMEFT at 1-loop order

Generally speaking, there is a **finite set of relevant evanescent operators** at a given loop-order:

E.g., $(\bar{\ell}\gamma_{\mu_1}\cdots\gamma_{\mu_n}\ell)(\bar{\ell}\gamma^{\mu_1}\cdots\gamma^{\mu_n}\ell)$ is irrelevant for 1-loop calculations

For the case of **1-loop SMEFT**, we look for the following criteria:

- operators generated by exchange of tree-level NP mediators
- NP mediators of spin 0, 1/2, or 1
- NP Lagrangian with up dim-5 couplings

see, e.g., tree-level dictionary: de Blas *et al.* [1711.10391]

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The redundant operators are

i) 23 (+2 BNV) generated by scalar mediators;

ii) none generated by fermion mediators;

iii) 21 (+3 BNV) generated by vector mediators.

SMEFT: redundant scalar-mediated operators

$(\bar{L}R)(\bar{R}L)$ & $(\bar{L}R)(\bar{L}R)$		$(\bar{R}^c R)(\bar{R}R^c)$	
$R_{\ell e}$	$(\bar{\ell}_p e_r)(\bar{e}_s \ell_t)$	$R_{e^c e}$	$(\bar{e}^c_p e_r)(\bar{e}_s e^c_t)$
$R_{\ell u}$	$(\bar{\ell}_p u_r)(\bar{u}_s \ell_t)$	$R_{u^c u}$	$(\bar{u}^c_{\alpha p} u_{\beta r})(\bar{u}_{\beta s} u^c_{\alpha t})$
$R_{\ell d}$	$(\bar{\ell}_p d_r)(\bar{d}_s \ell_t)$	$R_{d^c d}$	$(\bar{d}^c_{\alpha p} d_{\beta r})(\bar{d}_{\beta s} d^c_{\alpha t})$
R_{qe}	$(\bar{q}_p e_r)(\bar{e}_s q_t)$	$R_{e^c u}$	$(\bar{e}^c_p u_r)(\bar{u}_s e^c_t)$
$R^{(1)}_{qu}$	$(\bar{q}_p u_r)(\bar{u}_s q_t)$	$R_{e^c d}$	$(\bar{e}^c_p d_r)(\bar{d}_s e^c_t)$
$R^{(8)}_{qu}$	$(\bar{q}_p T^A u_r)(\bar{u}_s T^A q_t)$	$R_{u^c d}$	$(\bar{u}^c_{\alpha p} d_{\beta r})(\bar{d}_{\beta s} u^c_{\alpha t})$
$R^{(1)}_{qd}$	$(\bar{q}_p d_r)(\bar{d}_s q_t)$	$R'_{u^c d}$	$(\bar{u}^c_{\alpha p} d_{\beta r})(\bar{d}_{\alpha s} u^c_{\beta t})$
$R^{(8)}_{qd}$	$(\bar{q}_p T^A d_r)(\bar{d}_s T^A q_t)$		
$R_{\ell uqe}$	$(\bar{\ell}_{ip} u_r)\varepsilon^{ij}(\bar{q}_{js} e_t)$		
$(\bar{L}^c L)(\bar{L}L^c)$		$(\bar{R}^c R)(\bar{L}L^c)$	
$R_{\ell^c \ell}$	$(\bar{\ell}^c_{ip} \ell_{jr})(\bar{\ell}_{js} \ell^c_{it})$	$R_{u^c dqq^c}$	$(\bar{u}^c_{\alpha p} d_{\beta r})\varepsilon^{ij}(\bar{q}_{\beta is} q^c_{\alpha jt})$
$R_{q^c q}$	$(\bar{q}^c_{\alpha ip} q_{\beta jr})(\bar{q}_{\beta js} q^c_{\alpha it})$	$R_{u^c e\ell q^c}$	$(\bar{u}^c_p e_r)\varepsilon^{ij}(\bar{\ell}_{is} q^c_{jt})$
$R'_{q^c q}$	$(\bar{q}^c_{\alpha ip} q_{\beta jr})(\bar{q}_{\beta is} q^c_{\alpha jt})$	Baryon number violating	
$R_{q^c \ell}$	$(\bar{q}^c_{ip} \ell_{jr})(\bar{\ell}_{js} q^c_{it})$	$R_{q^c qq^c \ell}$	$\varepsilon_{\alpha\beta\gamma}\varepsilon_{ij}\varepsilon_{kl}(\bar{q}^c_{\alpha ip} q_{\beta jr})(\bar{q}^c_{\gamma ks} \ell_{lt})$
$R'_{q^c \ell}$	$(\bar{q}^c_{ip} \ell_{jr})(\bar{\ell}_{is} q^c_{jt})$	$R_{u^c ud^c e}$	$\varepsilon_{\alpha\beta\gamma}(\bar{u}^c_{\alpha p} u_{\beta r})(\bar{d}^c_{\gamma s} e_t)$

SMEFT: redundant vector-mediated operators

$(\bar{L}L)(\bar{L}L)$	
$R_{\ell\ell}^{(3)}$	$(\bar{\ell}_p\gamma_\mu\tau^I\ell_r)(\bar{\ell}_s\gamma^\mu\tau^I\ell_t)$
$R_{qq}^{(1,8)}$	$(\bar{q}_p\gamma_\mu T^A q_r)(\bar{q}_s\gamma^\mu T^A q_t)$
$R_{qq}^{(3,8)}$	$(\bar{q}_p\gamma_\mu\tau^I T^A q_r)(\bar{q}_s\gamma^\mu\tau^I T^A q_t)$
$R_{\ell q}^{(1)}$	$(\bar{\ell}_p\gamma_\mu q_r)(\bar{q}_s\gamma^\mu\ell_t)$
$R_{\ell q}^{(3)}$	$(\bar{\ell}_p\gamma_\mu\tau^I q_r)(\bar{q}_s\gamma^\mu\tau^I\ell_t)$
$(\bar{R}R)(\bar{R}R)$	
$R_{uu}^{(8)}$	$(\bar{u}_p\gamma_\mu T^A u_r)(\bar{u}_s\gamma^\mu T^A u_t)$
$R_{dd}^{(8)}$	$(\bar{d}_p\gamma_\mu T^A d_r)(\bar{d}_s\gamma^\mu T^A d_t)$
R_{eu}	$(\bar{e}_p\gamma_\mu u_r)(\bar{u}_s\gamma^\mu e_t)$
R_{ed}	$(\bar{e}_p\gamma_\mu d_r)(\bar{d}_s\gamma^\mu e_t)$
$R_{ud}^{(1)}$	$(\bar{u}_p\gamma_\mu d_r)(\bar{d}_s\gamma^\mu u_t)$
$R_{ud}^{(8)}$	$(\bar{u}_p\gamma_\mu T^A d_r)(\bar{d}_s\gamma^\mu T^A u_t)$
$(\bar{L}L)(\bar{R}R)$	
$R_{\ell qde}$	$(\bar{\ell}_p\gamma_\mu q_r)(\bar{d}_s\gamma^\mu e_t)$

$(\bar{L}^cR)(\bar{R}L^c)$	
$R_{\ell^c e}$	$(\bar{\ell}^c_p\gamma_\mu e_r)(\bar{e}_s\gamma^\mu\ell^c_t)$
$R_{\ell^c u}$	$(\bar{\ell}^c_p\gamma_\mu u_r)(\bar{u}_s\gamma^\mu\ell^c_t)$
$R_{\ell^c d}$	$(\bar{\ell}^c_p\gamma_\mu d_r)(\bar{d}_s\gamma^\mu\ell^c_t)$
$R_{q^c ed\ell^c}$	$(\bar{q}^c_p\gamma^\mu e_r)(\bar{d}_s\gamma_\mu\ell^c_t)$
$R_{q^c e}$	$(\bar{q}^c_p\gamma_\mu e_r)(\bar{e}_s\gamma^\mu q^c_t)$
$R_{q^c u}$	$(\bar{q}^c_{\alpha p}\gamma_\mu u_{\beta r})(\bar{u}_{\beta s}\gamma^\mu q^c_{\alpha t})$
$R'_{q^c u}$	$(\bar{q}^c_{\alpha p}\gamma_\mu u_{\beta r})(\bar{u}_{\alpha s}\gamma^\mu q^c_{\beta t})$
$R_{q^c d}$	$(\bar{q}^c_{\alpha p}\gamma_\mu d_{\beta r})(\bar{d}_{\beta s}\gamma^\mu q^c_{\alpha t})$
$R'_{q^c d}$	$(\bar{q}^c_{\alpha p}\gamma_\mu d_{\beta r})(\bar{d}_{\alpha s}\gamma^\mu q^c_{\beta t})$
Baryon number violating	
$R_{d^c\ell q^c u}$	$\varepsilon_{\alpha\beta\gamma}\varepsilon_{ij}(\bar{d}^c_{\alpha p}\gamma_\mu\ell_{ir})(\bar{q}^c_{\beta js}\gamma^\mu u_{\gamma t})$
$R_{u^c\ell q^c d}$	$\varepsilon_{\alpha\beta\gamma}\varepsilon_{ij}(\bar{u}^c_{\alpha p}\gamma_\mu\ell_{ir})(\bar{q}^c_{\beta js}\gamma^\mu d_{\gamma t})$
$R_{q^c eu^c q}$	$\varepsilon_{\alpha\beta\gamma}\varepsilon_{ij}(\bar{q}^c_{\alpha ip}\gamma_\mu e_r)(\bar{u}^c_{\beta s}\gamma^\mu q_{\gamma jt})$

Evaluating the evanescent shifts

We have computed the evanescent shift for all the redundant operators

$$\int_x \Delta g_a O^a = \mathcal{P}\left[\overline{\Gamma}(g, \eta) - \overline{\Gamma}(g, 0)\right]$$

Linear in η_i at dim-6

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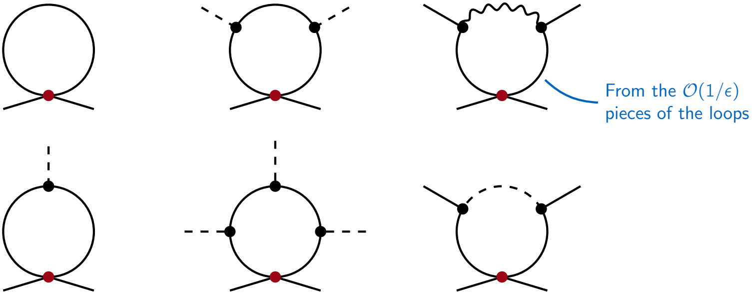
- Functional calculations with a bespoke version of MATCHETE
- Evanescent contributions stem from six covariant* trace topologies:



*Dressed with gauge lines

Matematica interface

Filter: Redundant | SMEFT | All

$R_{\ell e}^{prst}$ $R_{\ell u}^{prst}$ $R_{\ell d}^{prst}$ R_{qe}^{prst} $R_{qu}^{(1)prst}$ $R_{qu}^{(8)prst}$ $R_{qd}^{(1)prst}$ $R_{qd}^{(8)prst}$ $R_{\ell uqe}^{prst}$ $R_{\ell^c\ell}^{prst}$ $R_{q^cq}^{prst}$ $R_{q^cq}^{\prime prst}$ $R_{q^c\ell}^{prst}$ $R_{q^c\ell}^{\prime prst}$ $R_{e^ce}^{prst}$ $R_{u^cu}^{prst}$ $R_{d^cd}^{prst}$

$R_{e^cu}^{prst}$ $R_{e^cd}^{prst}$ $R_{u^cd}^{prst}$ $R_{u^cd}^{\prime prst}$ $R_{u^cdqq^c}^{prst}$ $R_{u^ce\ell q^c}^{prst}$ $R_{q^cqq^c\ell}^{prst}$ $R_{u^cud^ce}^{prst}$ $R_{\ell\ell}^{(3)prst}$ $R_{qq}^{(1,8)prst}$ $R_{qq}^{(3,8)prst}$ $R_{\ell q}^{(1)prst}$ $R_{\ell q}^{(3)prst}$ $R_{uu}^{(8)prst}$ $R_{dd}^{(8)prst}$

R_{eu}^{prst} R_{ed}^{prst} $R_{ud}^{(1)prst}$ $R_{ud}^{(8)prst}$ $R_{\ell qde}^{prst}$ $R_{\ell^ce}^{prst}$ $R_{\ell^cu}^{prst}$ $R_{\ell^cd}^{prst}$ $R_{q^ced\ell^c}^{prst}$ $R_{q^ce}^{prst}$ $R_{q^cu}^{prst}$ $R_{q^cu}^{\prime prst}$ $R_{q^cd}^{prst}$ $R_{q^cd}^{\prime prst}$ $R_{d^c\ell q^cu}^{prst}$ $R_{u^c\ell q^cd}^{prst}$ $R_{q^ceu^cq}^{prst}$

Operator definition:

$$R_{\ell qde}^{prst} = (\bar{\ell}_p \gamma_\mu q_r)(\bar{d}_s \gamma^\mu e_t)$$

Reduces to:

$Q_{\ell edq}^{prst}$, $Q_{quqd}^{(1)prst}$, Q_{dW}^{pr} , Q_{dB}^{pr} , Q_{dH}^{pr} , Q_{yd}^{pr} , Q_{eB}^{pr} , Q_{ed}^{prst} , Q_{eH}^{pr} , Q_{eW}^{pr} , $Q_{\ell d}^{prst}$, $Q_{\ell e}^{prst}$, $Q_{\ell equ}^{(1)prst}$, $Q_{\ell equ}^{(3)prst}$, $Q_{\ell q}^{(1)prst}$, $Q_{\ell q}^{(3)prst}$, $Q_{qd}^{(1)prst}$, $Q_{qd}^{(8)prst}$, Q_{qe}^{prst} , Q_{ye}^{pr}

Reduction Identity:

$$\begin{aligned} R_{\ell qde}^{prst} = & -2Q_{\ell edq}^{ptsr} + \frac{1}{16\pi^2}\Big(\frac{1}{6}\overline{y_e^{pt}}\; y_d^{uv} Q_{qd}^{(1)ursv} + \frac{1}{4} g_Y y_d^{rs} Q_{eB}^{pt} \\ & + \frac{3}{4} g_Y \overline{y_e^{pt}}\; \overline{Q_{dB}^{rs}} + Q_{eH}^{pt}\Big(6\overline{y_d^{uv}}\; y_d^{rv} y_d^{us} - 3\lambda y_d^{rs}\Big) \\ & + Q_{\ell equ}^{(1)ptuv}\Big(\frac{3}{4} y_d^{us} y_u^{rv} + 3 y_d^{rs} y_u^{uv}\Big) + \overline{y_e^{pt}}\; y_d^{uv} Q_{qd}^{(8)ursv} \\ & + \frac{3}{2}\overline{y_e^{uv}}\; y_d^{rs} Q_{\ell e}^{puvt} + 2\overline{y_e^{pu}}\; \overline{y_e^{vt}}\; y_e^{vu} \overline{Q_{dH}^{rs}} - \frac{1}{16} y_d^{us} y_u^{rv} Q_{\ell equ}^{(3)ptuv} \\ & - \frac{1}{4} g_L \overline{y_e^{pt}}\; \overline{Q_{dW}^{rs}} - \frac{1}{4}\overline{y_e^{ut}}\; y_d^{vs} Q_{\ell q}^{(1)puvr} - \frac{1}{4}\overline{y_e^{ut}}\; y_d^{vs} Q_{\ell q}^{(3)puvr} \\ & - \frac{1}{2}\overline{y_e^{ut}}\; y_d^{rv} Q_{\ell d}^{pusv} - \frac{1}{2}\overline{y_e^{pu}}\; y_d^{vs} Q_{qe}^{vrut} - \frac{3}{4} g_L y_d^{rs} Q_{eW}^{pt} \\ & - \overline{y_e^{pt}}\; \overline{y_u^{uv}}\; \overline{Q_{quqd}^{(1)uvrs}} - \lambda \overline{y_e^{pt}}\; \overline{Q_{dH}^{rs}} - \mu^2 \overline{y_e^{pt}}\; \overline{Q_{yd}^{rs}} \\ & - \overline{y_e^{pu}}\; y_d^{rv} Q_{ed}^{utsv} - \overline{y_e^{pt}}\; y_e^{uv} Q_{\ell edq}^{uvsr} - 3\overline{y_d^{uv}}\; y_d^{rs} Q_{\ell edq}^{ptvu} \\ & - 3\mu^2 y_d^{rs} Q_{ye}^{pt}\Big) \end{aligned}$$

› TeX

Outlook

- 1-loop UV-to-(SM)EFT matching is crucial in BSM phenomenology
- Consistent (SM)EFT computations must account for evanescent contribution
- Evanescent shifts for 1-loop BSM-to-SMEFT matching are now available
- We plane to automate handling of evanescent operators in the public **Matchete** package for EFT matching.

https://gitlab.com/matchete/matchete

(See talk by Julie Pagès)