Higher order dark matter annihilations in the Sun and implications for IceCube

Talk at PONT Avignon 2014

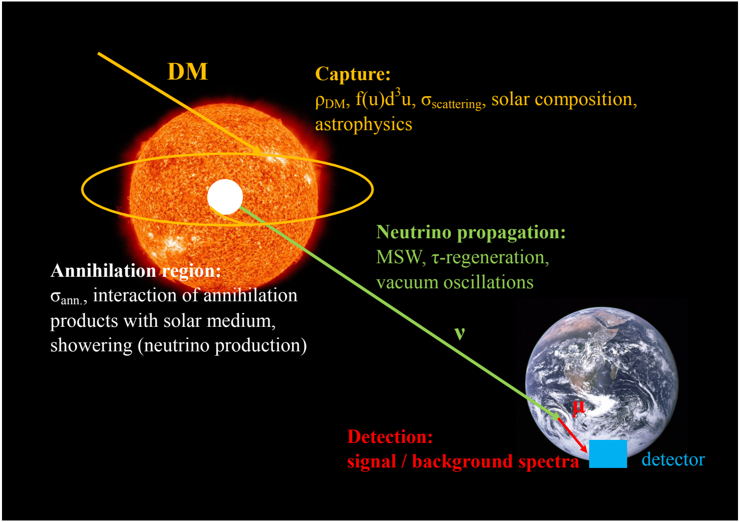
Based on arXiv:1311.1418 and arXiv:1402:4375 in collaboration with Alejandro Ibarra and Sebastian Wild

Maximilian Totzauer

2014/04/15

Outline of the talk

What's the idea?



Constraining $\sigma_{\mathrm{scattering}}$ with indirect detection?

Differential equation governing the dark matter density

- $\frac{\mathrm{d}N_{\mathrm{DM}}}{\mathrm{d}t} = \Gamma_{\mathrm{C}} - \underbrace{C_{\mathrm{A}} N_{\mathrm{DM}}^2}_{=2\Gamma_{\mathrm{A}}} - C_{\mathrm{E}} N_{\mathrm{DM}}$

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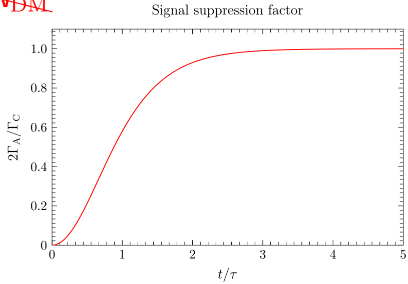

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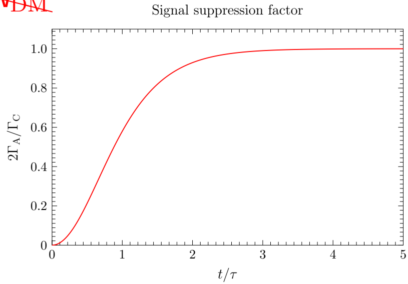

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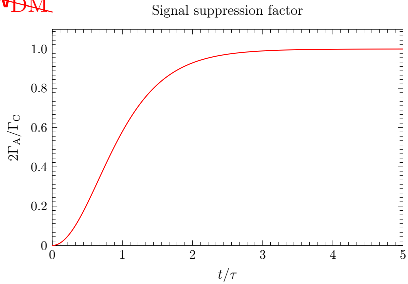

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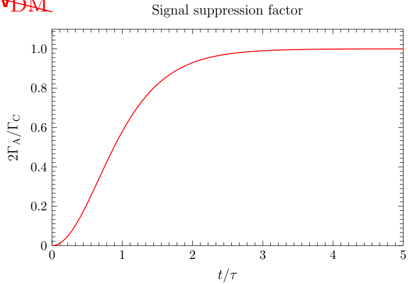

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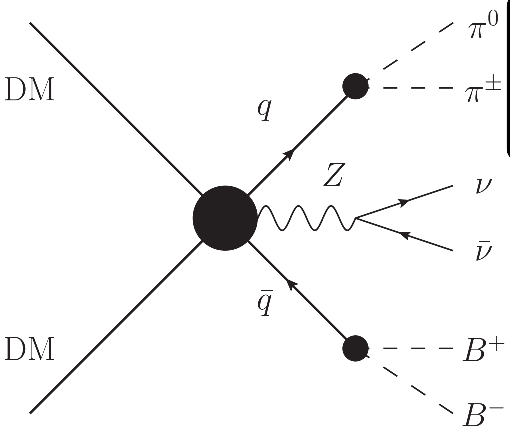

Possible annihilation products:
V, $u/d/s$, $c/b/t$,
$e/\mu/\tau$, $\nu_e/\nu_\mu/\nu_\tau$

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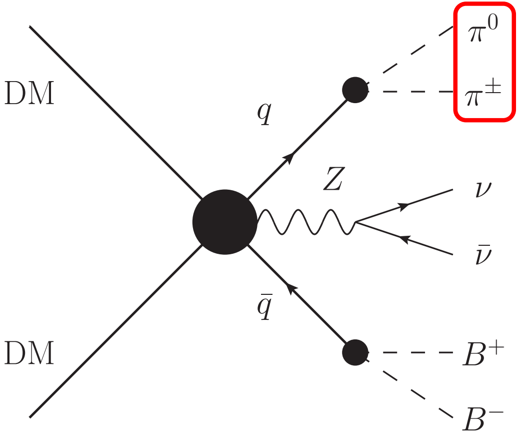

Light hadrons getting stopped ($\tau_{\text{interact.}} \ll \tau_{\text{dec.}}$)

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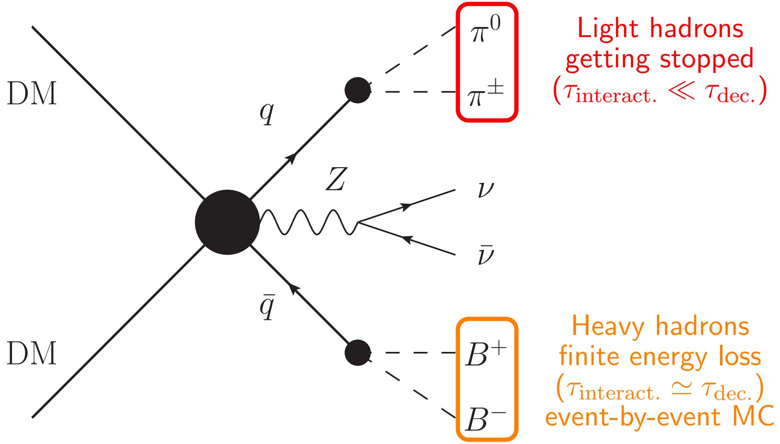

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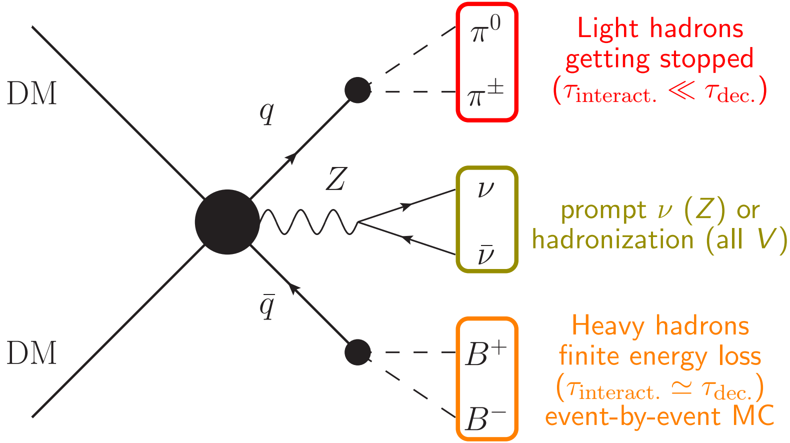

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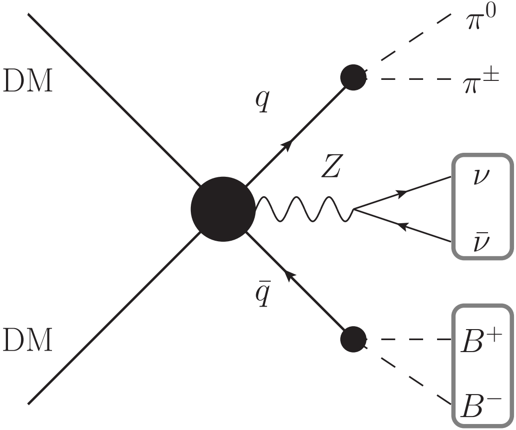

Limits so far calculated for e.g. W^+W^-, $b\bar{b}$
(arXiv:1212.4097)

obviously promising:
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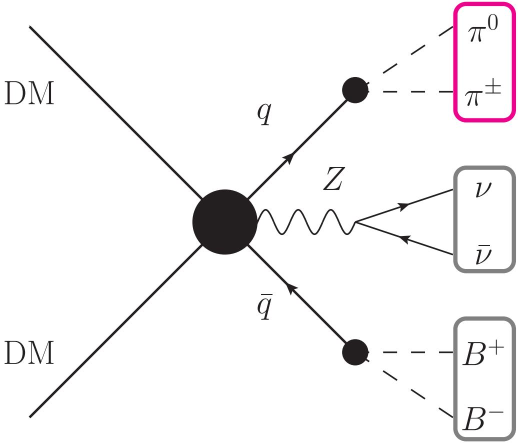

not yet constrained:
light quarks,
leptons

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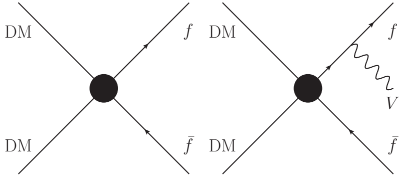

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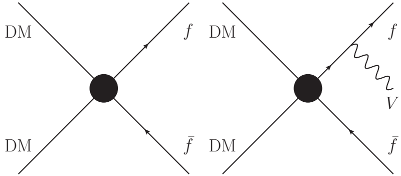

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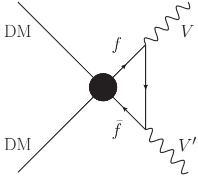
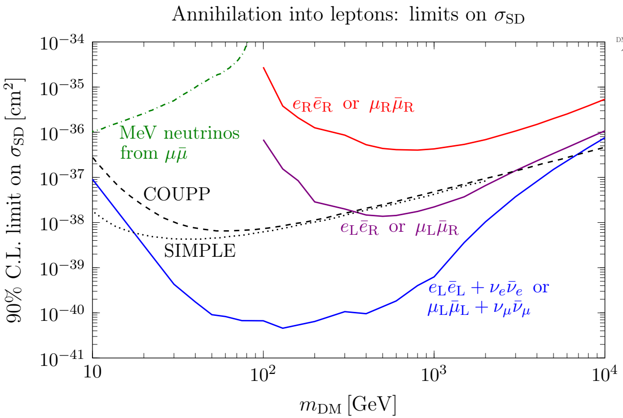
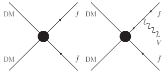


CASE 1: Limits from IceCube on $\sigma_{\rm SD}$ – leptons





Limits from MeV neutrinos from Bernal et al. (1208.0834)

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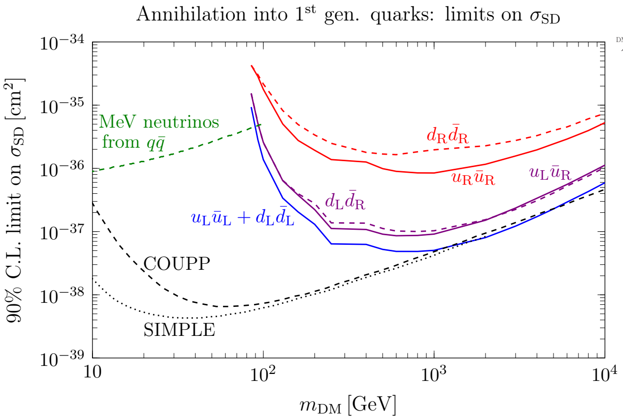

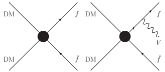

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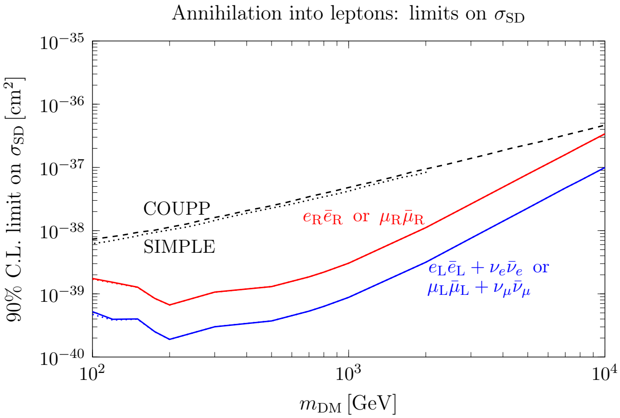

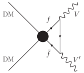

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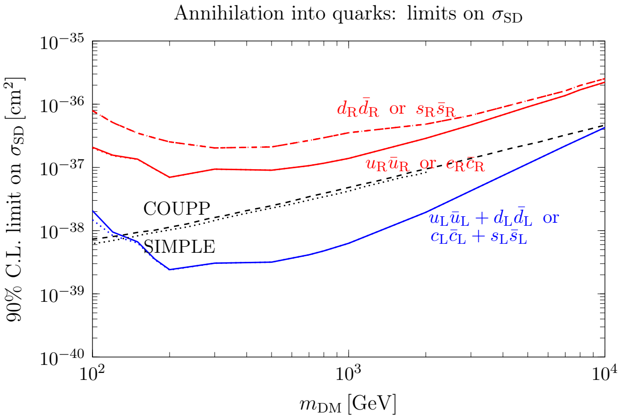

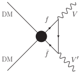

Conclusion & Outlook

Conclusions

- Higher-order corrections to annihilation processes in the Sun yield competitive constraints for
  - dark matter coupling to light quarks
  - leptophilic dark matter

Outlook

- Both cases (loops sub-dominant/dominant) can be mapped to particle physics models $\rightarrow$ discussed in arXiv:1402:4375
- The assumption of equilibration is vital $\rightarrow$ discussed in arXiv:1311.1418