Bright ideas for a Dark Universe

$(g\text{-}2)_\mu$, B-anomalies and DM: A loop model tale

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based on arXiv:2103.09835, 2104.03228 in collaboration with:

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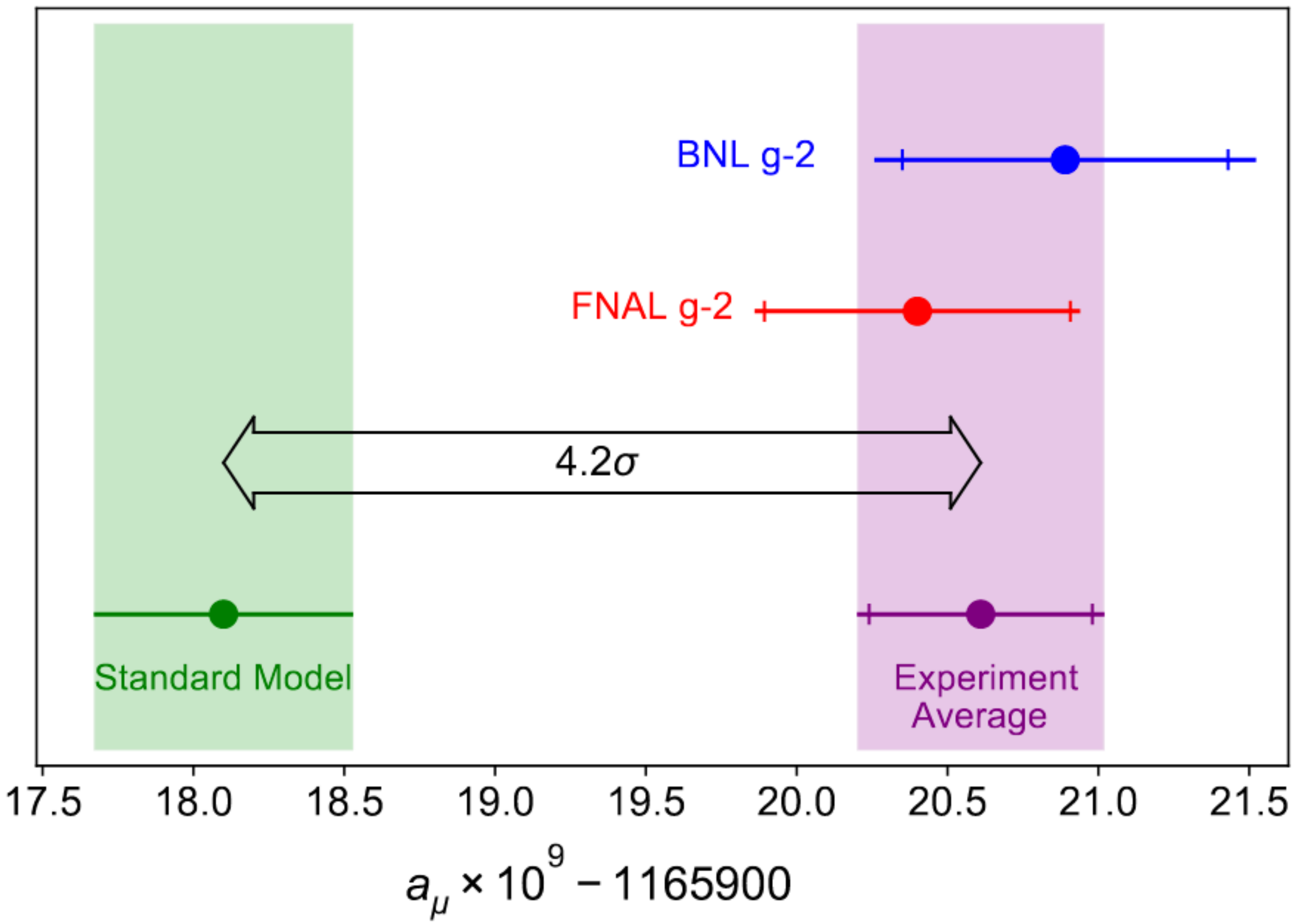
Karlsruher Institut für Technologie

The anomalous muon (g-2)

Striking discrepancy among Theory recommended value and exp. measurements



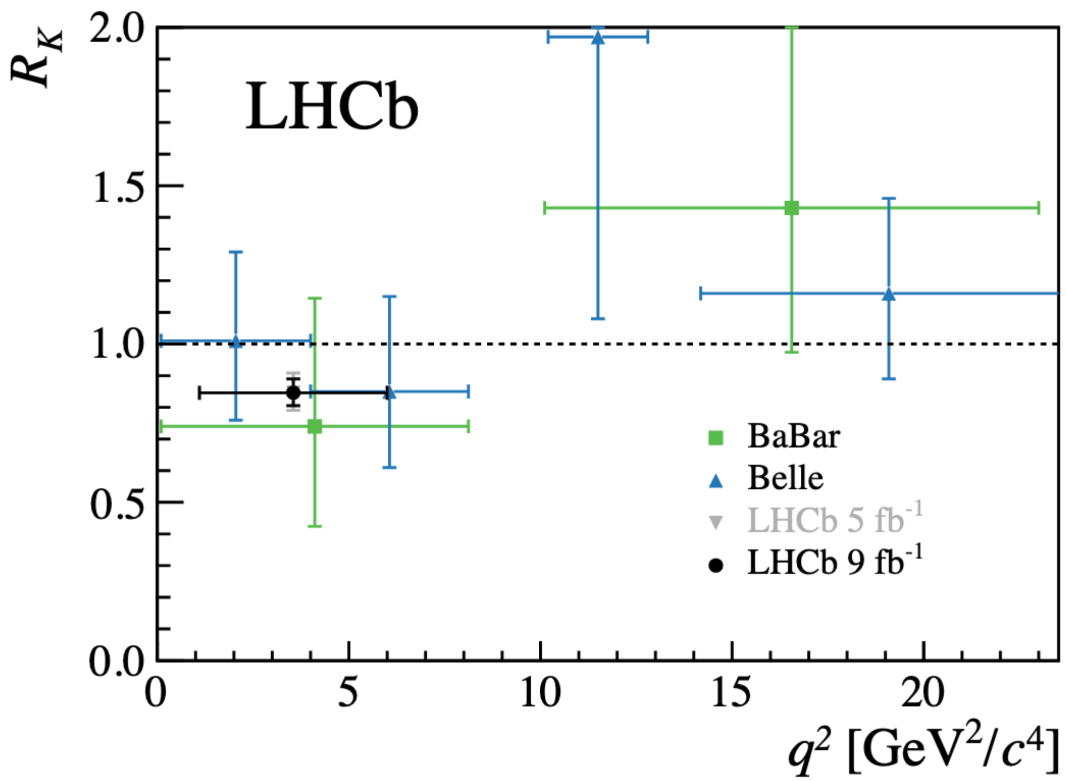
Potentially the single most striking cry for NP observed so far!

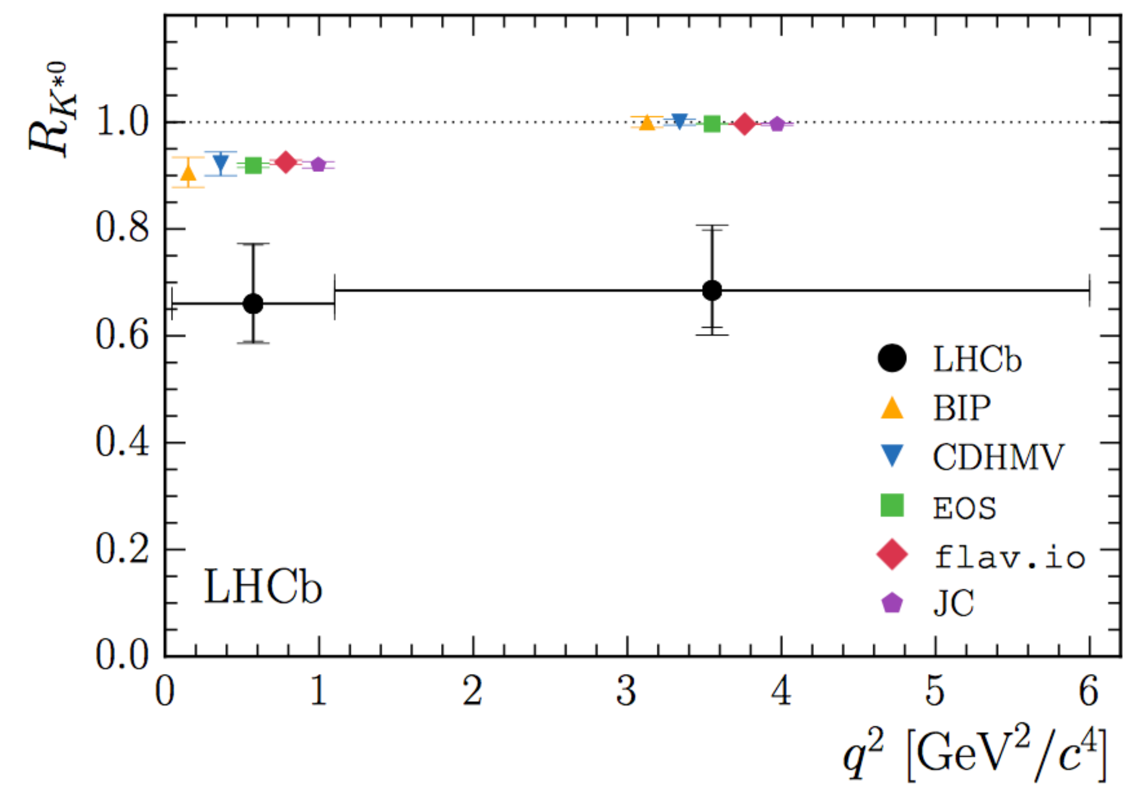
Opportunities with Semi-Leptonic B Decays

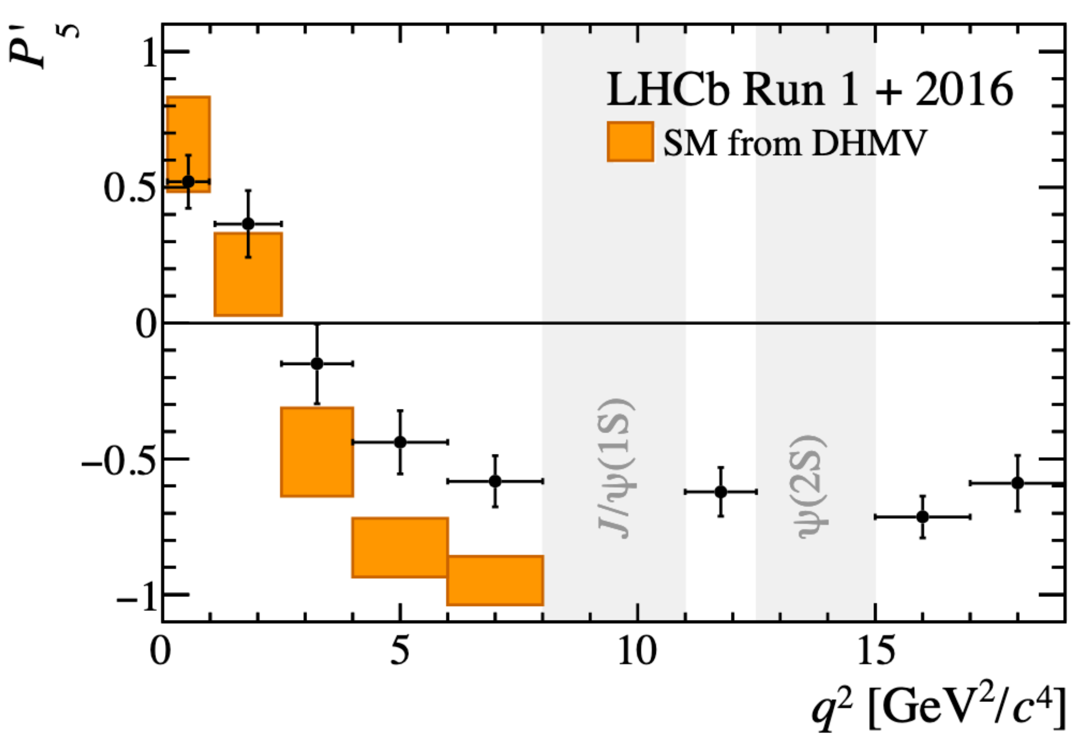
No tree-level flavour changing neutral currents (FCNC) in the SM

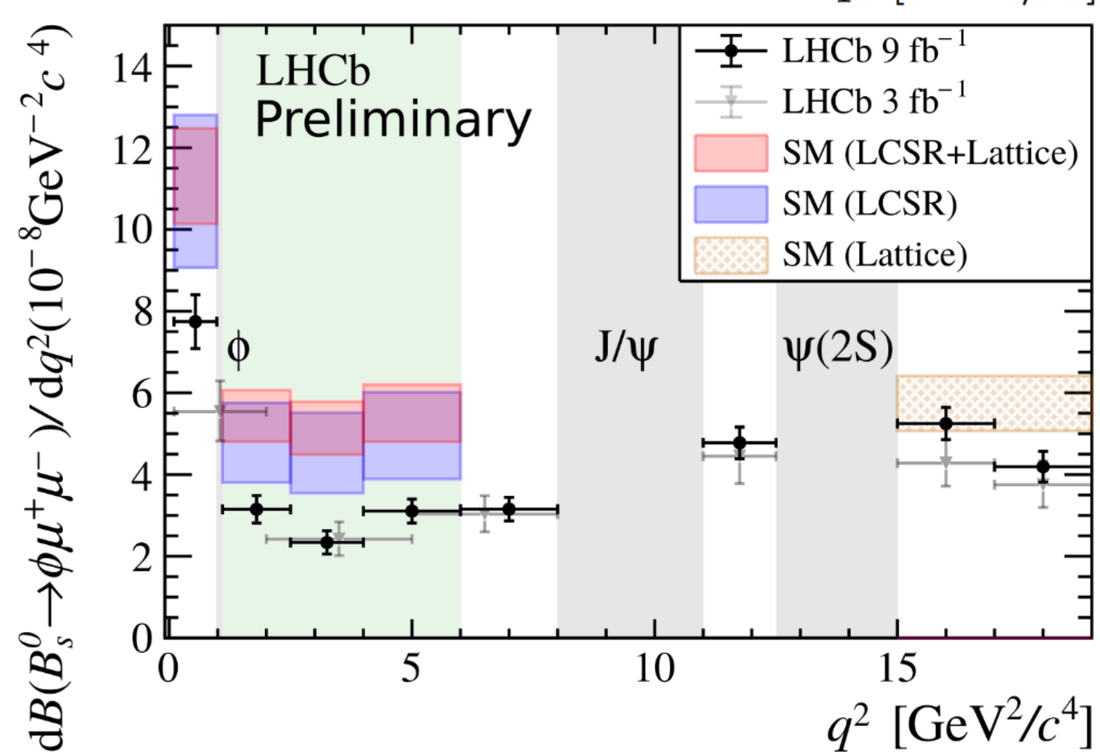
&

Intriguing set of "Anomalies" in data of exclusive B rare Decays









What kind of NP could be cut for the job?

- g-2

NP coupling to Muons; couplings with both Muon chirality is preferred, inducing also coupling to the SM Higgs to exploit chiral enhancement

$\Longrightarrow$ Leptoquark, or fermion(s) and scalar(s) (allowing for chirality flip)

- $b \to s\mu\mu$

NP coupling to Muons;

$\Longrightarrow$ Leptoquark and/or Zprime, or 2 fermions (1 fermion) and 1 scalar (2 scalars) with the single particle acting as mediator between the sectors

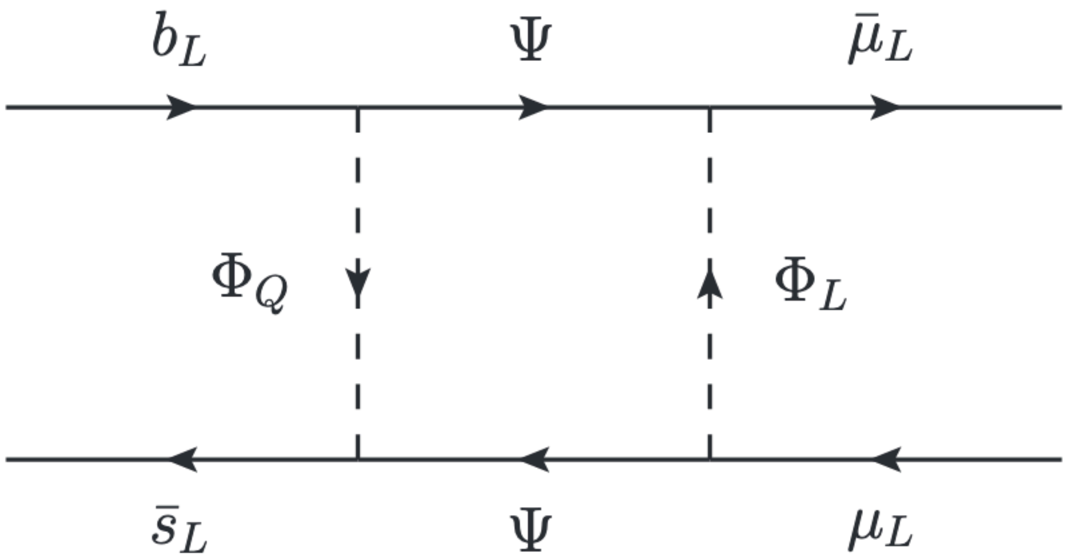
- DM

Stable candidate, neutral and colour singlet; possibly connected to the SM by means of a Dark Sector

$\Longrightarrow$ Axions, ALPs, fermions, scalars…

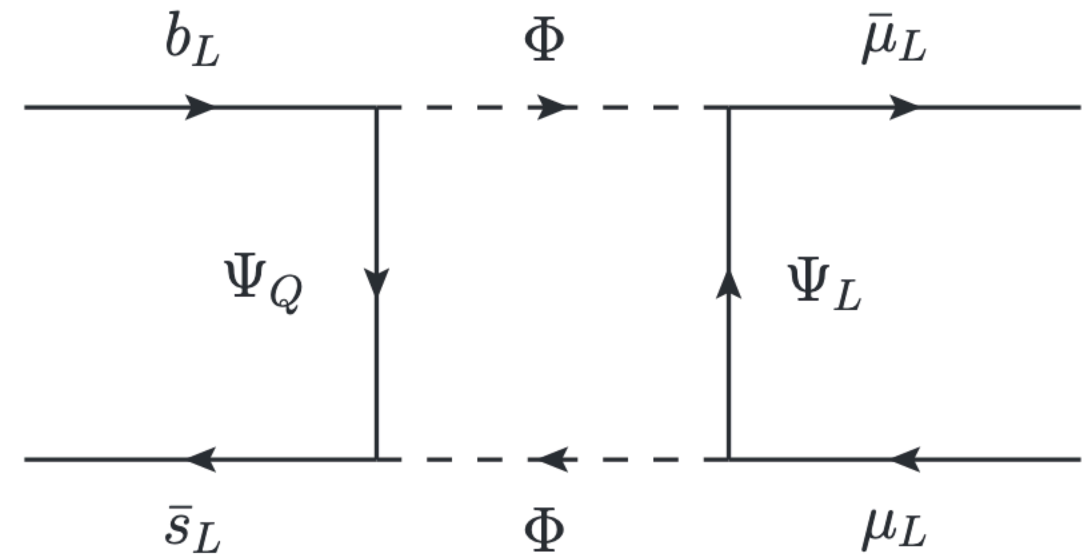
Systematic Studies of All Minimal Loop Models - I

We start by considering B anomalies and DM, so we need 3 fields



$Class\ \mathcal{F}$ – Fermion mediator

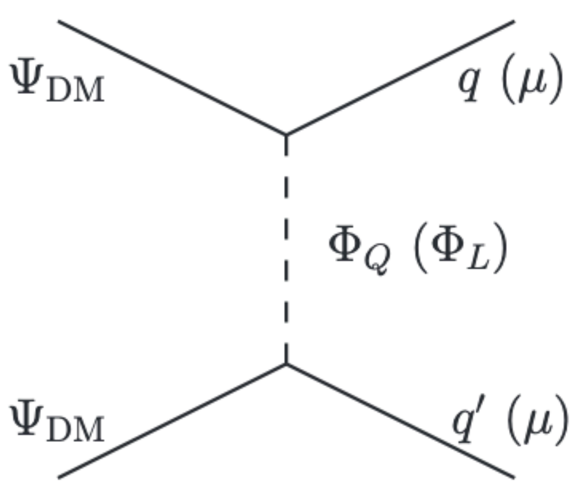
$$\mathcal{L}_{\mathcal{F}} \supset \Gamma_i^Q \, \bar{Q}_i \, P_R \Psi \, \Phi_Q + \Gamma_i^L \, \bar{L}_i \, P_R \Psi \, \Phi_L + \text{h.c.}$$

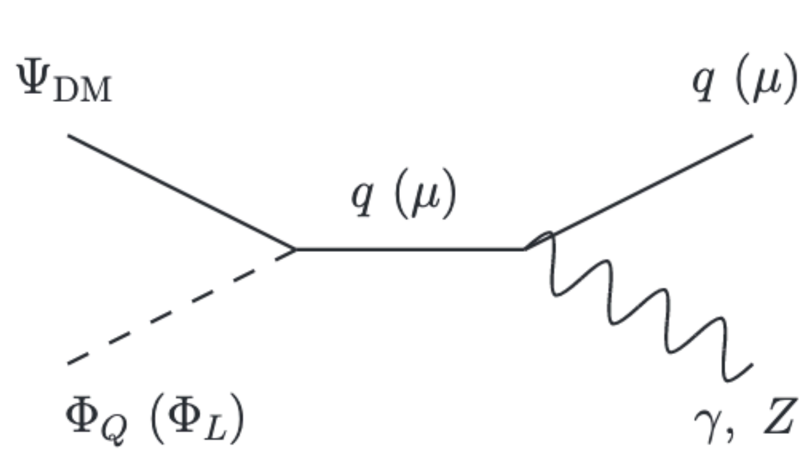


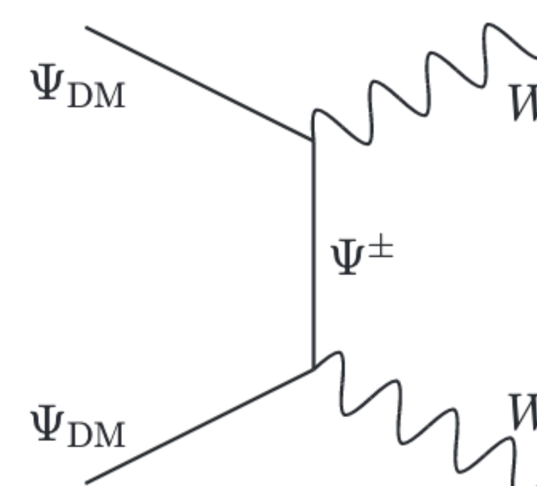
$Class\ \mathcal{S}$ – Scalar mediator

$$\mathcal{L}_{\mathcal{S}} \supset \Gamma_i^Q \, \bar{Q}_i \, P_R \Psi_Q \, \Phi + \Gamma_i^L \, \bar{L}_i \, P_R \Psi_L \, \Phi + \text{h.c.}$$

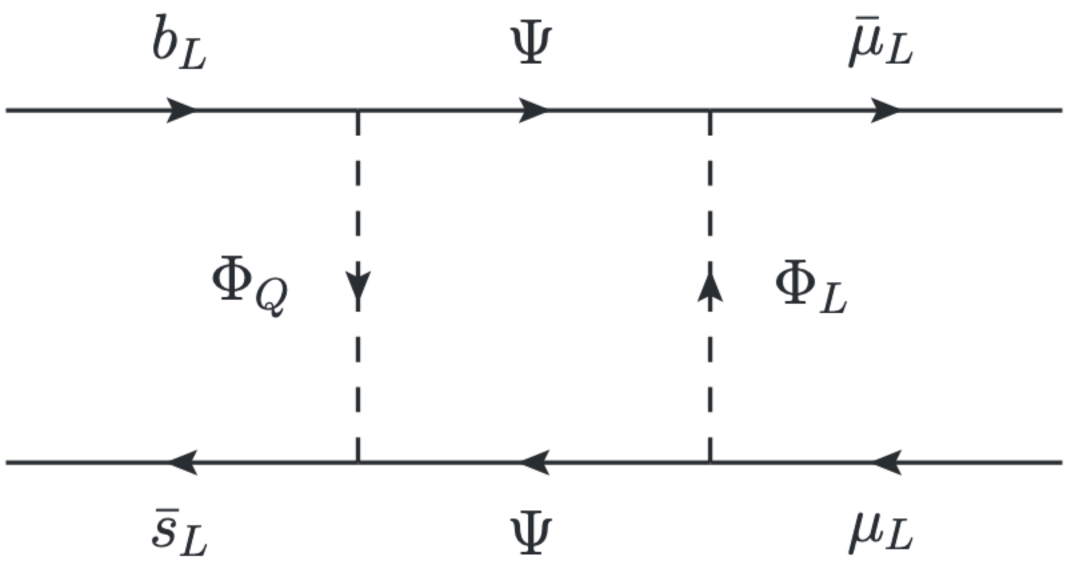
We want a viable DM candidate, which has to be stable and must not be over-abundant (ideally reproducing the relic density)



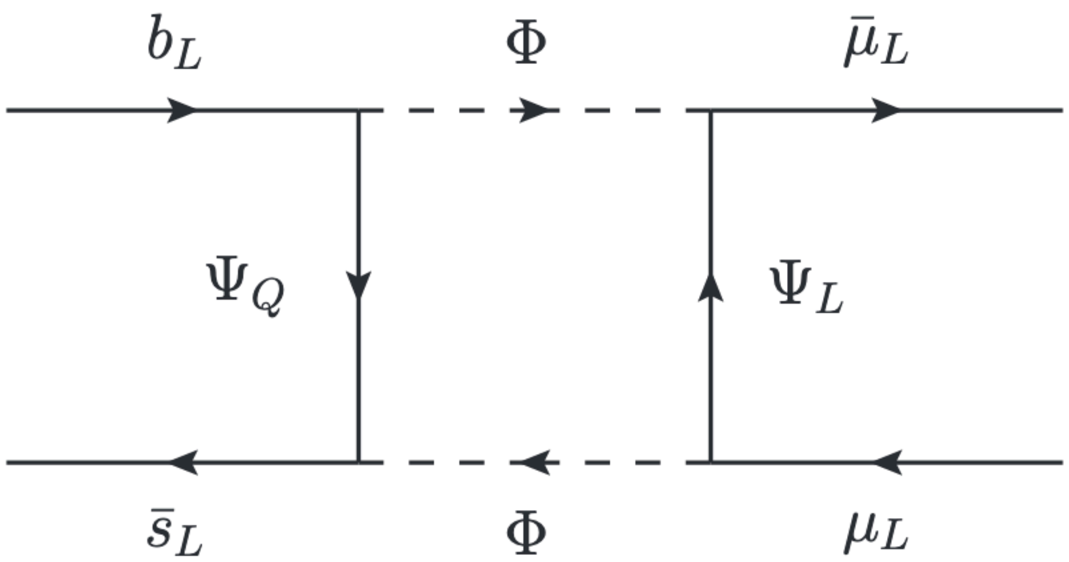




Allowed representations



$Class\ \mathcal{F}$ – Fermion mediator



$Class\ \mathcal{S}$ – Scalar mediator

$SU(3)_c$	Φ_Q, Ψ_Q	Φ_L, Ψ_L	Ψ, Φ
A	$\mathbf{3}$	$\mathbf{1}$	$\mathbf{1}$
B	$\mathbf{1}$	$\bar{\mathbf{3}}$	$\mathbf{3}$

$SU(2)_L$	Φ_Q, Ψ_Q	Φ_L, Ψ_L	Ψ, Φ
I	$\mathbf{2}$	$\mathbf{2}$	$\mathbf{1}$
II	$\mathbf{1}$	$\mathbf{1}$	$\mathbf{2}$
III	$\mathbf{3}$	$\mathbf{3}$	$\mathbf{2}$
IV	$\mathbf{2}$	$\mathbf{2}$	$\mathbf{3}$
V	$\mathbf{3}$	$\mathbf{1}$	$\mathbf{2}$
VI	$\mathbf{1}$	$\mathbf{3}$	$\mathbf{2}$

$U(1)_Y$	Φ_Q, Ψ_Q	Φ_L, Ψ_L	Ψ, Φ
	$1/6 - X$	$-1/2 - X$	X

- X chosen so that there is a neutral state (DM candidate)
- Fermionic DM only allowed for SU(2) singlet or triplet (doublet would require the presence of a additional Majorana fermions)
- Scalar DM allowed for any SU(2) rep. (doublet allowed by suitable mass splitting between CP-even and CP-odd, i.e. Inert Doublet)

Allowed representations

Label	Φ_Q	Φ_L	Ψ
$\mathcal{F}_{\mathrm{IA};-1}$	$(\mathbf{3},\mathbf{2},7/6)$	$(\mathbf{1},\mathbf{2},1/2)^\star$	$(\mathbf{1},\mathbf{1},-1)$
$\mathcal{F}_{\mathrm{IA};0}$	$(\mathbf{3},\mathbf{2},1/6)$	$(\mathbf{1},\mathbf{2},-1/2)^\star$	$(\mathbf{1},\mathbf{1},0)^\star$
$\mathcal{F}_{\mathrm{IB};-1/3}$	$(\mathbf{1},\mathbf{2},1/2)^\star$	$(\bar{\mathbf{3}},\mathbf{2},-1/6)$	$(\mathbf{3},\mathbf{1},-1/3)$
$\mathcal{F}_{\mathrm{IB};2/3}$	$(\mathbf{1},\mathbf{2},-1/2)^\star$	$(\bar{\mathbf{3}},\mathbf{2},-7/6)$	$(\mathbf{3},\mathbf{1},2/3)$
$\mathcal{F}_{\mathrm{IIA}}$	$(\mathbf{3},\mathbf{1},2/3)$	$(\mathbf{1},\mathbf{1},0)^\star$	$(\mathbf{1},\mathbf{2},-1/2)$
$\mathcal{F}_{\mathrm{IIB}}$	$(\mathbf{1},\mathbf{1},0)^\star$	$(\bar{\mathbf{3}},\mathbf{1},-2/3)$	$(\mathbf{3},\mathbf{2},1/6)$
$\mathcal{F}_{\mathrm{IIIA};-3/2}$	$(\mathbf{3},\mathbf{3},5/3)$	$(\mathbf{1},\mathbf{3},1)^\star$	$(\mathbf{1},\mathbf{2},-3/2)$
$\mathcal{F}_{\mathrm{IIIA};-1/2}$	$(\mathbf{3},\mathbf{3},2/3)$	$(\mathbf{1},\mathbf{3},0)^\star$	$(\mathbf{1},\mathbf{2},-1/2)$
$\mathcal{F}_{\mathrm{IIIA};1/2}$	$(\mathbf{3},\mathbf{3},-1/3)$	$(\mathbf{1},\mathbf{3},-1)^\star$	$(\mathbf{1},\mathbf{2},1/2)$
$\mathcal{F}_{\mathrm{IIIB};-5/6}$	$(\mathbf{1},\mathbf{3},1)^\star$	$(\bar{\mathbf{3}},\mathbf{3},1/3)$	$(\mathbf{3},\mathbf{2},-5/6)$
$\mathcal{F}_{\mathrm{IIIB};1/6}$	$(\mathbf{1},\mathbf{3},0)^\star$	$(\bar{\mathbf{3}},\mathbf{3},-2/3)$	$(\mathbf{3},\mathbf{2},1/6)$
$\mathcal{F}_{\mathrm{IIIB};7/6}$	$(\mathbf{1},\mathbf{3},-1)^\star$	$(\bar{\mathbf{3}},\mathbf{3},-5/3)$	$(\mathbf{3},\mathbf{2},7/6)$
$\mathcal{F}_{\mathrm{IVA};-1}$	$(\mathbf{3},\mathbf{2},7/6)$	$(\mathbf{1},\mathbf{2},1/2)^\star$	$(\mathbf{1},\mathbf{3},-1)$
$\mathcal{F}_{\mathrm{IVA};0}$	$(\mathbf{3},\mathbf{2},1/6)$	$(\mathbf{1},\mathbf{2},-1/2)^\star$	$(\mathbf{1},\mathbf{3},0)^\star$
$\mathcal{F}_{\mathrm{IVB};-1/3}$	$(\mathbf{1},\mathbf{2},1/2)^\star$	$(\bar{\mathbf{3}},\mathbf{2},-1/6)$	$(\mathbf{3},\mathbf{3},-1/3)$
$\mathcal{F}_{\mathrm{IVB};2/3}$	$(\mathbf{1},\mathbf{2},-1/2)^\star$	$(\bar{\mathbf{3}},\mathbf{2},-7/6)$	$(\mathbf{3},\mathbf{3},2/3)$
$\mathcal{F}_{\mathrm{VA}}$	$(\mathbf{3},\mathbf{3},2/3)$	$(\mathbf{1},\mathbf{1},0)^\star$	$(\mathbf{1},\mathbf{2},-1/2)$
$\mathcal{F}_{\mathrm{VB};-5/6}$	$(\mathbf{1},\mathbf{3},1)^\star$	$(\bar{\mathbf{3}},\mathbf{1},1/3)$	$(\mathbf{3},\mathbf{2},-5/6)$
$\mathcal{F}_{\mathrm{VB};1/6}$	$(\mathbf{1},\mathbf{3},0)^\star$	$(\bar{\mathbf{3}},\mathbf{1},-2/3)$	$(\mathbf{3},\mathbf{2},1/6)$
$\mathcal{F}_{\mathrm{VB};7/6}$	$(\mathbf{1},\mathbf{3},-1)^\star$	$(\bar{\mathbf{3}},\mathbf{1},-5/3)$	$(\mathbf{3},\mathbf{2},7/6)$
$\mathcal{F}_{\mathrm{VIA};-3/2}$	$(\mathbf{3},\mathbf{1},5/3)$	$(\mathbf{1},\mathbf{3},1)^\star$	$(\mathbf{1},\mathbf{2},-3/2)$
$\mathcal{F}_{\mathrm{VIA};-1/2}$	$(\mathbf{3},\mathbf{1},2/3)$	$(\mathbf{1},\mathbf{3},0)^\star$	$(\mathbf{1},\mathbf{2},-1/2)$
$\mathcal{F}_{\mathrm{VIA};1/2}$	$(\mathbf{3},\mathbf{1},-1/3)$	$(\mathbf{1},\mathbf{3},-1)^\star$	$(\mathbf{1},\mathbf{2},1/2)$
$\mathcal{F}_{\mathrm{VIB}}$	$(\mathbf{1},\mathbf{1},0)^\star$	$(\bar{\mathbf{3}},\mathbf{3},-2/3)$	$(\mathbf{3},\mathbf{2},1/6)$

Label	Ψ_Q	Ψ_L	Φ
$\mathcal{S}_{\mathrm{IA}}$	$(\mathbf{3},\mathbf{2},1/6)$	$(\mathbf{1},\mathbf{2},-1/2)$	$(\mathbf{1},\mathbf{1},0)^\star$
$\mathcal{S}_{\mathrm{IIA};-1/2}$	$(\mathbf{3},\mathbf{1},2/3)$	$(\mathbf{1},\mathbf{1},0)^\star$	$(\mathbf{1},\mathbf{2},-1/2)^\star$
$\mathcal{S}_{\mathrm{IIA};1/2}$	$(\mathbf{3},\mathbf{1},-1/3)$	$(\mathbf{1},\mathbf{1},-1)$	$(\mathbf{1},\mathbf{2},1/2)^\star$
$\mathcal{S}_{\mathrm{IIB}}$	$(\mathbf{1},\mathbf{1},0)^\star$	$(\bar{\mathbf{3}},\mathbf{1},-2/3)$	$(\mathbf{3},\mathbf{2},1/6)$
$\mathcal{S}_{\mathrm{IIIA};-1/2}$	$(\mathbf{3},\mathbf{3},2/3)$	$(\mathbf{1},\mathbf{3},0)^\star$	$(\mathbf{1},\mathbf{2},-1/2)^\star$
$\mathcal{S}_{\mathrm{IIIA};1/2}$	$(\mathbf{3},\mathbf{3},-1/3)$	$(\mathbf{1},\mathbf{3},-1)$	$(\mathbf{1},\mathbf{2},1/2)^\star$
$\mathcal{S}_{\mathrm{IIIB}}$	$(\mathbf{1},\mathbf{3},0)^\star$	$(\bar{\mathbf{3}},\mathbf{3},-2/3)$	$(\mathbf{3},\mathbf{2},1/6)$
$\mathcal{S}_{\mathrm{IVA};-1}$	$(\mathbf{3},\mathbf{2},7/6)$	$(\mathbf{1},\mathbf{2},1/2)$	$(\mathbf{1},\mathbf{3},-1)^\star$
$\mathcal{S}_{\mathrm{IVA};0}$	$(\mathbf{3},\mathbf{2},1/6)$	$(\mathbf{1},\mathbf{2},-1/2)$	$(\mathbf{1},\mathbf{3},0)^\star$
$\mathcal{S}_{\mathrm{IVA};1}$	$(\mathbf{3},\mathbf{2},-5/6)$	$(\mathbf{1},\mathbf{2},-3/2)$	$(\mathbf{1},\mathbf{3},1)^\star$
$\mathcal{S}_{\mathrm{VA};-1/2}$	$(\mathbf{3},\mathbf{3},2/3)$	$(\mathbf{1},\mathbf{1},0)^\star$	$(\mathbf{1},\mathbf{2},-1/2)^\star$
$\mathcal{S}_{\mathrm{VA};1/2}$	$(\mathbf{3},\mathbf{3},-1/3)$	$(\mathbf{1},\mathbf{1},-1)$	$(\mathbf{1},\mathbf{2},1/2)^\star$
$\mathcal{S}_{\mathrm{VB}}$	$(\mathbf{1},\mathbf{3},0)^\star$	$(\bar{\mathbf{3}},\mathbf{1},-2/3)$	$(\mathbf{3},\mathbf{2},1/6)$
$\mathcal{S}_{\mathrm{VIA};-1/2}$	$(\mathbf{3},\mathbf{1},2/3)$	$(\mathbf{1},\mathbf{3},0)^\star$	$(\mathbf{1},\mathbf{2},-1/2)^\star$
$\mathcal{S}_{\mathrm{VIA};1/2}$	$(\mathbf{3},\mathbf{1},-1/3)$	$(\mathbf{1},\mathbf{3},-1)$	$(\mathbf{1},\mathbf{2},1/2)^\star$
$\mathcal{S}_{\mathrm{VIB}}$	$(\mathbf{1},\mathbf{1},0)^\star$	$(\bar{\mathbf{3}},\mathbf{3},-2/3)$	$(\mathbf{3},\mathbf{2},1/6)$

DM multiplets marked by *, highlighted models studied in detail in the paper

Flavour bounds

Not only B-anomalies, but also B_s-$B_s$bar mixing!

$$\left(\delta C^9_\mu\right)_\mathcal{F} = -\left(\delta C^{10}_\mu\right)_\mathcal{F} = \frac{\sqrt{2}}{4G_F V_{tb}V^*_{ts}} \frac{\Gamma_Q|\Gamma^L_\mu|^2}{32\pi\alpha_{\rm EM}M^2_\Psi}\left(\eta F\left(x_Q,x_L\right) + 2\chi^M\eta^M G\left(x_Q,x_L\right)\right),$$

$$\left(\delta C^{B\bar{B}}\right)_\mathcal{F} = \frac{\Gamma^2_Q}{128\pi^2 M^2_\Psi}\left(\eta_{BB} F\left(x_Q,x_L\right) + 2\chi^M\eta^M G\left(x_Q,x_L\right)\right),$$

$$\left(\delta C^9_\mu\right)_\mathcal{S} = -\left(\delta C^{10}_\mu\right)_\mathcal{S} = -\frac{\sqrt{2}}{4G_F V_{tb}V^*_{ts}} \frac{\Gamma_Q|\Gamma^L_\mu|^2}{32\pi\alpha_{\rm EM}M^2_\Phi}\left(\eta - \chi^M\eta^M\right) F\left(y_Q,y_L\right),$$

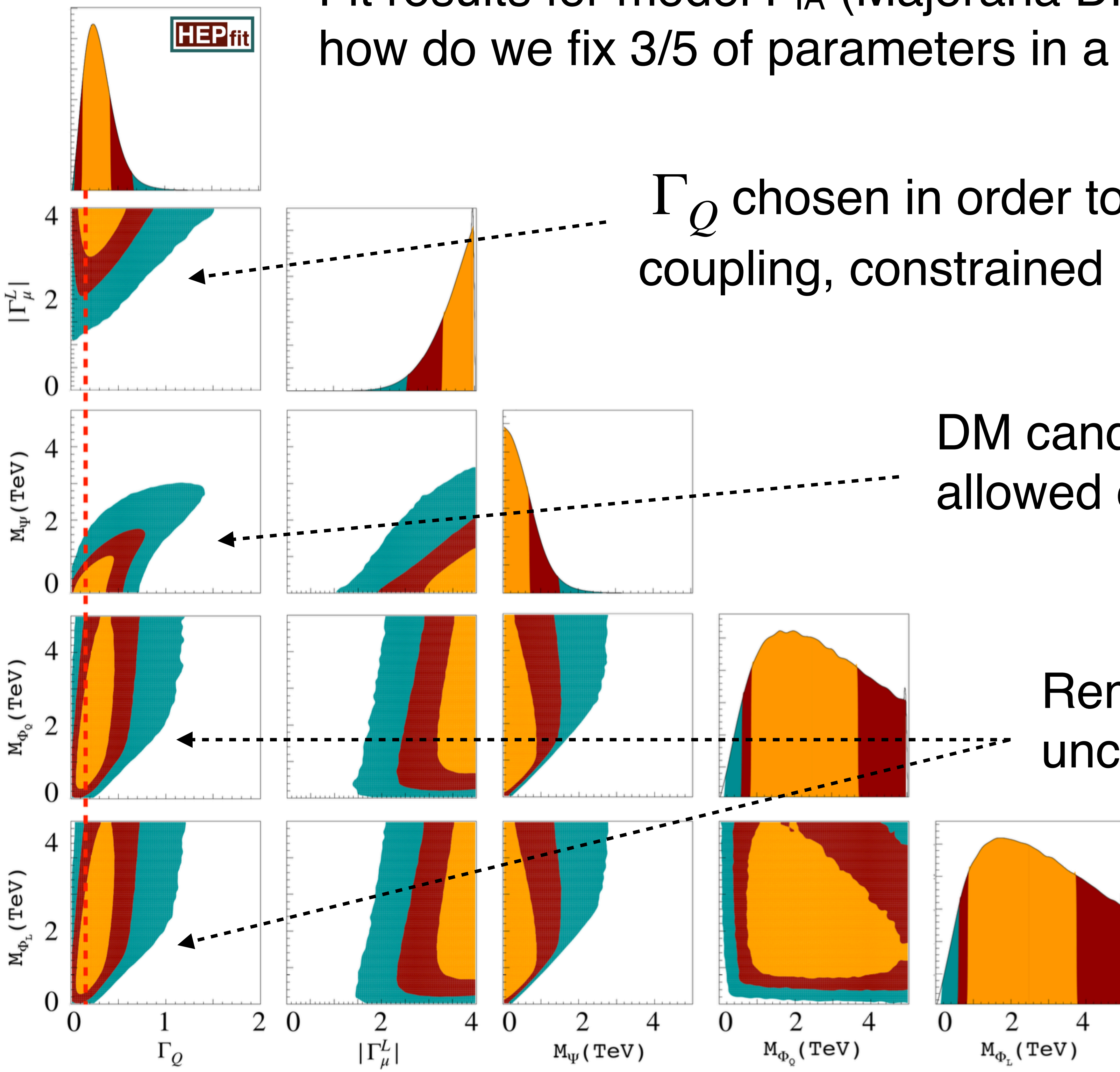
$$\left(\delta C^{B\bar{B}}\right)_\mathcal{S} = \frac{\Gamma^2_Q}{128\pi^2 M^2_\Phi}\left(\eta_{BB} - \chi^M\eta^M\right) F\left(y_Q,y_L\right),$$

We start by making a combined fit to Flavour anomalies and B_s-$B_s$bar mixing, in order to extract allowed ranges for 3 masses and 2 couplings

- We require that the DM candidate has to be the lightest NP state
- We allow the remaining masses to be as heavy as 5 TeV
- We allow the lepton coupling in the range [0, 4], while for the quark coupling [0, 2] in models of class F and [-2, 0] in models of class S, in order to reproduce the desired sign in C9 (no effect on B_s-$B_s$bar mixing)

Flavour bounds

Fit results for model F_{IA} (Majorana DM) to extract benchmarks: how do we fix 3/5 of parameters in a 2D plot?



Γ_Q chosen in order to minimise the lepton coupling, constrained by B_s-$B_s$bar mixing

DM candidate mass allowed only up to ~ 1 TeV

Remaining masses largely unconstrained at the 2σ level

Main LHC constraints

A pair of heavy NP candidates can be produced ad LHC by QCD / EW Drell-Yann mediated processes, sequently decaying in jets/leptons + DM

- DM coupling to both heavy states (e.g. scalar DM in class S)

$$pp \to \Psi_Q \Psi_Q \to q q' + \not{E}_T$$

$$pp \to \Psi_L \Psi_L \to \mu^+ \mu^- + \not{E}_T$$

- DM coupling to only 1 heavy state (e.g. fermion DM in class S)

$$pp \to \Phi\Phi \to q q' + \not{E}_T$$

$$pp \to \Psi_L \Psi_L \to \mu^+ \mu^- + \Phi\Phi \to \mu^+ \mu^- + q q' + \not{E}_T$$

or

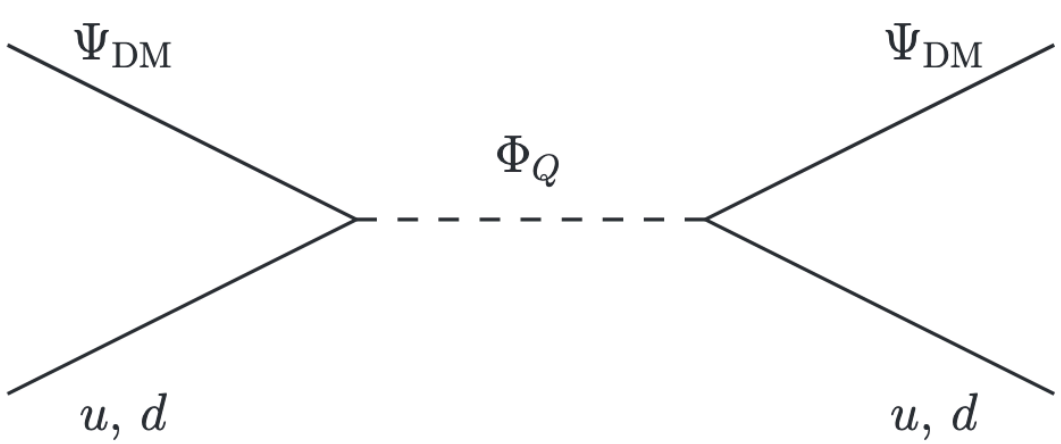
$$pp \to \Phi\Phi \to \mu^+ \mu^- + \not{E}_T$$

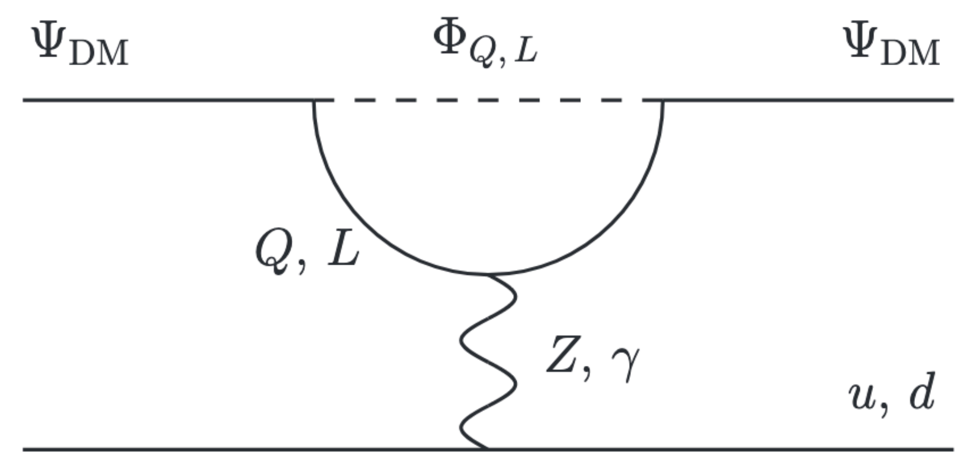
$$pp \to \Psi_Q \Psi_Q \to q q' + \Phi\Phi \to q q' + \mu^+ \mu^- + \not{E}_T$$

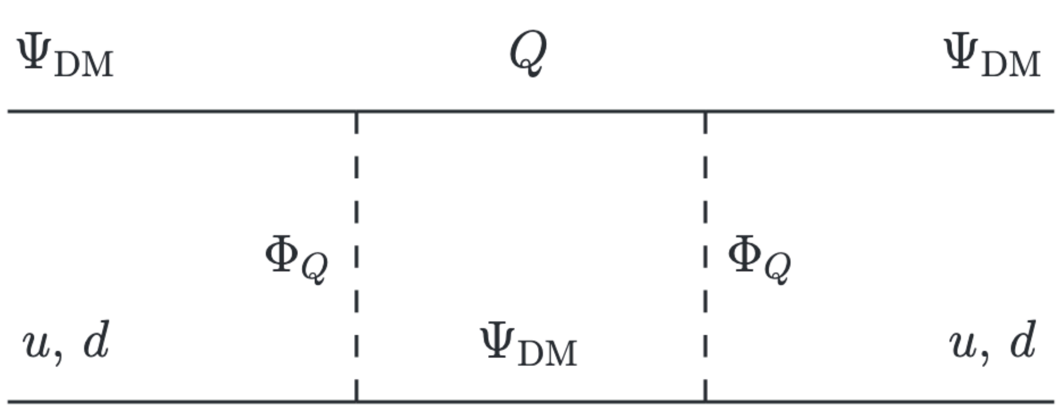
We will recast LHC SUSY searches of jets and/or leptons + ME

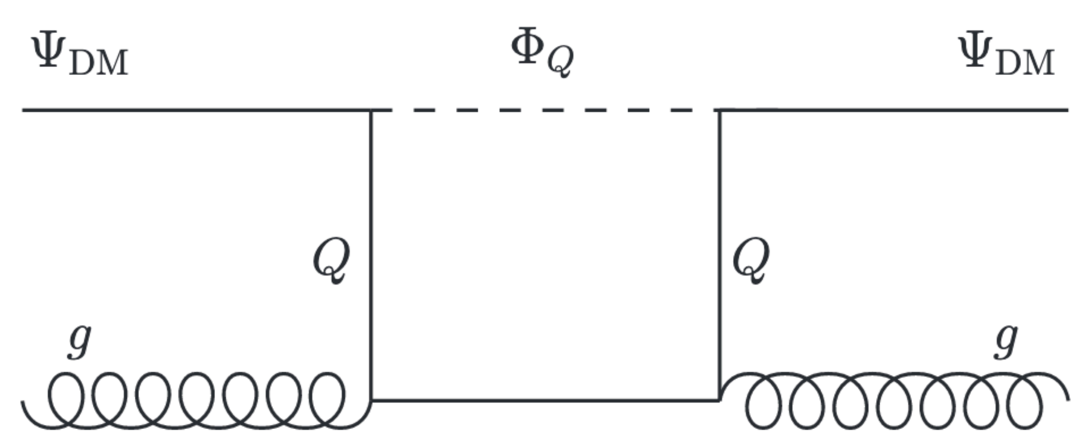
Main DM constraints

- DM should reproduced the measured relic density $\Omega_{\rm DM}h^2 = 0.1199 \pm 0.0022$ (or at most be under-abundant)
- DM should evade DD constraints, where non-relativistic DM scatters with nucleons in an atom. Principal constrains come from Xenon1T experiment



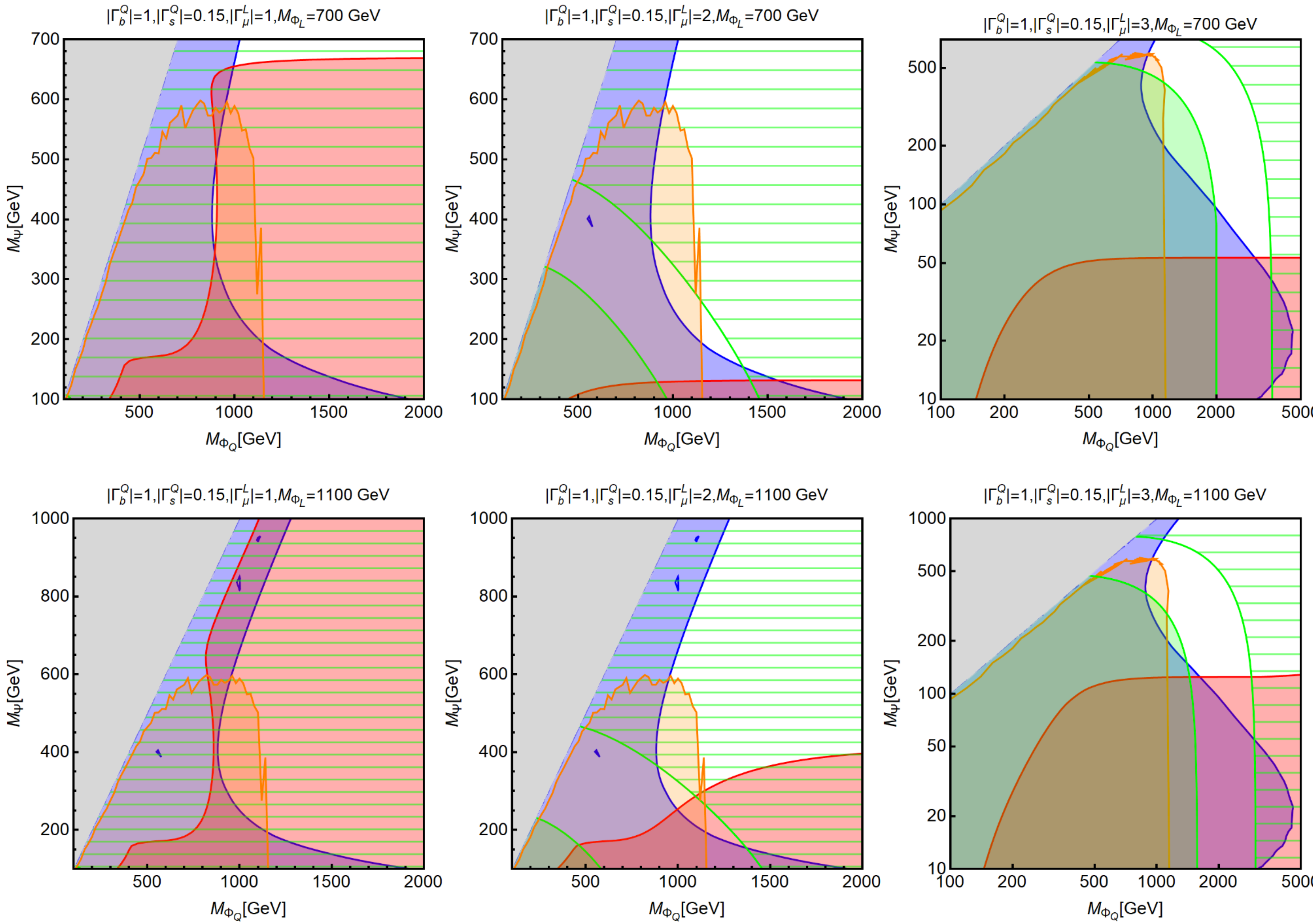






F_{IA} with Majorana DM

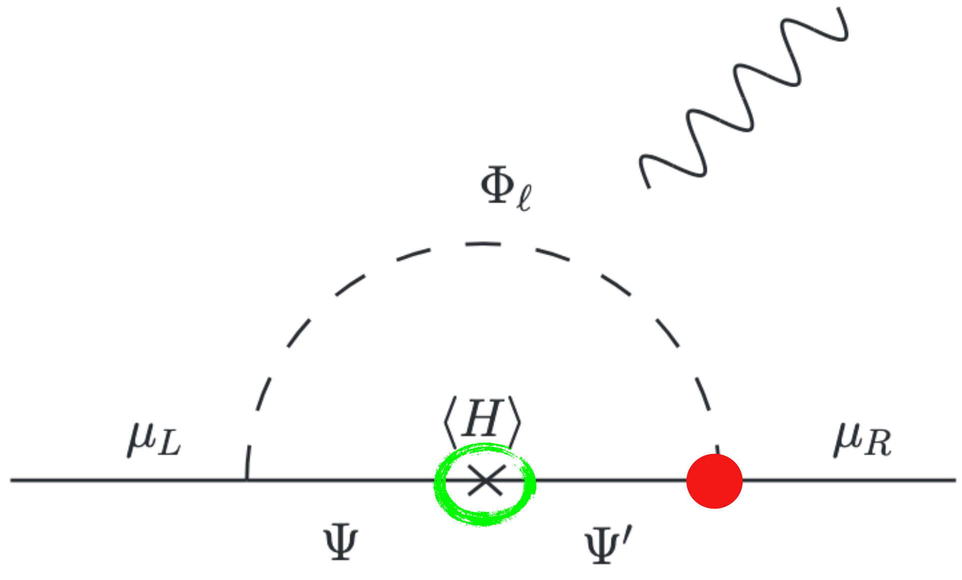
Φ_Q	Φ_L	Ψ
$(\mathbf{3},\mathbf{2},1/6)$	$(\mathbf{1},\mathbf{2},-1/2)$	$(\mathbf{1},\mathbf{1},0)^\star$

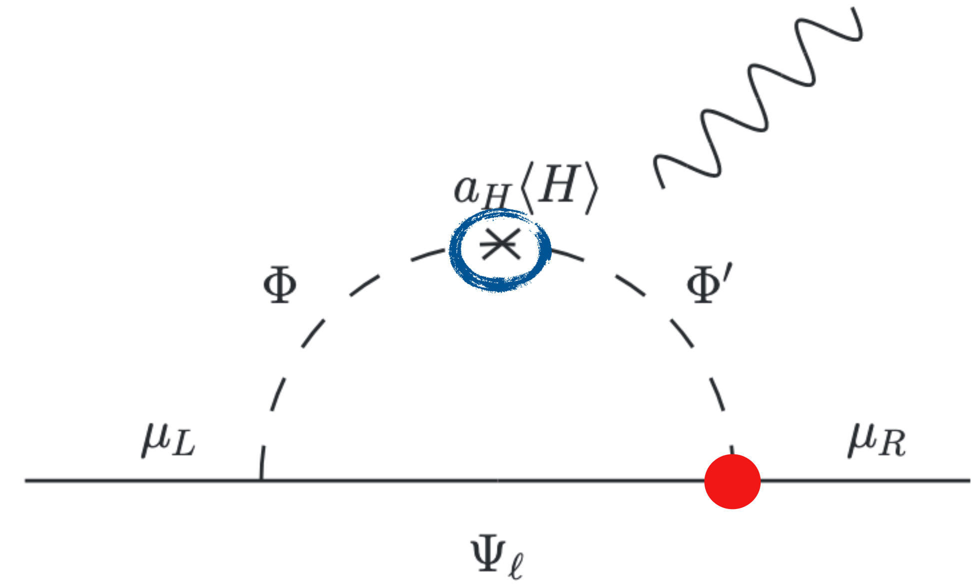


A viable model capable to address B-anomalies while evading LHC bounds and DM Direct Detection, providing also the observed relic density! Allowed only with Majorana, since Dirac interactions with Z/γ induces strong constraints from DD

Systematic Studies of All Minimal Loop Models - II

We're adding also the muon (g-2), so we allow also muon RH couplings (only 4 fields)





- Fermion flavour mediator

$$\mathcal{L}_{\mathcal{F}}^{\Phi_\ell \Phi'_\ell} \supset \Gamma_i^Q \, \bar{Q}_i \, P_R \Psi \, \Phi_q + \Gamma_i^L \, \bar{L}_i \, P_R \Psi \, \Phi_\ell + \Gamma_i^E \, \bar{E}_i \, P_L \Psi \, \Phi'_\ell + a_H \Phi_\ell^\dagger \Phi'_\ell \, H + \text{h.c.}$$

$$\mathcal{L}_{\mathcal{F}}^{\Psi \Psi'} \supset \Gamma_i^Q \, \bar{Q}_i \, P_R \Psi \, \Phi_q + \Gamma_i^L \, \bar{L}_i \, P_R \Psi \, \Phi_\ell + \Gamma_i^E \, \bar{E}_i \, P_L \Psi' \, \Phi_\ell + \lambda_{HL} \bar{\Psi} \, P_L \Psi' \, H + \lambda_{HR} \bar{\Psi} P_R \Psi' H + \text{h.c.}$$

- Scalar flavour mediator

$$\mathcal{L}_{\mathcal{S}}^{\Phi \Phi'} \supset \Gamma_i^Q \, \bar{Q}_i \, P_R \Psi_q \, \Phi + \Gamma_i^L \, \bar{L}_i \, P_R \Psi_\ell \, \Phi + \Gamma_i^E \, \bar{E}_i \, P_L \Psi_\ell \, \Phi' + a_H \Phi^\dagger \Phi' \, H + \text{h.c.}$$

$$\mathcal{L}_{\mathcal{S}}^{\Psi_\ell \Psi'_\ell} \supset \Gamma_i^Q \, \bar{Q}_i \, P_R \Psi_q \, \Phi + \Gamma_i^L \, \bar{L}_i \, P_R \Psi_\ell \, \Phi + \Gamma_i^E \, \bar{E}_i \, P_L \Psi'_\ell \, \Phi + \lambda_{H1} \bar{\Psi}_\ell \, P_R \Psi'_\ell \, H + \lambda_{H2} \bar{\Psi}_\ell \, P_L \Psi'_\ell \, H + \text{h.c.}$$

Allowed representations

We start from the models that we know fit B-anomalies and DM, and add a fourth field inducing RH muon couplings

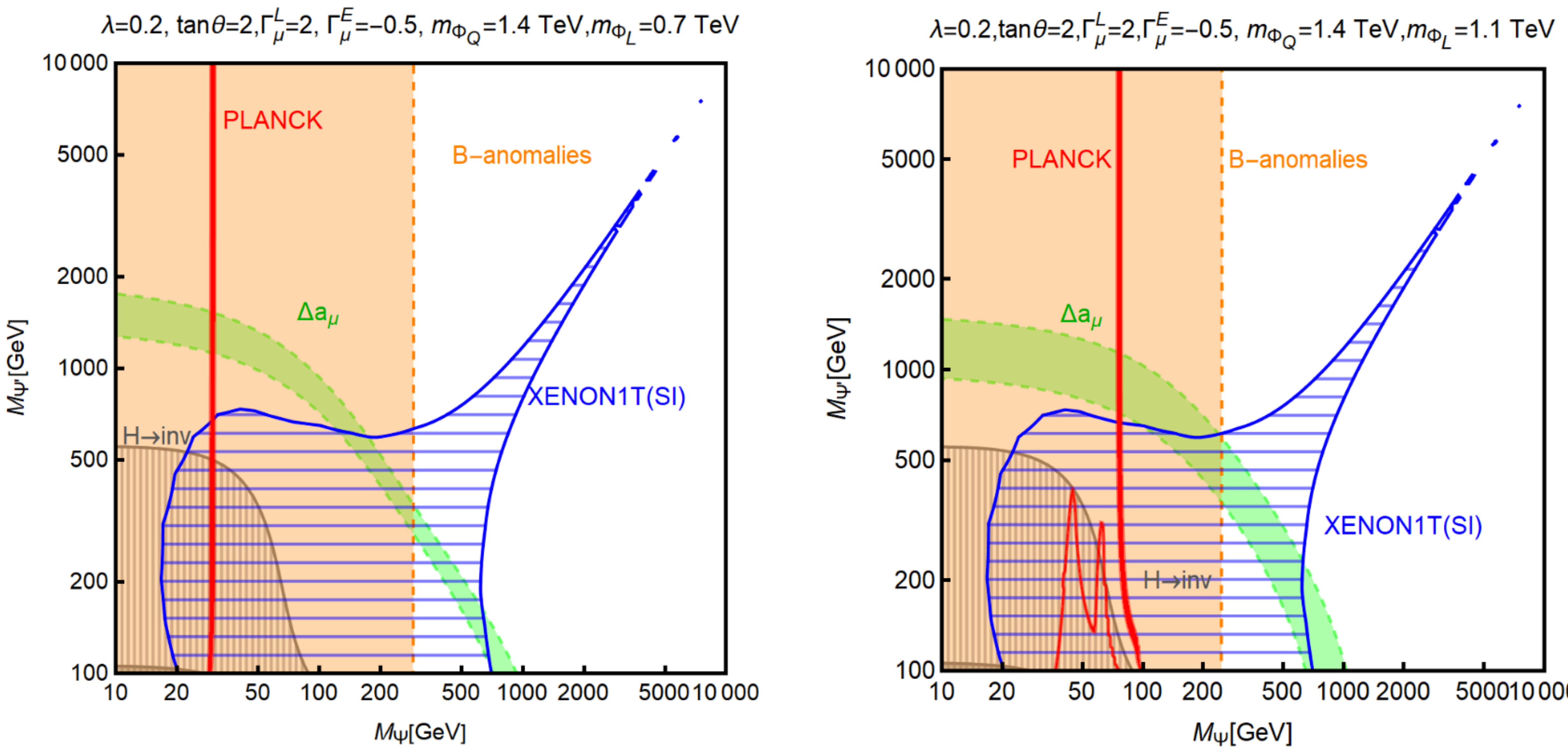
Label	Φ_q/Ψ_q	Φ_ℓ/Ψ_ℓ	Ψ/Φ	Φ'_ℓ/Ψ'_ℓ	Ψ'/Φ'
$\mathcal{F}_{\rm Ia}/\mathcal{S}_{\rm Ia}$	$(\mathbf{3},\mathbf{2},1/6)$	$(\mathbf{1},\mathbf{2},-1/2)$	$(\mathbf{1},\mathbf{1},0)$	$(\mathbf{1},\mathbf{1},-1)$	–
$\mathcal{F}_{\rm Ib}/\mathcal{S}_{\rm Ib}$	$(\mathbf{3},\mathbf{2},1/6)$	$(\mathbf{1},\mathbf{2},-1/2)$	$(\mathbf{1},\mathbf{1},0)$	–	$(\mathbf{1},\mathbf{2},-1/2)$
$\mathcal{F}_{\rm Ic}/\mathcal{S}_{\rm Ic}$	$(\mathbf{3},\mathbf{2},7/6)$	$(\mathbf{1},\mathbf{2},1/2)$	$(\mathbf{1},\mathbf{1},-1)$	$(\mathbf{1},\mathbf{1},0)$	–
$\mathcal{F}_{\rm IIa}/\mathcal{S}_{\rm IIa}$	$(\mathbf{3},\mathbf{1},2/3)$	$(\mathbf{1},\mathbf{1},0)$	$(\mathbf{1},\mathbf{2},-1/2)$	$(\mathbf{1},\mathbf{2},-1/2)$	–
$\mathcal{F}_{\rm IIb}/\mathcal{S}_{\rm IIb}$	$(\mathbf{3},\mathbf{1},2/3)$	$(\mathbf{1},\mathbf{1},0)$	$(\mathbf{1},\mathbf{2},-1/2)$	–	$(\mathbf{1},\mathbf{1},-1)$
$\mathcal{F}_{\rm IIc}/\mathcal{S}_{\rm IIc}$	$(\mathbf{3},\mathbf{1},-1/3)$	$(\mathbf{1},\mathbf{1},-1)$	$(\mathbf{1},\mathbf{2},1/2)$	–	$(\mathbf{1},\mathbf{1},0)$
$\mathcal{F}_{\rm Va}/\mathcal{S}_{\rm Va}$	$(\mathbf{3},\mathbf{3},2/3)$	$(\mathbf{1},\mathbf{1},0)$	$(\mathbf{1},\mathbf{2},-1/2)$	$(\mathbf{1},\mathbf{2},-1/2)$	–
$\mathcal{F}_{\rm Vb}/\mathcal{S}_{\rm Vb}$	$(\mathbf{3},\mathbf{3},2/3)$	$(\mathbf{1},\mathbf{1},0)$	$(\mathbf{1},\mathbf{2},-1/2)$	–	$(\mathbf{1},\mathbf{1},-1)$
$\mathcal{F}_{\rm Vc}/\mathcal{S}_{\rm Vc}$	$(\mathbf{3},\mathbf{3},-1/3)$	$(\mathbf{1},\mathbf{1},-1)$	$(\mathbf{1},\mathbf{2},1/2)$	–	$(\mathbf{1},\mathbf{1},0)$

Singlet DM

Singlet-Doublet mixed DM

F_{IB} with singlet-doublet DM

Φ_Q	Φ_L	Ψ	Ψ'
$(\mathbf{3}, \mathbf{2}, 1/6)$	$(\mathbf{1}, \mathbf{2}, -1/2)$	$(\mathbf{1}, \mathbf{1}, 0)^\star$	$(\mathbf{1}, \mathbf{2}, -1/2)^\star$



Viable model to address everything simultaneously!

Conclusions

- To address B-anomalies and DM via loop models, we need at least 3 fields, with the DM either being a SU(2) singlet or doublet

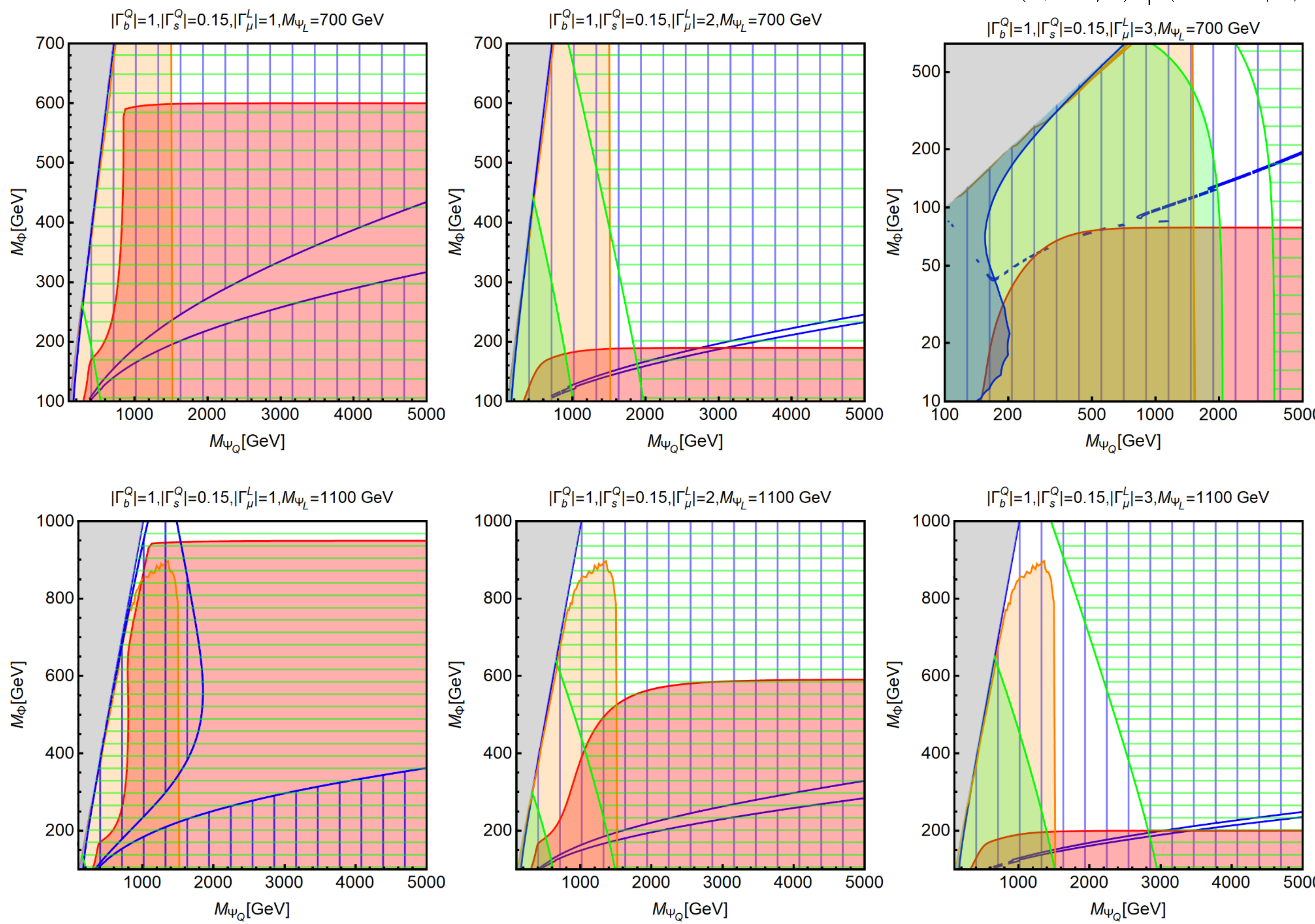
- To address g-2 as well via loop models, we need at least 4 fields, with coupling to RH muons allowed and the DM either being a SU(2) singlet or doublet

- This is actually doable! Constraints from LHC and DM searches are complementary, and allowed models can be further test with the advent of new data in both fields!

Back-up Slides

S_{IA} with complex DM

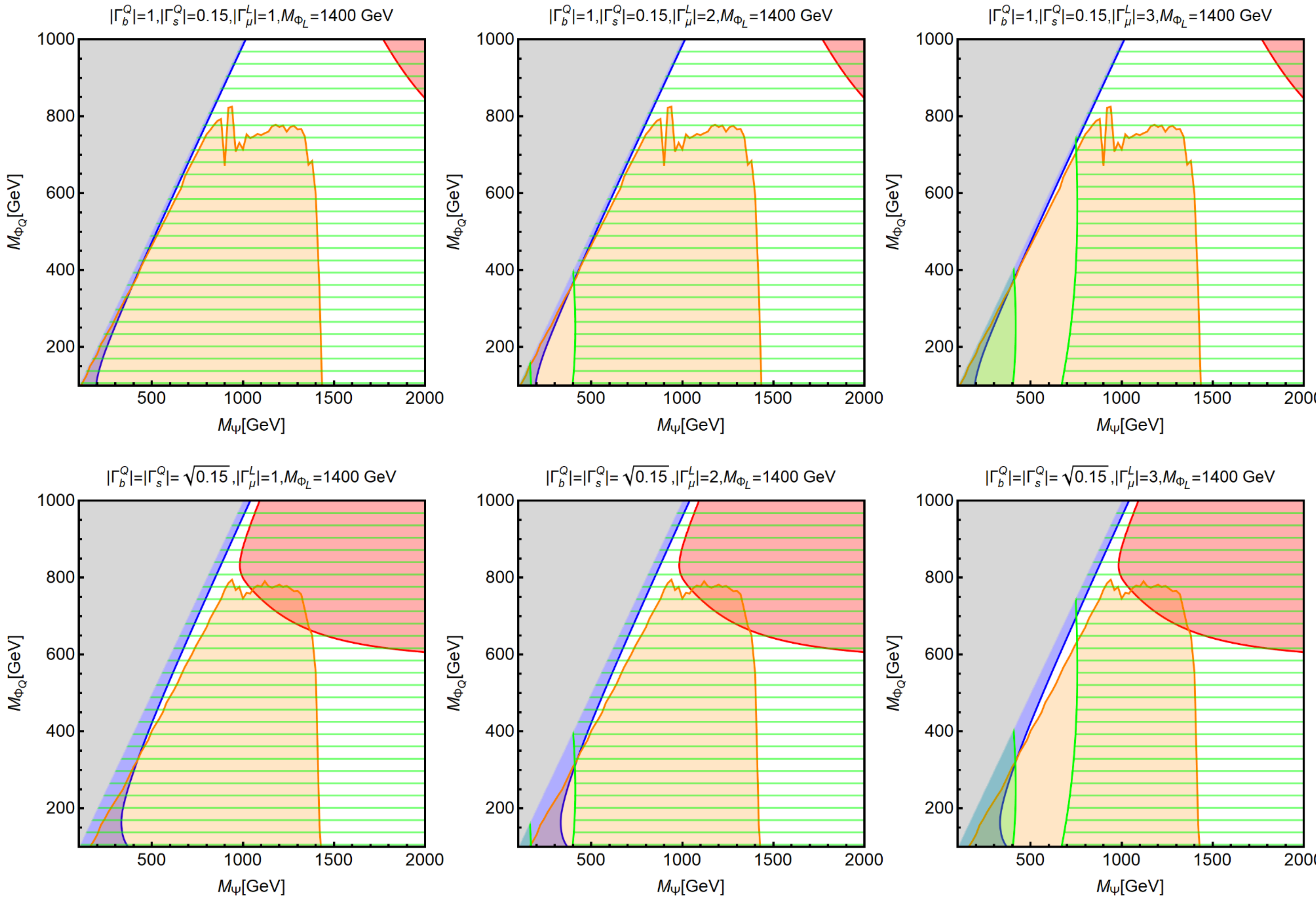
Ψ_Q	Ψ_L	Φ
$(\mathbf{3},\mathbf{2},1/6)$	$(\mathbf{1},\mathbf{2},-1/2)$	$(\mathbf{1},\mathbf{1},0)^\star$



Viable model only if O(100KeV) mass splitting is assumed between CP-even and CP-odd DM comp. (avoiding DD constr. due to non-relativistic scattering)

F_{IB} with real DM

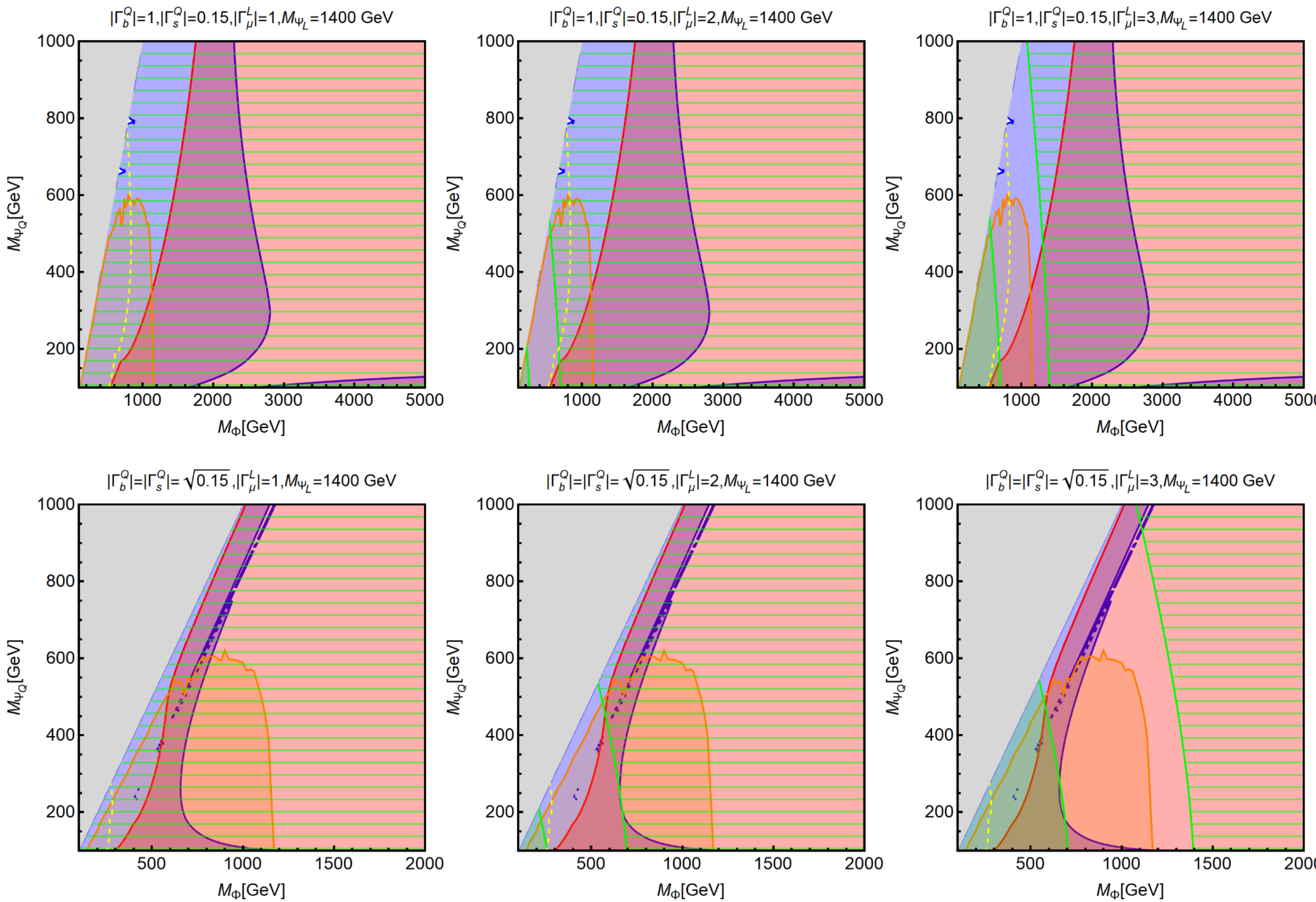
Φ_Q	Φ_L	Ψ
$(\mathbf{1},\mathbf{2},1/2)^\star$	$(\bar{\mathbf{3}},\mathbf{2},-1/6)$	$(\mathbf{3},\mathbf{1},-1/3)$



Requires mass splitting between CP-even and CP-odd DM comp. Either an under-abundant DM is produced, or a not-good-enough contribution to B-anomalies

S_{IIB} with Dirac DM

Ψ_Q	Ψ_L	Φ
$(\mathbf{1},\mathbf{1},0)^\star$	$(\bar{\mathbf{3}},\mathbf{1},-2/3)$	$(\mathbf{3},\mathbf{2},1/6)$

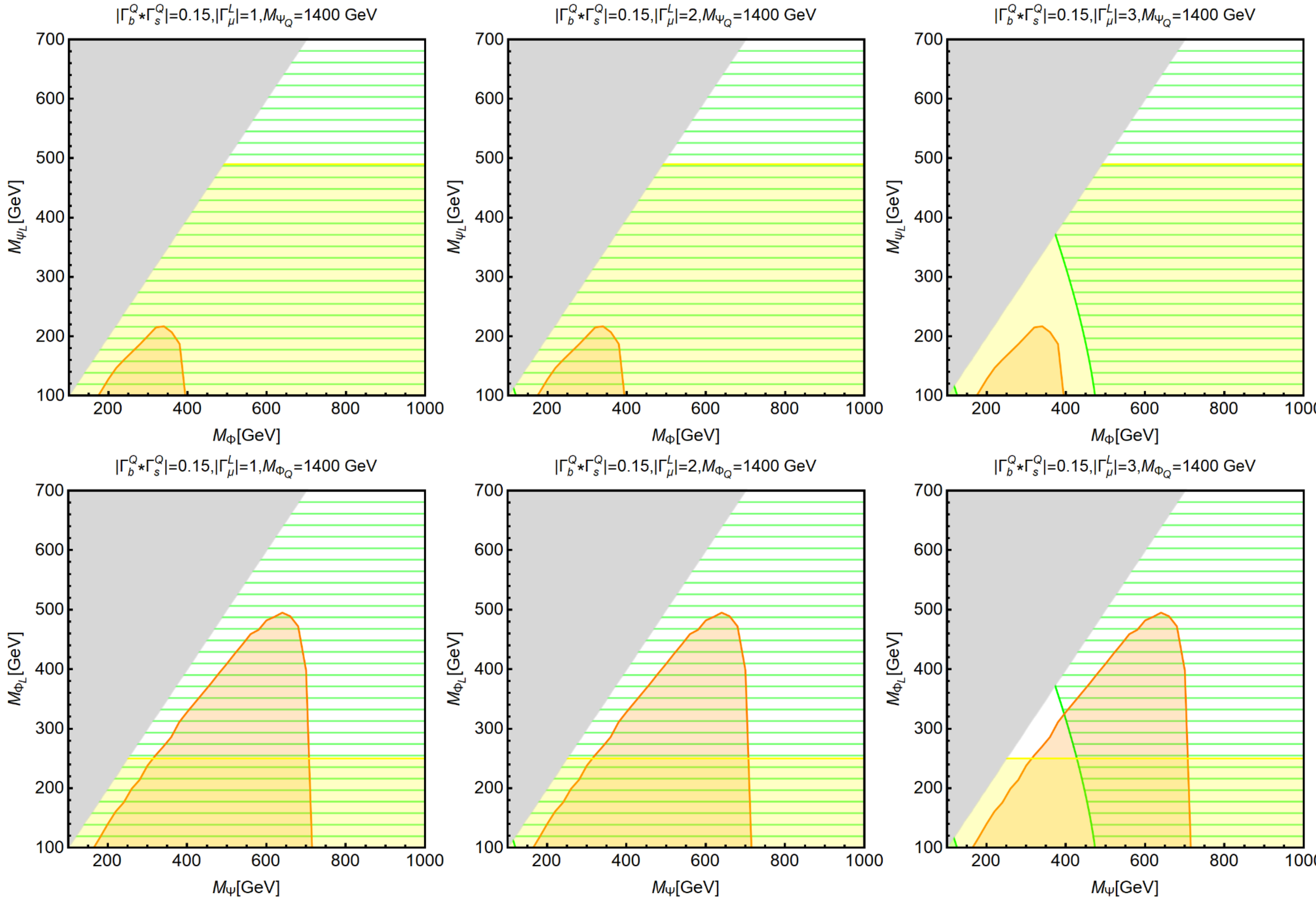


Model excluded by DM bounds!

S_{IIIA} and F_{IIIA}: triplet DM

Ψ_Q	Ψ_L	Φ
$(\mathbf{3},\mathbf{3},2/3)$	$(\mathbf{1},\mathbf{3},0)^\star$	$(\mathbf{1},\mathbf{2},-1/2)^\star$

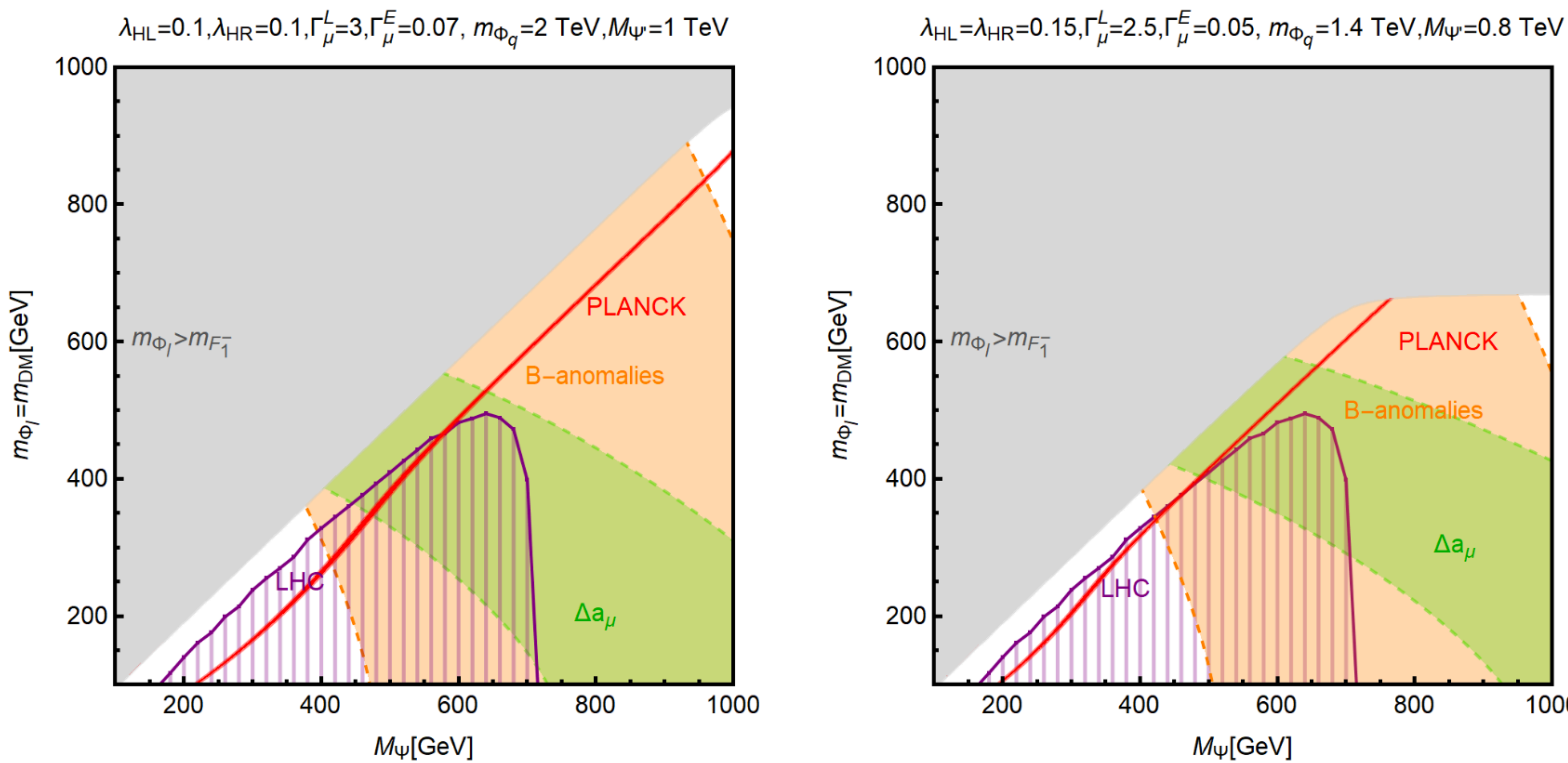
Φ_Q	Φ_L	Ψ
$(\mathbf{3},\mathbf{3},2/3)$	$(\mathbf{1},\mathbf{3},0)^\star$	$(\mathbf{1},\mathbf{2},-1/2)$



Models strongly constraint by LHC disappearing tracks,
DM strongly under-abundant!

F_{IIB} with singlet DM

Φ_Q	Φ_L	Ψ	Ψ'
$(\mathbf{3}, \mathbf{1}, 2/3)$	$(\mathbf{1}, \mathbf{1}, 0)^\star$	$(\mathbf{1}, \mathbf{2}, -1/2)$	$(\mathbf{1}, \mathbf{1}, -1)$



Viable model to address everything simultaneously!