Easing the σ_8-tension with neutrino-dark matter interactions

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Based on the work by

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Motivations

Neutrino masses

- Evidence from oscillation experiments, but not previously accounted for in this type of DM interaction study.

H_0 tension

- Planck vs. local measurements (e.g. SH0ES)

σ_8 tension

- Planck vs. local measurements (e.g. KiDS-1000)

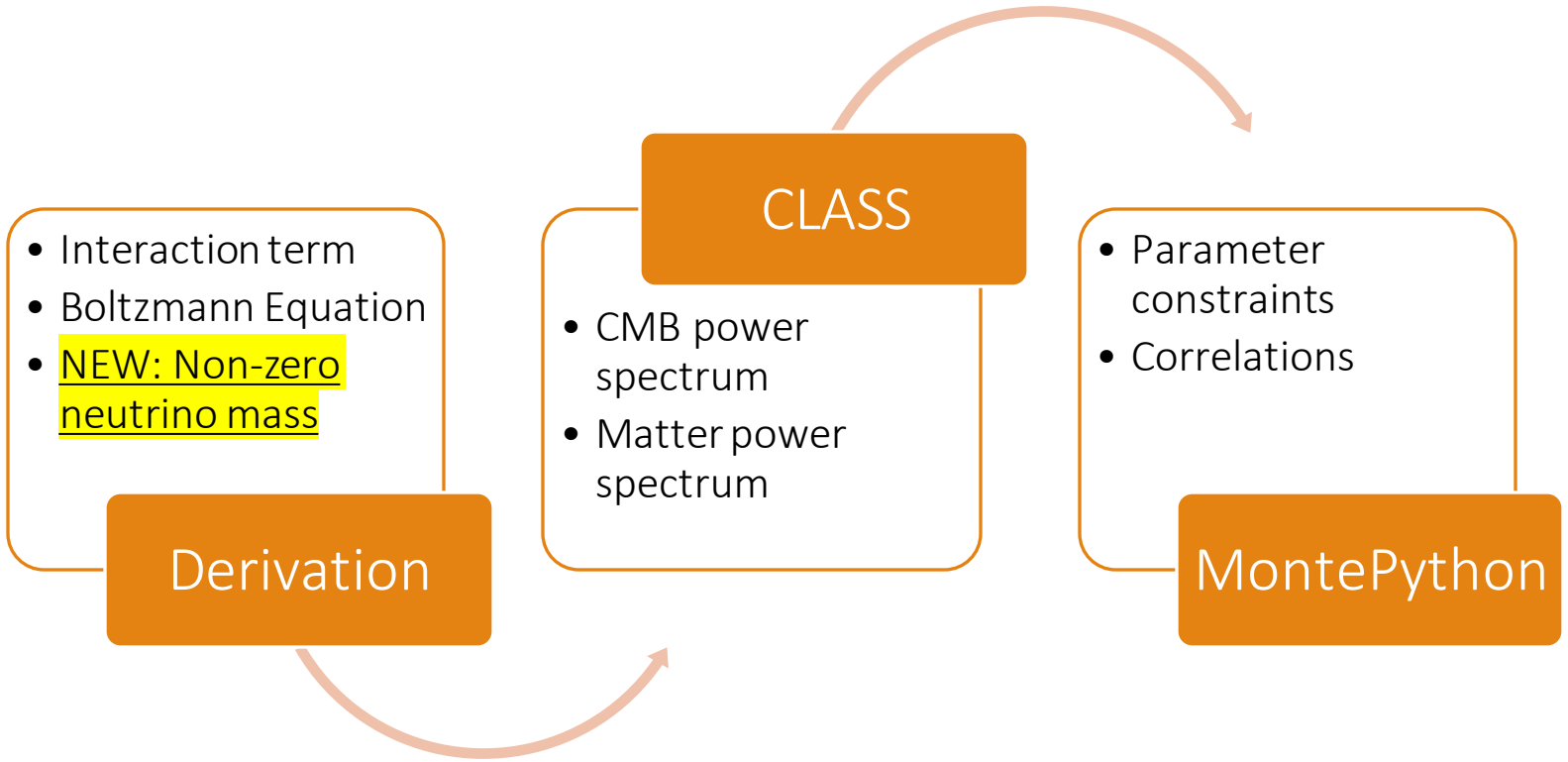
Newly derived interaction term (constant cross-section):

$$C_\chi = a\, u_{\nu\chi}\, \frac{\sigma_{\rm Th}\rho_\chi}{100\,{\rm GeV}}\, \frac{p^2}{E_\nu^2}$$

Modifications to neutrino Boltzmann eqs:

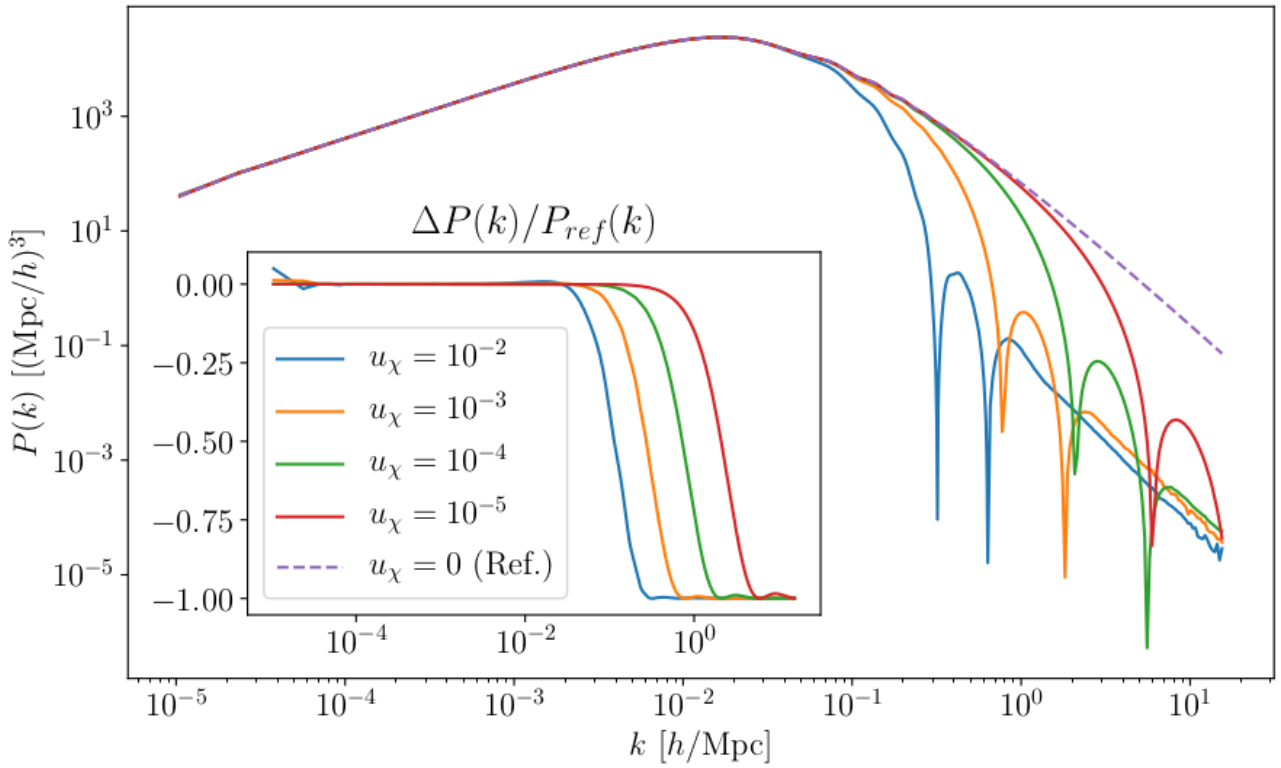
$$\frac{\partial \Psi_1}{\partial \tau} = [...] - C_\chi \frac{v_\chi E_\nu(p)}{3 f^{(0)}(p)} \frac{df^{(0)}(p)}{dp} - C_\chi \Psi_1$$
$$\frac{\partial \Psi_2}{\partial \tau} = [...] - \frac{9}{10} C_\chi \Psi_2 \,,$$
$$\frac{\partial \Psi_l}{\partial \tau} = [...] - C_\chi \Psi_l, \quad l \geq 3 \,,$$

Note use of momentum-dependent eqs.



Modification to DM eq:

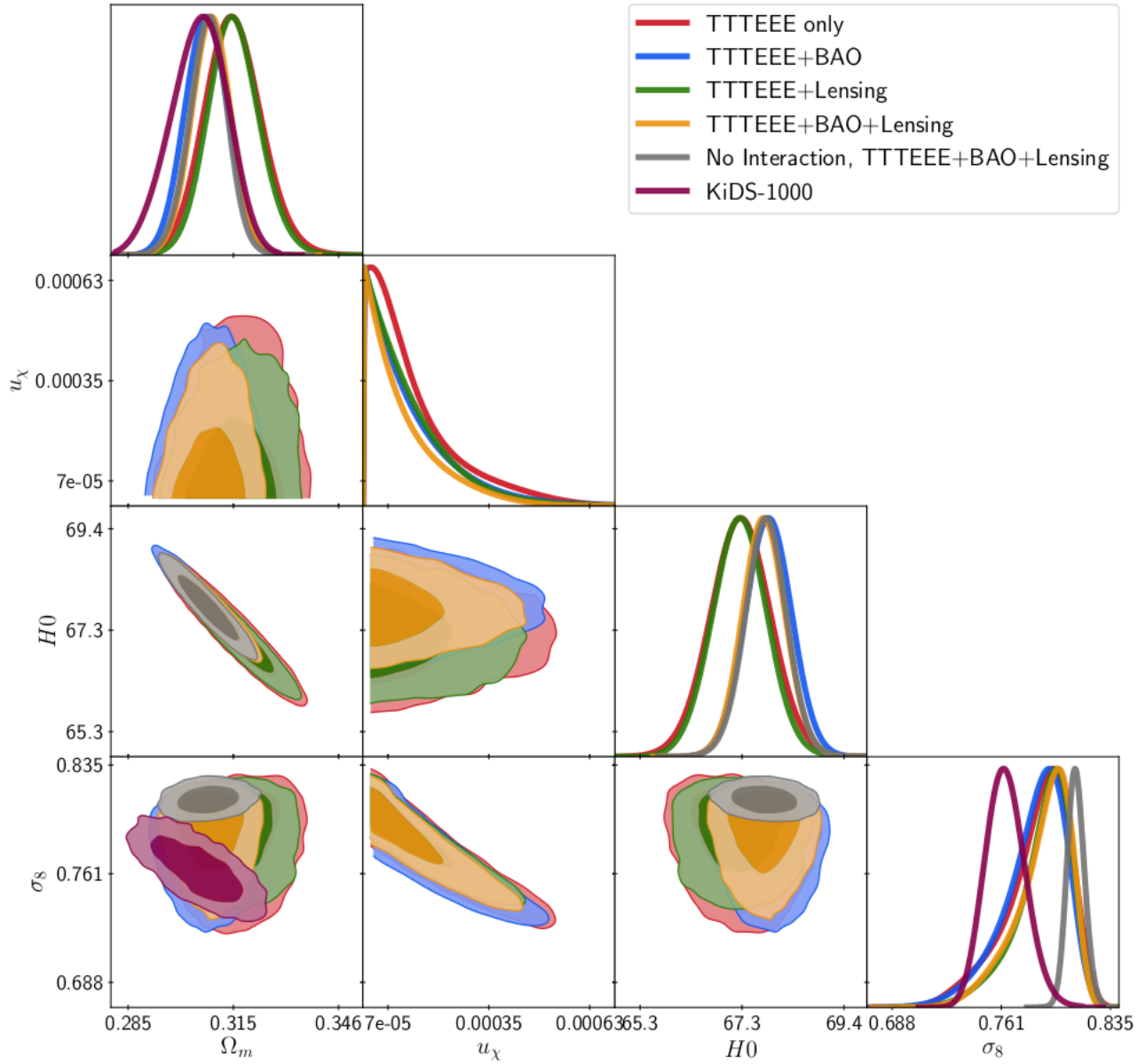
$$\dot{\theta}_\chi = [...] + K_\chi \frac{3}{4} k \frac{\int p^2 dp\, p f^{(0)}(p)\, C_\chi(p) \left(\frac{\theta_\chi E_\nu(p)}{3k f^{(0)}(p)} \frac{df^{(0)}(p)}{dp} + \Psi_1 \right)}{\int p^2 dp\, p f^{(0)}(p)}$$



$$u_{\nu\chi} = \frac{\sigma_0}{\sigma_{\mathrm{Th}}} \left(\frac{m_\chi}{100\,\mathrm{GeV}} \right)^{-1}$$

- Suppression similar to WDM
- 'Peaks' shifted to slightly higher *k* compared to massless neutrino case (Same *u* yields smaller effect)
  For comparison see arXiv:1903.00540
- Matches expectation from new p^2/E^2 dependence

$$C_\chi = a\, u_{\nu\chi} \frac{\sigma_{\mathrm{Th}} \rho_\chi}{100\,\mathrm{GeV}} \frac{p^2}{E_\nu^2}$$



- No significant impact on H_0
- Stronger interaction → lower σ_8