Constraining mixed dark matter scenarios with the “help” of isocurvature perturbations

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with Fabian Schmidt

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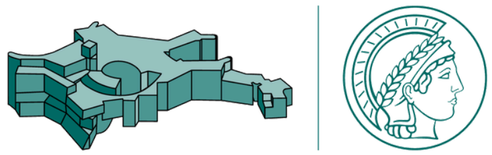
Parma



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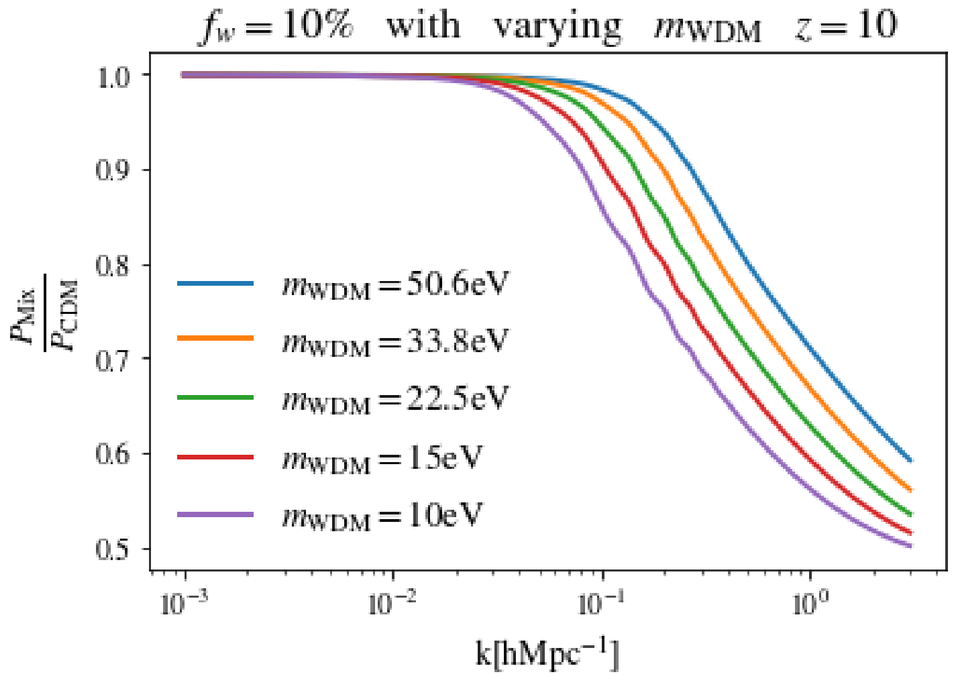
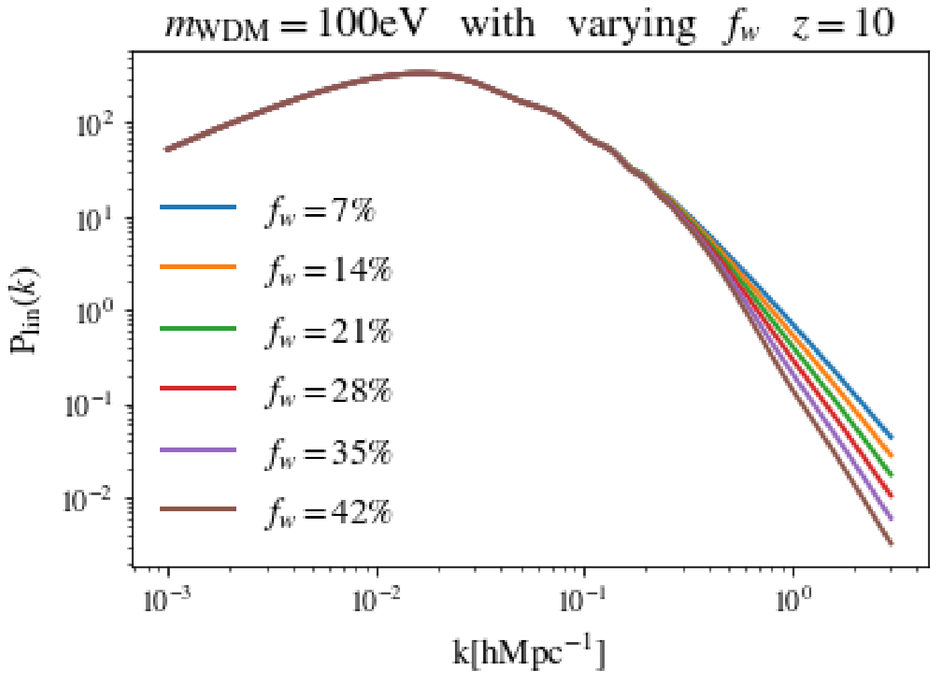
What do we investigate and how?

- CDM + thermally produced WDM mixture

- The effect of WDM mass and the fraction on linear PS





What to consider in linear theory?

$$\frac{\partial}{\partial\eta}\delta_s = -\theta_s, \qquad s \in \{w, c\}$$

$$\frac{\partial}{\partial\eta}\theta_s + aH\theta_s = \frac{3}{2}\Omega_m(a)(aH)^2\delta_m$$

$$\delta_m := f_w\delta_w + f_c\delta_c$$
$$\delta_r := \delta_c - \delta_w$$

$$\frac{\partial^2}{\partial\eta^2}\delta_m + aH\frac{\partial}{\partial\eta}\delta_m - \frac{3}{2}\Omega_m(a)(aH)^2\delta_m = 0$$

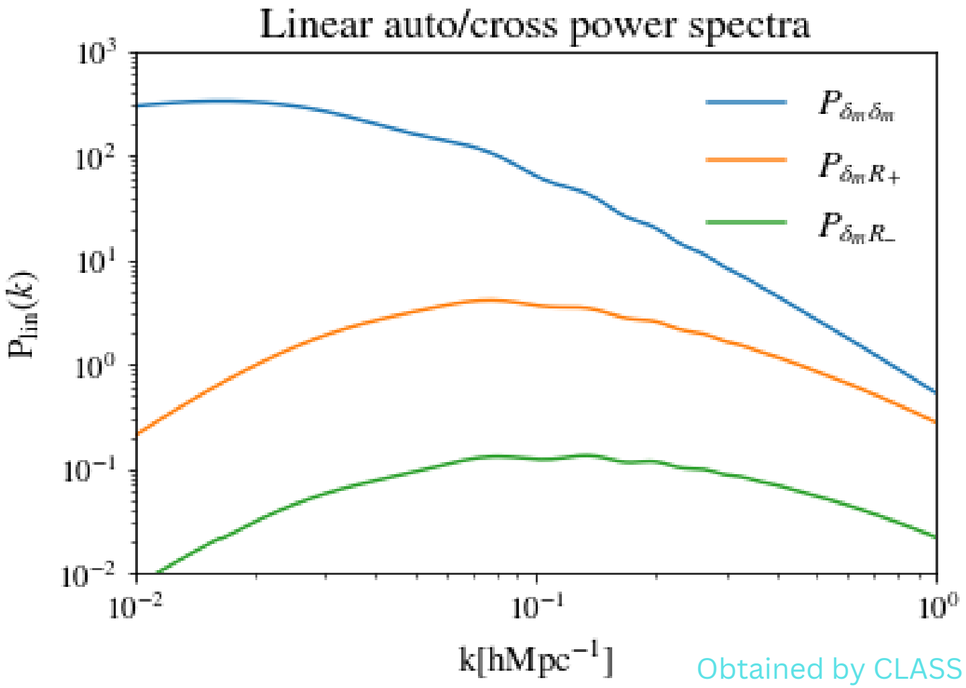
$$\frac{\partial^2}{\partial\eta^2}\delta_r + aH\frac{\partial}{\partial\eta}\delta_r = 0$$

$$\delta_m^{(1)}(\vec{x},\eta) = D_+(\eta)\delta_m^{(0)}(\vec{x}); \qquad \theta_m^{(1)}(\vec{x},\eta) = -aHf_+D_+(\eta)\delta_m^{(0)}(\vec{x})$$

$$\delta_r^{(1)}(\vec{x}) = R_+(\vec{x}) + D_-(\eta)R_-(\vec{x}); \qquad \theta_r^{(1)}(\vec{x},\eta) = -aHf_-D_-(\eta)R_-(\vec{x})$$

3 different modes!

6 different power spectra!



Obtained by CLASS

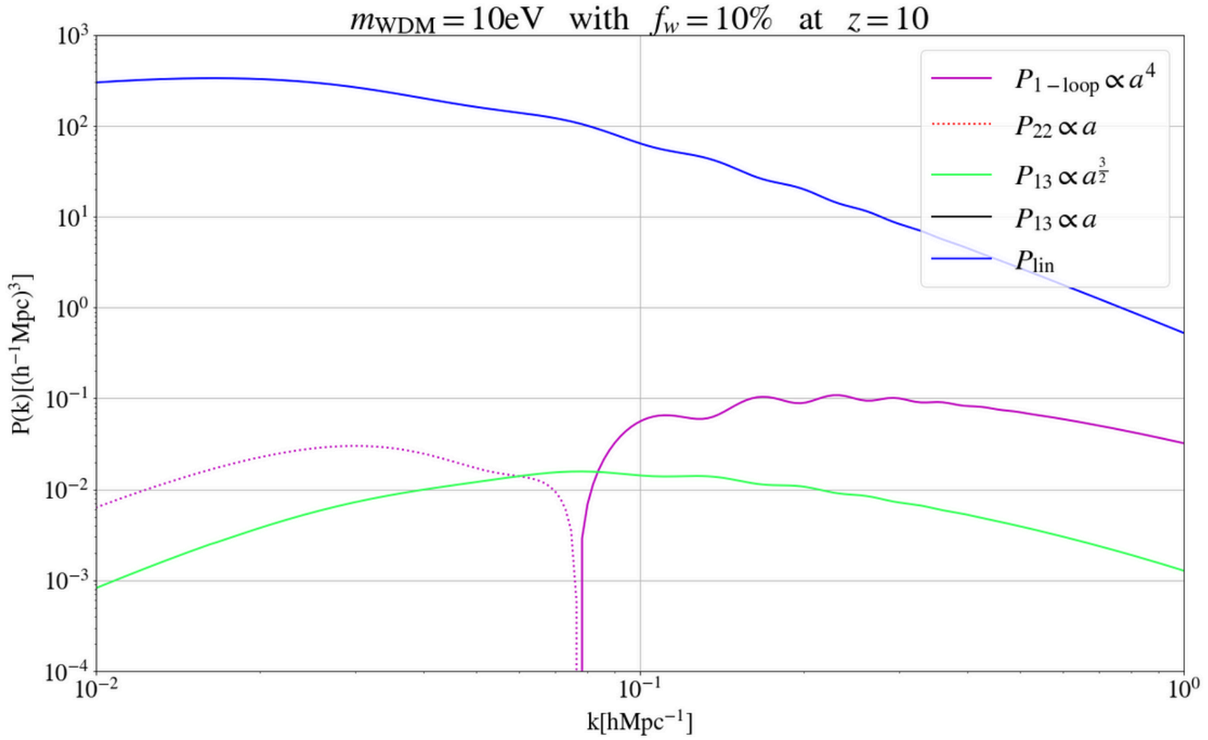
$z = 10 \quad f_w = 10\% \quad m_{WDM} = 10\text{eV}$

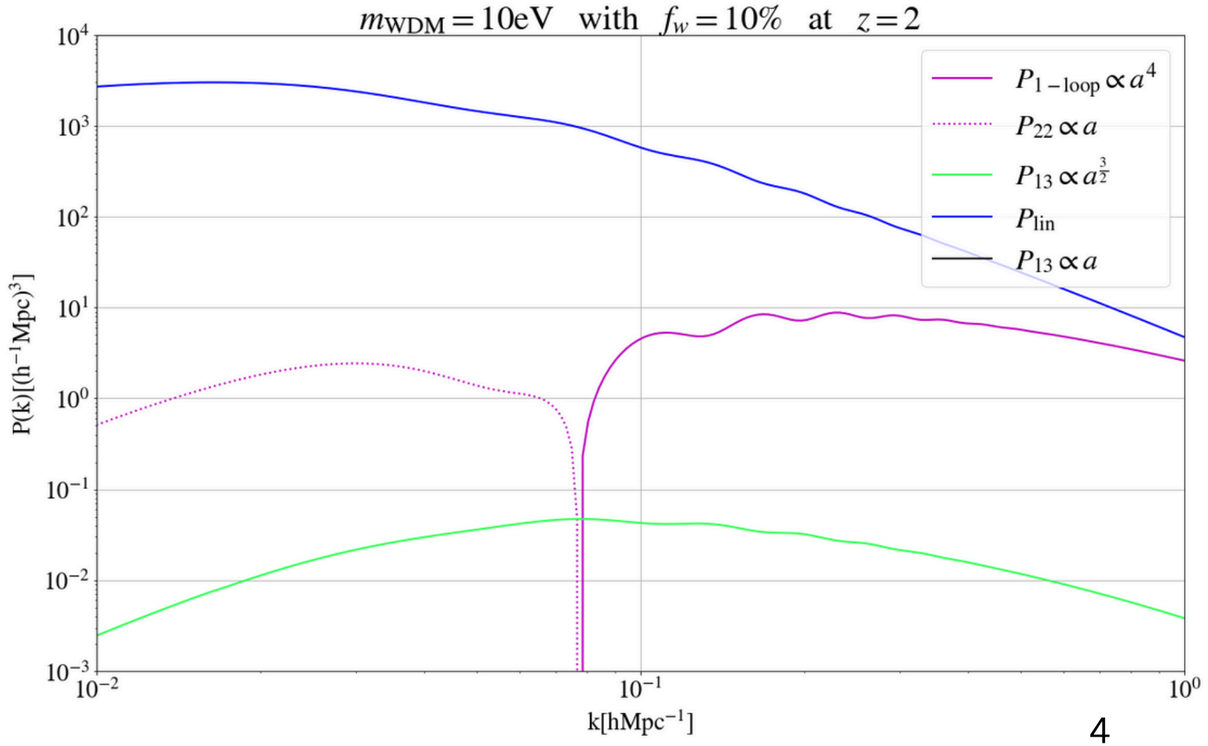
Introducing non-linearities

!Preliminary!

$$P_{22}^{\rm iso} \supset +a \int_q F'(q, k-q) P_{\delta_m R_-}(k-q) P_{\delta_m R_-}(q)$$

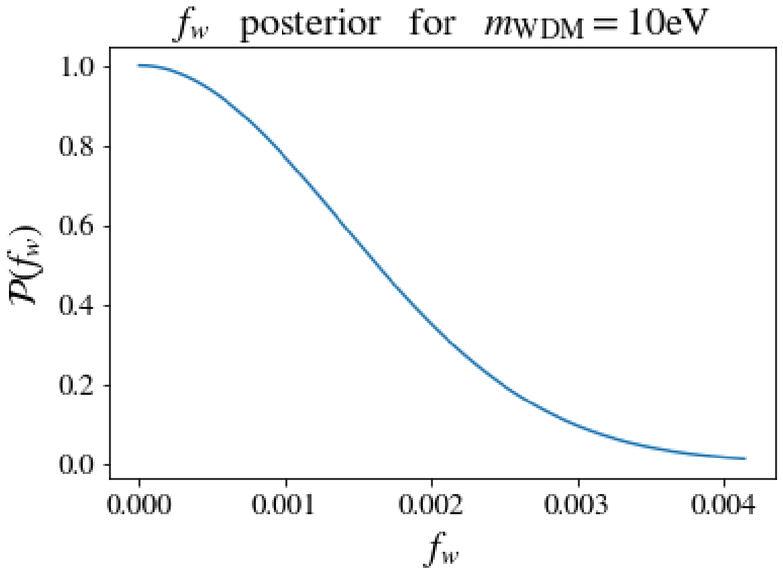
$$P_{13}^{\rm iso} \supset a^{\frac{3}{2}} \int_q F(q,k) P_{\delta_m R_+}(k) P_{\delta_m R_-}(q) + a \int_q F'(q,k) P_{\delta_m R_-}(k) P_{\delta_m R_-}(q)$$



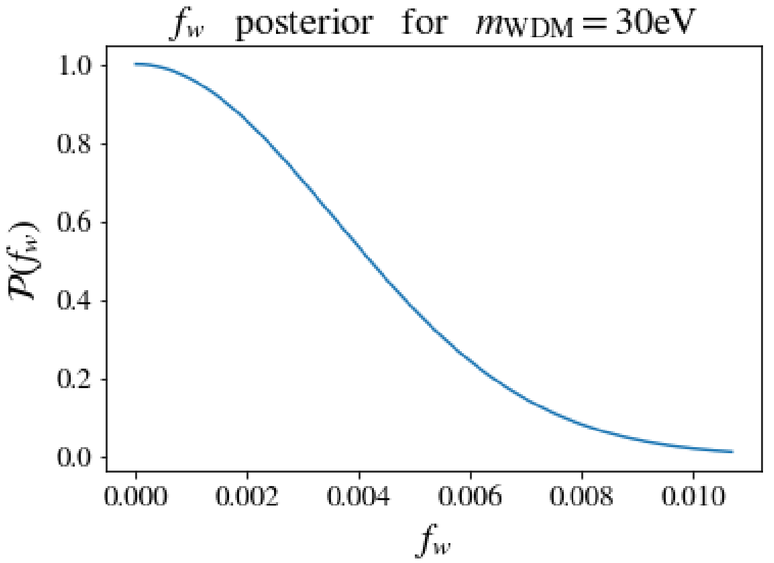


Fisher forecast on f_w

!Preliminary!

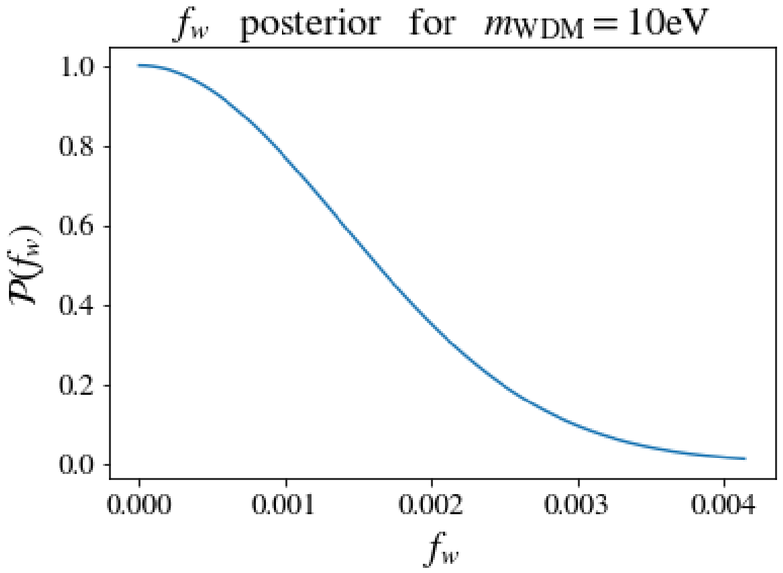


HETDEX survey
No P_ϵ



Fisher forecast on f_w

!Preliminary!



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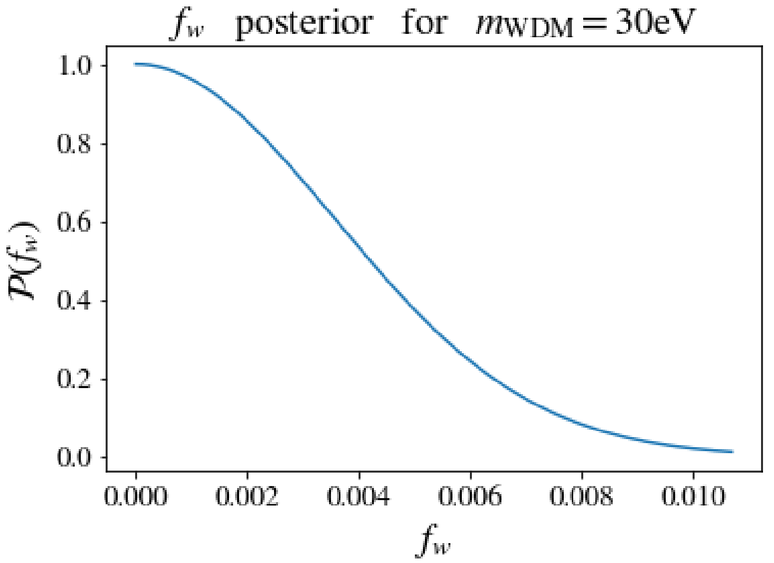

What about galaxies?

$$\mathcal{O}_r \in \delta_m R_+, v_r^2, \delta_m R_-, \ldots \qquad \mathcal{O}_m \in \delta_m^2, \mathcal{G}$$

$$P_{gg}^{1-\text{loop}} \supset a^3 b_{\delta\delta}^r \int_q \tilde{F}(q, k-q) P_{\delta_m \delta_m}(q) P_{\delta_m R_+}(k-q) \quad \not\supset \quad P_{13}^{\text{iso}} \supset a^{\frac{3}{2}} \int_q F(q,k) P_{\delta_m R_+}(k) P_{\delta_m R_-}(q)$$

Conclusion

- Effects sourced by the isocurvature modes are significant at high redshifts.
- Galaxy density field is affected more by the isocurvature perturbations compared to the matter density field.

What to do next?

- Cosmological inference
- Testing other possible scenarios
- Simulations to investigate small scales