Neutrino propagation in the galactic DM halo

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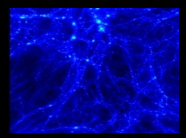
MultiDark
Multimessenger Approach for Dark Matter Detection



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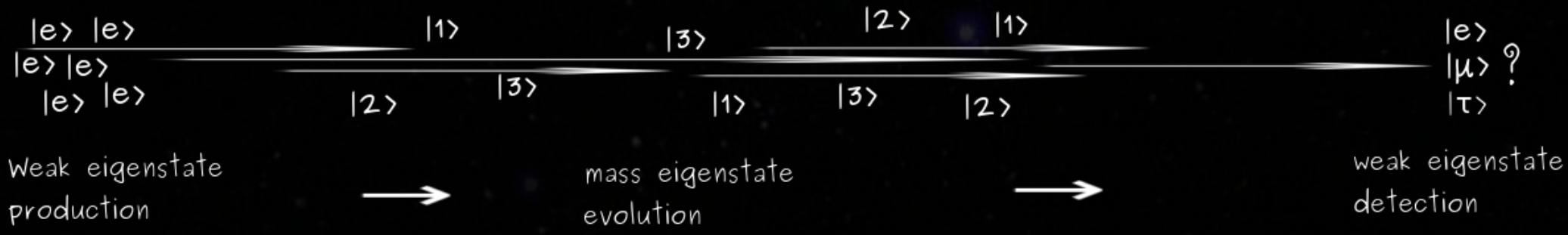
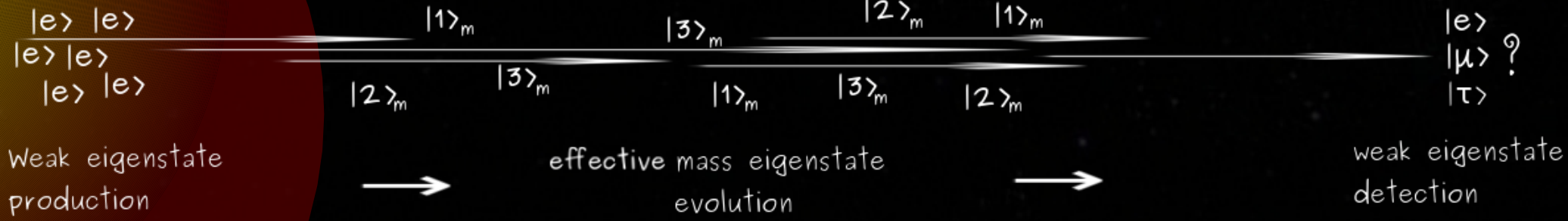
Neutrino oscillations and matter effects

Neutrinos oscillate in flavour



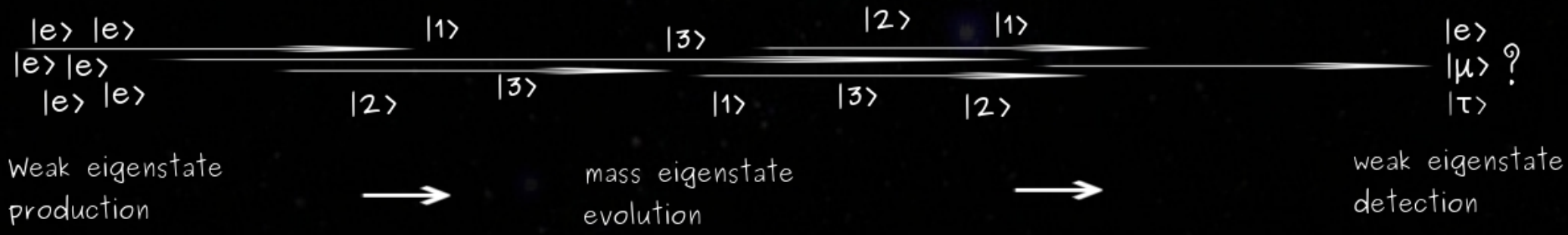
Matter can affect oscillations through coherent forward scattering

$$\mathcal{H}_{\text{tot}} = \mathcal{H}_{\text{vac}} + \mathcal{V}$$



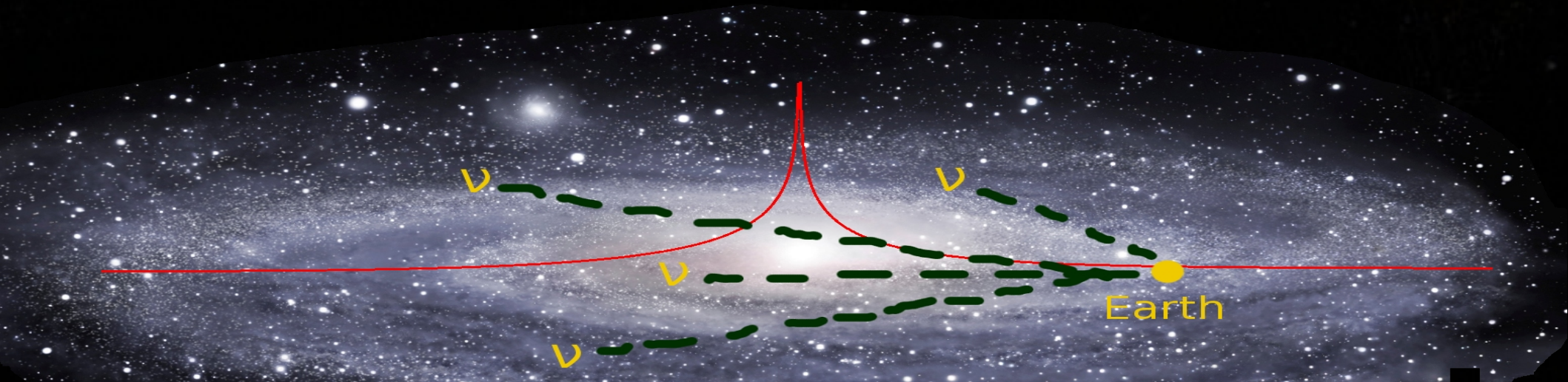
Neutrino oscillations and **dark matter** effects

Neutrinos oscillate in flavour



Dark Matter might affect oscillations through coherent forward scattering

$$\mathcal{H}_{\text{tot}} = \mathcal{H}_{\text{vac}} + \mathcal{V}_{\text{DM}}$$



Assumptions

Dark Matter

- Generic DM potential

$$\mathcal{V}_{\mathrm{DM}} = G_F N_\chi \underline{\underline{\lambda}}$$

such that the effect is measurable on VHE-ν only

- Candidate mass included in V_{DM}

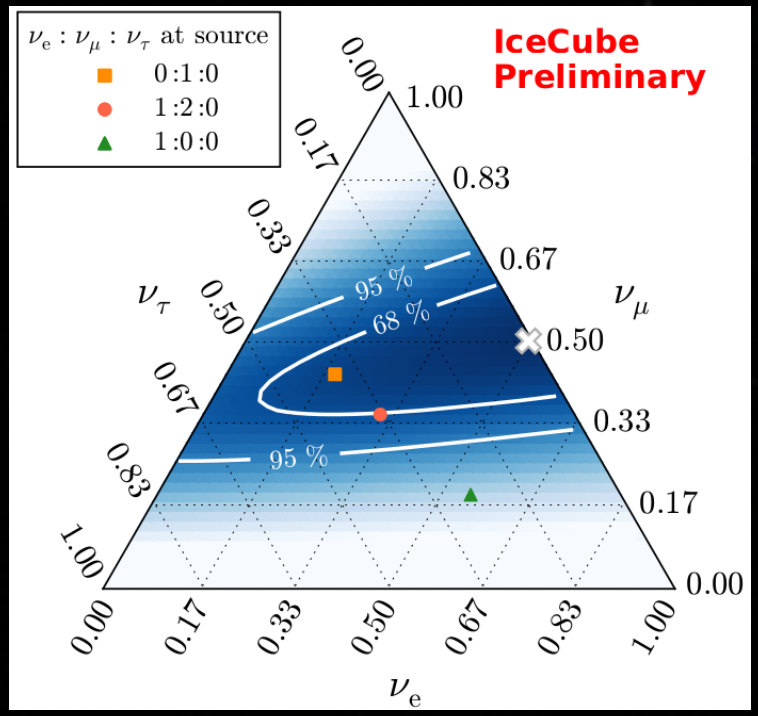
DM profile

- Constant DM profile
- More realistic NFW profile

Neutrinos

- Averaged neutrino oscillations
- Neutrino production at any point in the galaxy
- Monoenergetic neutrinos with E = 1 PeV
- Oscillation parameters fixed - best fit in [D.V. Forero *et al*., PRD**90**-093006 (2014)]

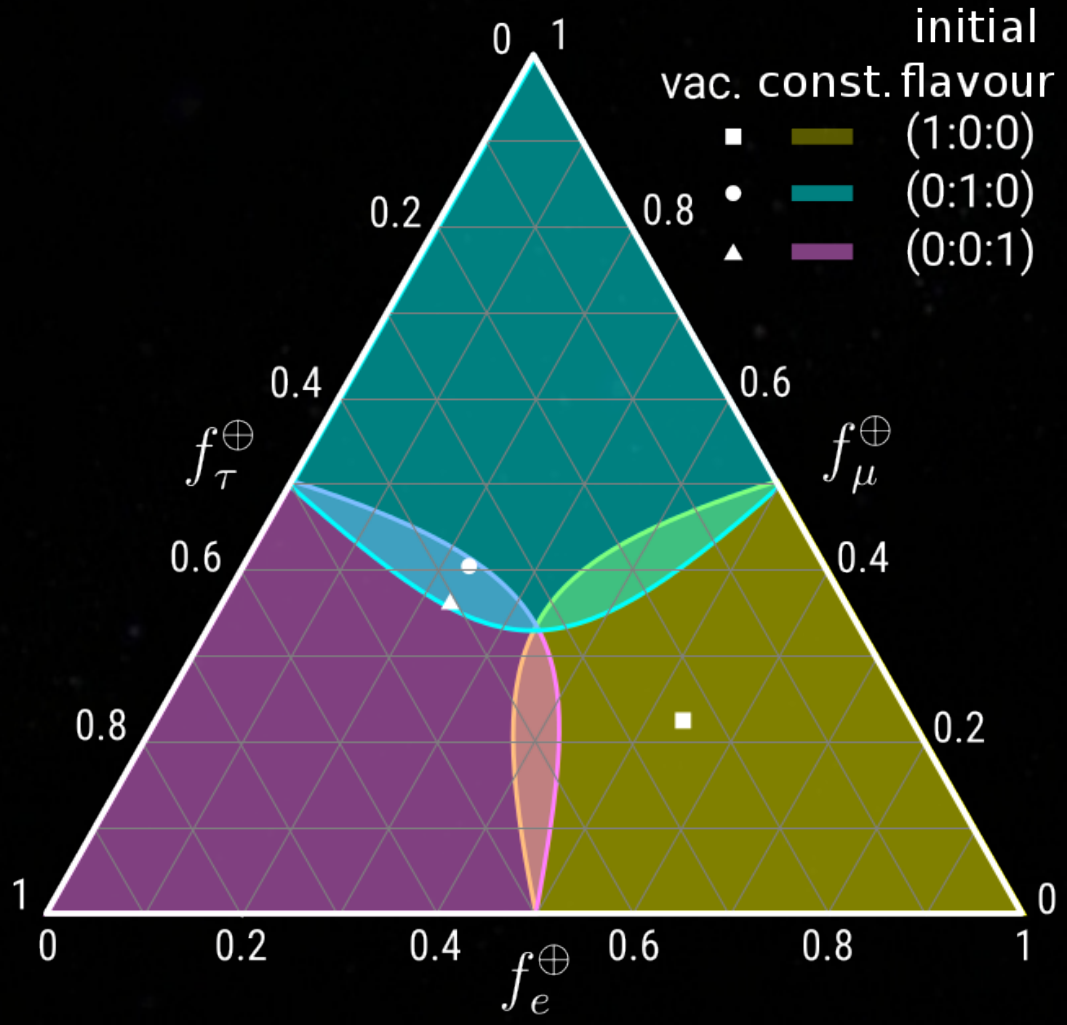
IceCube VHE neutrinos. Flavour composition



[IceCube Collaboration – ICRC 2015 - *arXiv:1510.05223*]

Events in TeV – PeV range

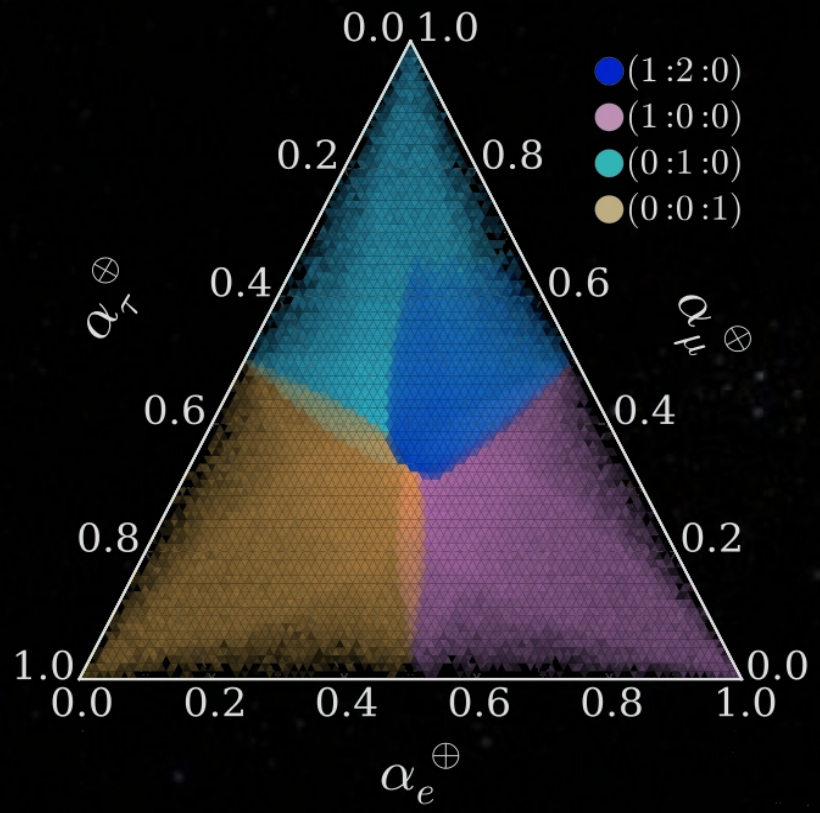
Constant DM profile



Flavour composition at Earth

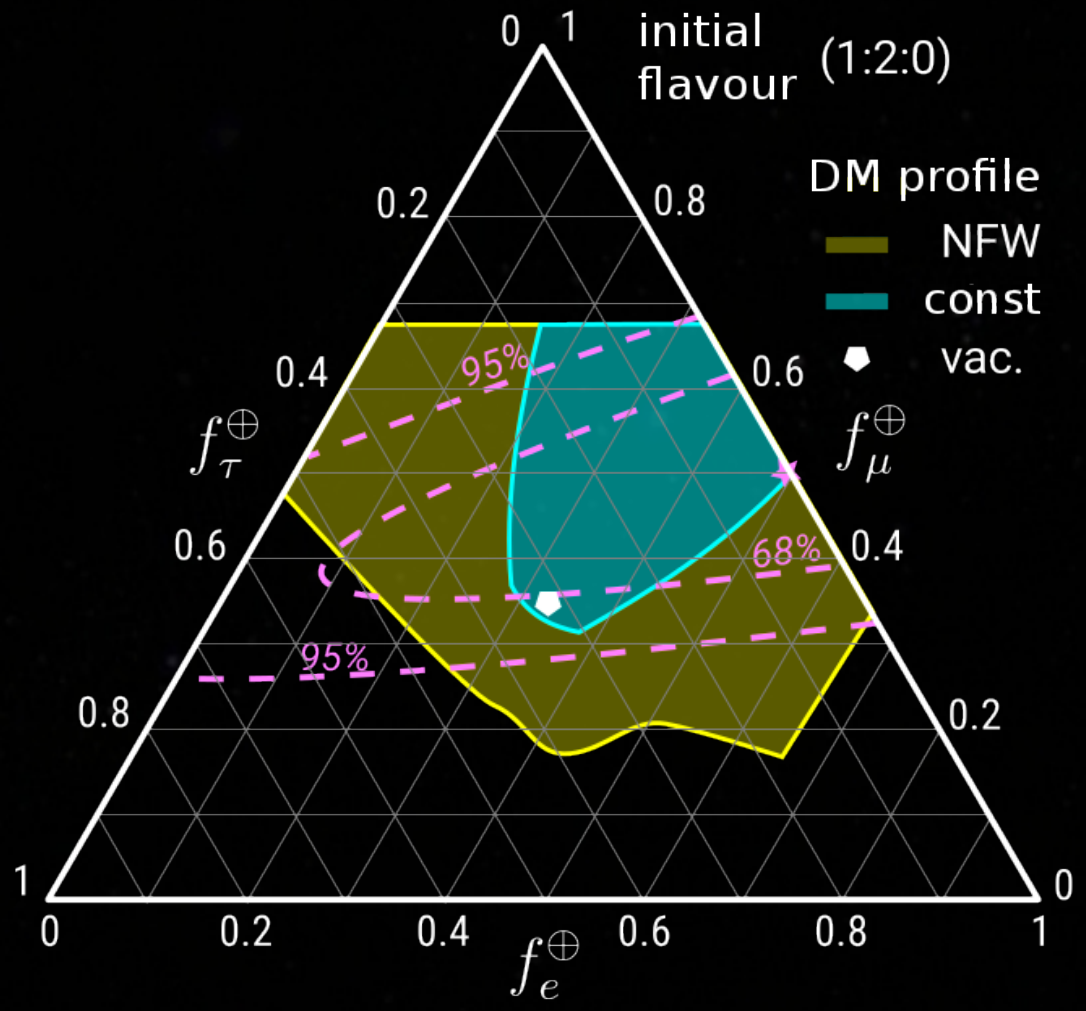
Random potential entries

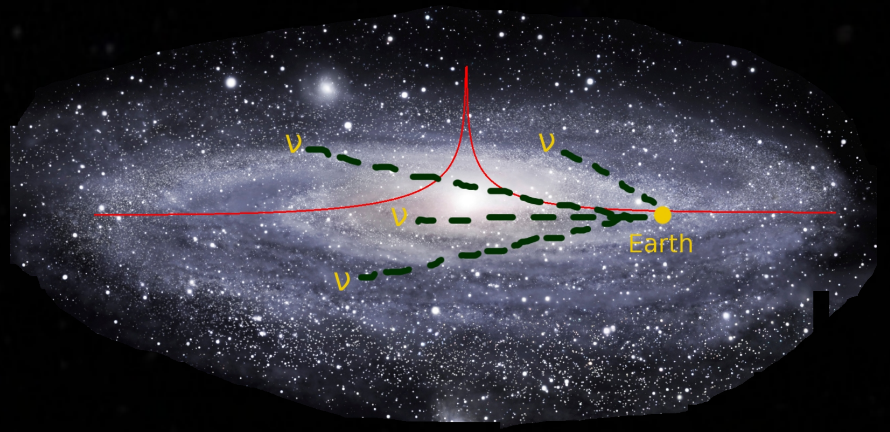
$|V_{ij}| < 10^{-17}$ eV



[C. A. Argüelles *et al*. - PRL **115**, 161303 (2015)]

NFW DM profile





DM distribution broadens neutrino flavour composition at Earth

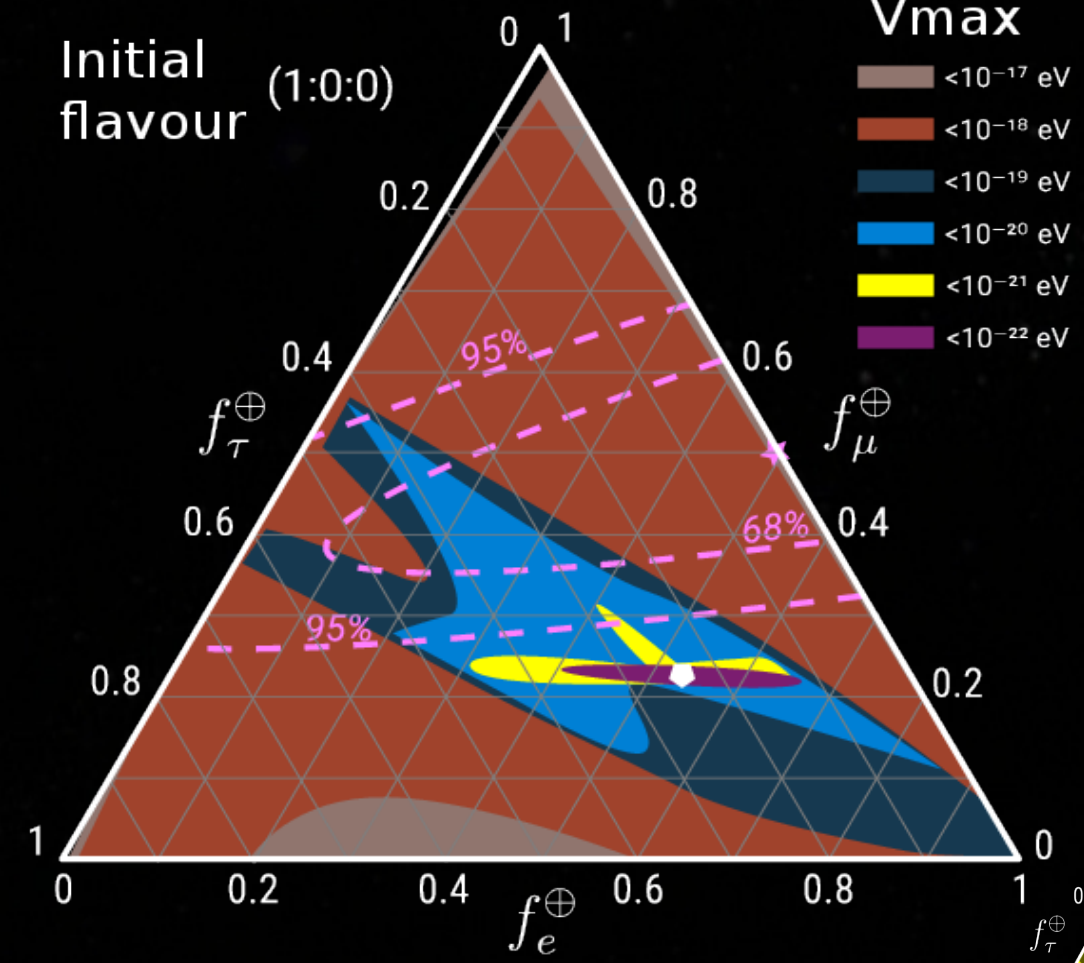
- - - VHE neutrino IceCube data

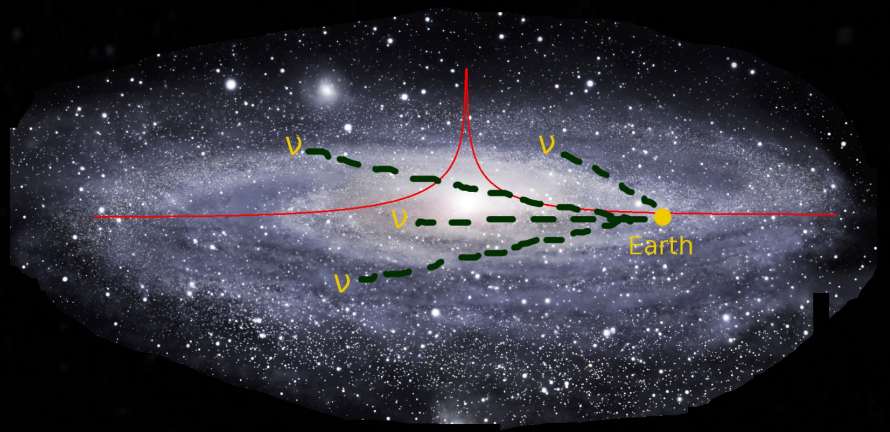
Flavour composition at Earth

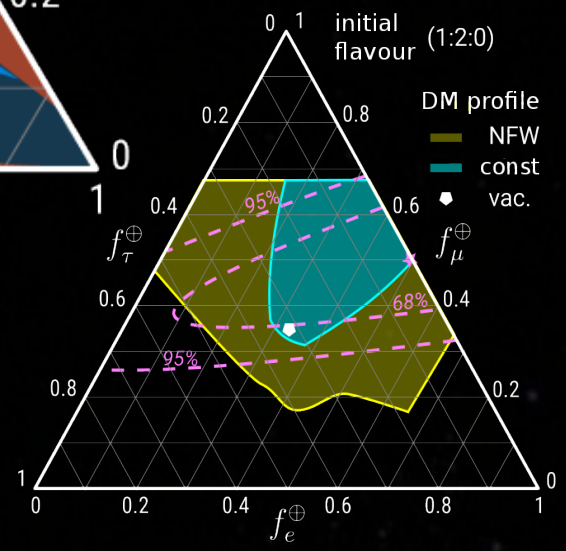
Assuming:

- any production point
- random V_{DM}

NFW DM profile







- - - VHE neutrino IceCube data

Flavour composition at Earth

Assuming:

- any production point
- random V_{DM}

Conclusions

- **VHE neutrino oscillations** might be **affected by** the presence of **DM** in the Milky Way

- This could explain a non-standard VHE neutrino flavour composition observed at Earth

- The flavour composition at Earth could give **information** about the **interaction** of **DM** with **neutrinos**

Possible interpretation

Interpretation	Parameter	Case A	Case B	Case C
	$V_{ij}^{\oplus}$ [eV]	1×10^{-17}	1×10^{-20}	1×10^{-22}
$\lambda = 1$	m_{DM} [eV]	4×10^{-12}	4×10^{-9}	4×10^{-7}
Weak coupling	λ_{11}	3×10^{22}	3×10^{19}	3×10^{17}
100 GeV Dark Matter	$m_{Z'}$ [eV]	5.4×10^{-1}	1.7×10^{1}	1.7×10^{2}
Weak coupling	λ_{11}	3×10^{14}	3×10^{11}	3×10^{9}
1 keV Dark Matter	$m_{Z'}$ [eV]	5.4×10^{3}	1.7×10^{5}	1.7×10^{6}

$$\mathcal{V}_{\mathrm{DM}} = G_F N_\chi \underline{\underline{\lambda}}$$