Probing conversion-driven freeze-out at the LHC

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The Model

We consider a simplified model extending the SM with two fields

Field	Spin	SU(3)$_C$	SU(2)$_L$	U(1)$_Y$	Z$_2$
X	1/2 (Majorana)	1	1	0	Odd
Y	0	3	1	-2/3	Odd

Interacting via a Yukawa-like term
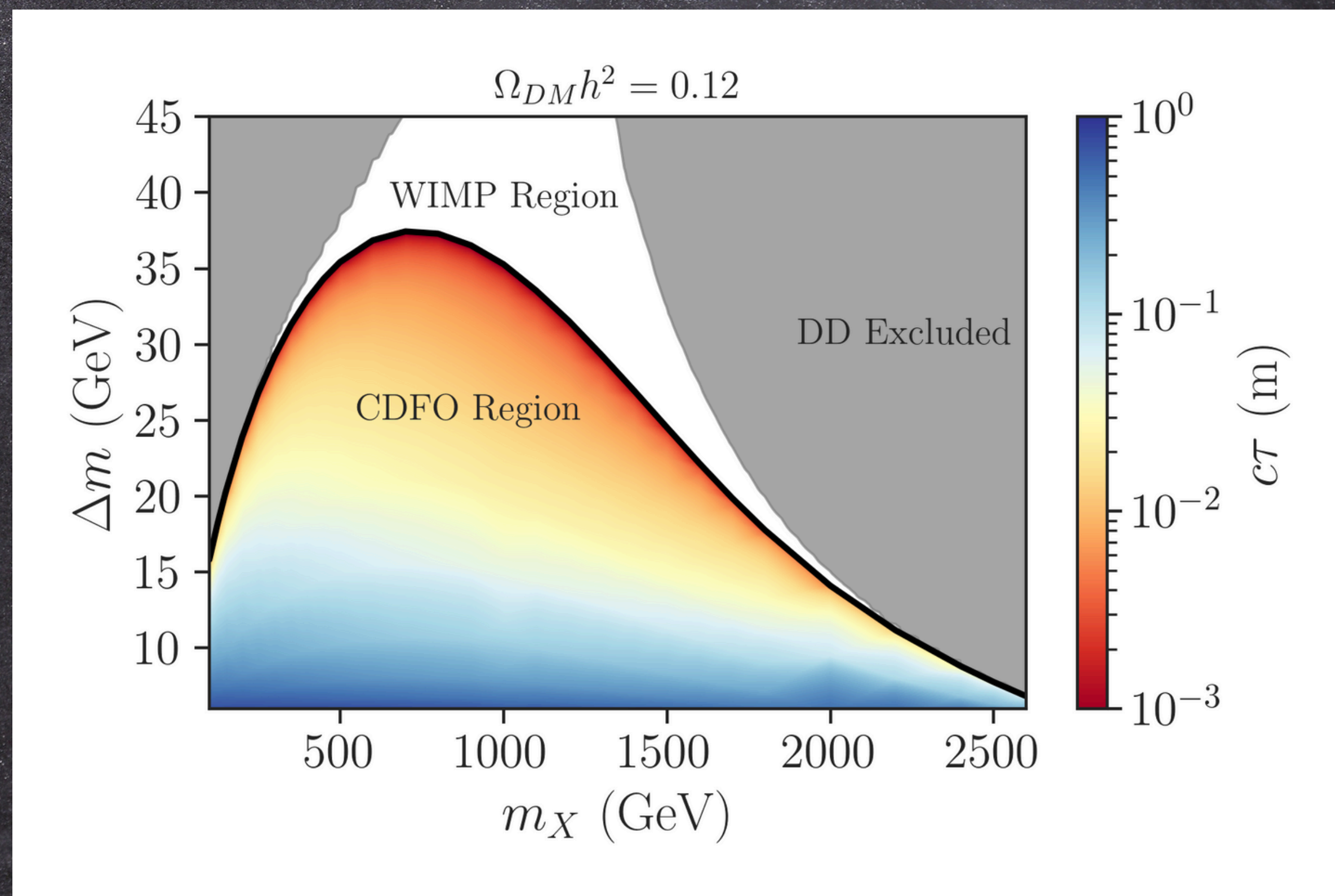
$$\mathcal{L}_{\text{int}} = \lambda_X Y \bar{q}_R X + \text{h.c.}$$

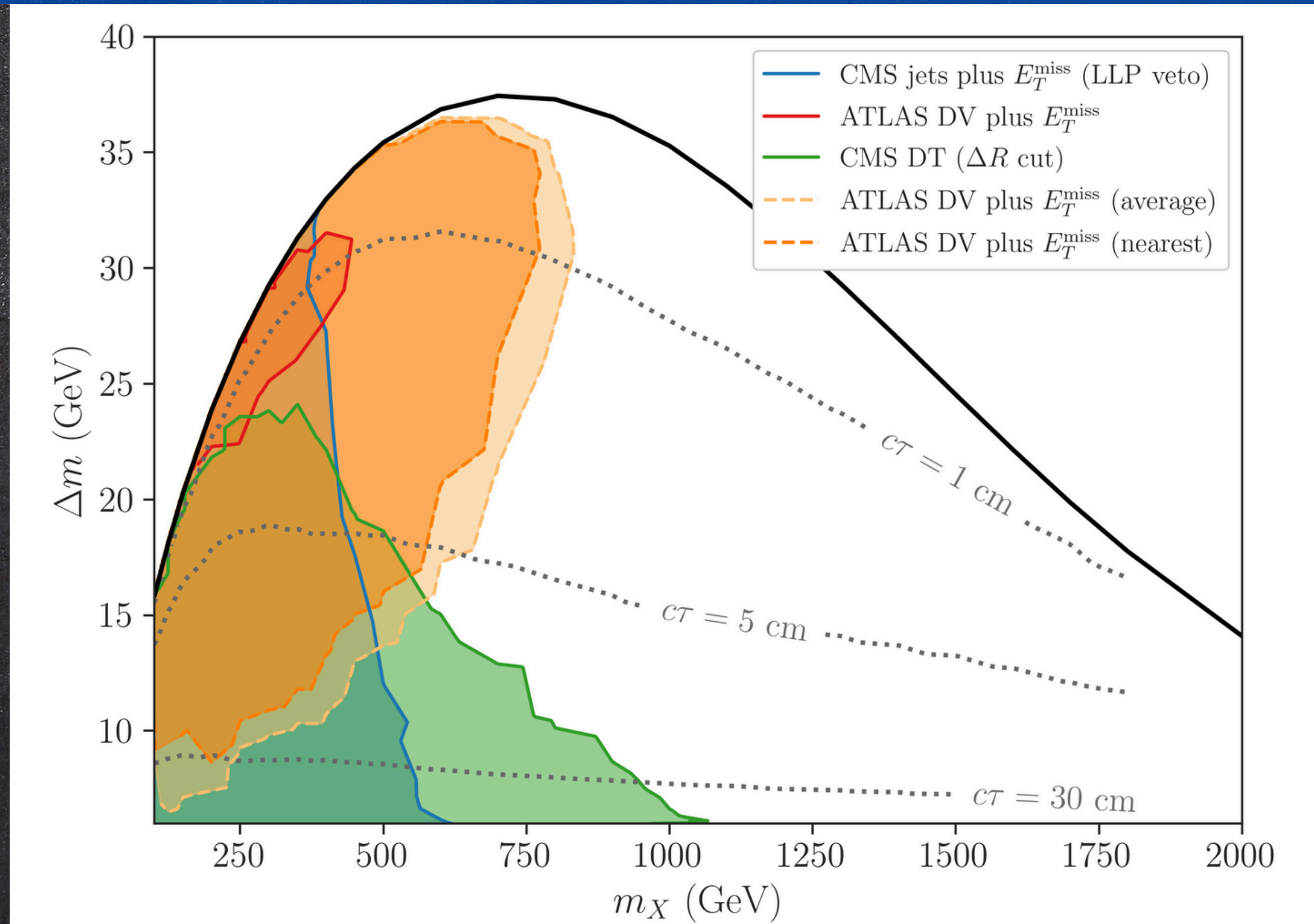**Quarkphillic "t-channel" Dark Matter Model**

The Conversion-Driven Regime

- **If the trillinear coupling is very small (~10^{-7}), X and Y are not in chemical equilibrium during freeze-out, and part of the parameter space forbidden in coannihilations becomes allowed**

Current constraints + Proposed Search

"Probing conversion-driven freeze-out at the LHC" - arXiv:2404.16086

Conclusions

- **The Conversion-driven freeze-out regime is a viable, and thus also necessary alternative for DM production in order to have a full coverage of allowed parameter space**

- **Expected lifetimes match up well with collider experiments, but current searches are still limited, with challenges to cover soft and slightly displaced signatures**

- **Nevertheless, we show that small adjustments can have a very sizable impact in the sensitivity of future searches even with current statistics and systematics.**

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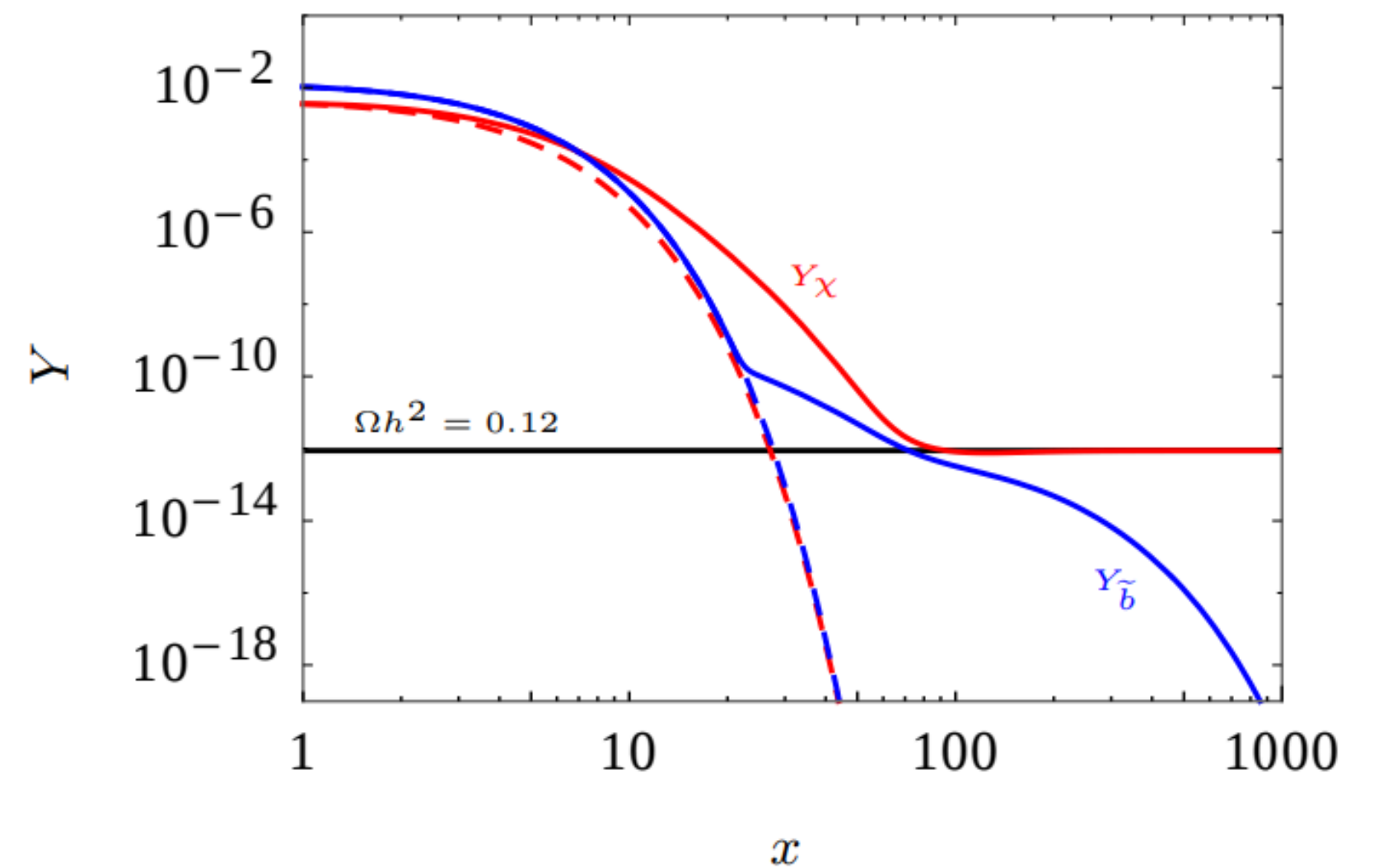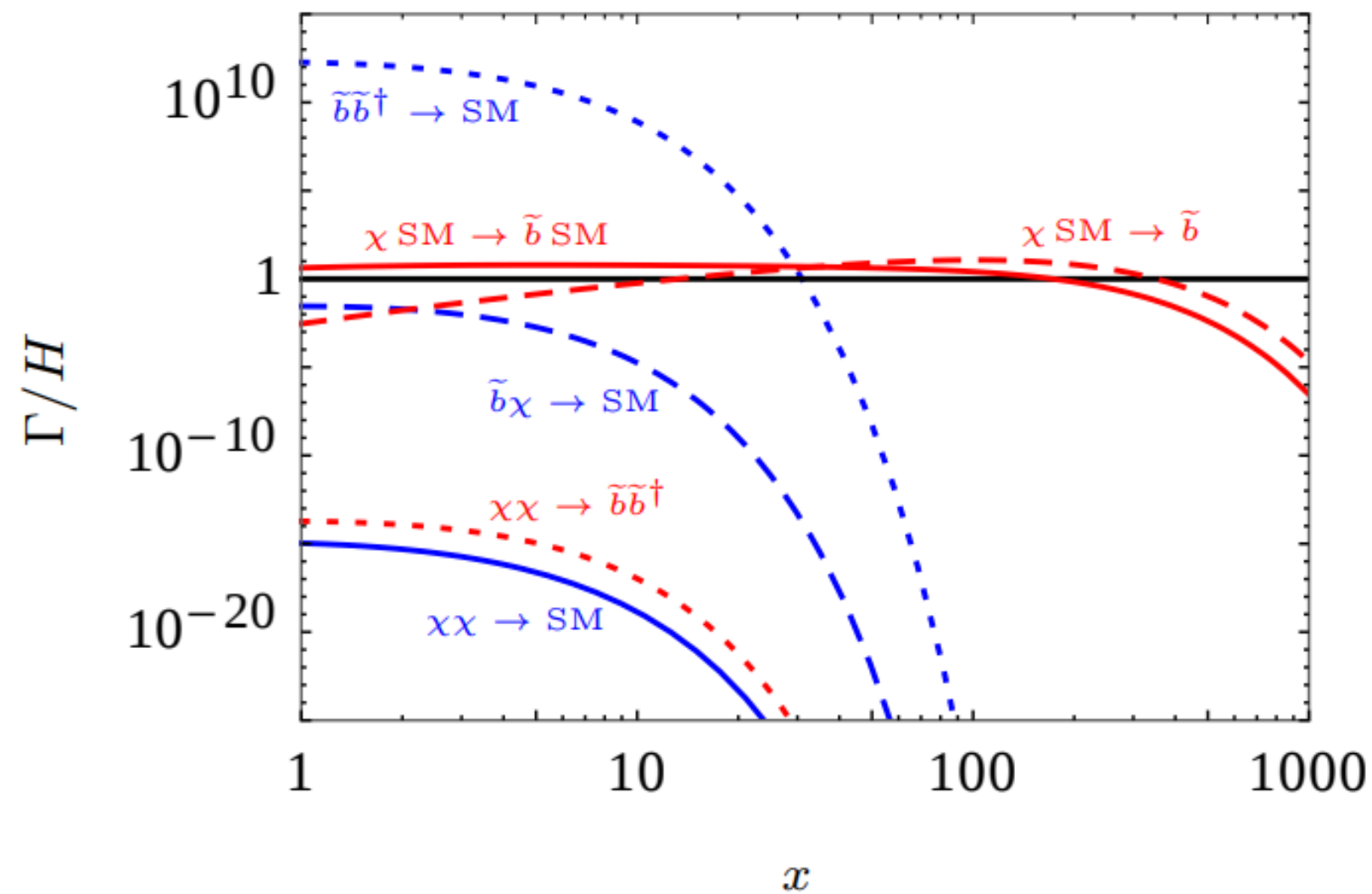
Acknowledgements

...and thanks for your attention!

(And following, backup slides)

The Conversion-Driven Regime

HiLumi Projections