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Summer 2016 and 2017 Fermilab with Dan Hooper

April 2018 University of Washington with Ann Nelson

Background

- **2018-2020 Postdoc at King's College London**

Mainly working with Malcolm Fairbairn, Diego Blas, James Alvey and Nash Sabti

Background

- **2020-2022 Alexander von Humboldt fellow at the Technical University of Munich**

Mainly working with Mathias Garny, Thomas Schwetz, Alejandro Ibarra, and great students:
Mar Ciscar, Petter Taule, Víctor Maura and Johann Nikolaides

My Research

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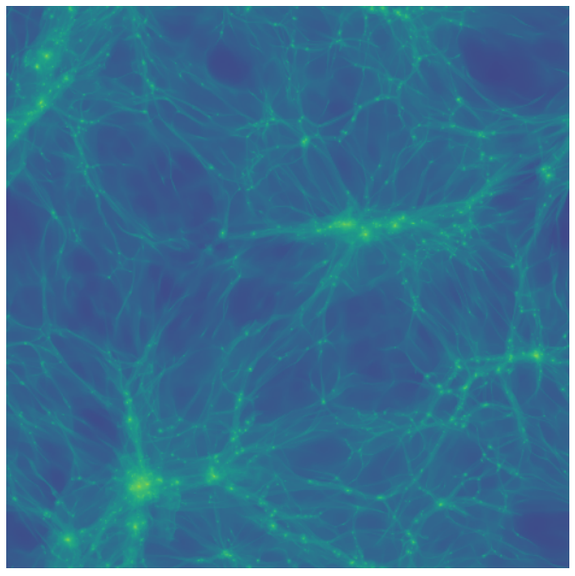

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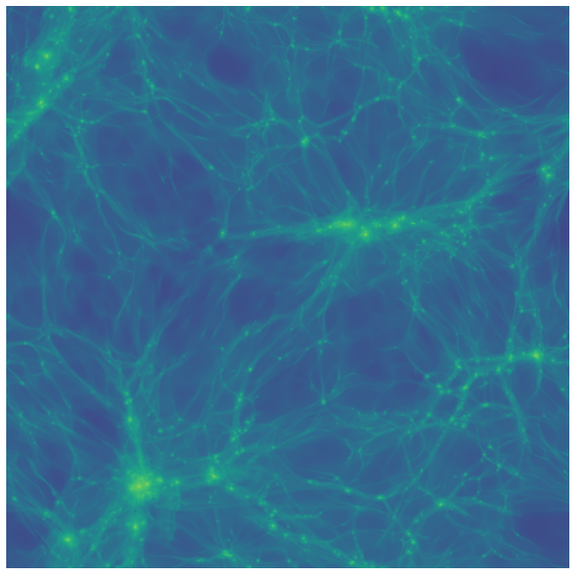

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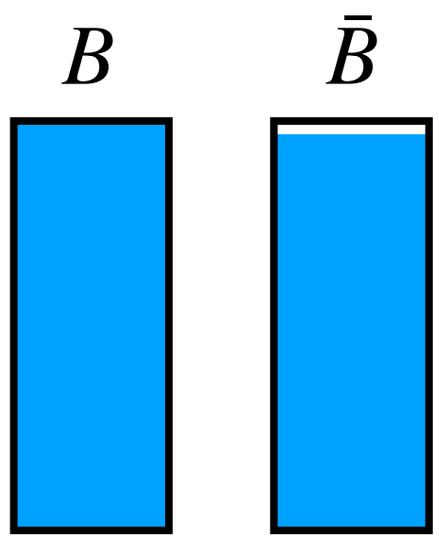

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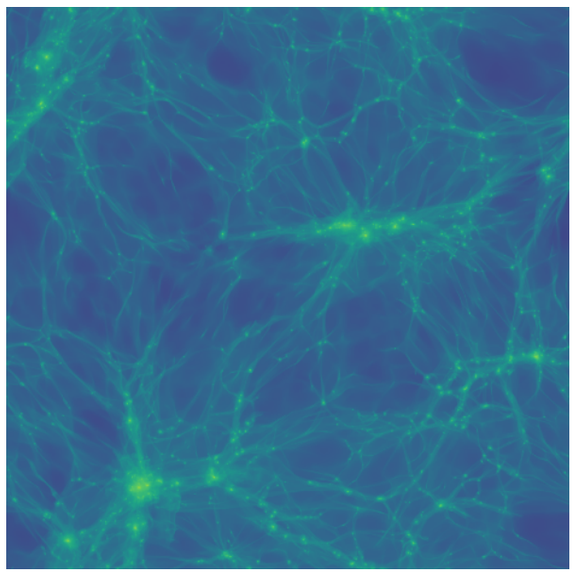

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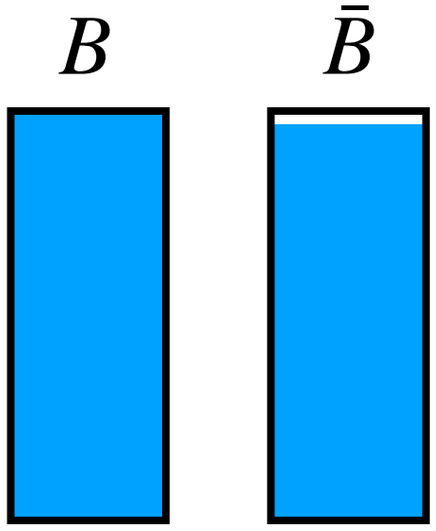
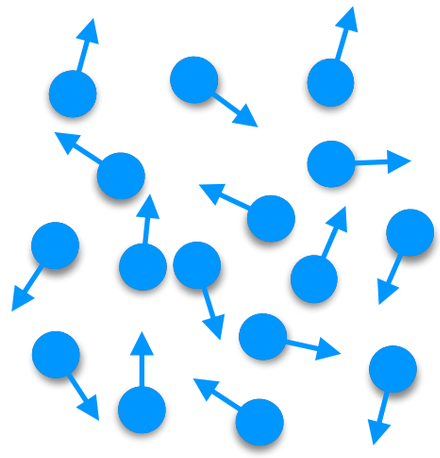


Neutrino Cosmology



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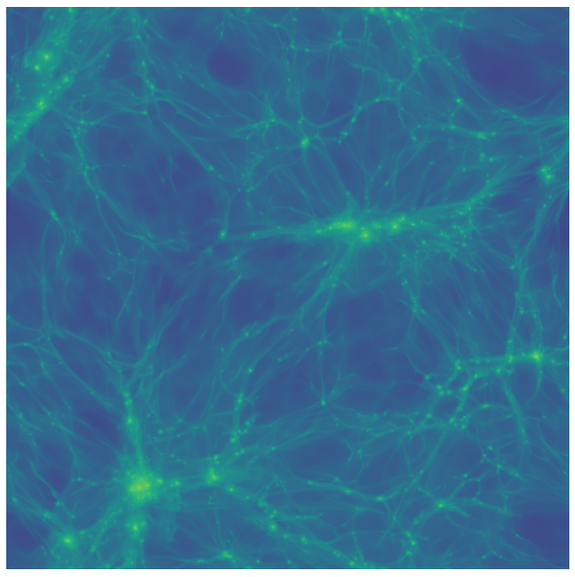

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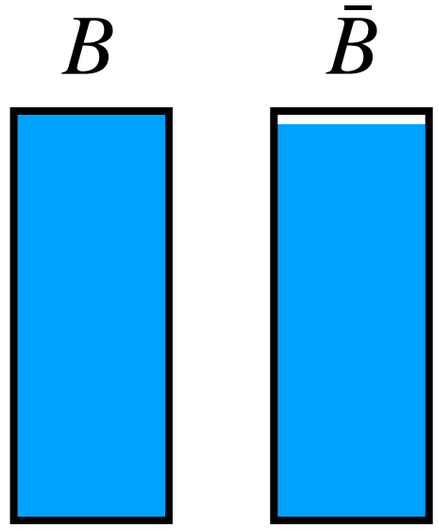

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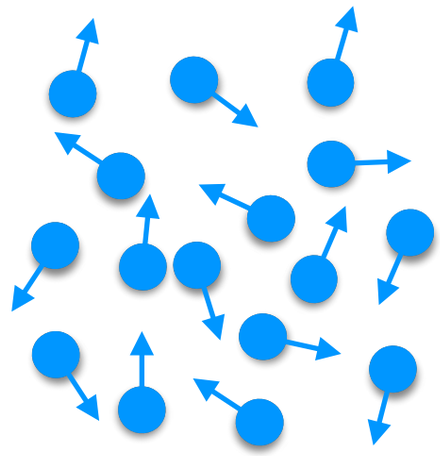

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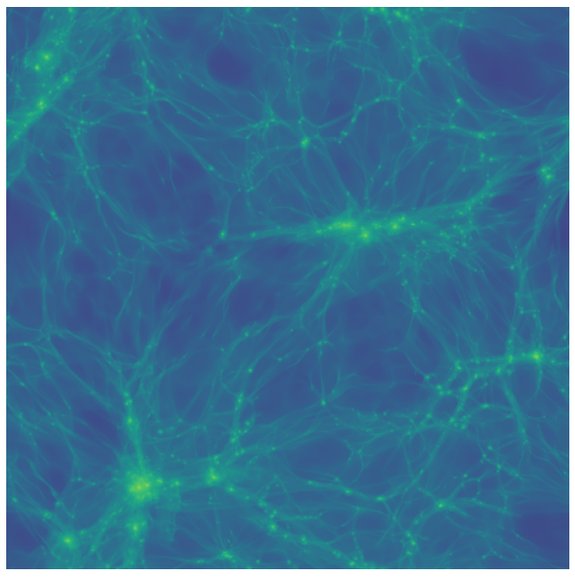

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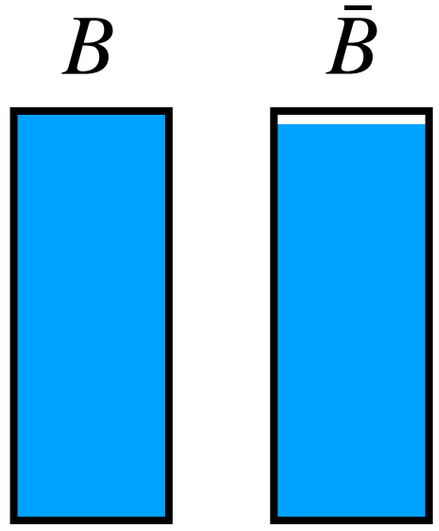

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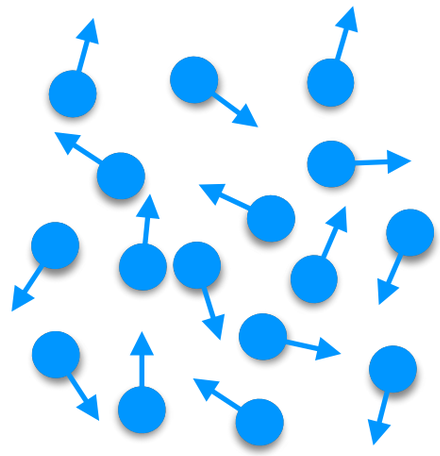

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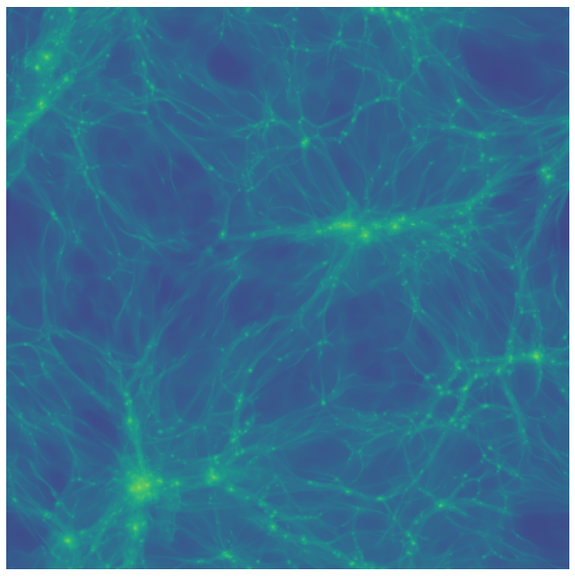

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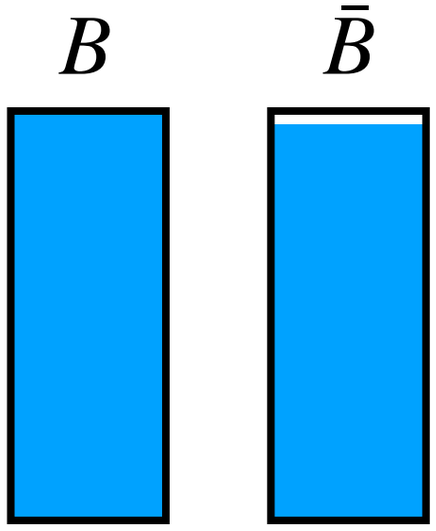

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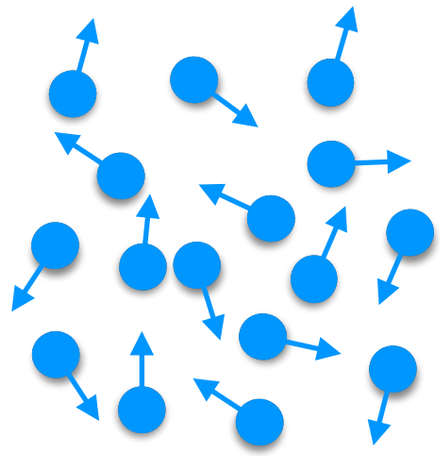

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Theoretical perspective but at the boundary with laboratory and cosmological data

Colliders **DM Experiments** **BBN** **CMB**

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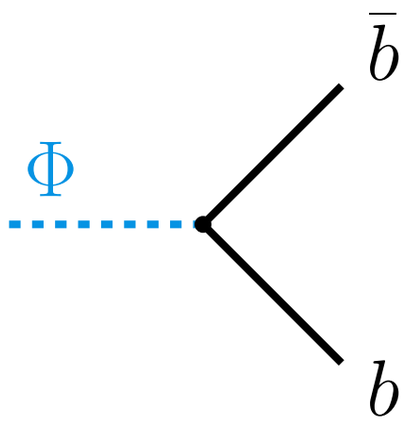

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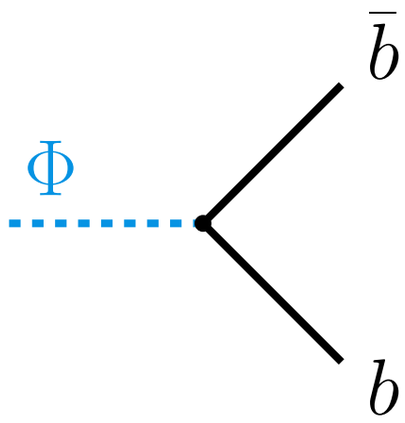

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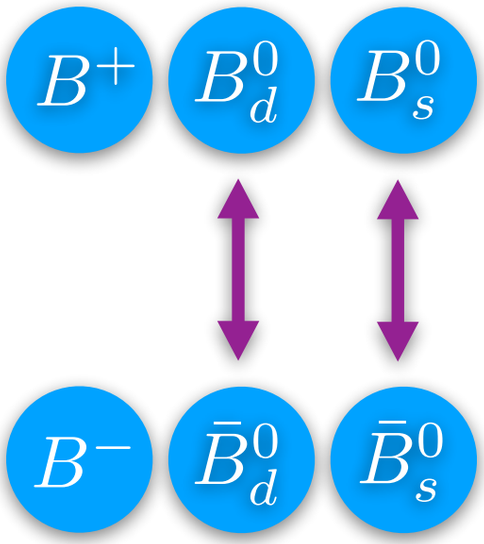

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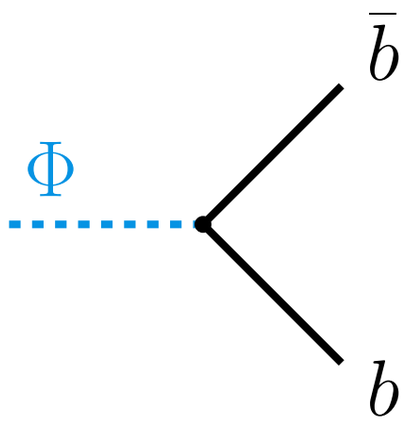

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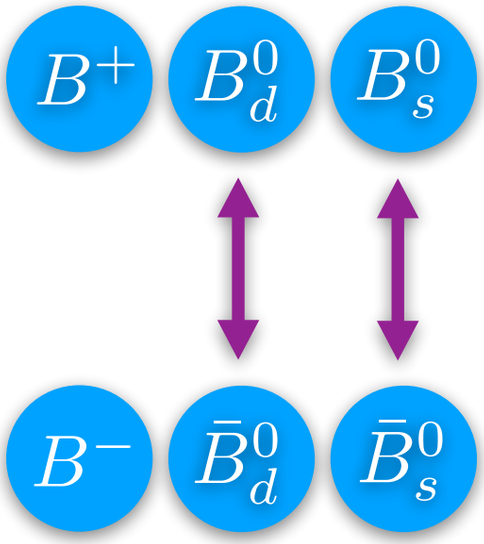

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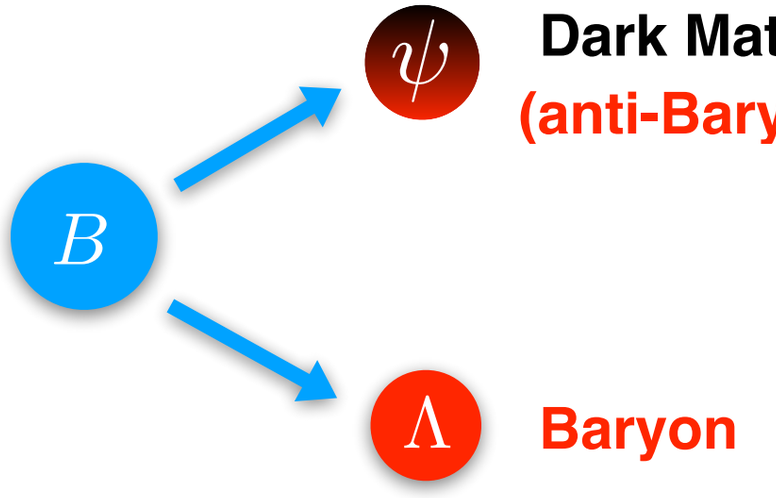
B-mesons decay into Dark Matter and hadrons



Dark Matter (anti-Baryon)

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$\mathrm{Br}\,(B \to \psi + \mathcal{B} + \mathcal{M})$

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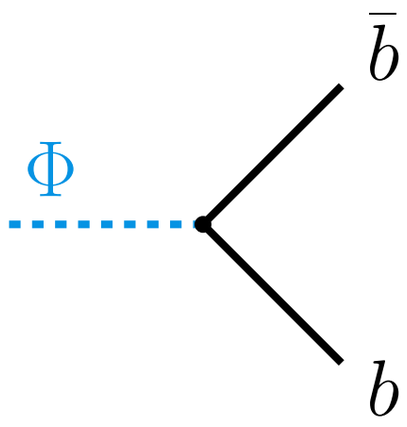

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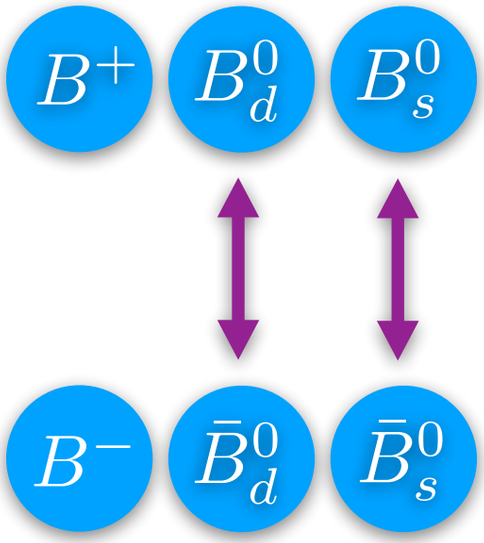

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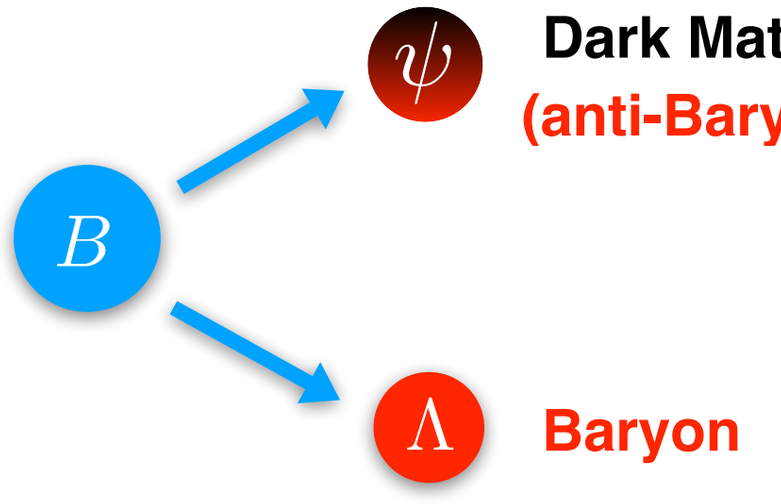

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With:

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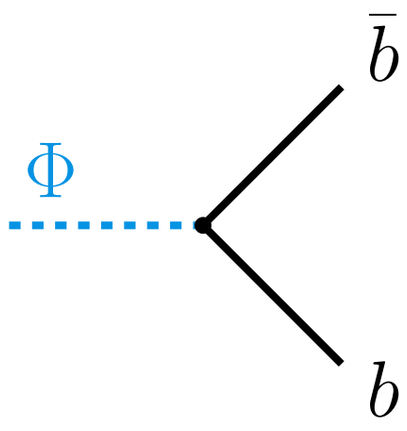

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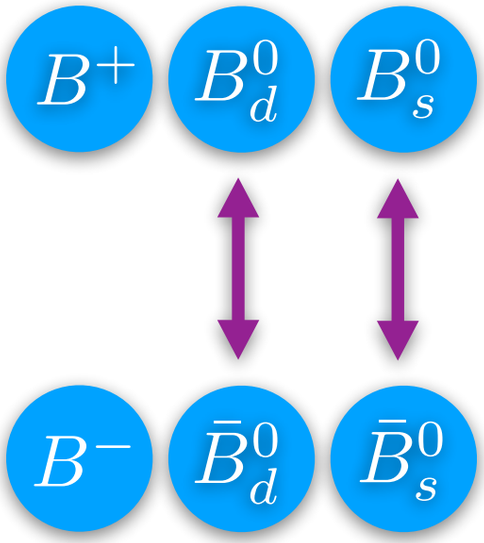

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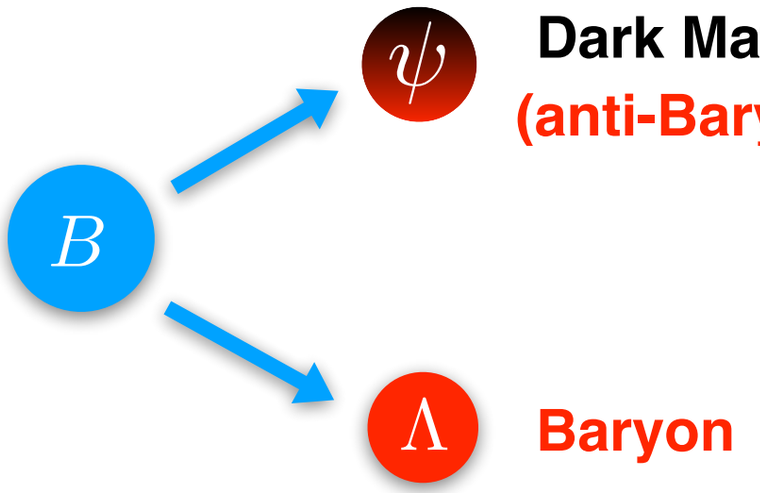

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- **Shown that the mechanism is fully testable at current collider experiments**
  Alonso-Álvarez, Elor & M.E. 21'

The signals we proposed are currently being searched for with old data from Belle and BaBar (see Belle : PRD 105 (2022) L051101). Belle-II and LHCb are considering performing analogous searches! 😀

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WIMPs
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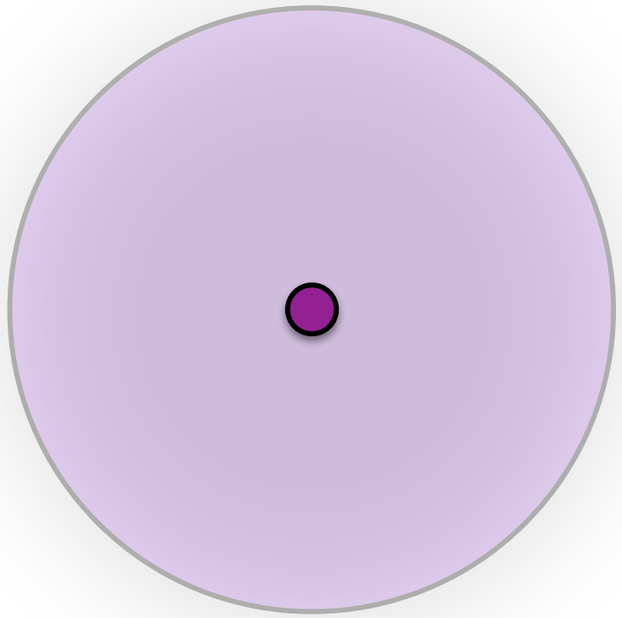

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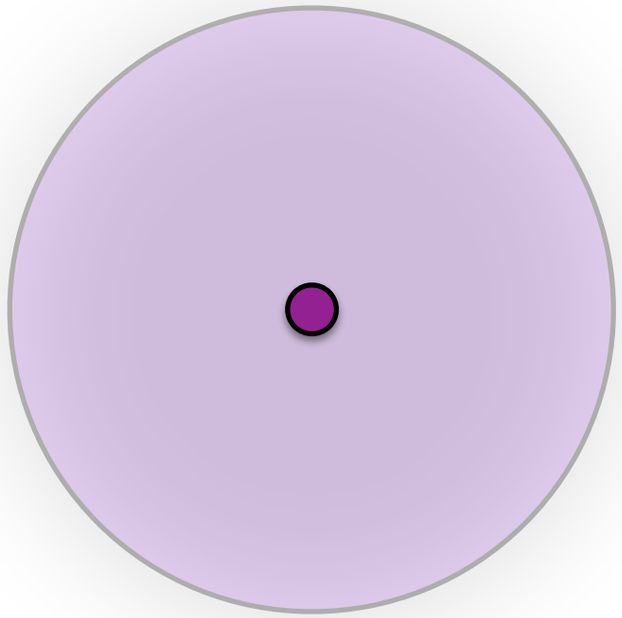

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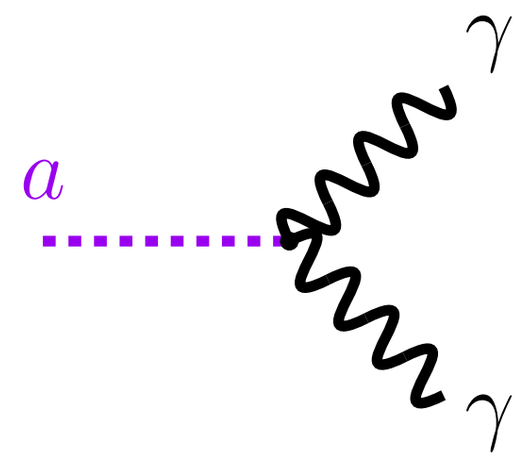

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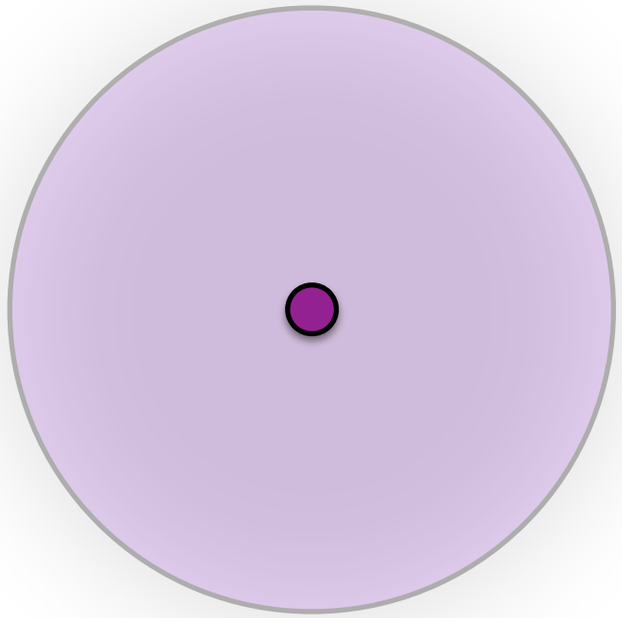

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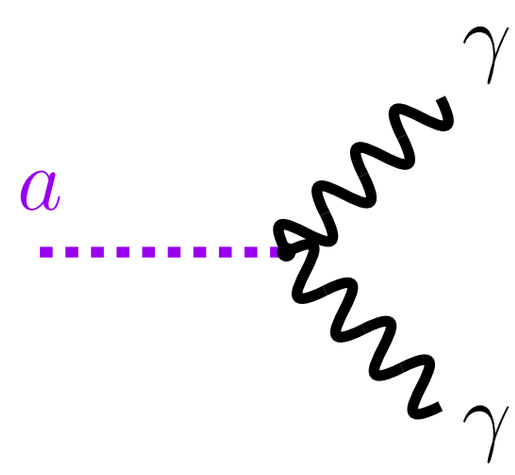

Such decays will happen during the dark ages at z > 20 and could reionize the Universe. Something which Planck data constraints for $m_a \sim 10^{-14}\,\mathrm{eV} - 10^{-12}\,\mathrm{eV}$

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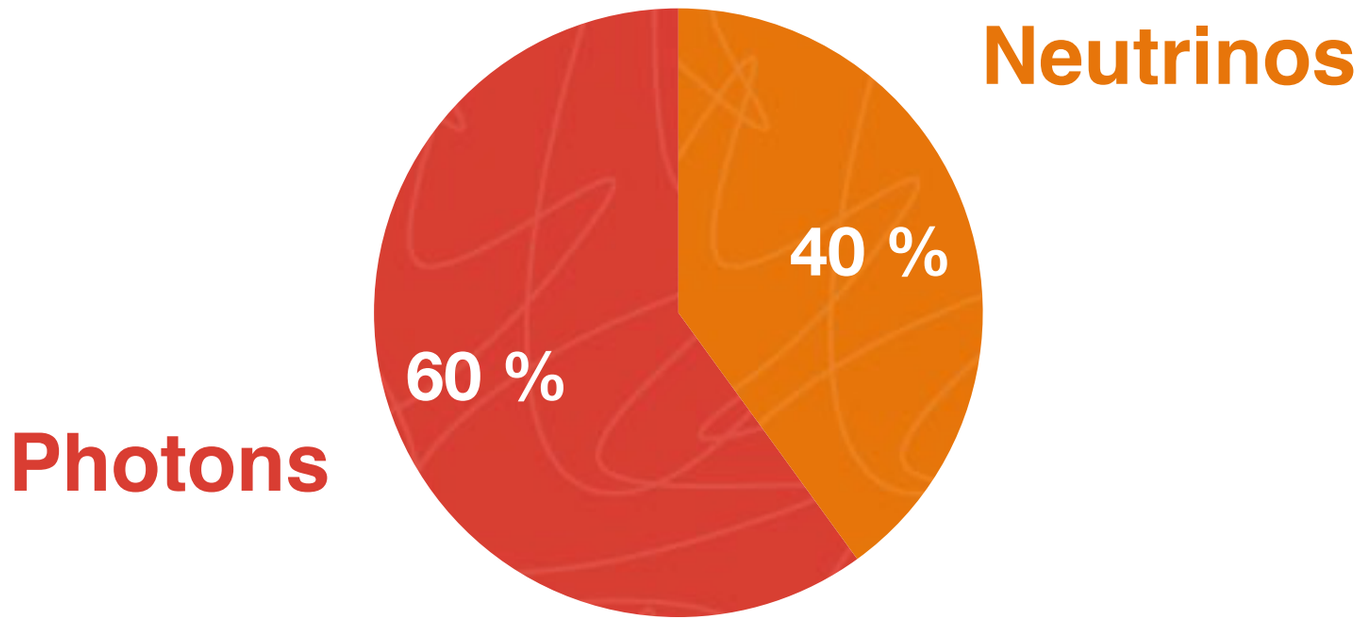

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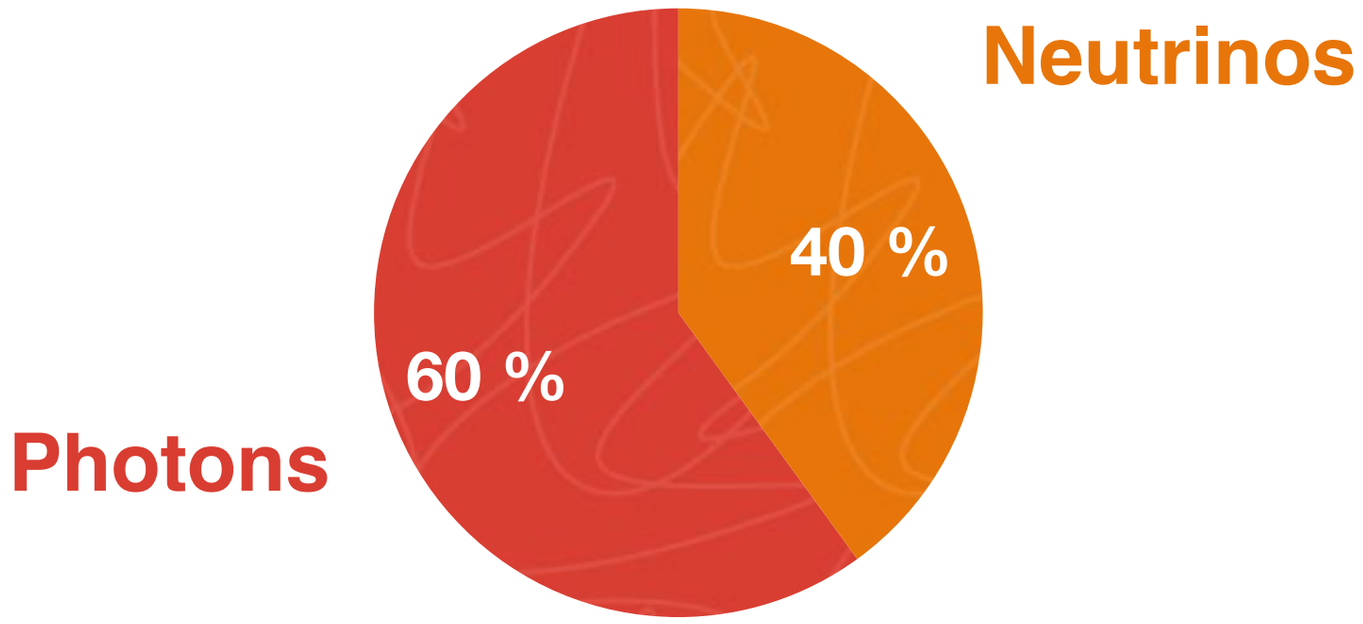

Use cosmological data to understand their properties

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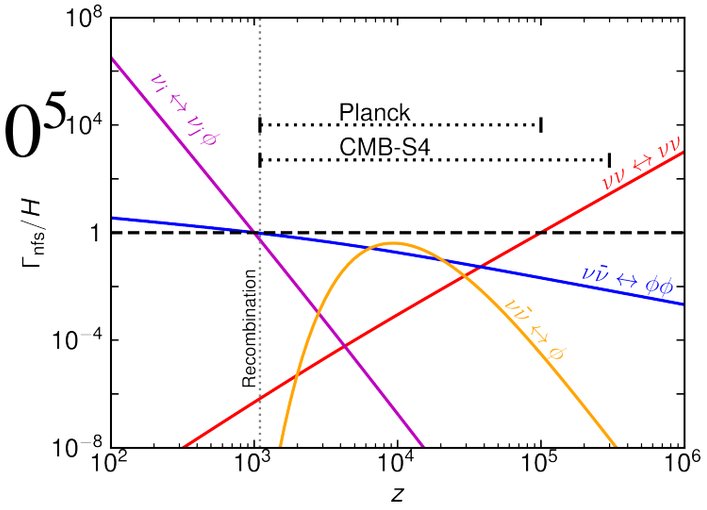

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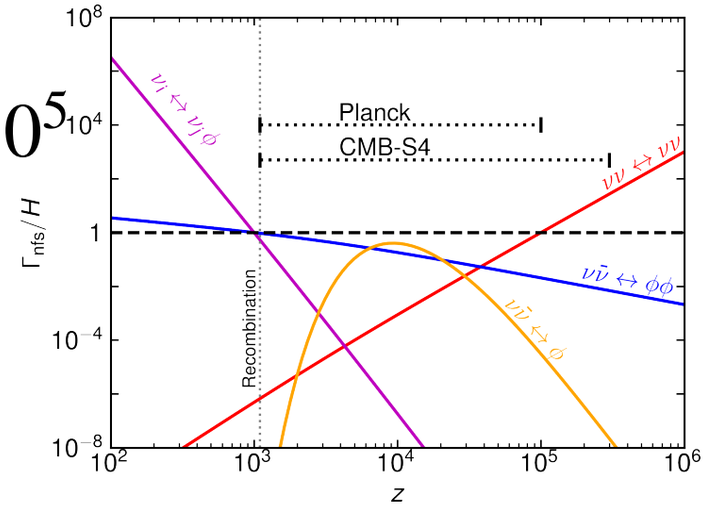

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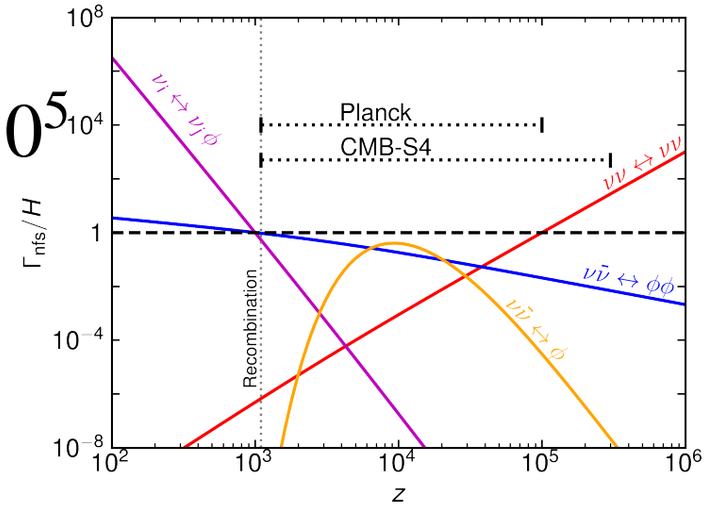
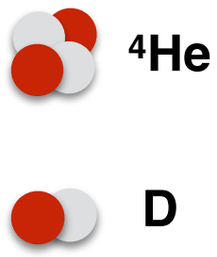
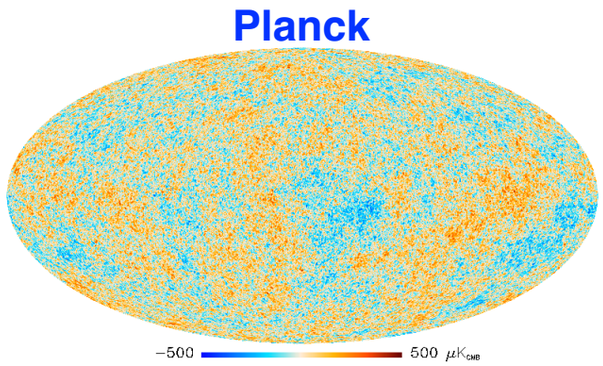


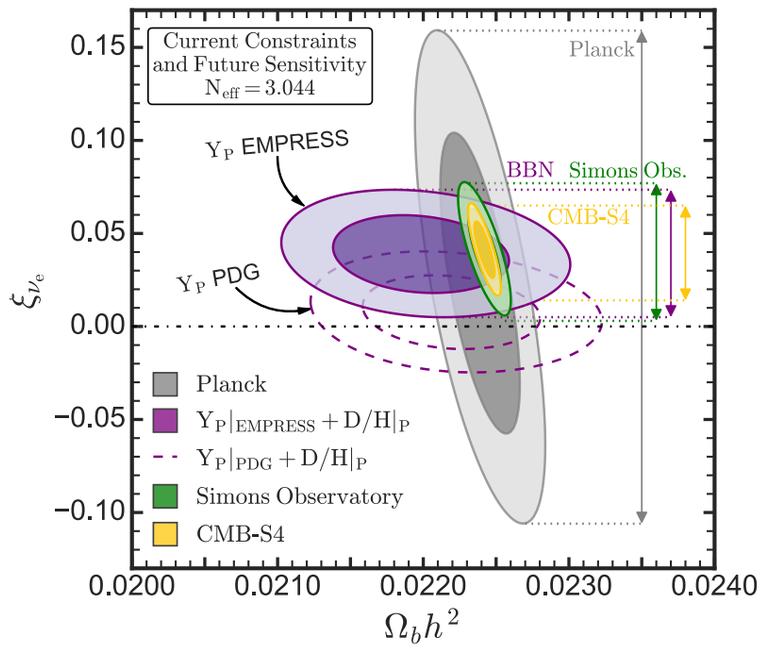
- **Primordial lepton asymmetries**

  M.E., Ibarra & Maura 22'





We need better rates: $d + d \to {}^3\mathrm{He} + n$ and $d + d \to {}^3\mathrm{H} + p$ at $10\,\mathrm{keV} < E < 500\,\mathrm{keV}$



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  Taule, M.E. & Garny 22'

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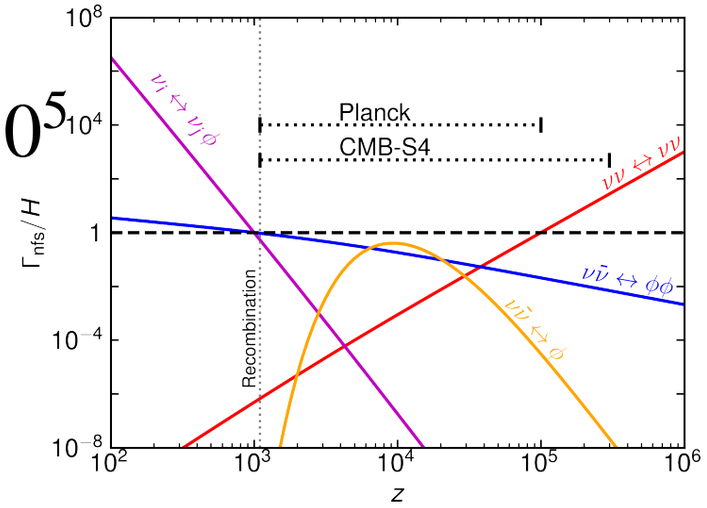
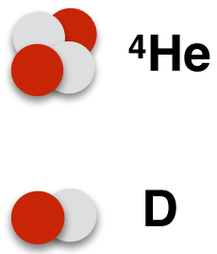
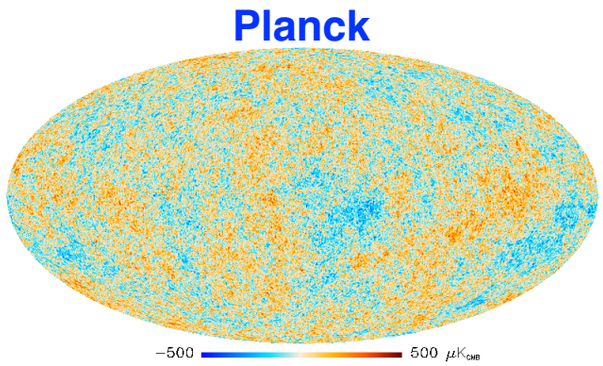
  ongoing work with Stefan Sandner and Sam Witte

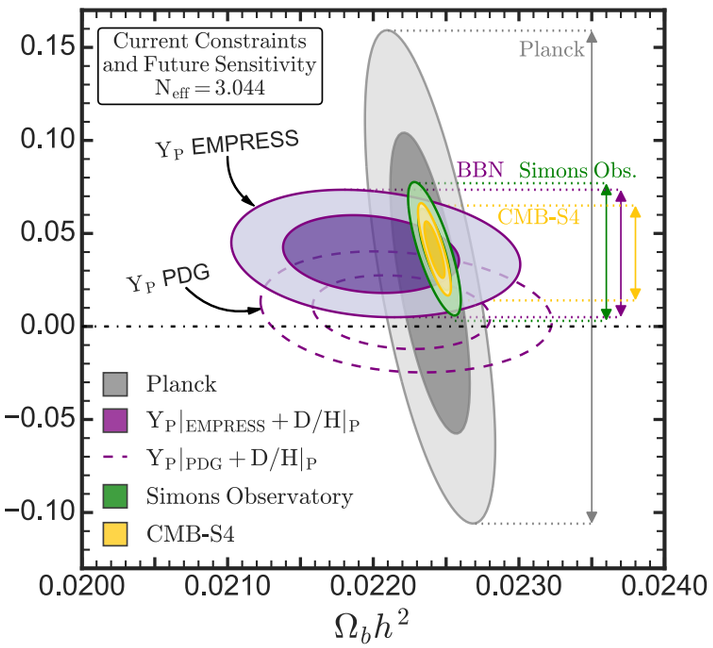


- **Primordial lepton asymmetries**

  M.E., Ibarra & Maura 22'







We need better rates: $d + d \to {}^3\mathrm{He} + n$ and $d + d \to {}^3\mathrm{H} + p$ at $10\,\mathrm{keV} < E < 500\,\mathrm{keV}$

- **Revisited the process of neutrino decoupling in the early Universe. New method to calculate $N_{\rm eff}$ in the Standard Model and beyond:**

  M.E. 20'
  M.E. 21'

$$N_{\rm eff}^{\rm SM} = 3.044(1)$$

currently working on neutrino decoupling in the presence of large lepton asymmetries with Valerie Domcke and Mario Fernández Navarro

Neutrino Cosmology

- **Understanding the cosmological model dependence of cosmological neutrino mass bounds**

Planck [ΛCDM] :

$$\sum m_\nu < 0.12\,\mathrm{eV}$$

This bound is rather robust to typical extensions of ΛCDM

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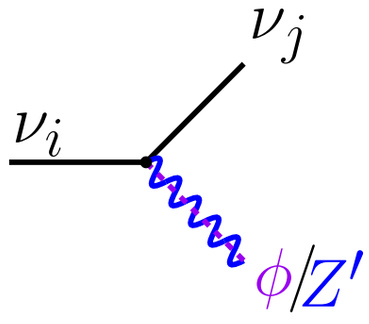

M.E, Lopez-Pavon, Rius & Sandner 20'

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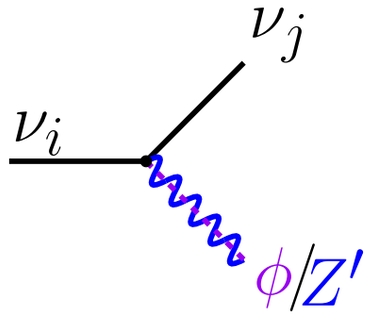

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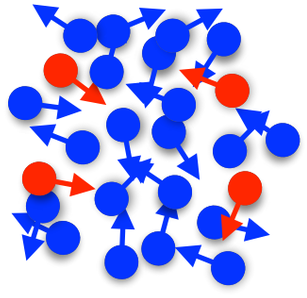

M.E., Schwetz, Terol-Calvo 22'

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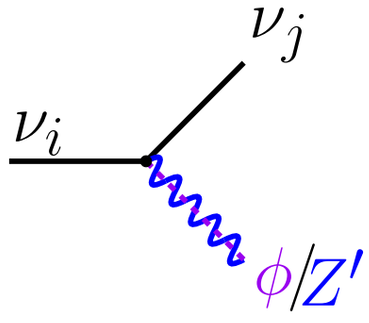

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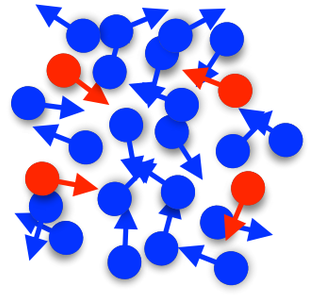

M.E., Schwetz, Terol-Calvo 22'

They are a bit exotic, but if a neutrino mass were to be detected in the laboratory then we will need to drastically change our cosmological model!

Outlook at CERN

- **Continue investigating signatures and developing models of Dark Matter and Baryogenesis**

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  I love discussing physics and I will be happy to start new projects in other fronts!! Including other aspects of early Universe cosmology, GWs, theory, flavor physics …

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  In this context: BSM/Cosmo JC Tuesdays at 11:30 in the TH common room

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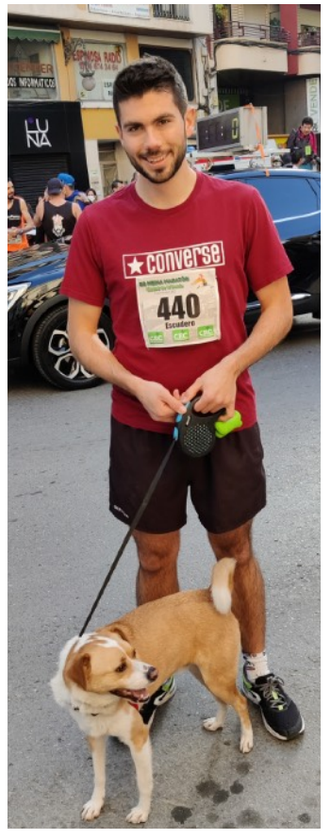

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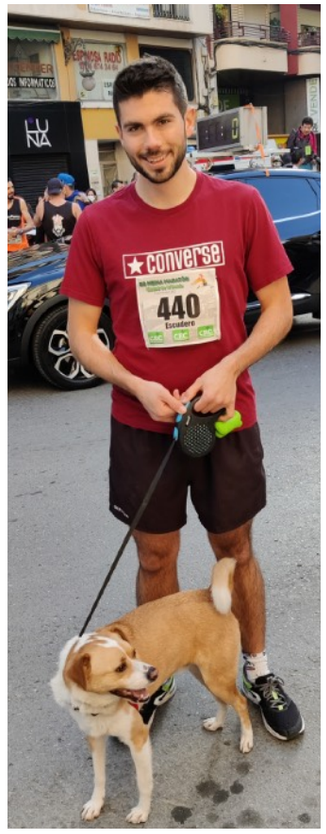

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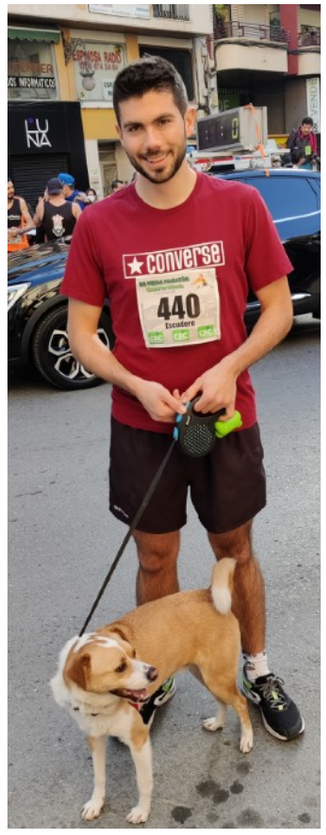

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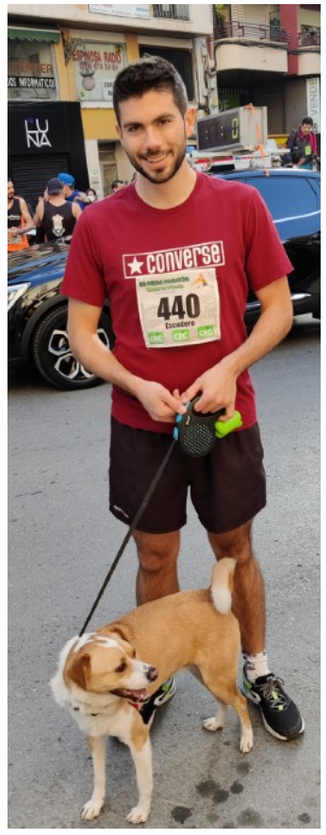

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