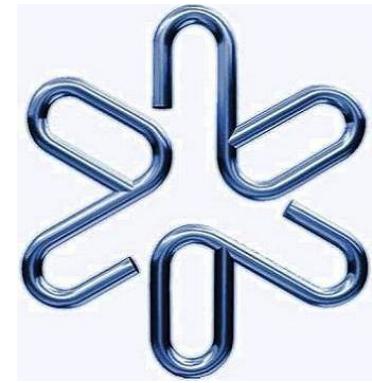


MeV dark matter: EFT constraints

Giovanni Grilli di Cortona



Istituto de Física
Universidade de São Paulo

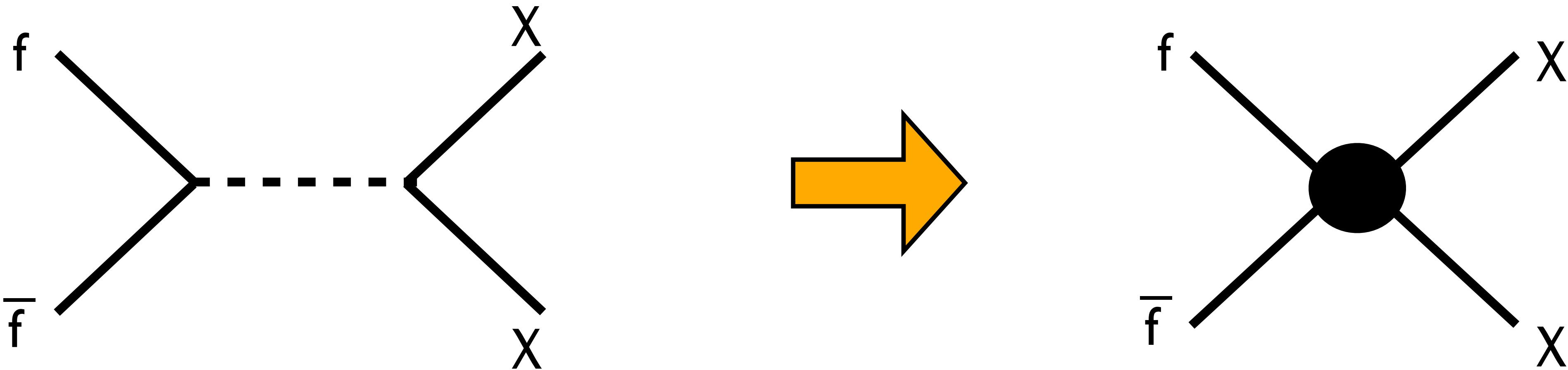


based on: E. Bertuzzo, C. Caniu and GGdC

JHEP 1708 (2017) 093 - arXiv:1705.06325

A. Belyaev, E. Bertuzzo, C. Caniu, O. Eboli, GGdC, F. locco in prep.

Dark Matter Effective Field Theory



$$\mathcal{L} = \mathcal{L}_{\text{SM}} + \mathcal{L}_{\text{DM}} + \mathcal{L}_V + J_{\text{DM}}^\mu V_\mu + J_{\text{SM}}^\mu V_\mu$$

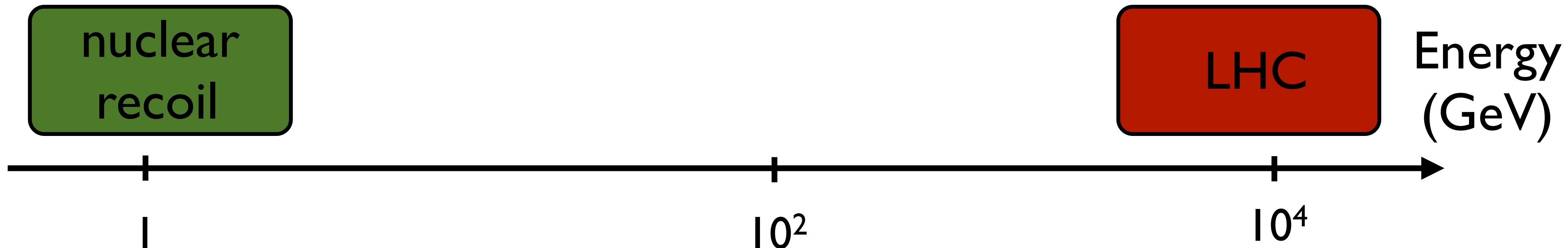
$$\mathcal{L} \supset \sum_i \frac{c_i}{\Lambda^{d-4}} J_{\text{DM}}^\mu J_\mu^{\text{SM}}$$

$$J_\mu^{\text{SM}} = \bar{f}_i \gamma_\mu f_i$$

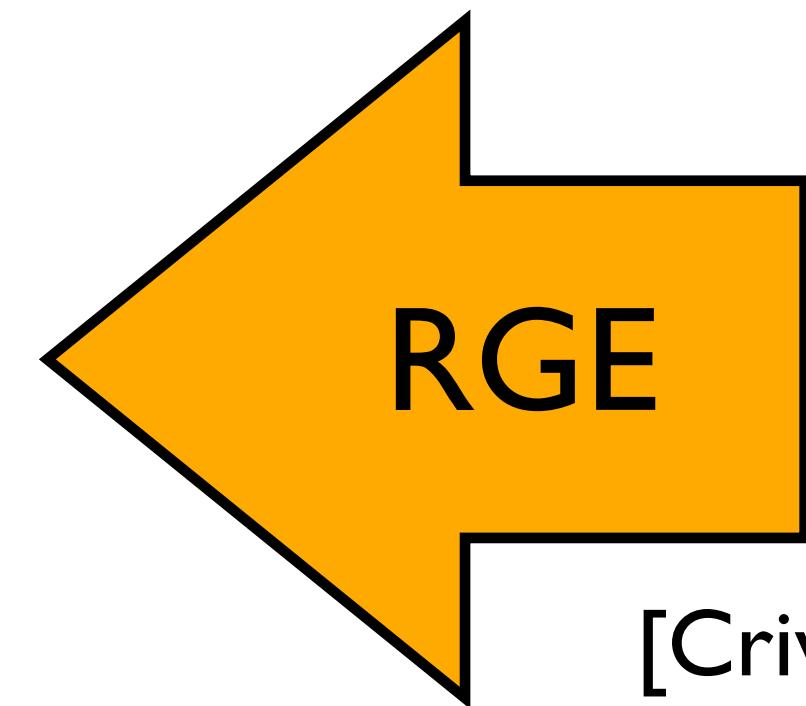
$$J_\mu^{\text{DM}} = \bar{\chi} \gamma_\mu \chi$$

$$c_i = g_*^{n_i - 2}$$

Dark Matter Effective Field Theory



$$\mathcal{L} \supset \sum_i \frac{g_*^2(\mu)}{\Lambda^2} (\bar{f}_i \gamma_\mu f_i) (\bar{\chi} \gamma^\mu \chi)$$

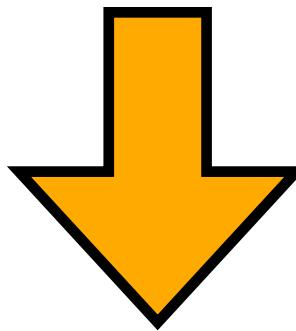


[Crivellin et al '14,
D'Eramo et al '14,
D'Eramo et al '16]

$$\mathcal{L} \supset \sum_i \frac{g_*^2(\Lambda)}{\Lambda^2} (\bar{f}_i \gamma_\mu f_i) (\bar{\chi} \gamma^\mu \chi)$$

Effects of the running

$$\mathcal{L} \supset \sum_{i=1}^3 \frac{g_*^2(\Lambda)}{\Lambda^2} [\bar{u}_i \gamma_\mu u_i + \bar{d}_i \gamma_\mu d_i] (\bar{\chi} \gamma^\mu \chi)$$

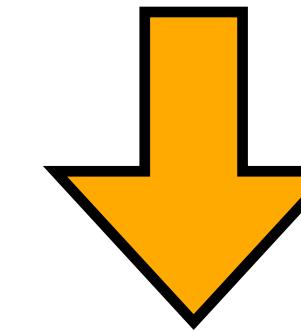


RGE

- I) modify the coupling
- II) generate coupling of DM with leptons

$$c_V^{(\ell)}(1 \text{ GeV}) \simeq \frac{4\alpha_{em}}{3\pi} g_*^2(\Lambda) \left[\theta(\Lambda - m_Z) \ln \frac{\Lambda}{m_Z} + \frac{1}{2} \ln \frac{\Lambda}{m_Z} \right]$$

$$\mathcal{L} \supset \sum_{i=1}^3 \frac{g_*^2(\Lambda)}{\Lambda^2} (\bar{\ell}_i \gamma_\mu \ell_i) (\bar{\chi} \gamma^\mu \chi)$$



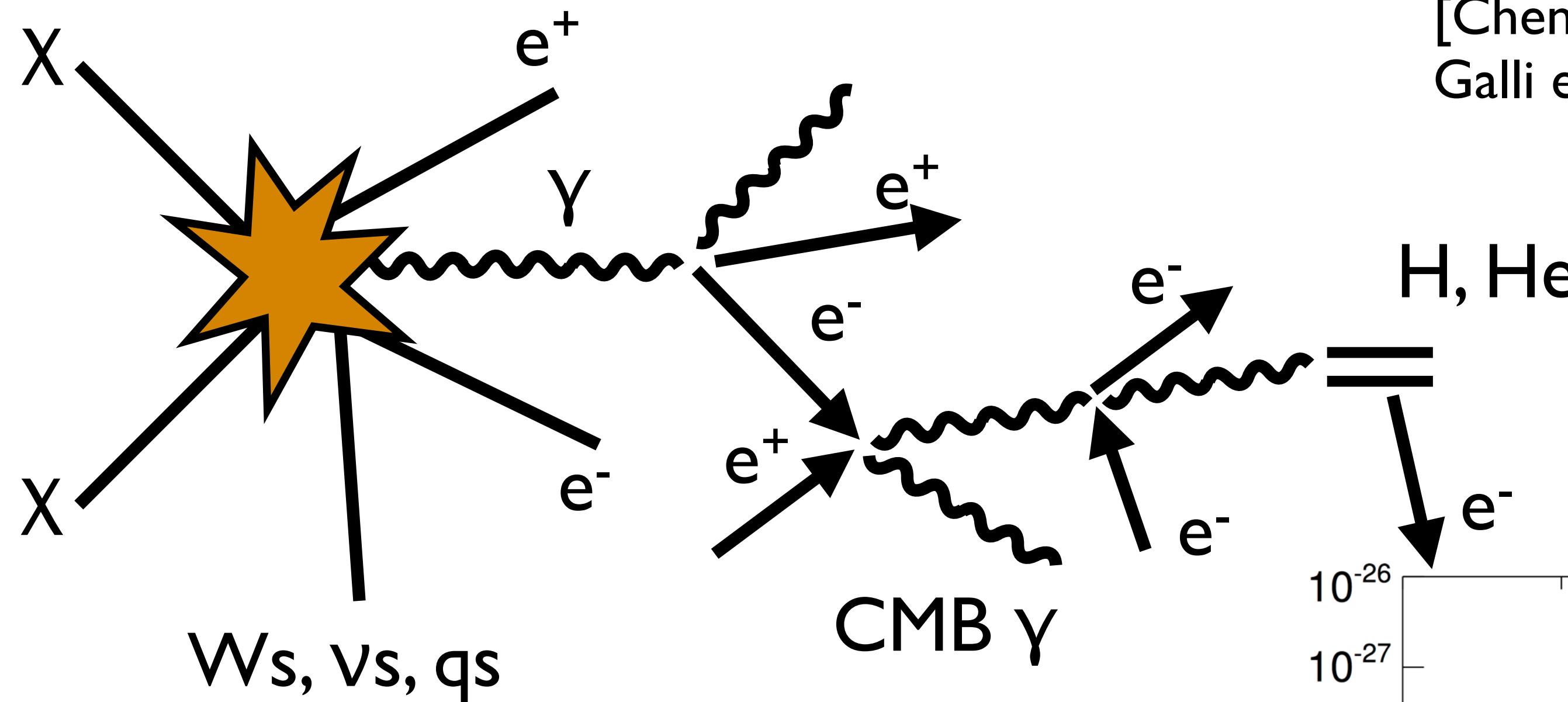
RGE

- I) modify the coupling
- II) generate coupling of DM with quarks

$$c_V^{(u)}(1 \text{ GeV}) \simeq \frac{4\alpha_{em}}{3\pi} g_*^2(\Lambda) \ln \frac{\Lambda}{m_Z}$$

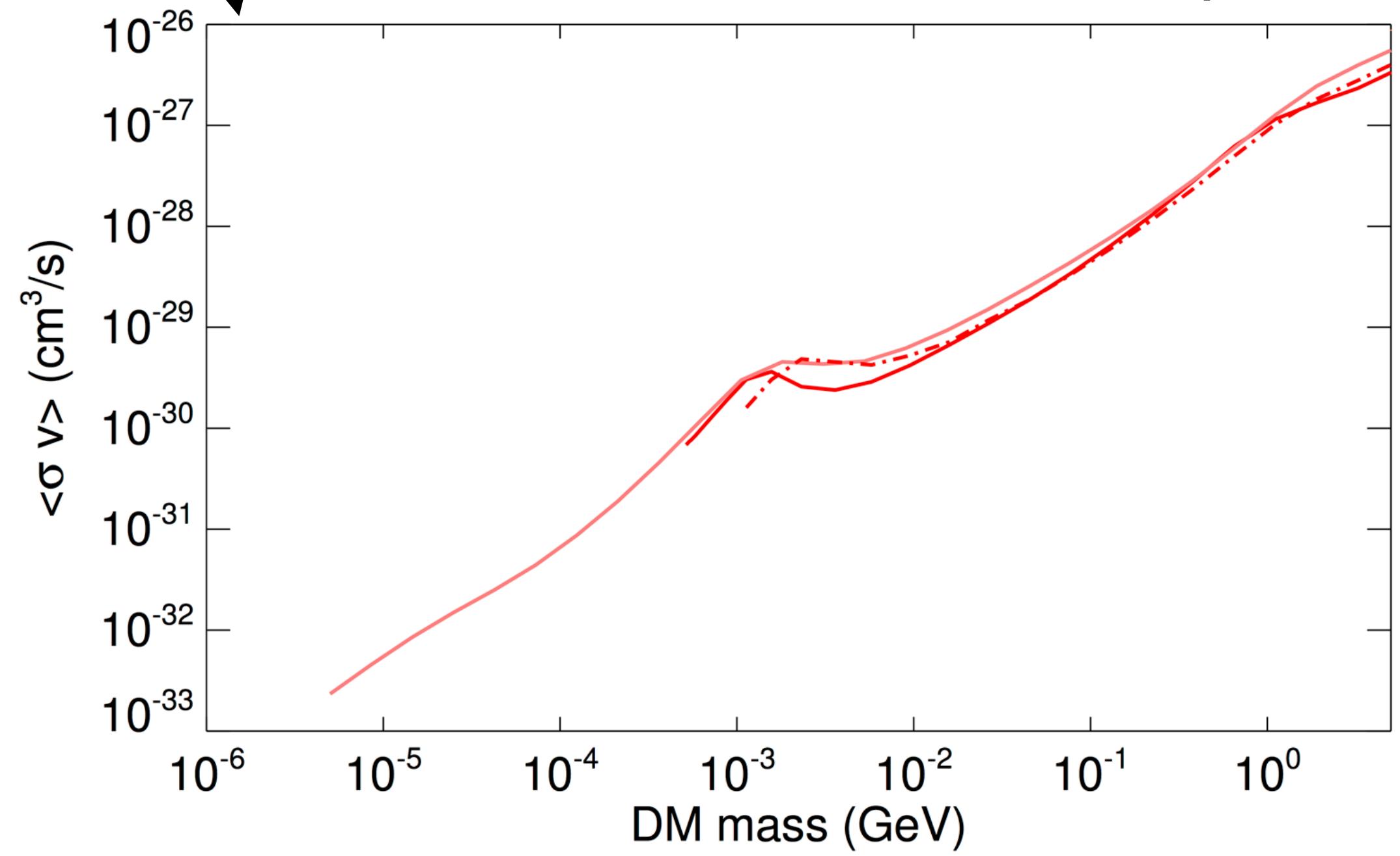
$$c_V^{(d)}(1 \text{ GeV}) \simeq -\frac{2\alpha_{em}}{3\pi} g_*^2(\Lambda) \ln \frac{\Lambda}{m_Z}$$

CMB and BBN

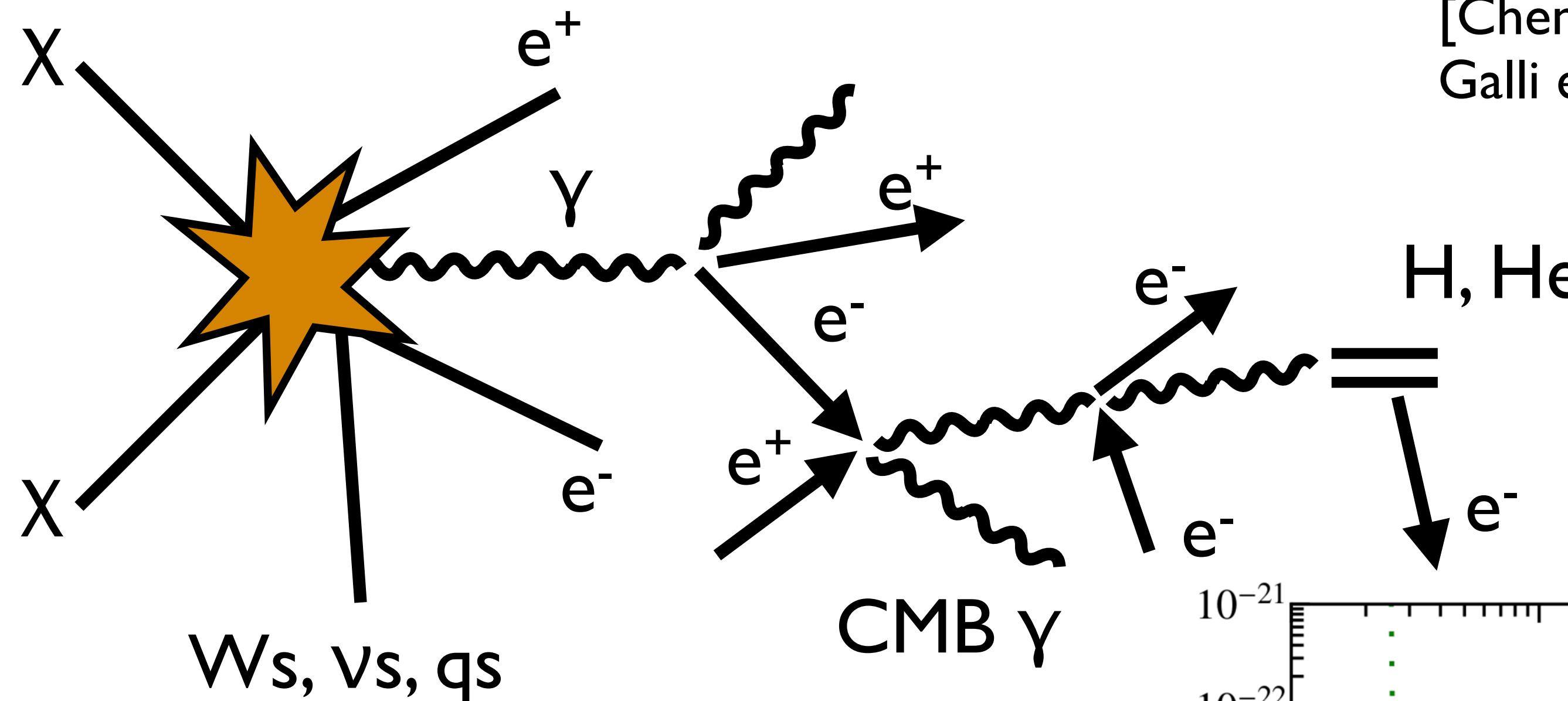


[Chen et al '03, Padmanabhan et al '05,
Galli et al '09, Slatyer et al '09]

[Slatyer '15]

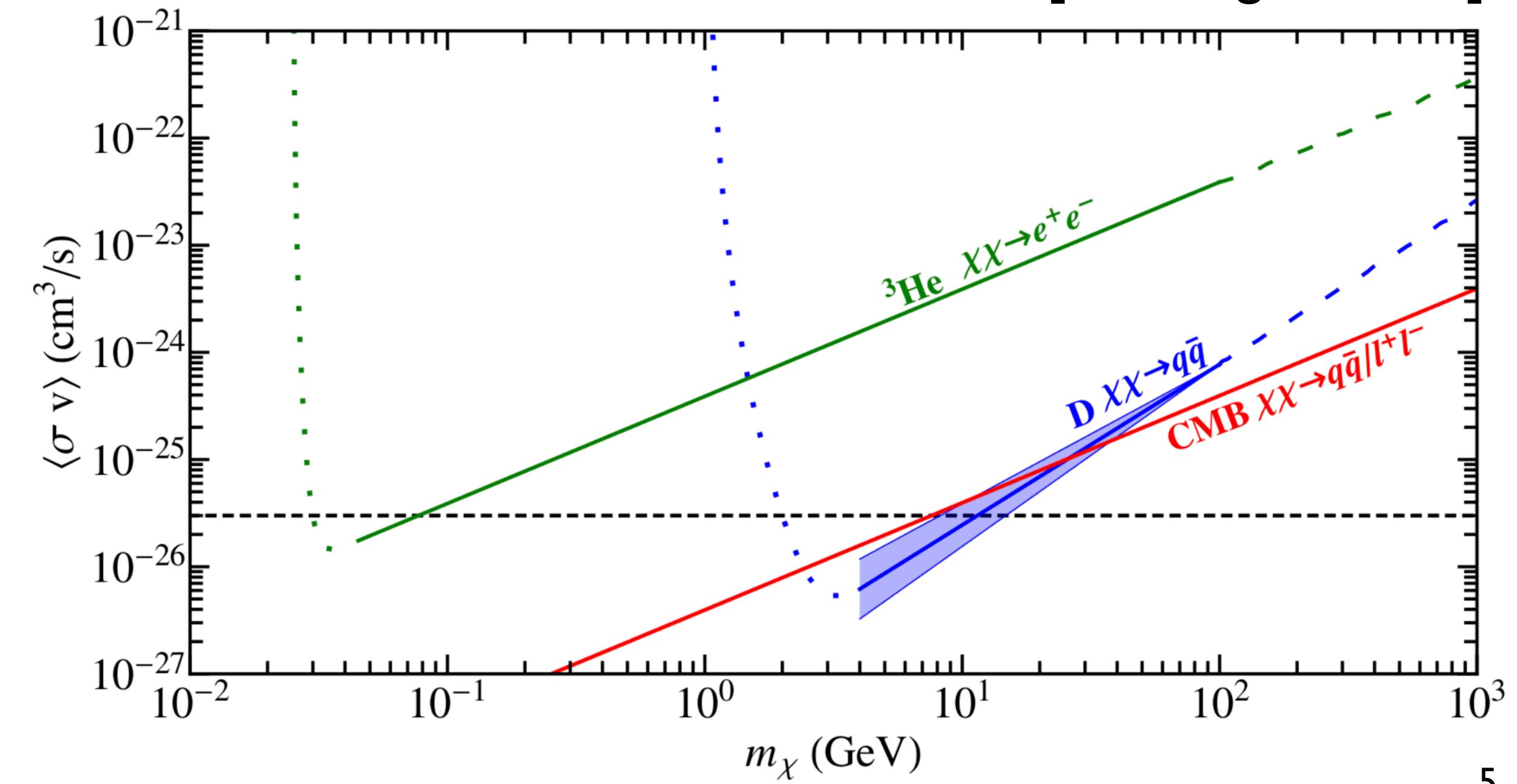


CMB and BBN



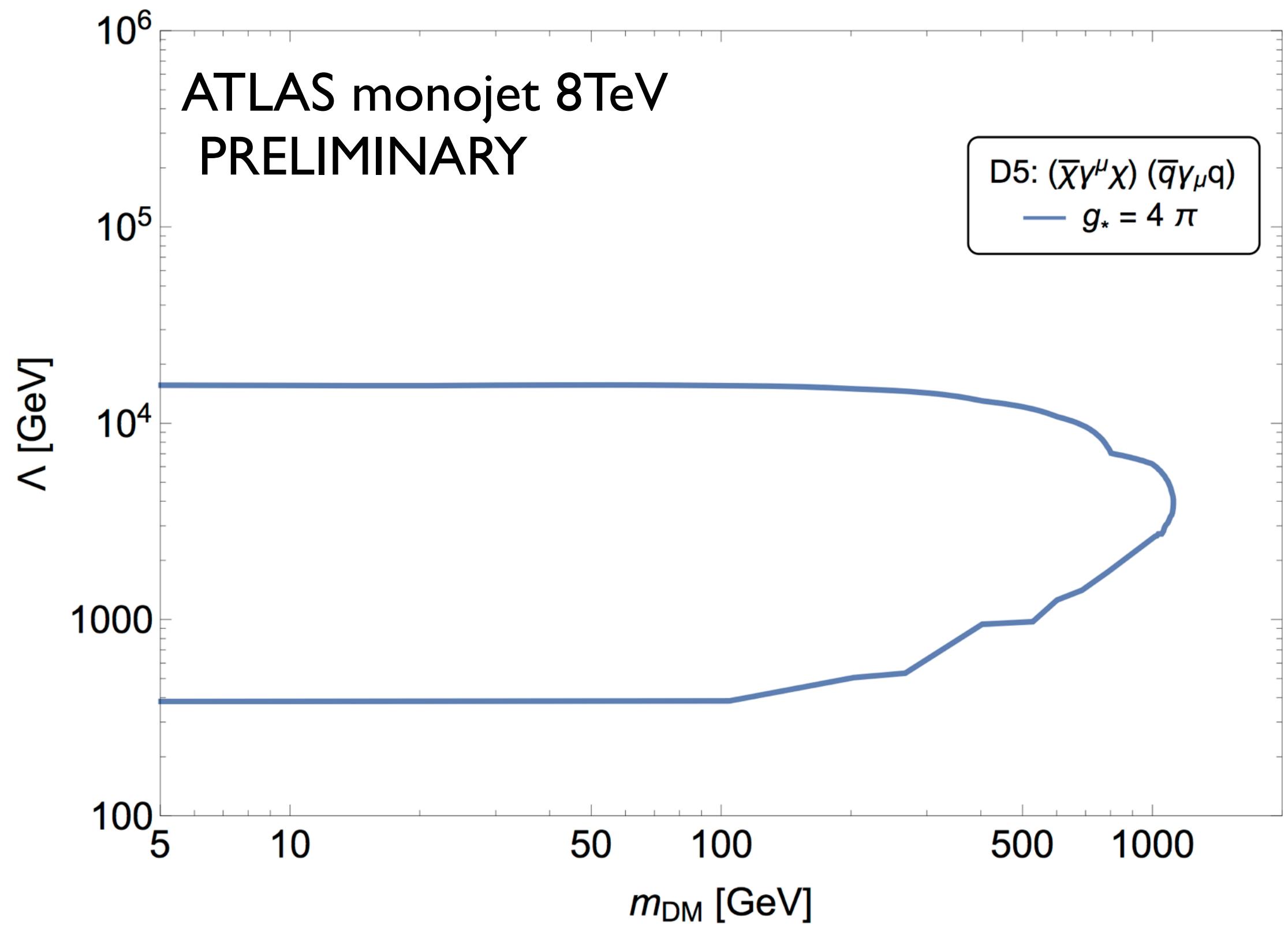
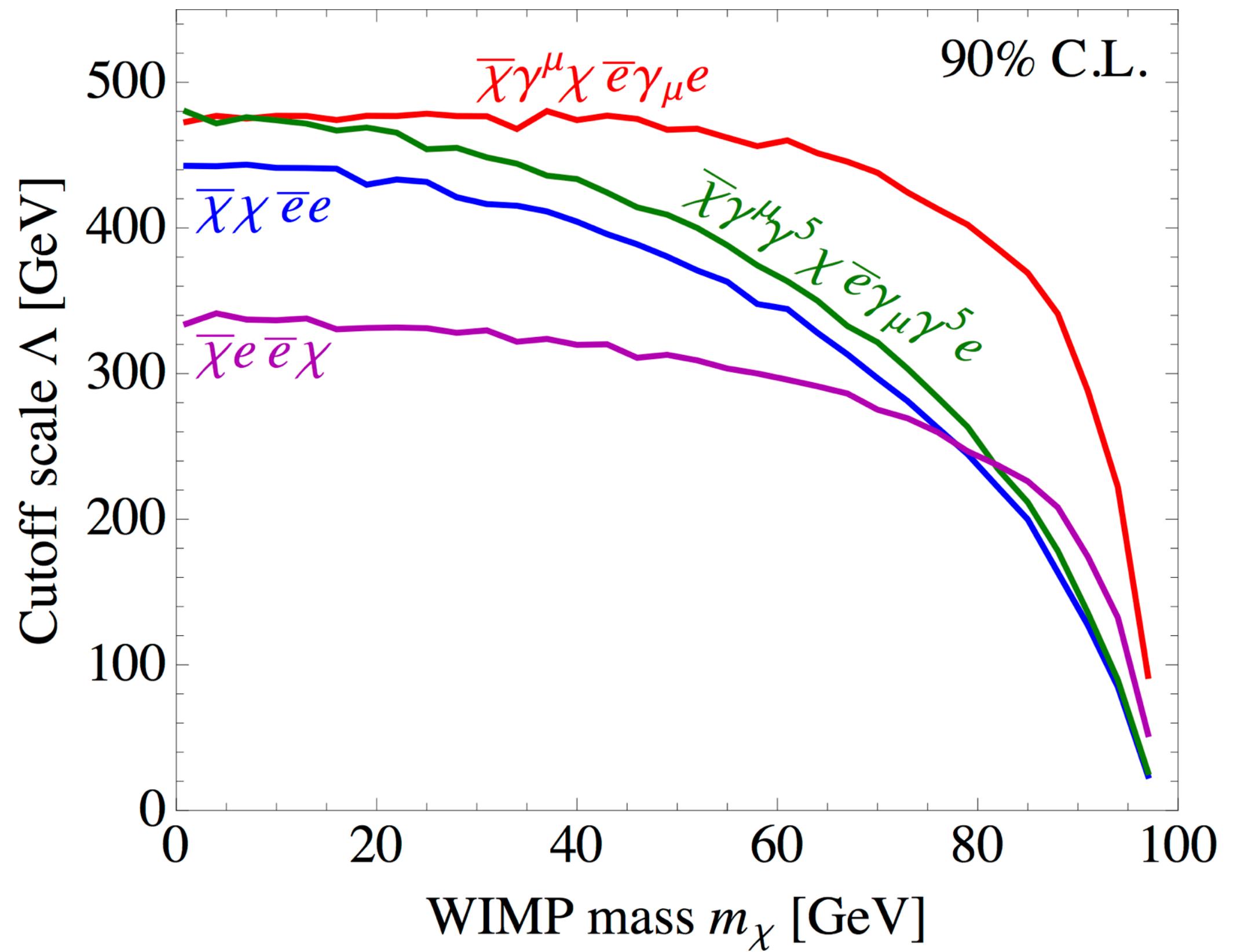
[Chen et al '03, Padmanabhan et al '05,
Galli et al '09, Slatyer et al '09]

[Henning et al '12]



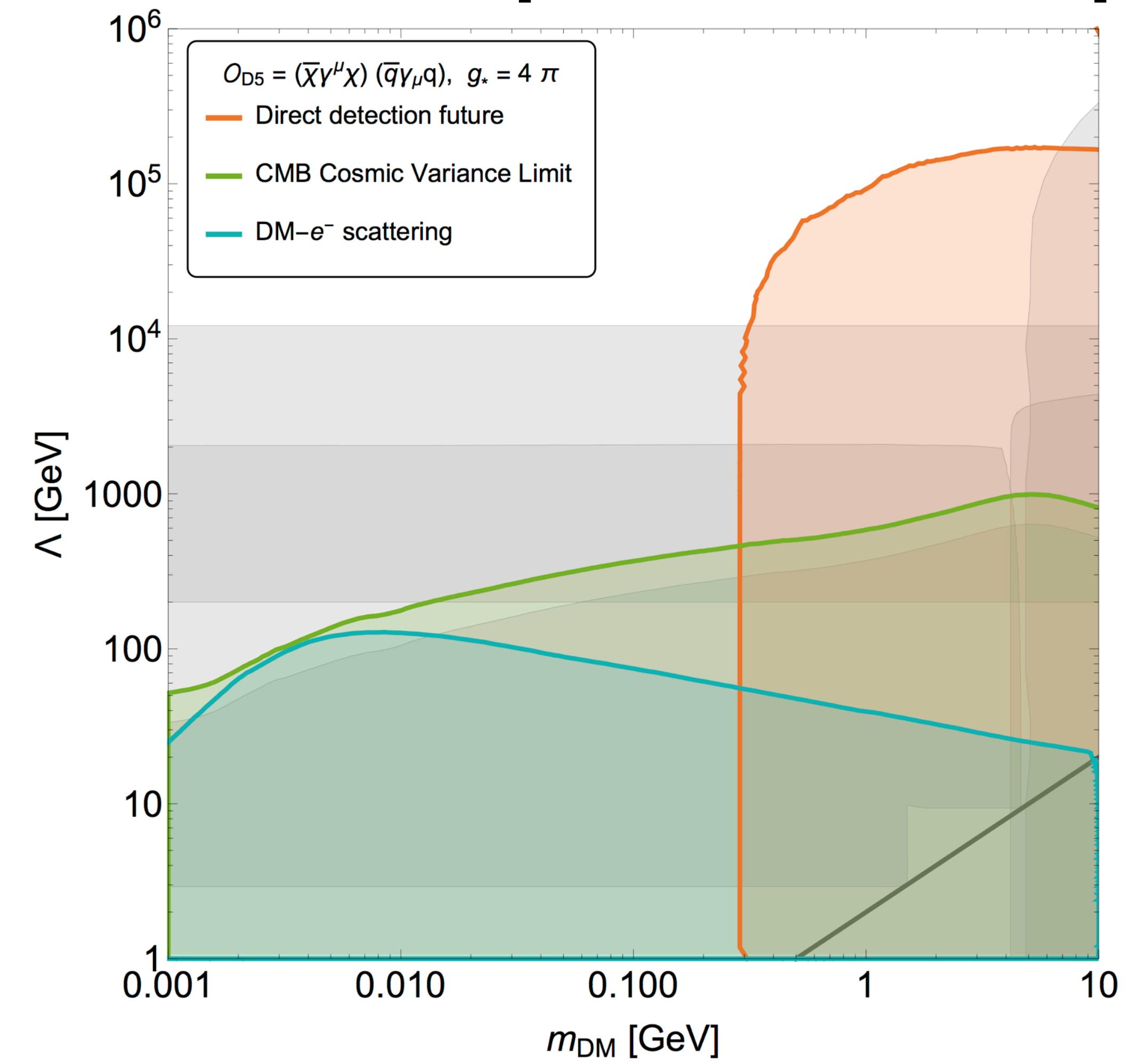
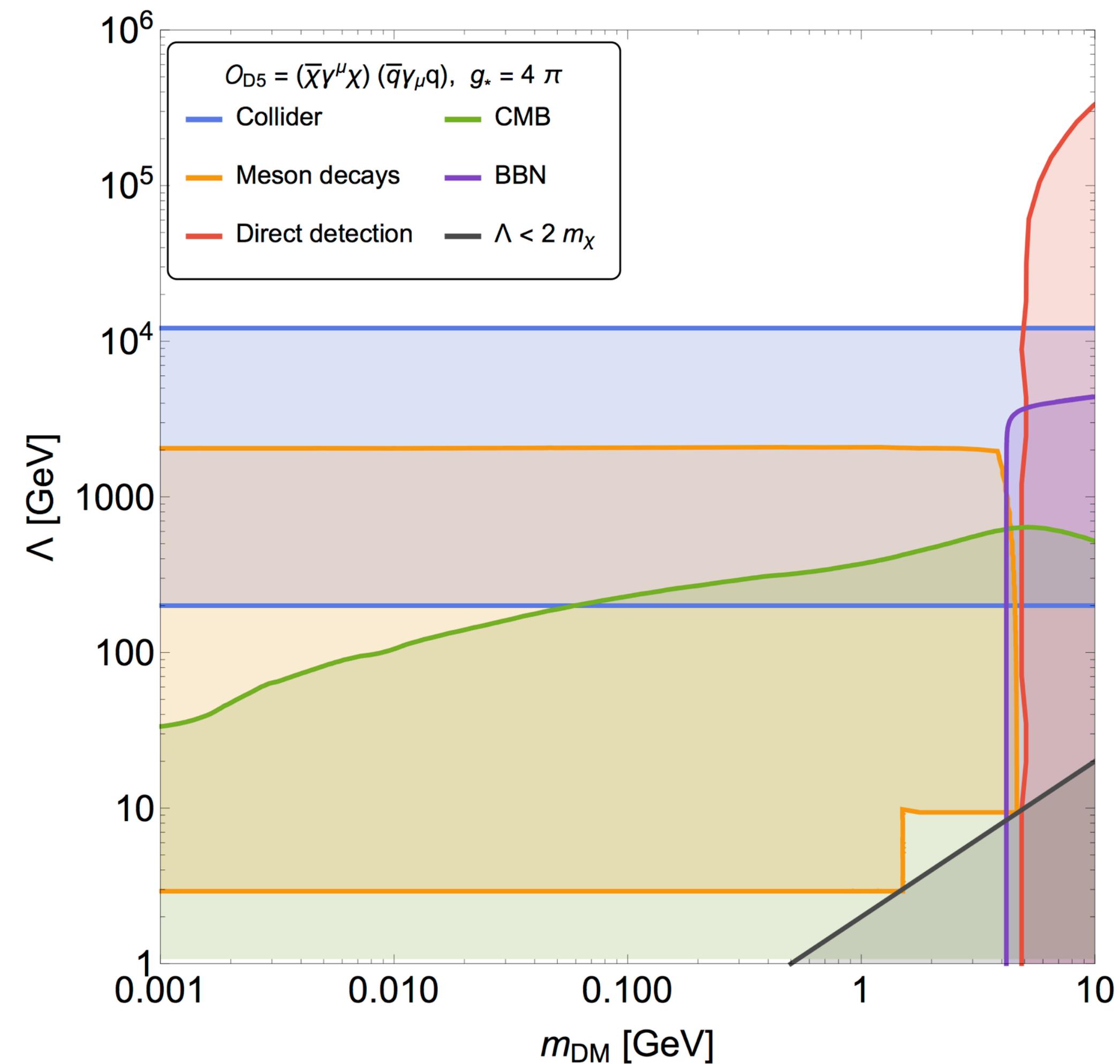
Collider

[Fox et al '11]



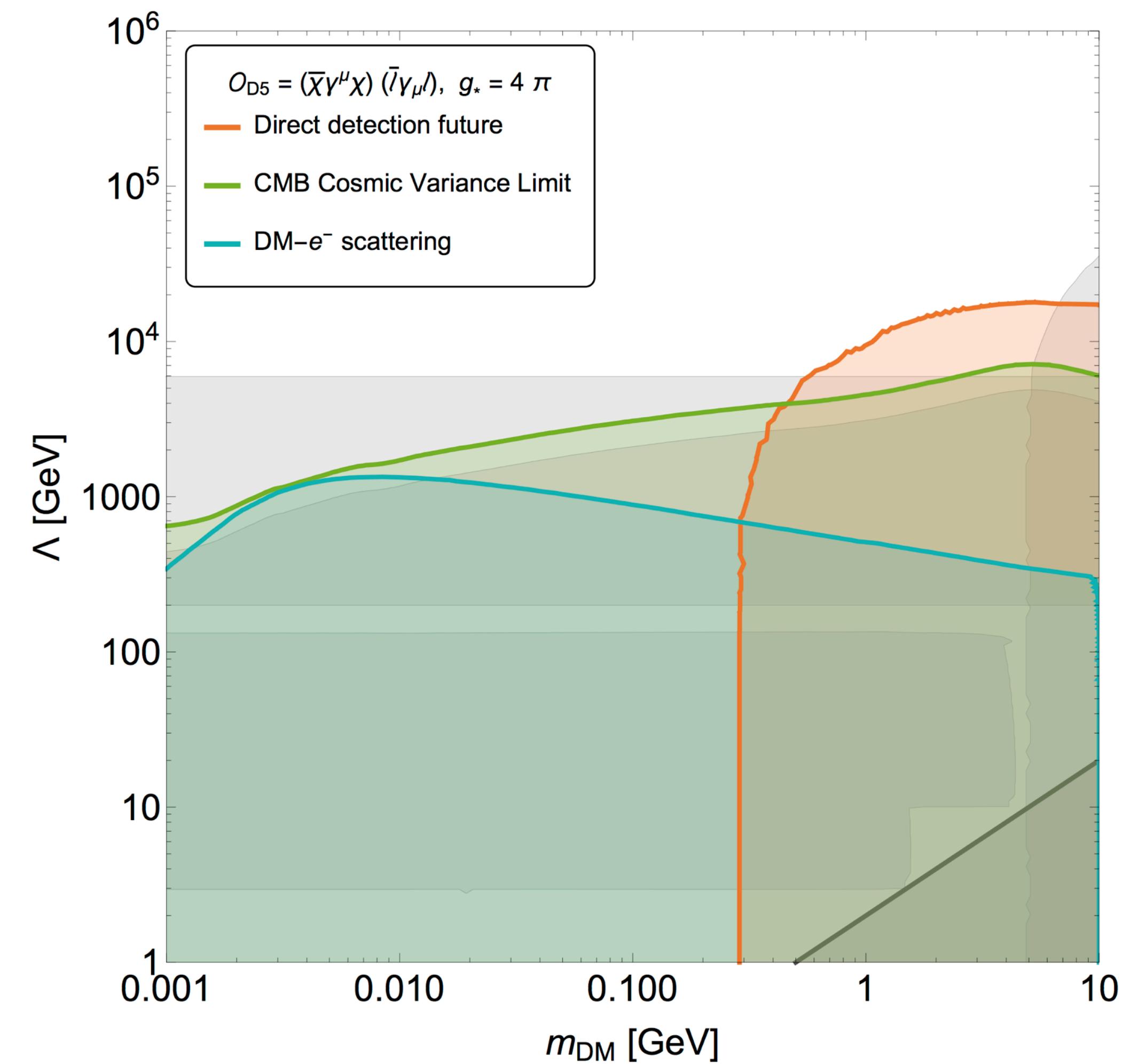
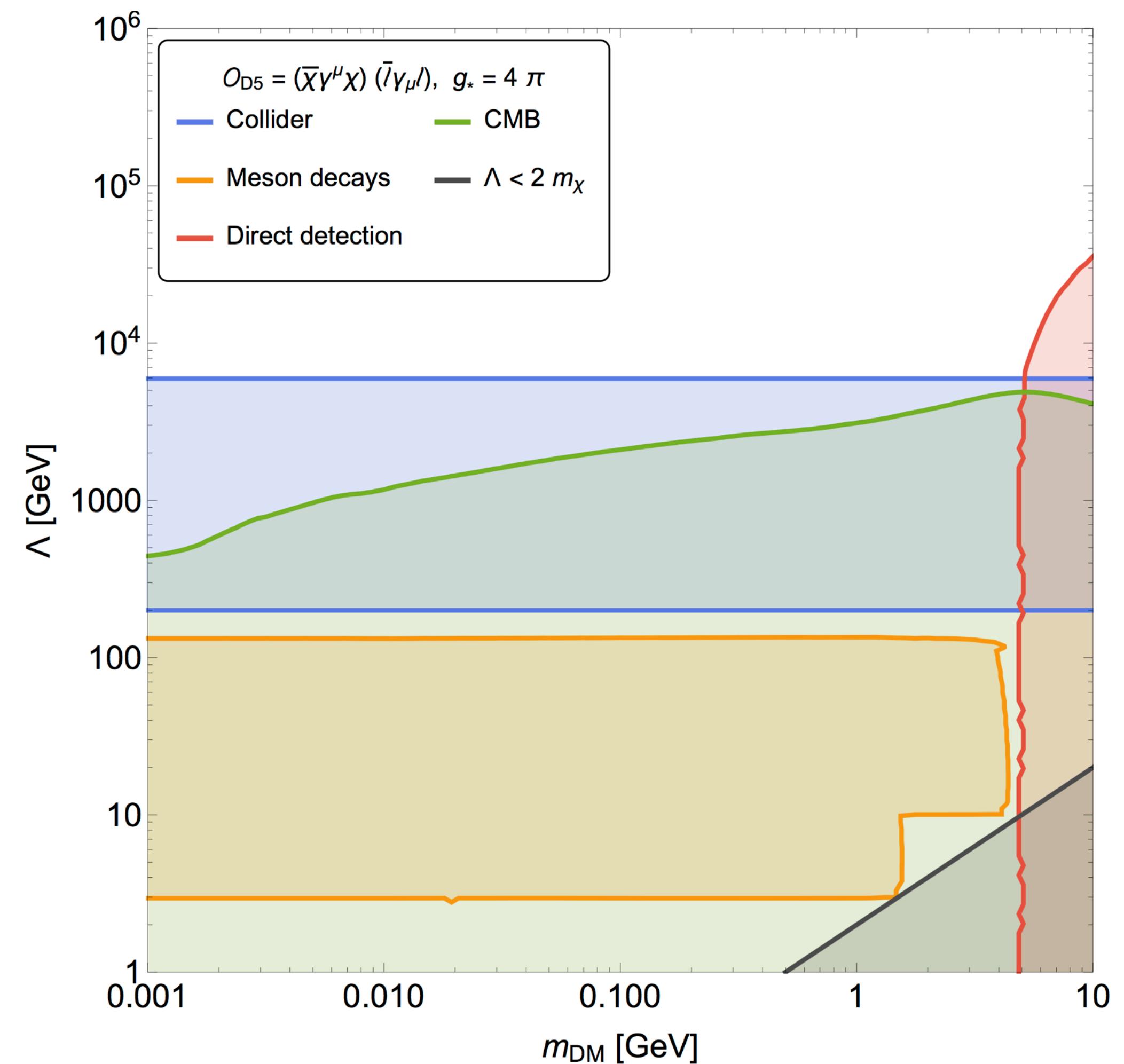
Summary

[Bertuzzo, Caniu, GGdC '17]



Summary

[Bertuzzo, Caniu, GGdC '17]



Conclusions

We analyzed Dark Matter in the MeV range in the effective field theory framework.

We showed constraints and future prospect from collider, meson decay, DM direct detection experiments, DM-electron scattering experiments, CMB and BBN.

Most of the parameter space to which future electron scattering and CMB experiments are sensitive is already ruled out.