Mixed Messages

Constraining dark matter with astrophysical signals (or lack thereof)

Based on the works:

- **M. Mosbech, A. Jenkins, S. Bose, C. Boehm, M. Sakellariadou, & Y. Wong, in prep. 2022**

- **M. Mosbech, C. Boehm, & Y. Wong, in prep. 2022**

- **M. Mosbech & Z. Picker, arXiv:2203.05743, under review**

Markus R. Mosbech – Invisibles 2022

Let's introduce a scattering model
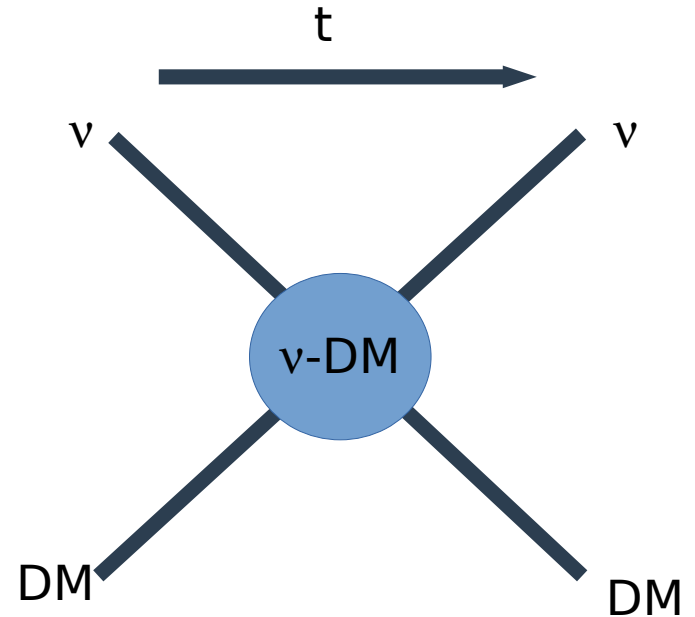
Simple scattering with neutrinos

Ignore implications for creation/annihilation
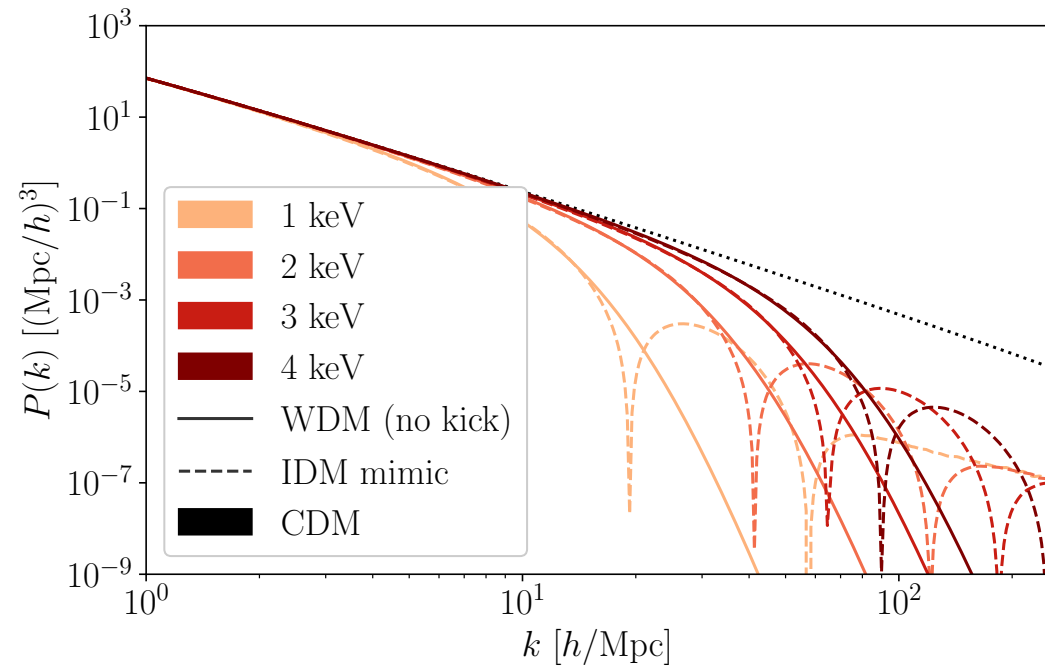
Assume constant cross-section

Arguments in favor:
Neutrinos are weird
Cannot test in detector

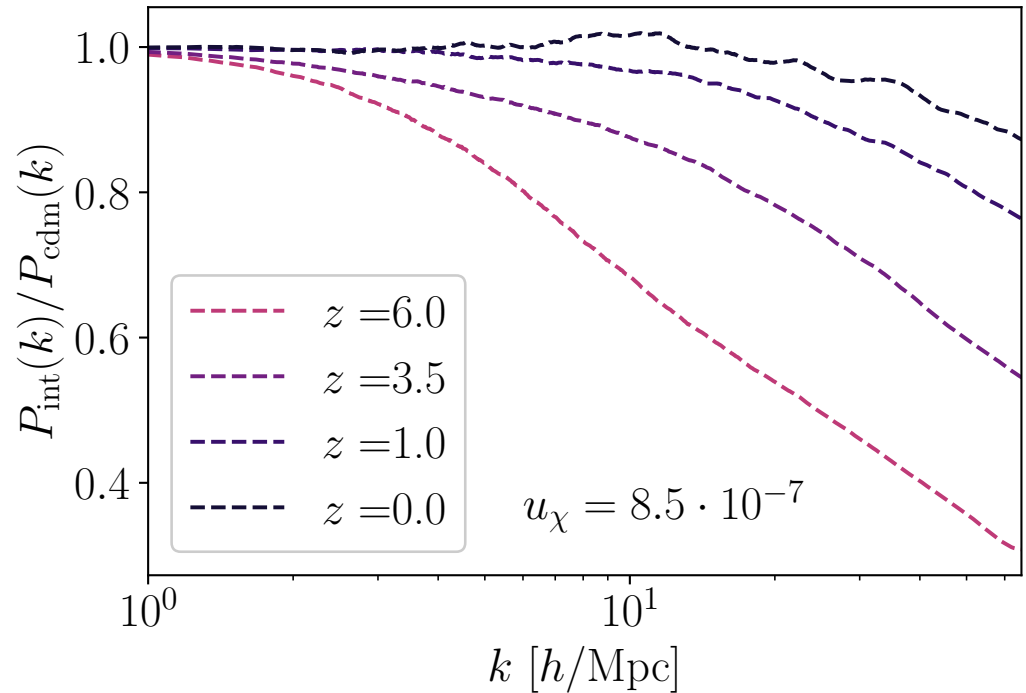**Comparison to WDM: similar at 'small' k, then oscillations**

Linear and nonlinear evolution

Comparison to WDM: similar at 'small' k, then oscillations

Suppression gets smaller, oscillations disappear

What does it look like?
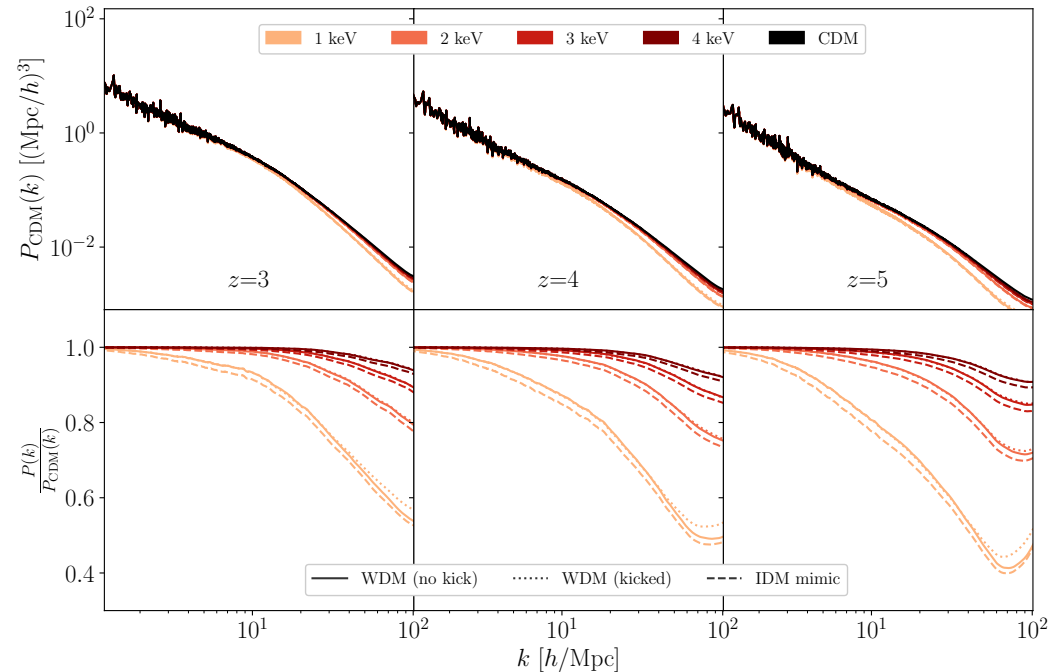
It looks like warm dark matter!

The plot shows $P_{\mathrm{int}}(k)/P_{\mathrm{cdm}}(k)$ versus $k\,[h/\mathrm{Mpc}]$ with curves for $z = 6.0$, $z = 3.5$, $z = 1.0$, $z = 0.0$ and $u_\chi = 8.5 \cdot 10^{-7}$.

"Late" time predictions

m_{WDM}	Mimic $u_{\nu\chi}$
1 keV	$8.5 \cdot 10^{-7}$
2 keV	$1.75 \cdot 10^{-7}$
3 keV	$7.0 \cdot 10^{-8}$
4 keV	$3.6 \cdot 10^{-8}$

Looks like the oscillations are gone!
Interacting and warm look almost the same.

Close enough that it could just be a different WDM mass

This suppression can be probed with SKA.

🐦 **@M_Mosbech**

"Late" time predictions

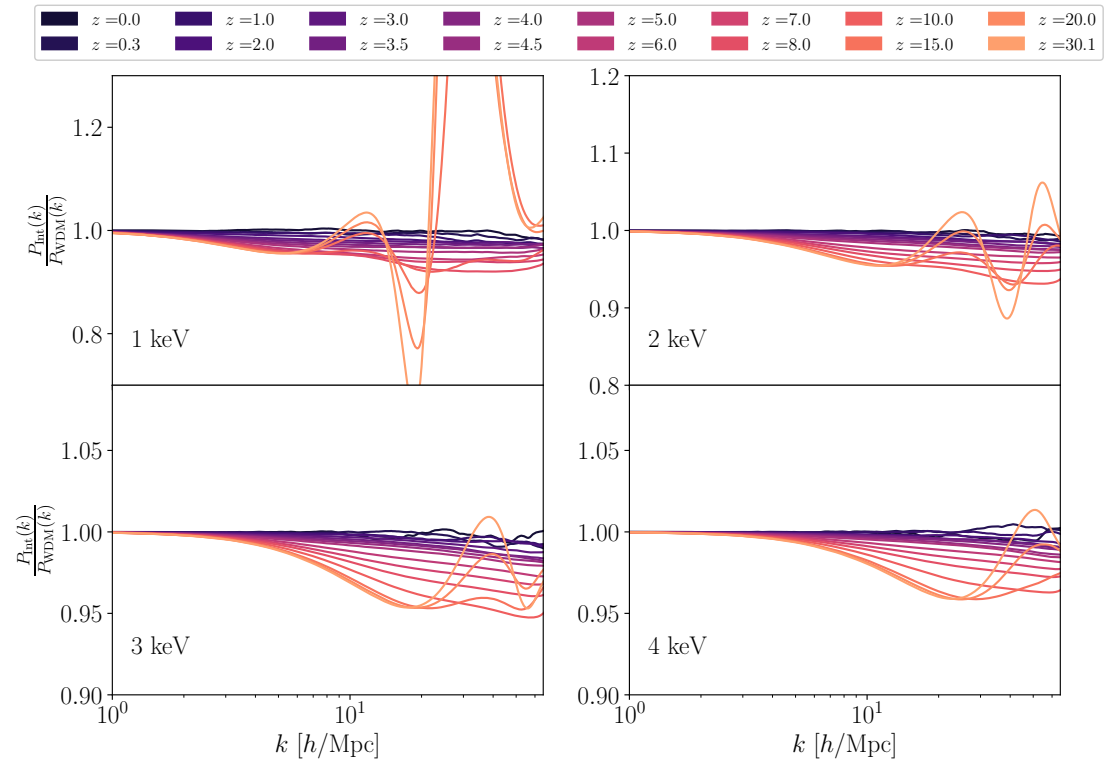| m_{WDM}	Mimic $u_{\nu\chi}$
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High z data needed to distinguish

🐦 **@M_Mosbech**

Small PBHs lose mass, constrained by γ-rays

Extended distributions change shape $\rightarrow$ signal today is different

Must be included in local bounds

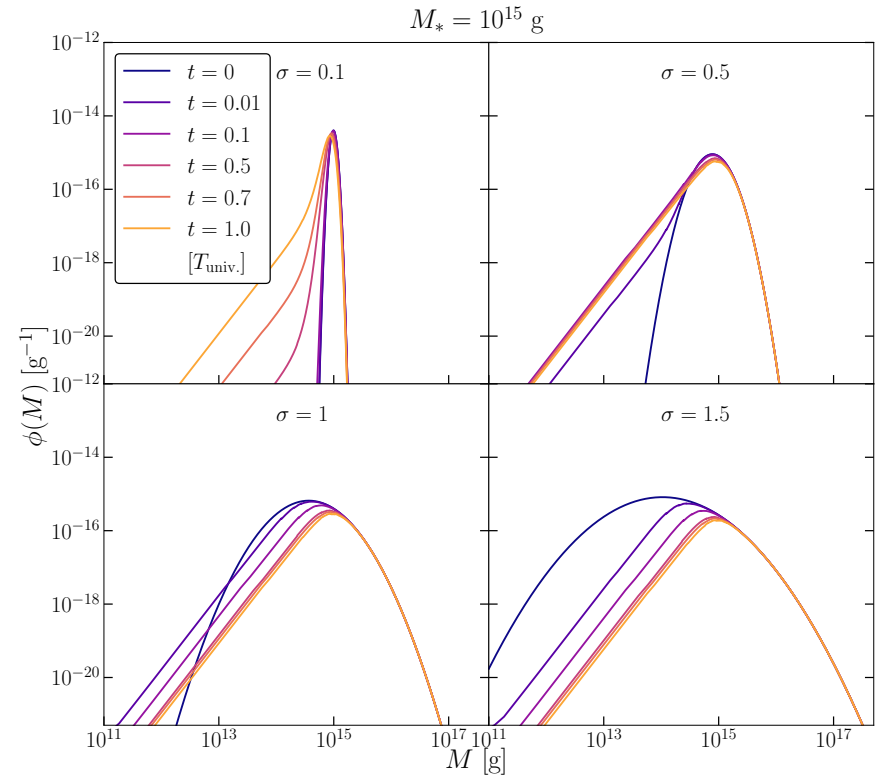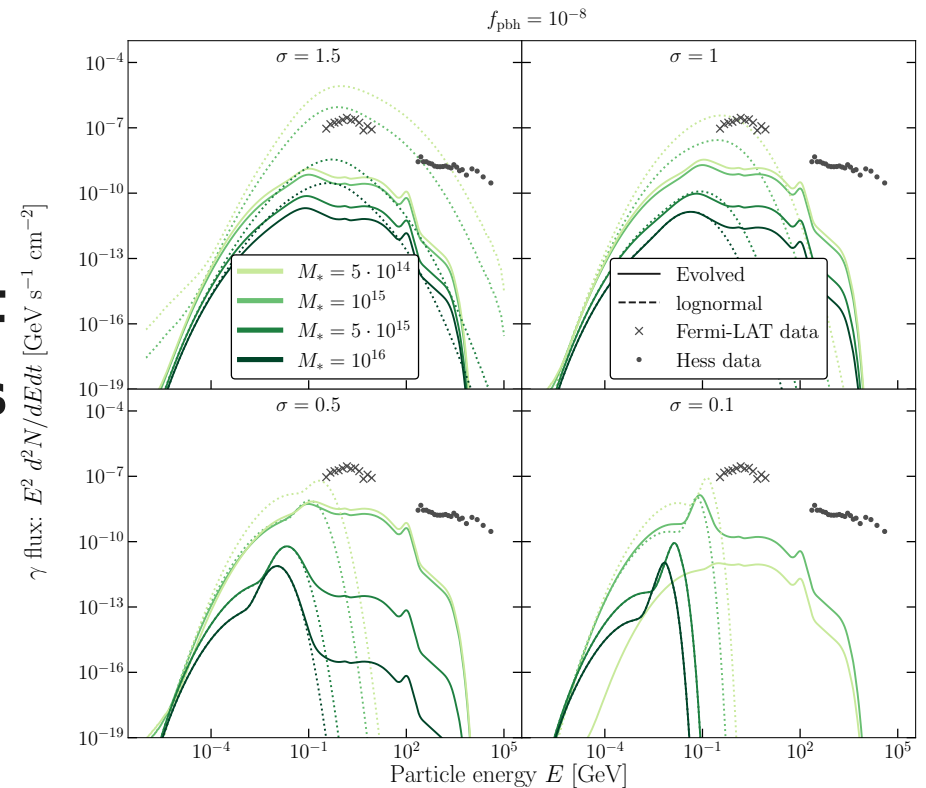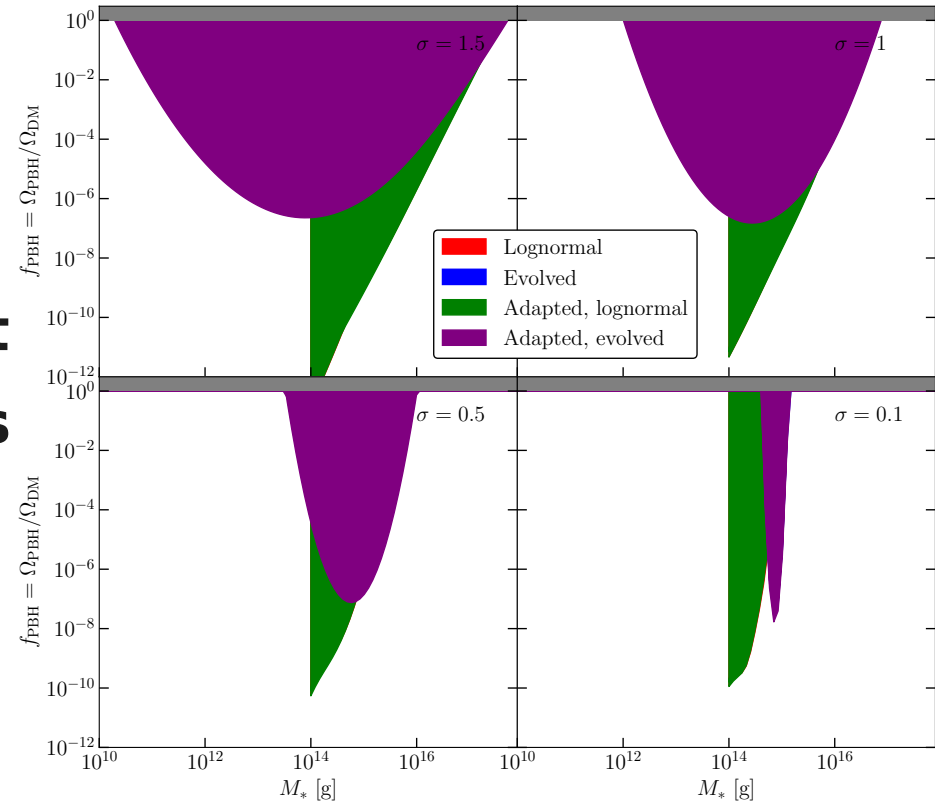$$\phi(M,t) = \phi(M_0(M,t), t_0) \frac{\mathrm{d}M_0(M,t)}{\mathrm{d}M}$$

Encore: Primordial Black Holes

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Summary

SKA can improve constraints on DM-neutrino interactions by two orders of magnitude

High-z data necessary to distinguish IDM and WDM

Alternative DM candidate PBH: lifetime evolution must be accounted for in extended distributions