DM@LHC, Oxford 2014

Invisible Z' and dark matter Collider and Direct Detection searches

B. Zaldívar, *ULB Belgium*

in collab with: Arcadi, Mambrini, Tytgat, Pokorsky

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Complementarities induced by portals

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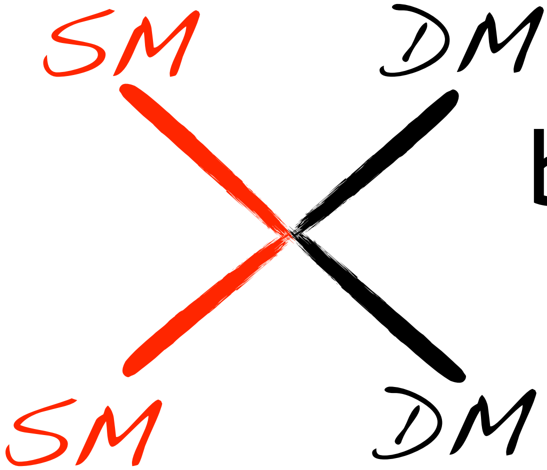
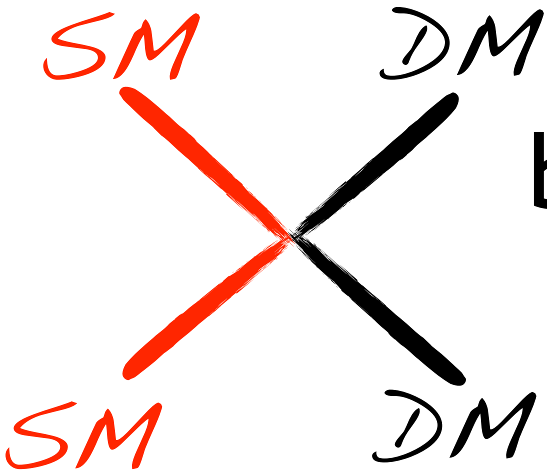
[the empty unnecessary slide about the motivation to look for dark matter@lhc, and the necessity to go beyond EFT....]



beyond
EFT?



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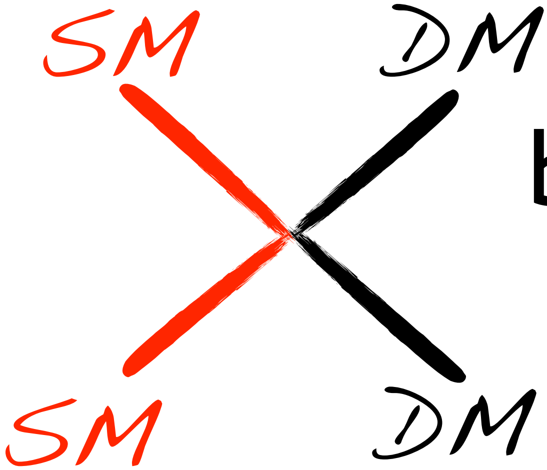

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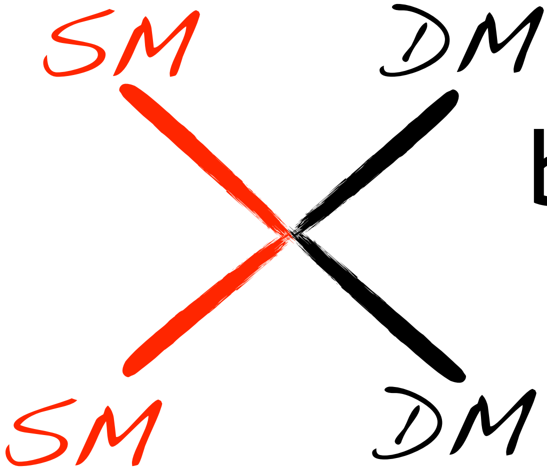
same analysis,
watch out validity, etc



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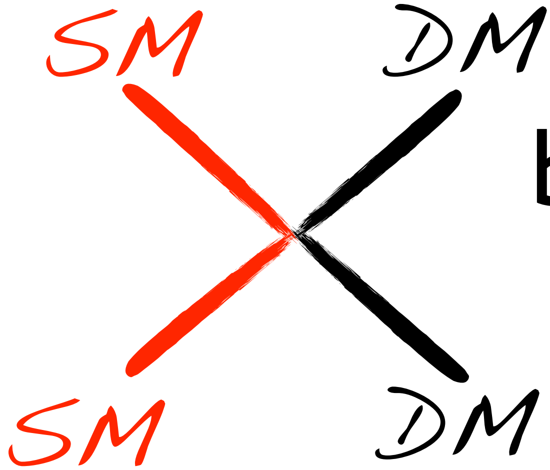

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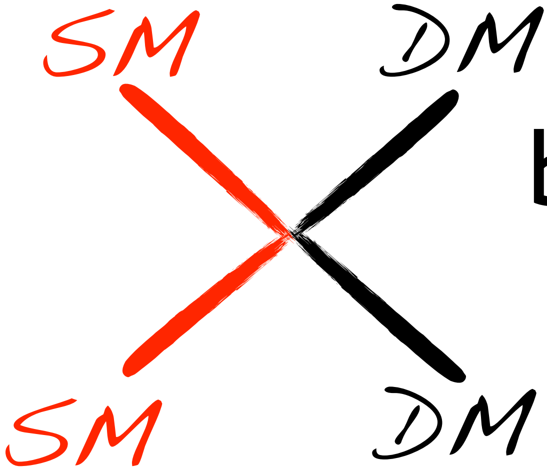

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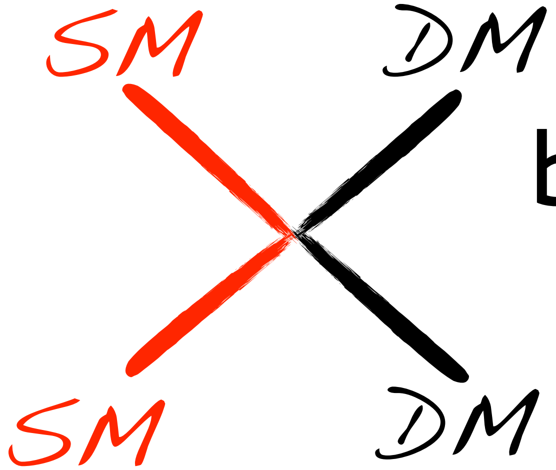

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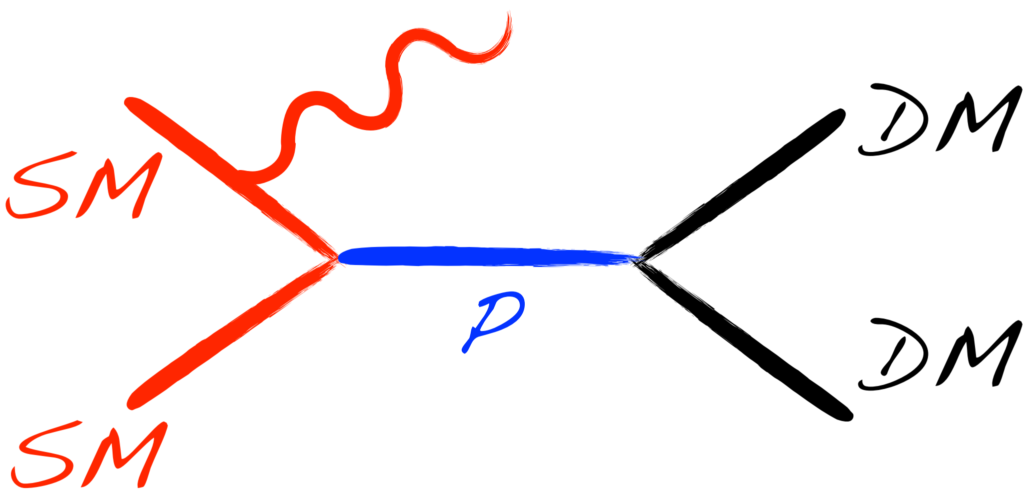

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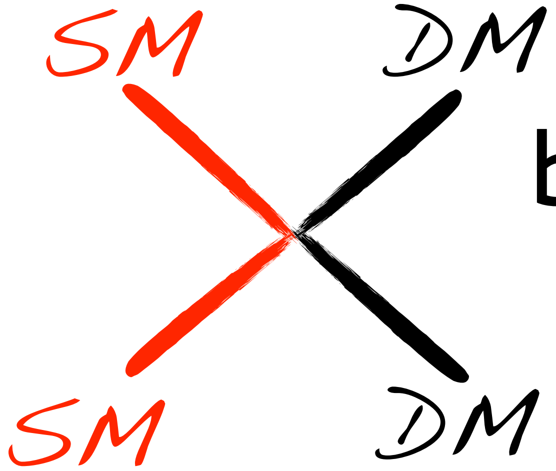

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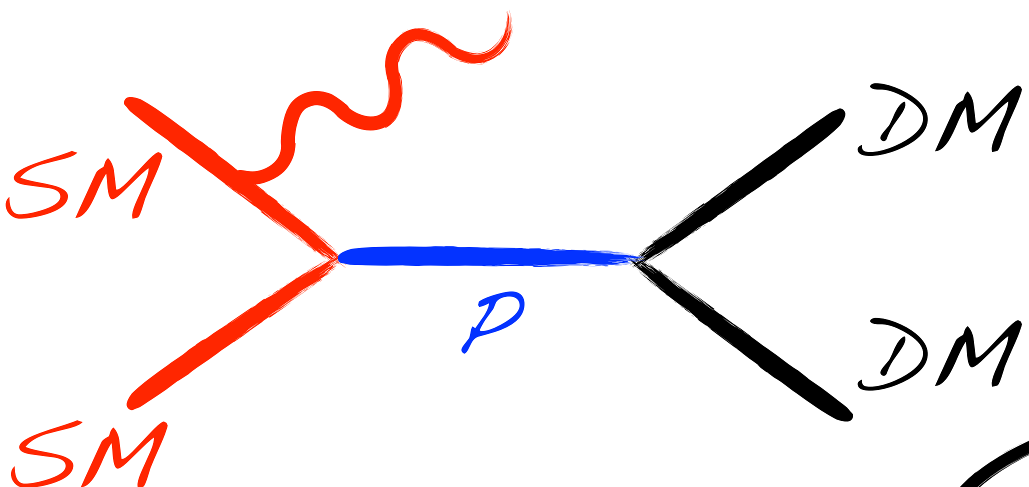
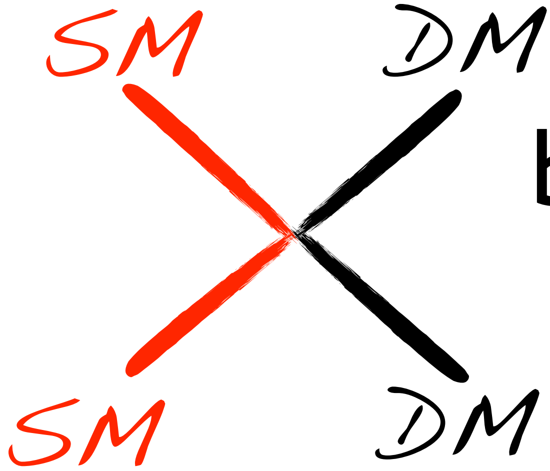


no extra assumptions



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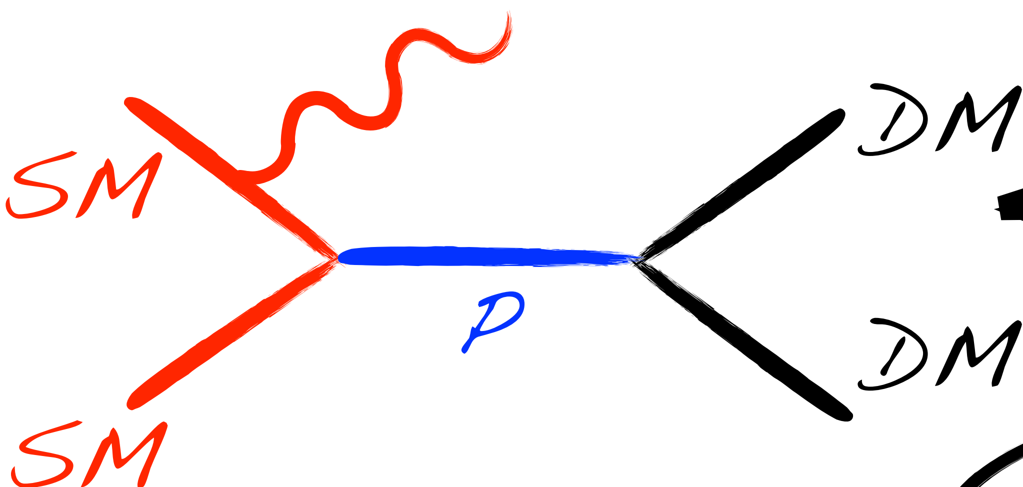

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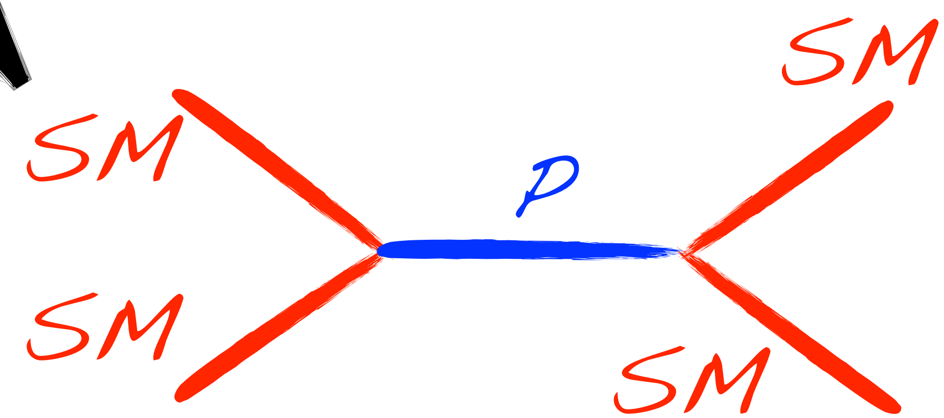

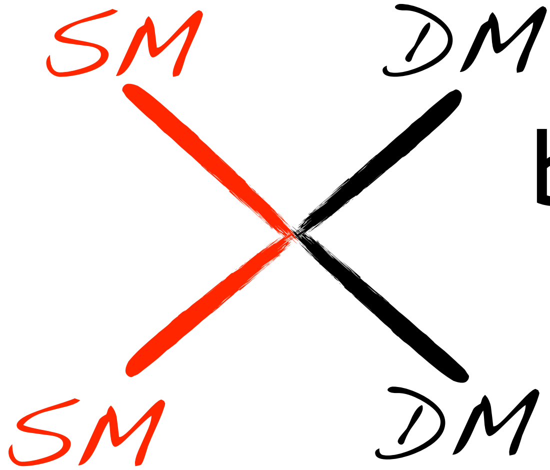

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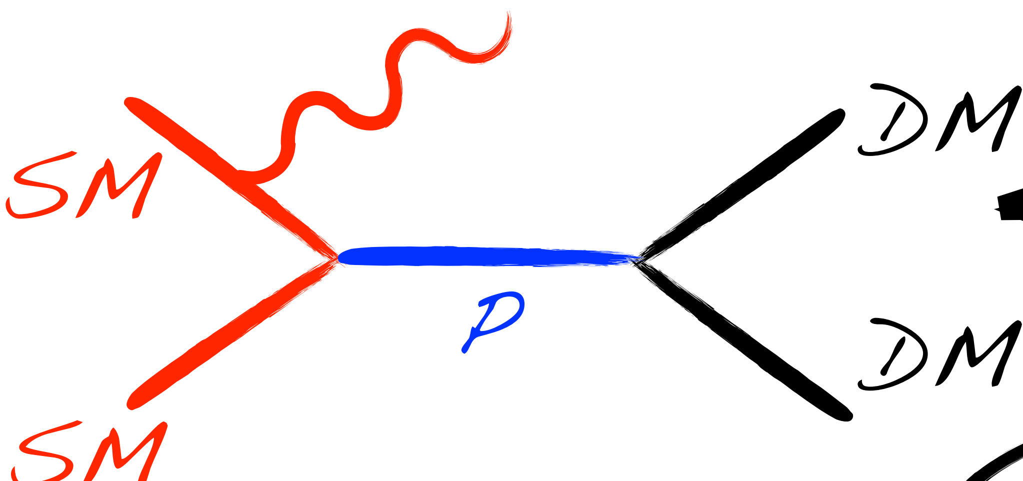

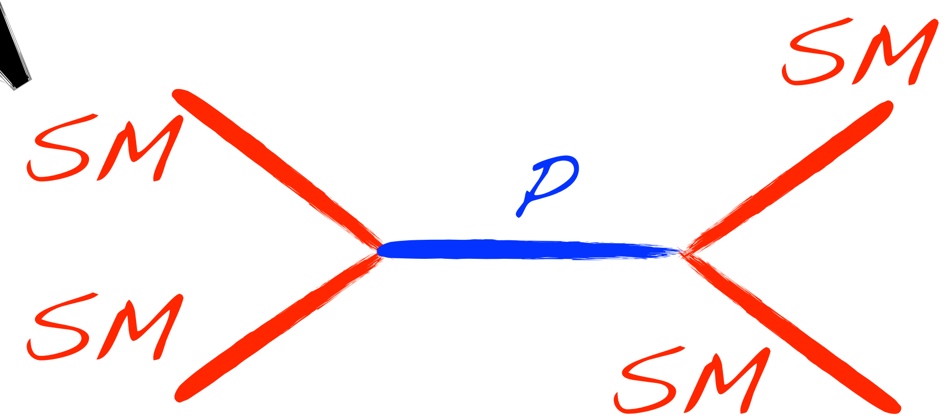

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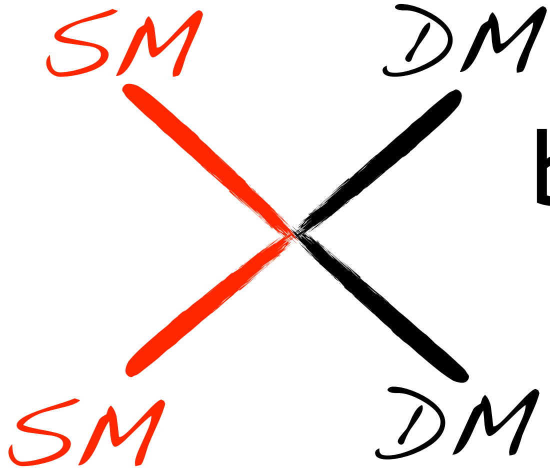

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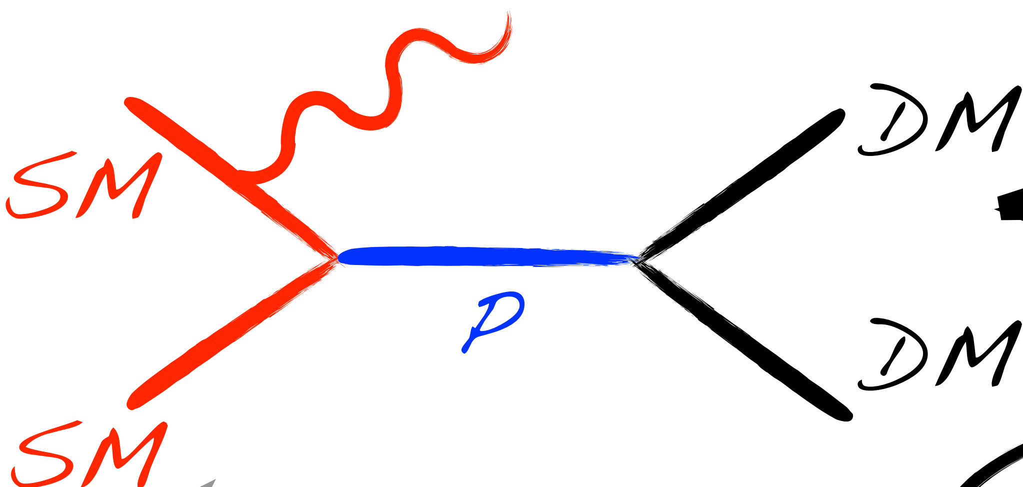

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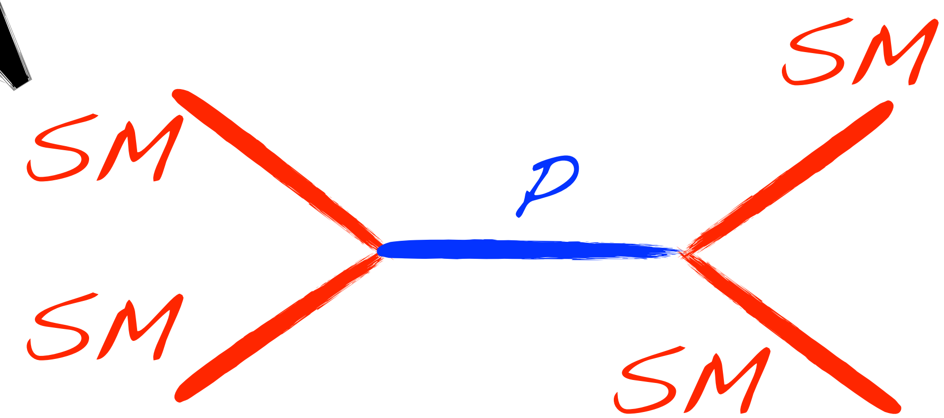

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ETmiss analyses ⟷ Direct Detection

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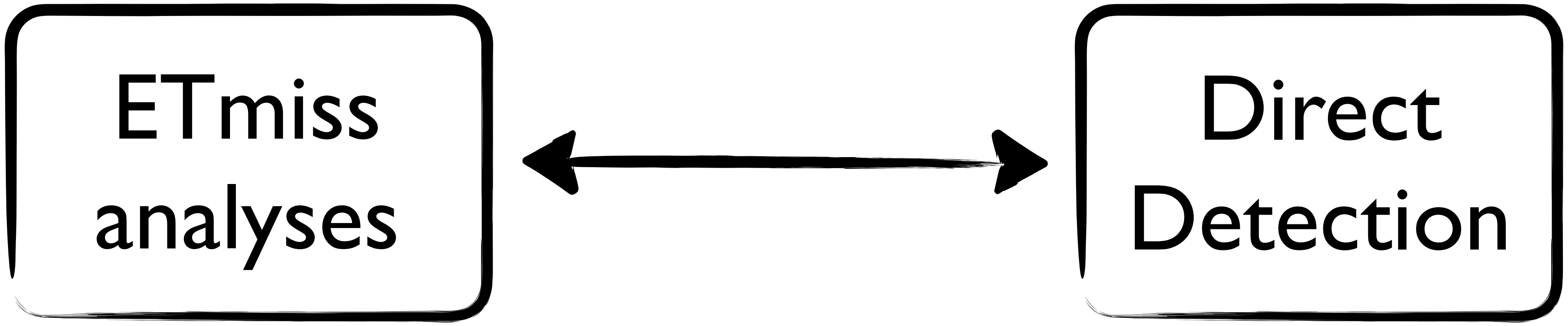
This talk:

Di-signal analyses ⟷ Direct Detection



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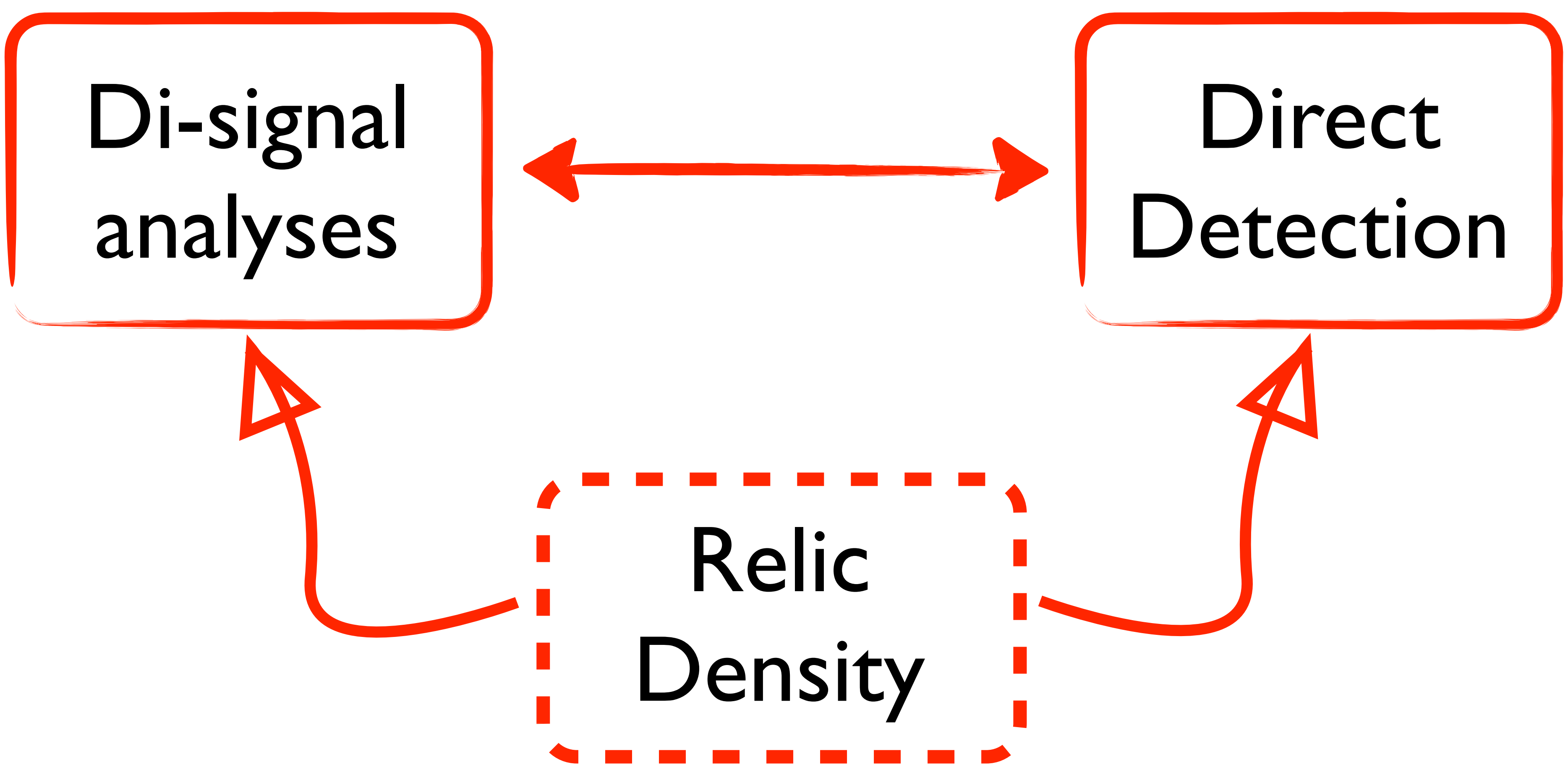
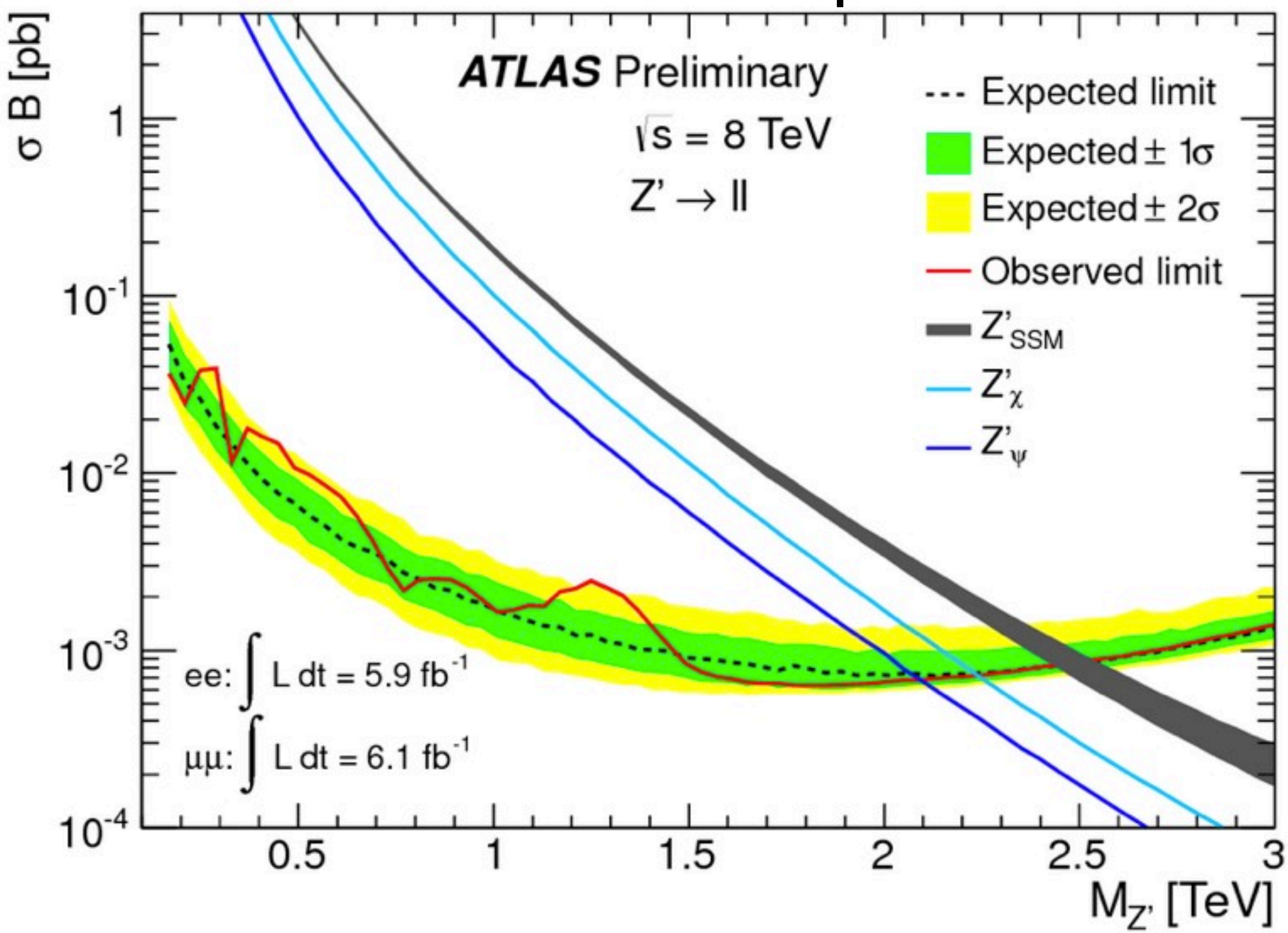


Constraints on Sequential Model

hep-ex/1209.2535



analogous result from CMS: hep-ex/1212.6175

#1: Adding invisible branching

$$\sigma(q\bar{q} \to Z' \to \ell\ell) \approx \frac{g_D^4}{12\pi}(|V^q|^2 + |A^q|^2)(|V^\ell|^2 + |A^\ell|^2) \times \frac{s}{(s - M_{Z'}^2)^2 + \Gamma_{Z'}^2 M_{Z'}^2}$$

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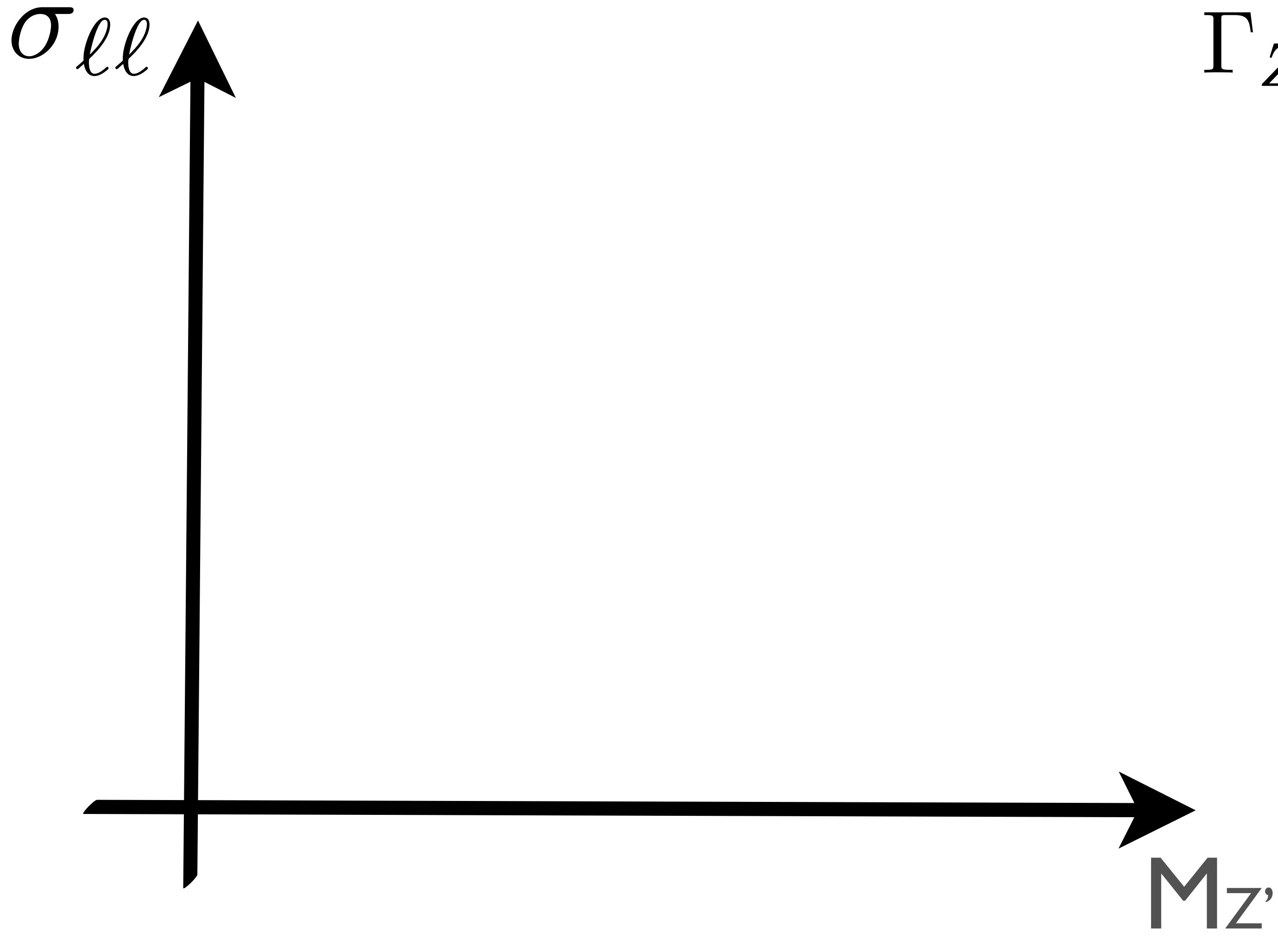

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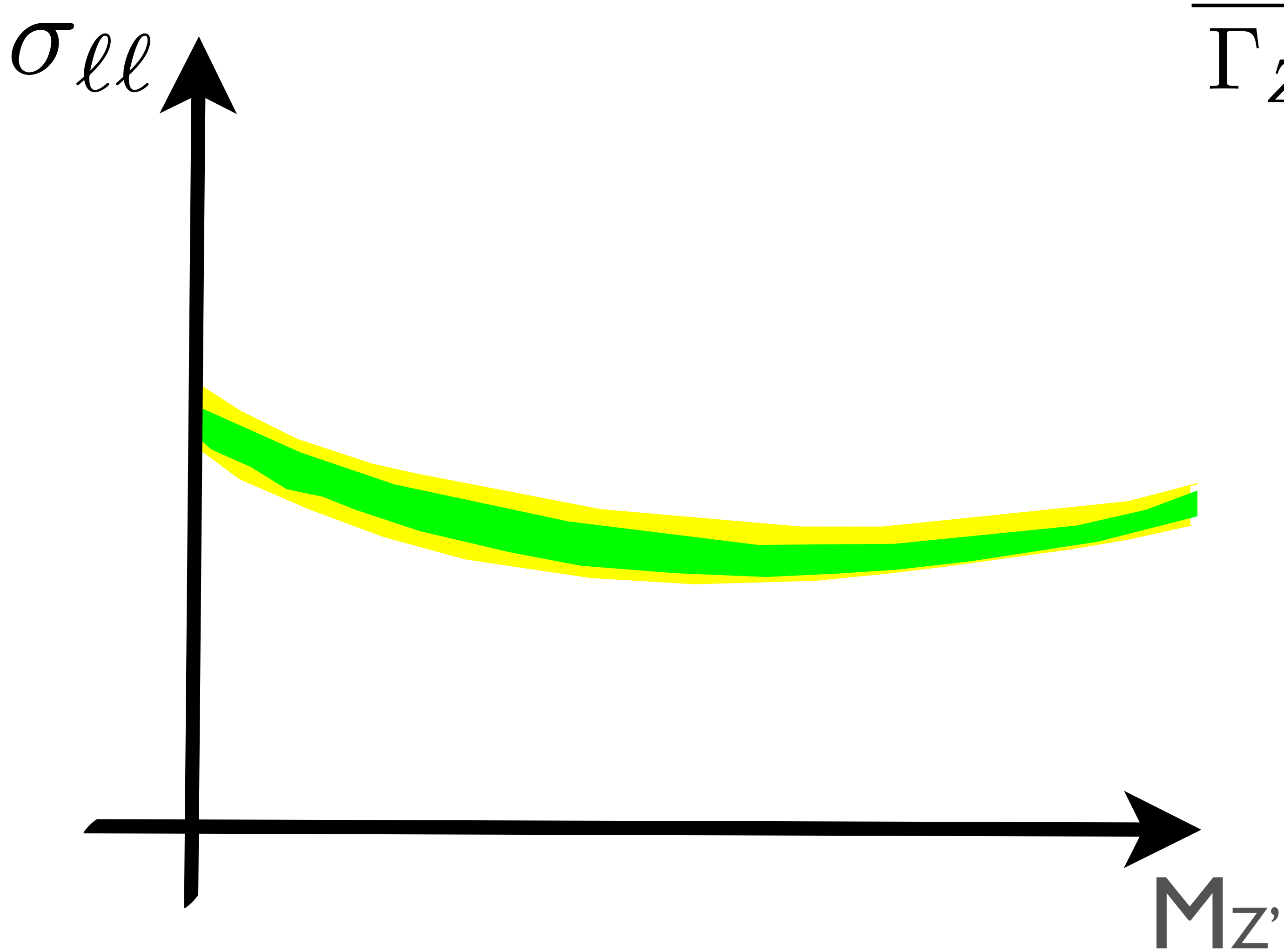

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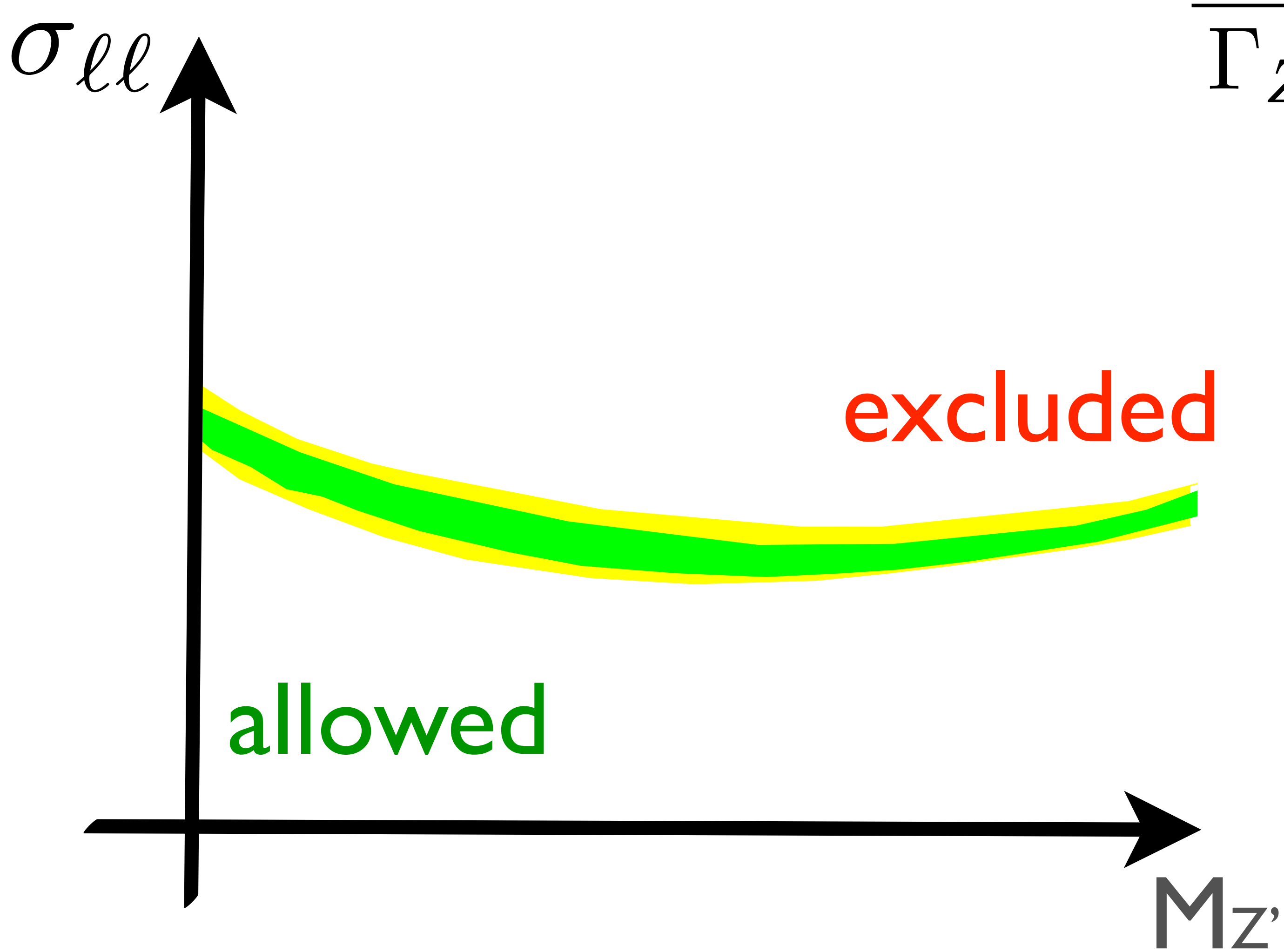

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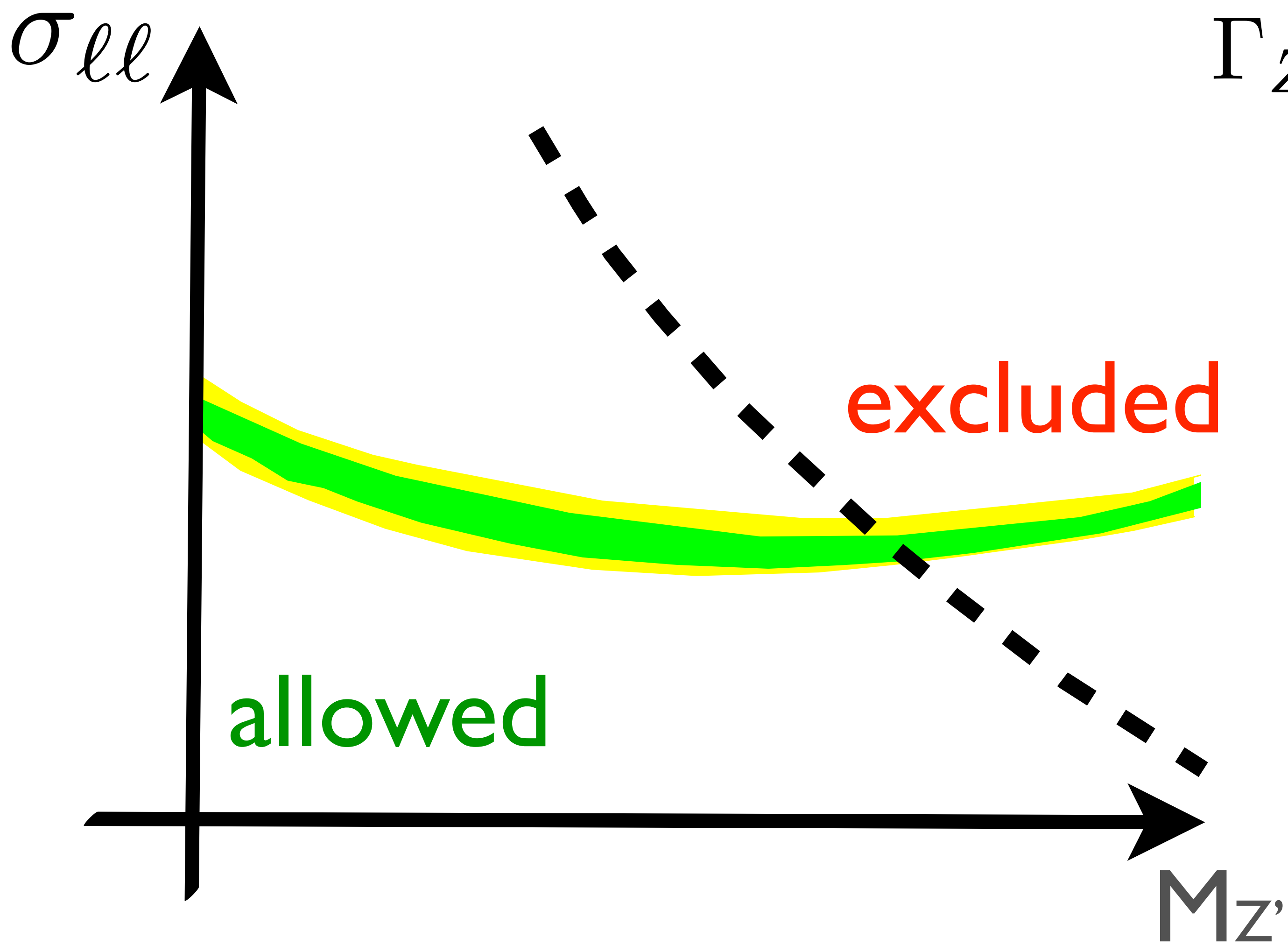

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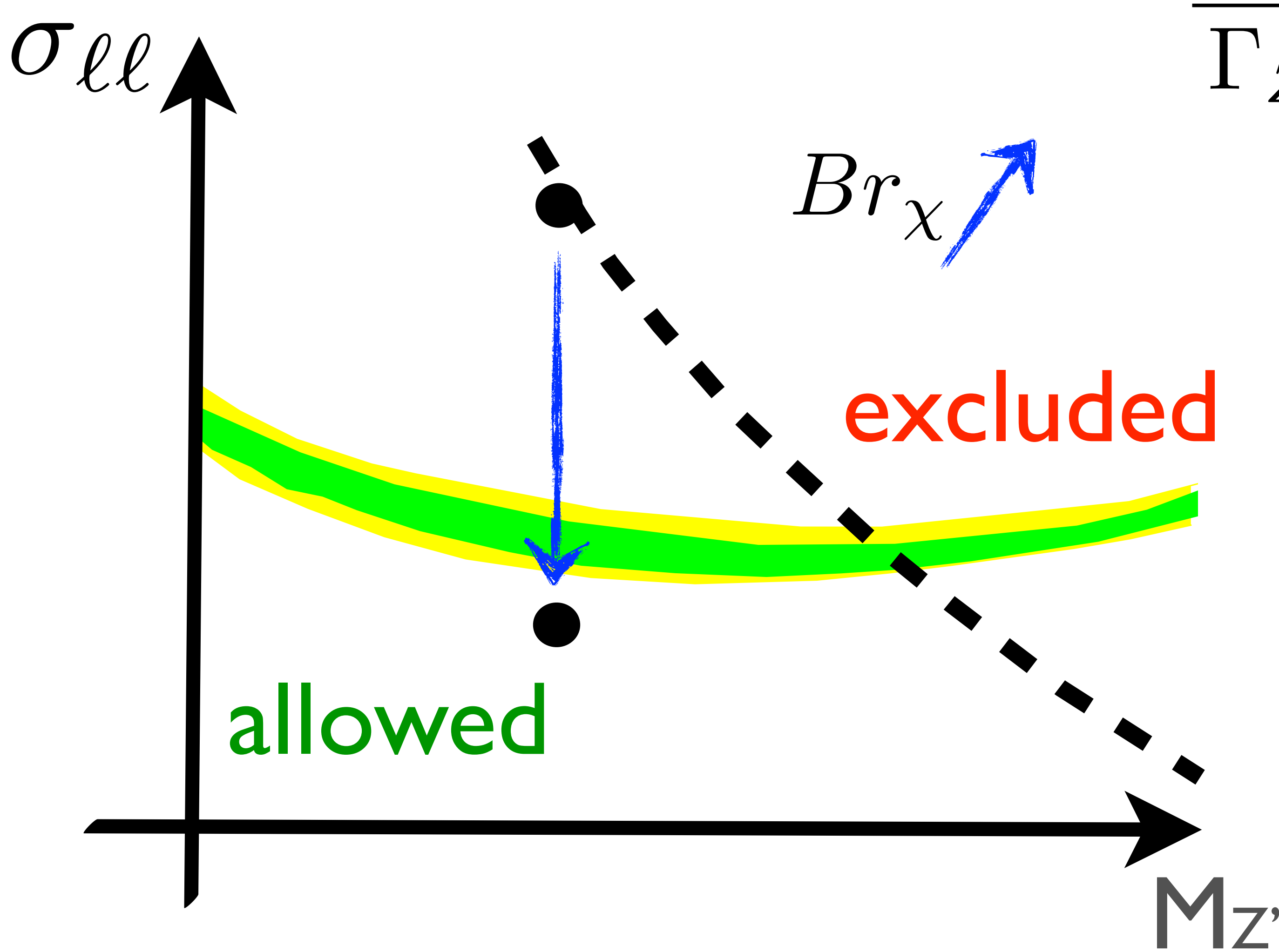

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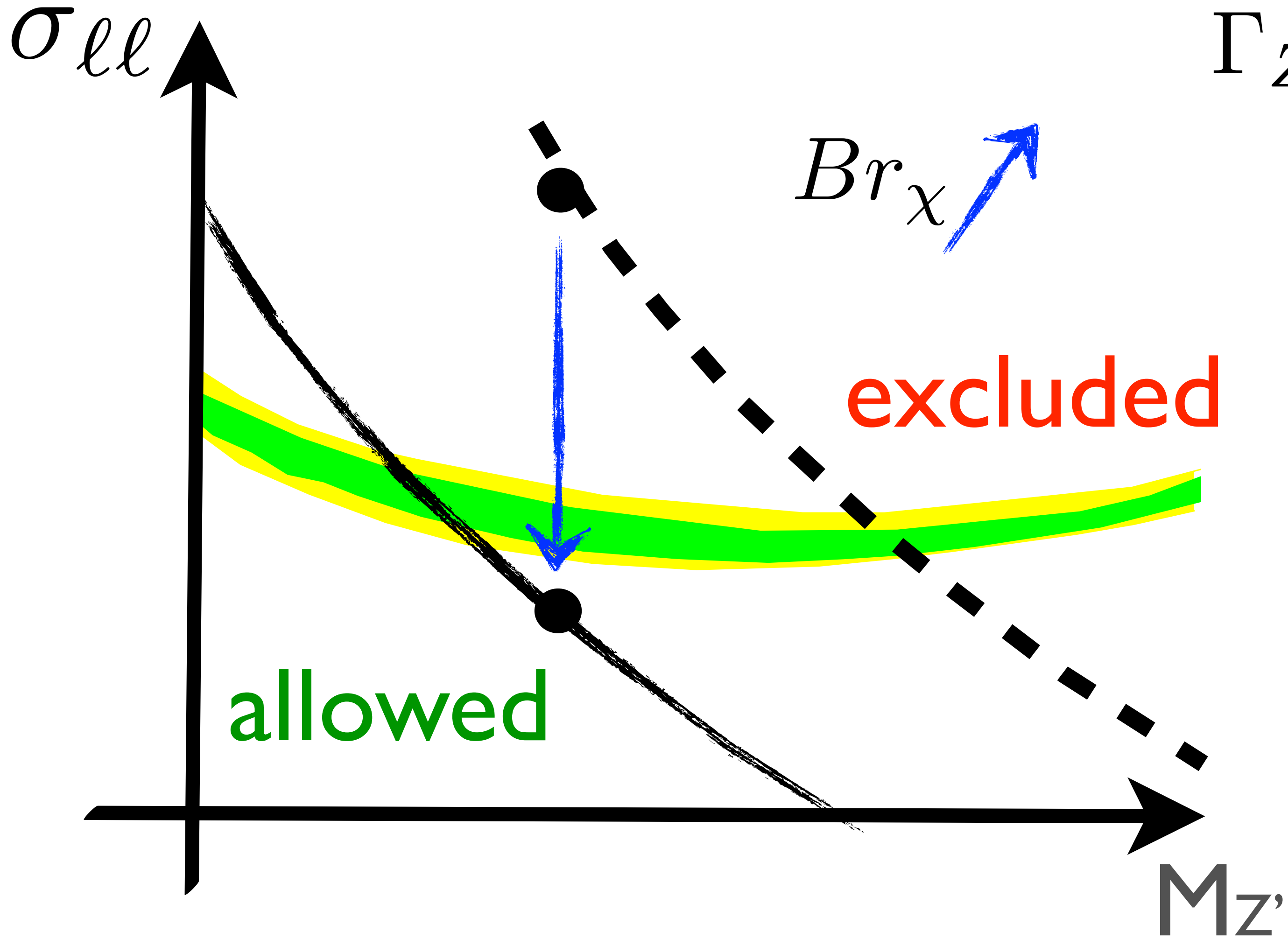

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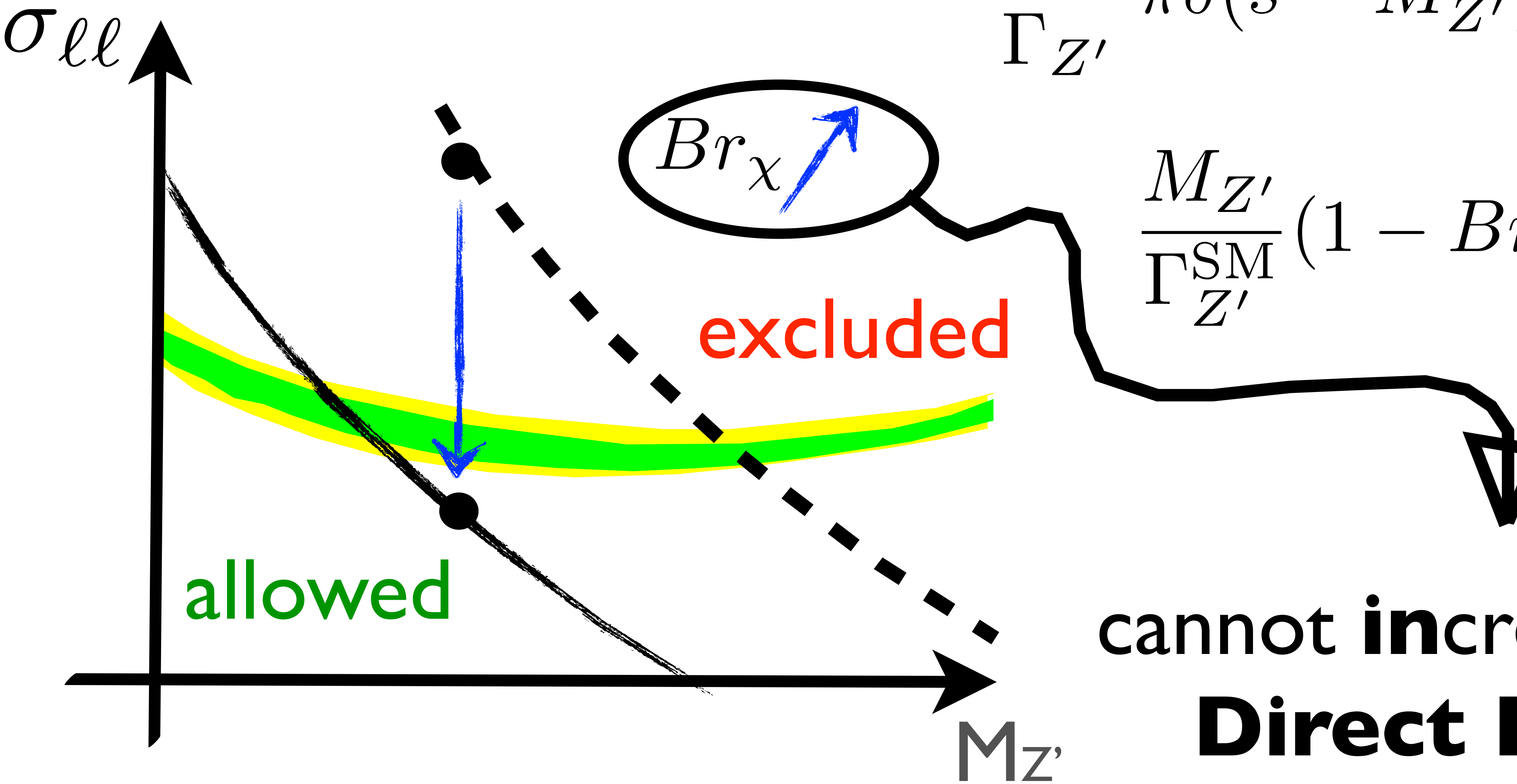


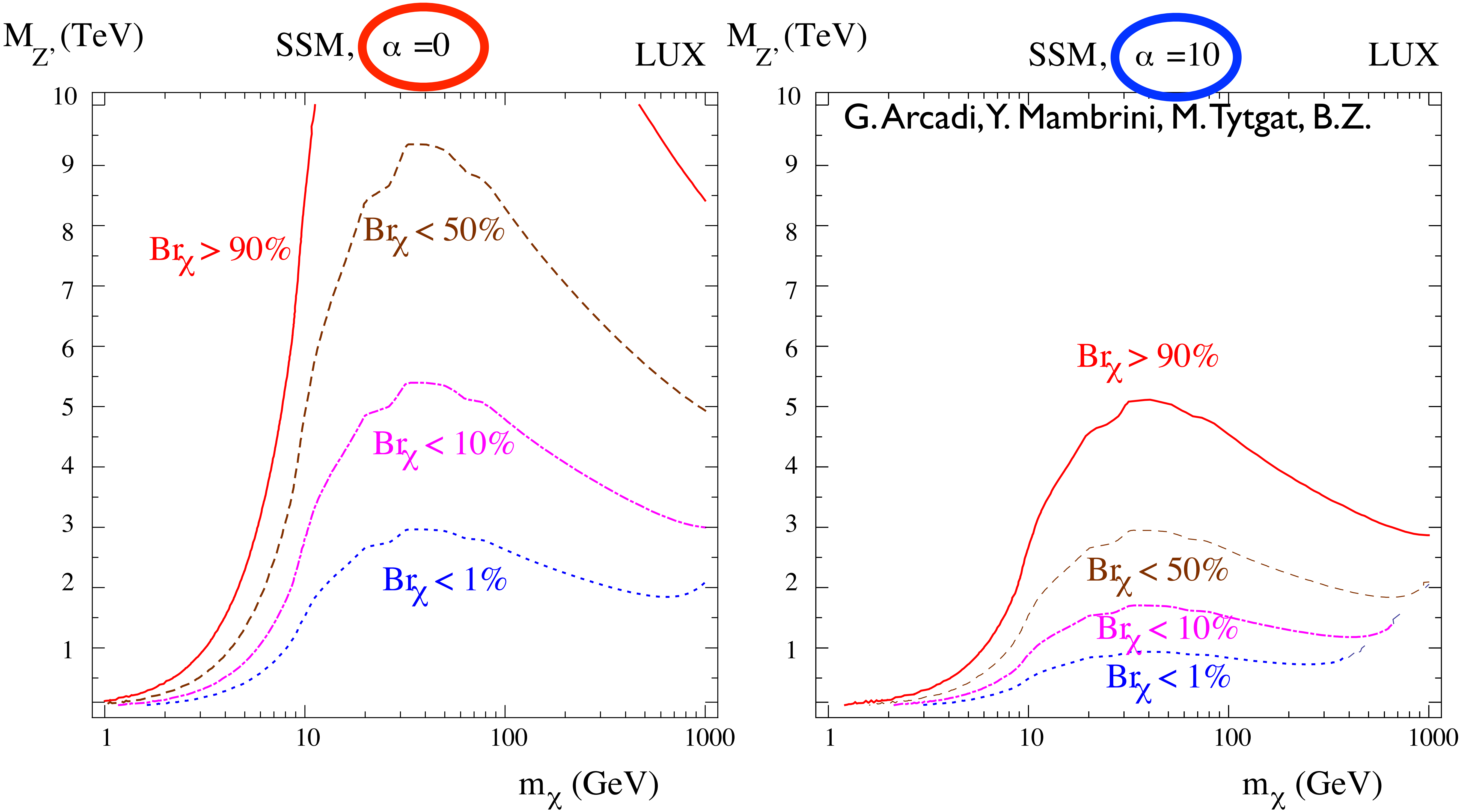
$$\frac{M_{Z'}}{\Gamma_{Z'}^{\rm SM}}(1 - Br_\chi)\pi\delta(s - M_{Z'}^2)$$

cannot **in**crease arbitrarily:

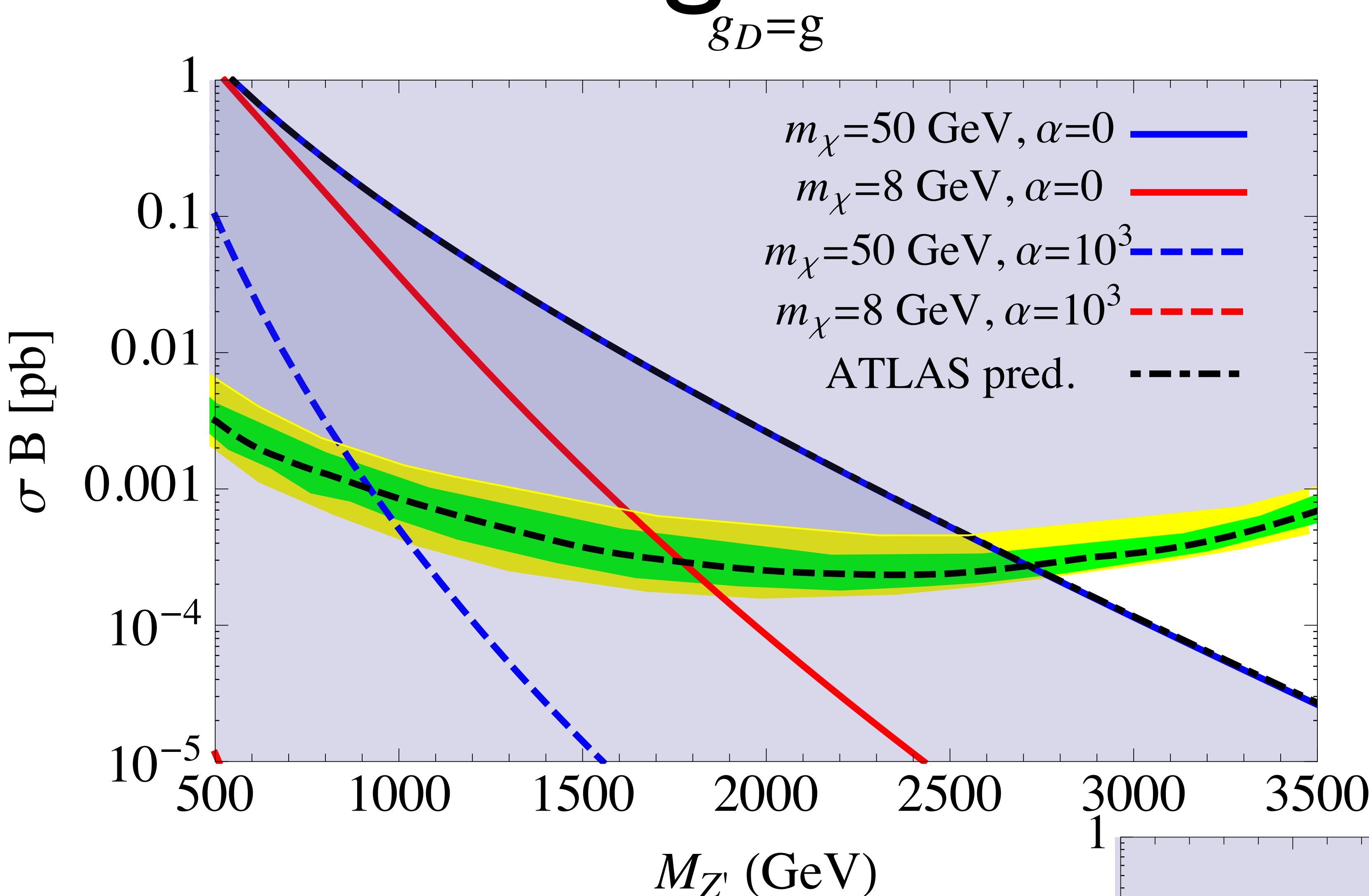
Direct Detection!

Constraining invisible branching

$$Br_\chi = \left[1 + \frac{g_D^4}{M_{Z'}^4}\frac{\#}{(1+\alpha^2)\sigma_{SI}}\right]^{-1} \qquad \alpha \equiv \frac{A_\chi}{V_\chi}$$



Relaxing brazilian exclusion



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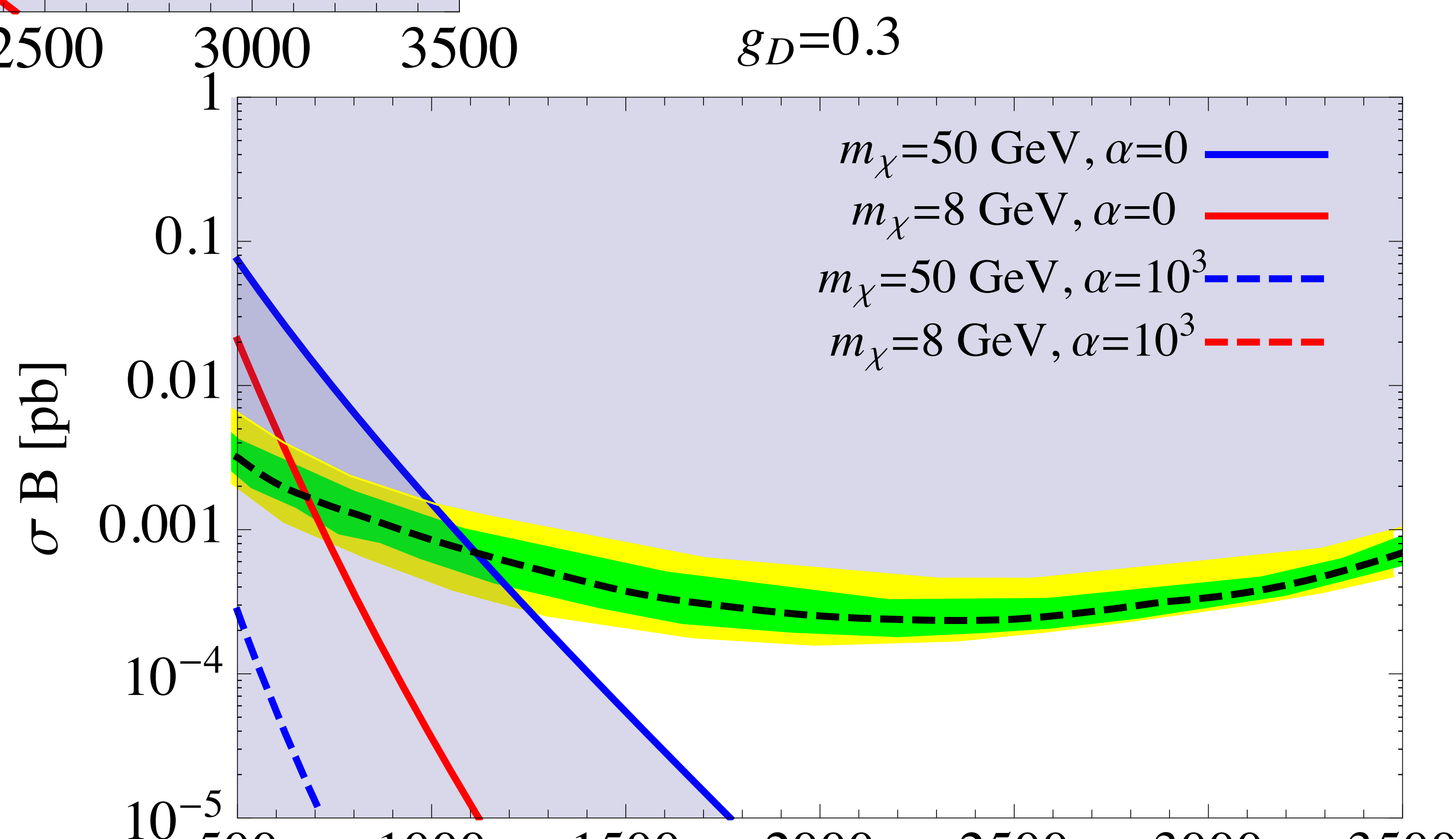
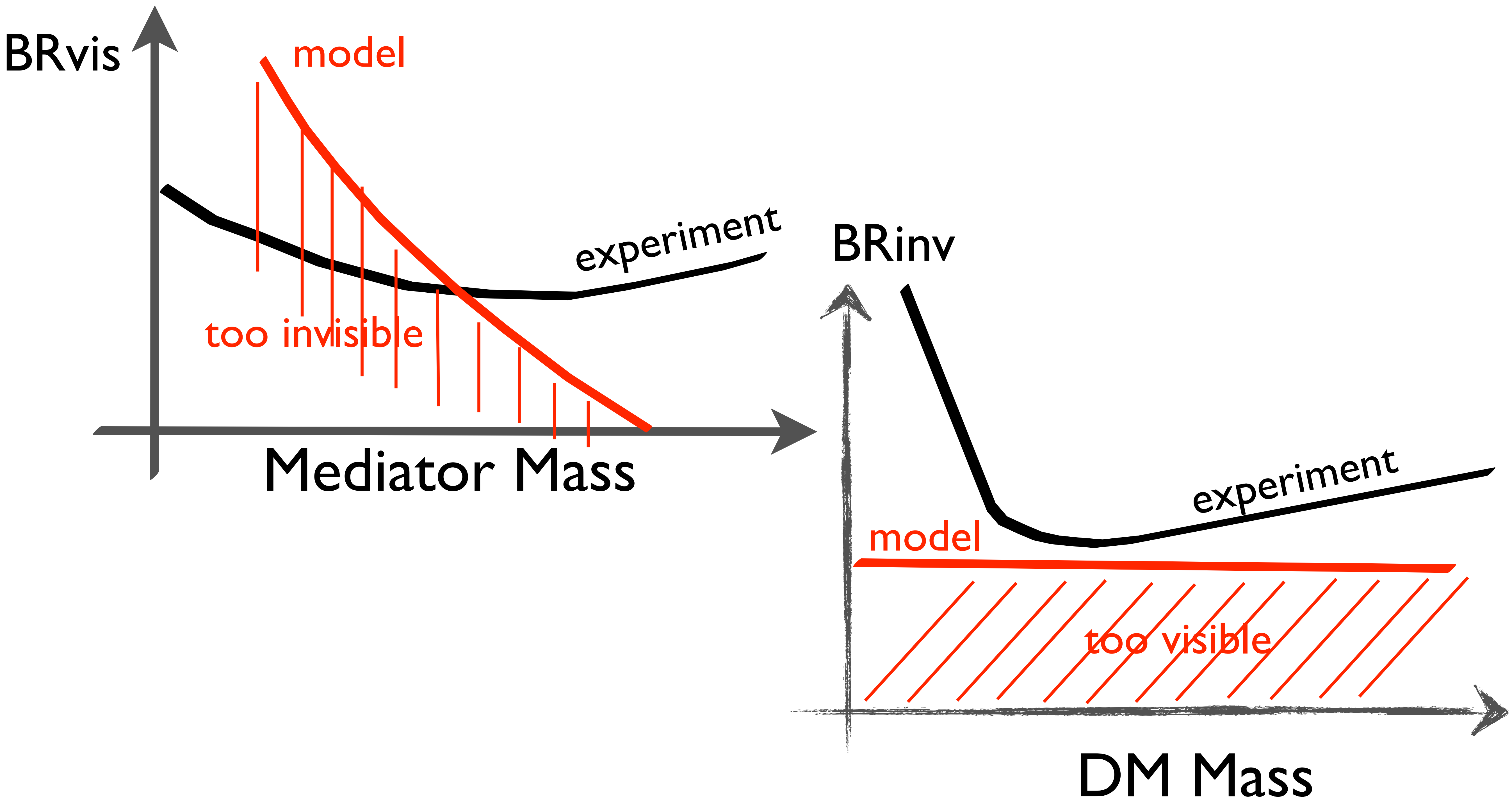


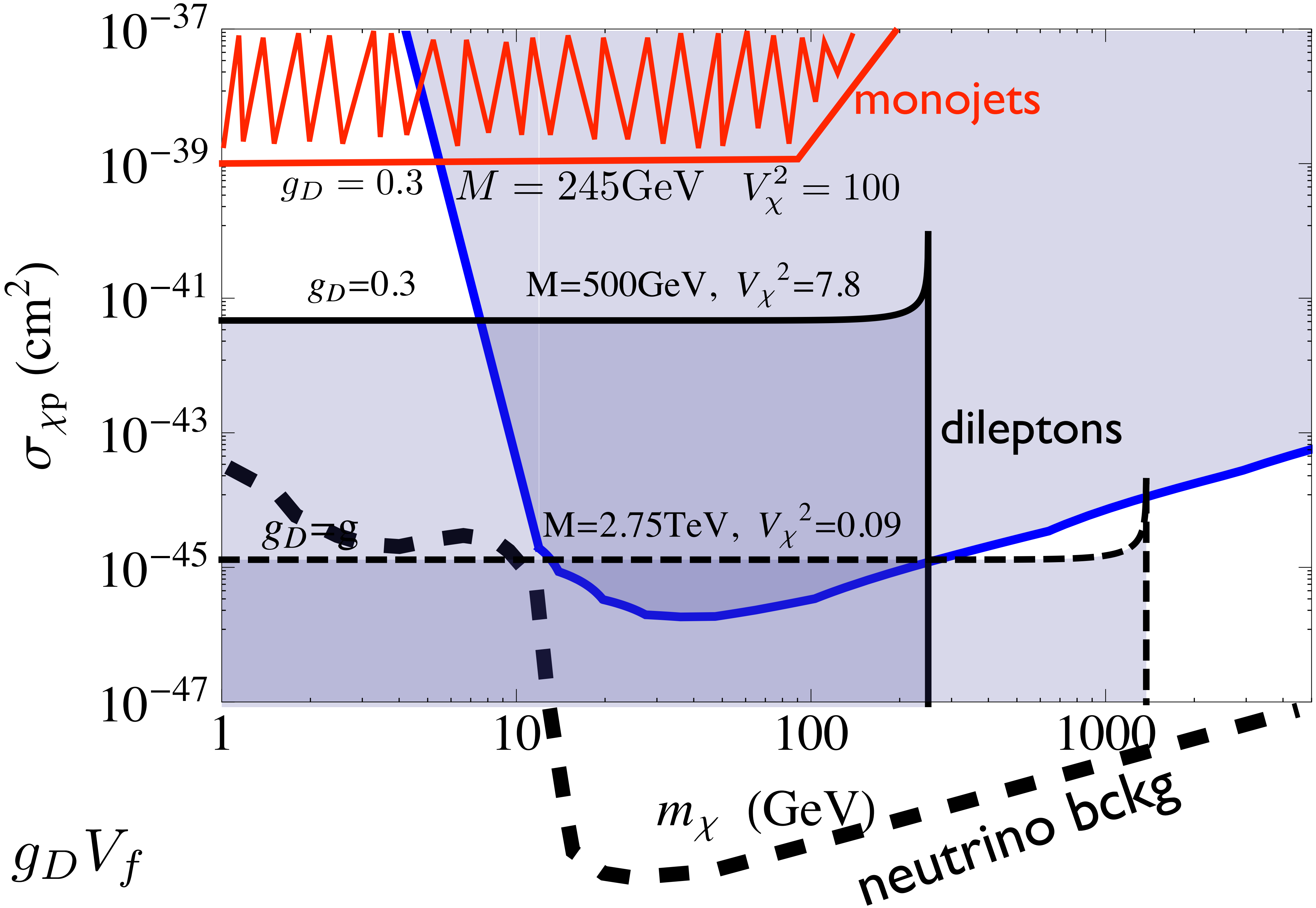
G. Arcadi, Y. Mambrini, M. Tytgat, B.Z.

Complementarity

$$Br_{\text{invisible}} + Br_{\text{visible}} = 1$$



Constraint on Direct Detection

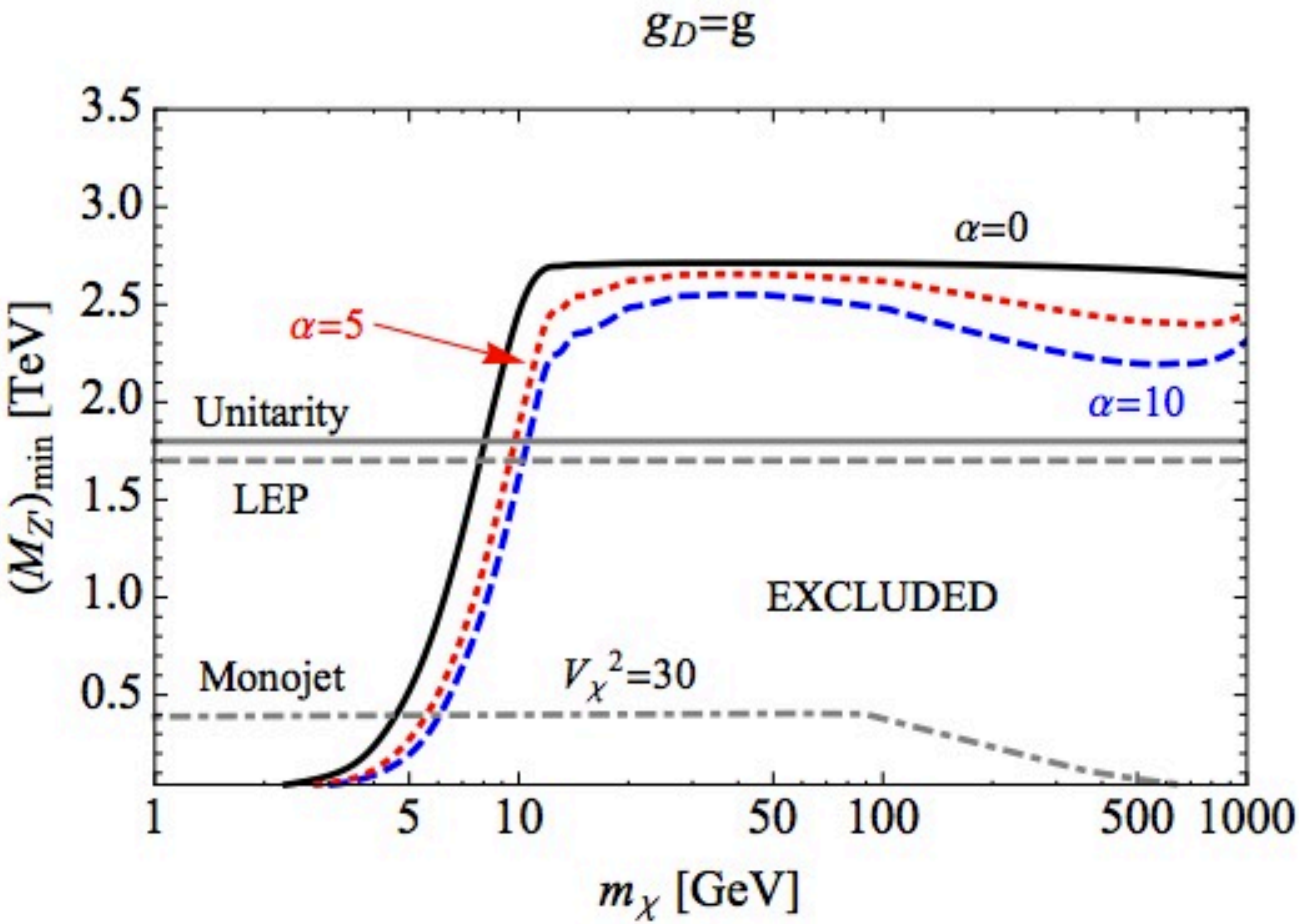


$$g_f = g_D V_f$$

$$g_\chi = g_D V_\chi$$

$$\Lambda = M/\sqrt{g_f g_\chi}$$

Summary Plot



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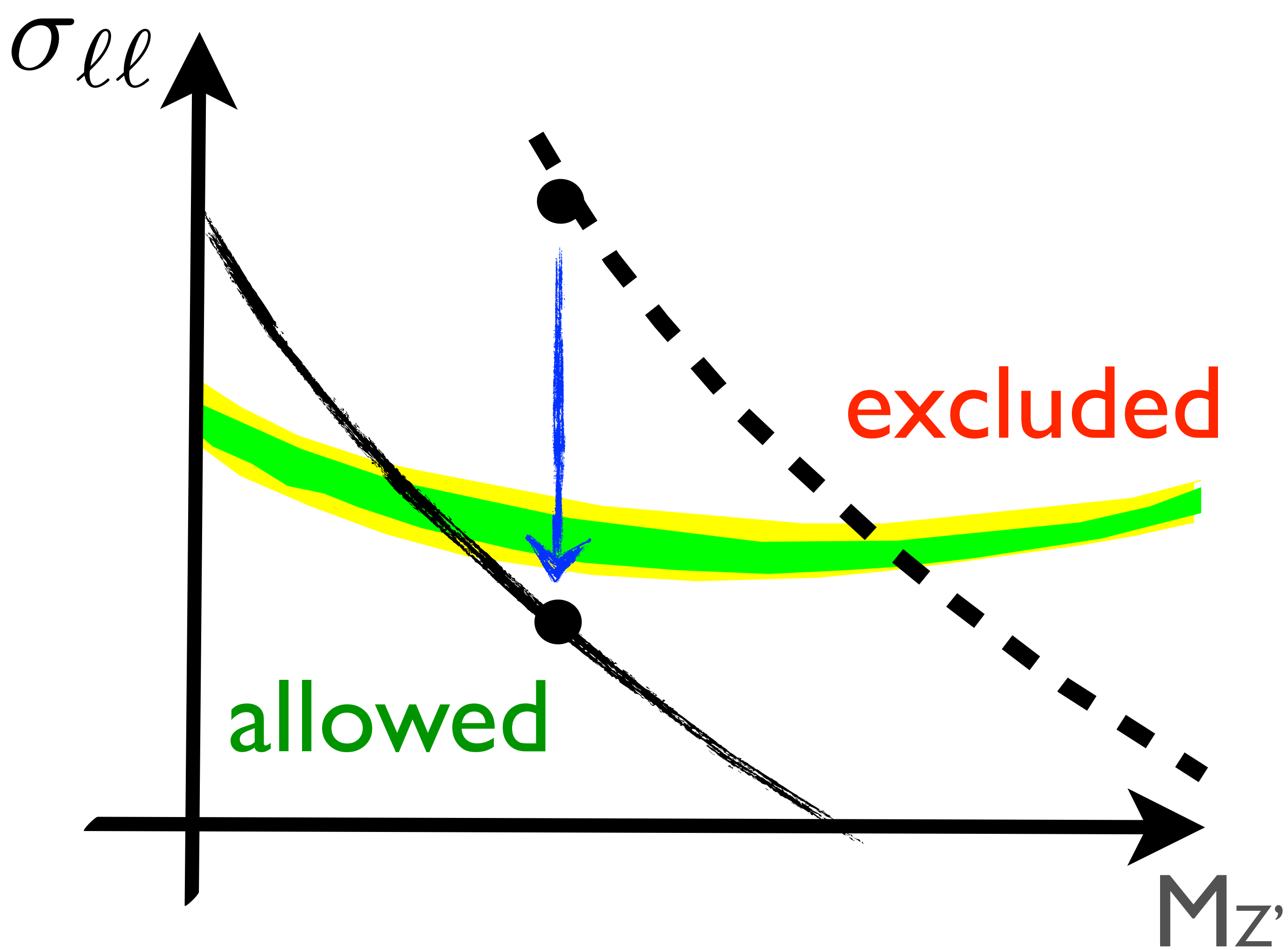

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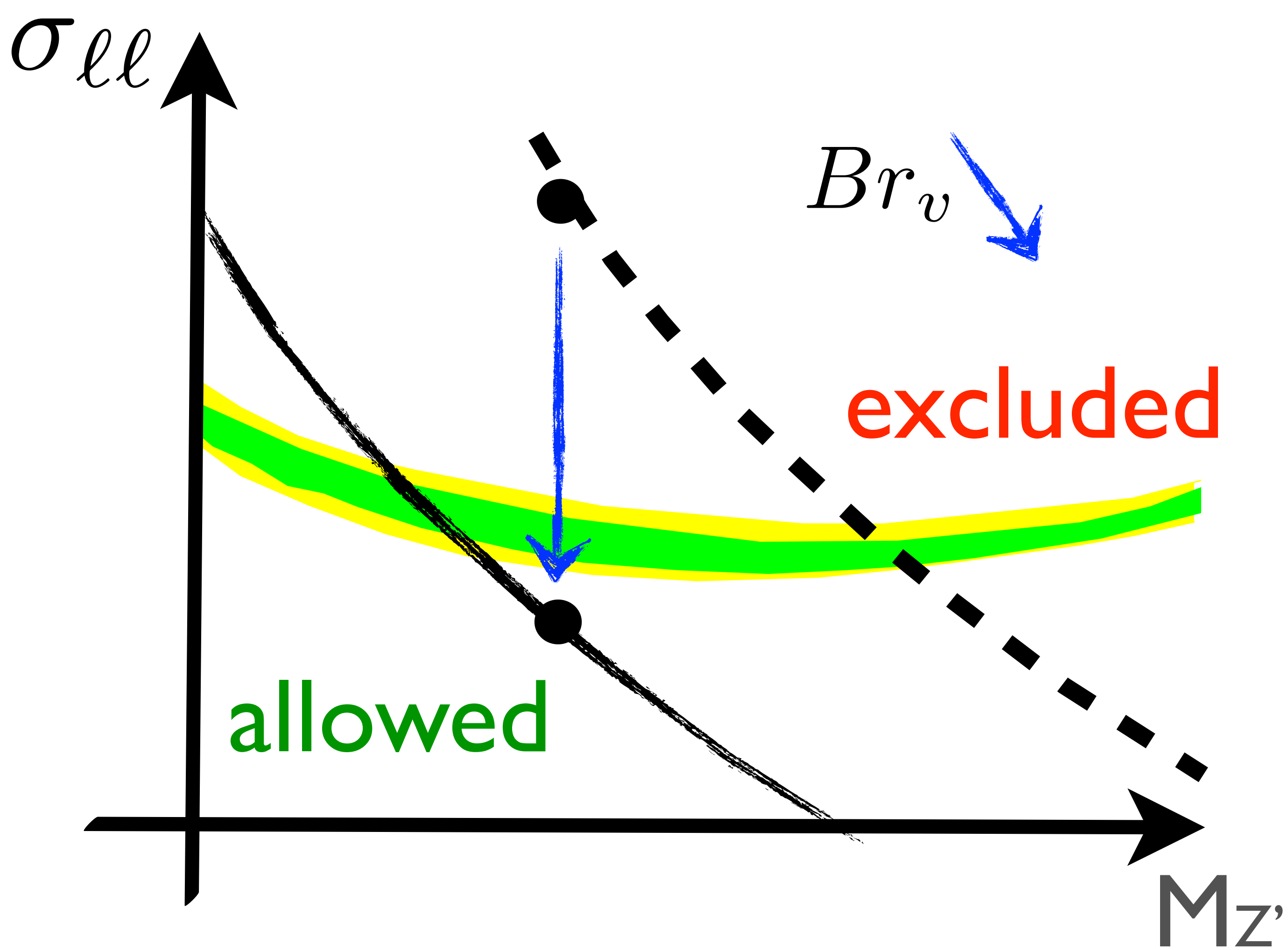

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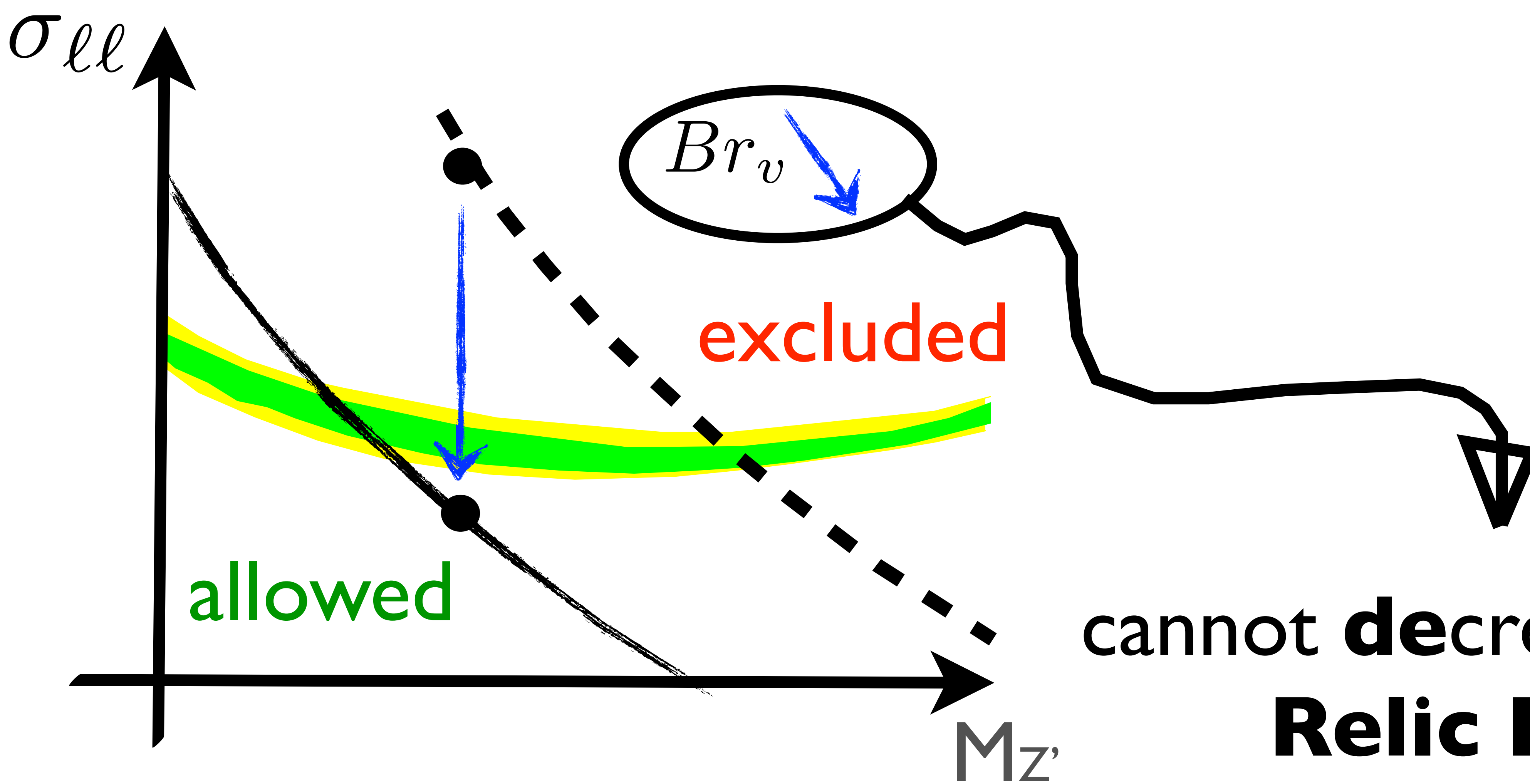

cannot **de**crease arbitrarily:
Relic Density!

Relic Abundance

Distinction of 2 regimes is relevant now

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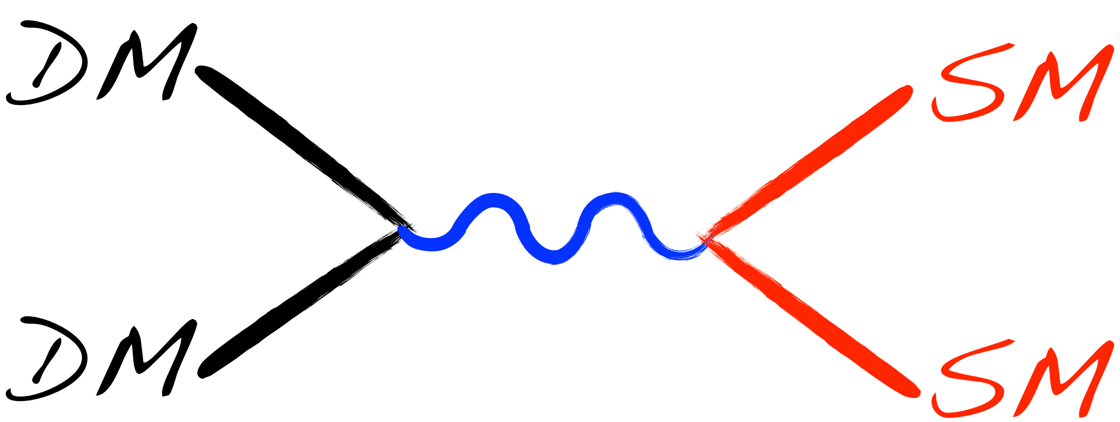
Heavy Mediator

$$M \gg m_\chi$$

e.g. vector

$$\langle \sigma v \rangle \propto \frac{g_\chi^2 g_v^2 m_\chi^2}{2\pi M^4} + \mathcal{O}(m_q^2, v^2)$$



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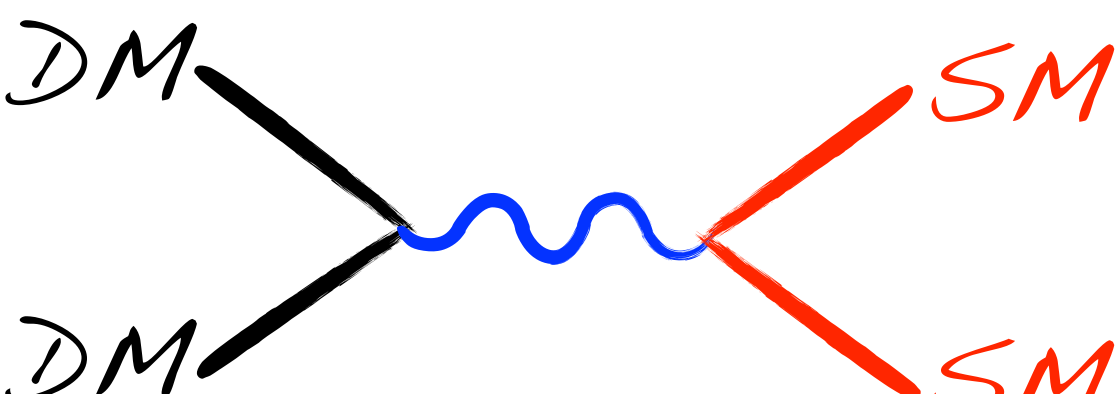
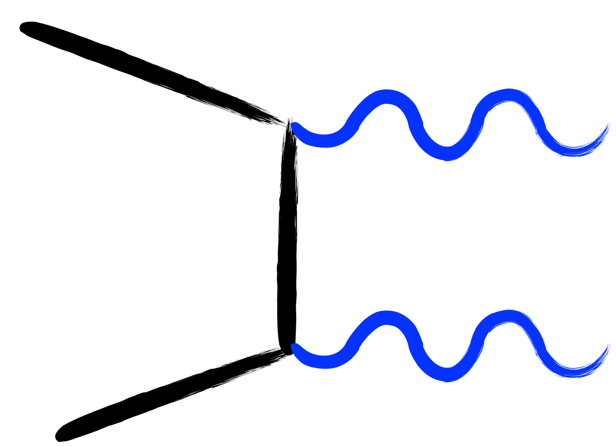


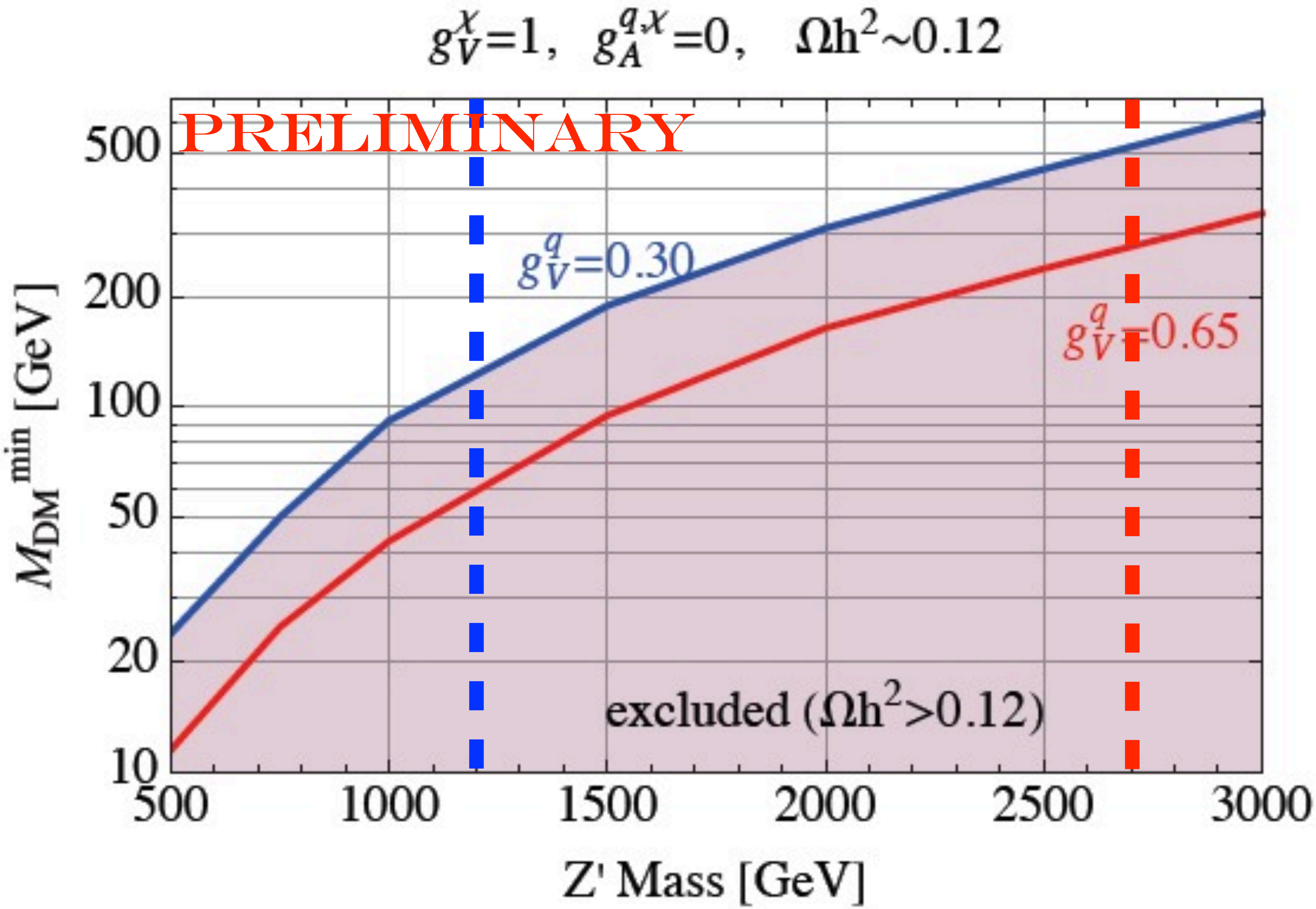
Light Mediator

$M \ll m_\chi$

$$\langle \sigma v \rangle \propto \frac{g_\chi^4}{16\pi m_\chi^2} + \mathcal{O}(v^2)$$



Heavy Mediator

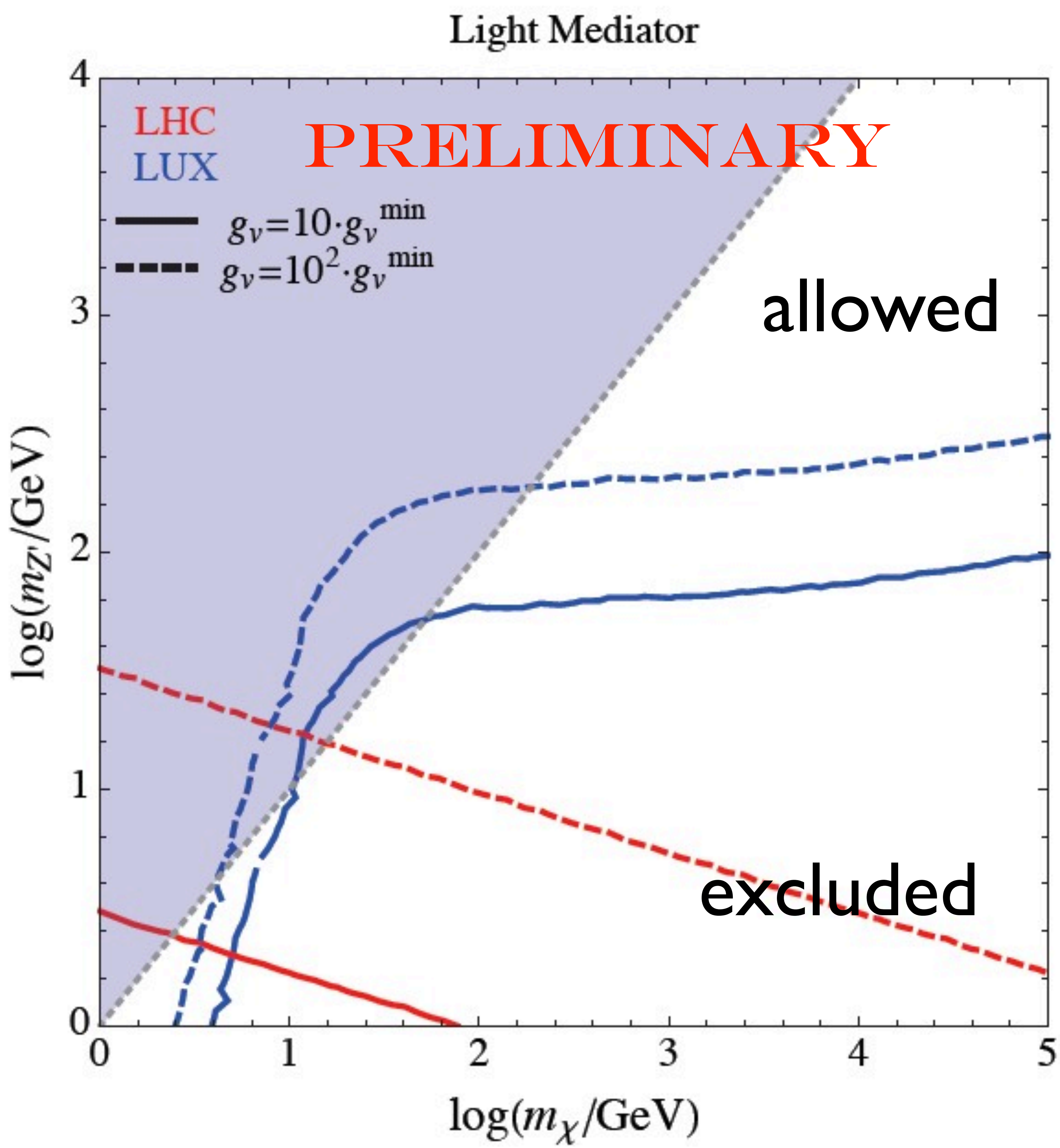


Y. Mambrini, S.Pokorski, B.Z., in preparation

Light Mediator

Di-lepton
+
Relic Abundance

Direct Detection
+
Relic Abundance



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$$\sigma^{\rm LHC}_{\rm disignal} = \tilde{f}(g_v^2, M)$$

$$\sigma_{\rm DD} = h(g_v g_\chi, m_\chi, M)$$

$$\langle \sigma v \rangle = \tilde{h}(g_v g_\chi, m_\chi, M)$$

Message

$$\mathcal{L}_{\rm UV} = f(g_v, g_\chi, m_\chi, M)$$

$$\sigma^{\rm LHC}_{\rm disignal} = \tilde{f}(g_v^2, M)$$

$$\sigma_{\rm DD} = h(g_v g_\chi, m_\chi, M)$$

$$\langle \sigma v \rangle = \tilde{h}(g_v g_\chi, m_\chi, M)$$

$$M = M(m_\chi, \sigma^{\rm exp}_{\rm LHC}, \sigma^{\rm exp}_{\rm DD}, \langle \sigma v \rangle^{\rm exp})$$

CONCLUSIONS

- Going beyond EFT has important implications for LHC studies
- For s-channel UV's, ETmiss + Direct Detection + Pure Visible give enriched complementarity
- Extra (reasonable) assumptions on UV model could imply interesting consequences on present LHC data interpretation
- **Complementarity is important: it helps discriminating models!**

- thanks!!!