

A new solution to old problems in particle/astroparticle physics

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PhD Programme: Beyond the SM – Interplay between particle and astroparticle physics

Supervisors:

Filipe Joaquim (CFTP/IST)
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2021: MSc in Engineering Physics

MSc Thesis:

Phenomenology of the minimal inverse-seesaw model with Abelian flavour symmetries



MSc Thesis (MEFT)

Supervisors:

Filipe Joaquim
Ricardo Felipe

Highlighted Publications:

- **Flavour and dark matter in a scoto/type-II seesaw model**
D.M. Barreiros, H.B. Camara, F.R. Joaquim
Published in: JHEP 08 (2022) 030
- **Dark-sector seeded solution to the strong CP problem**
H.B. Câmara, F.R. Joaquim, J.W.F. Valle
Published in: Phys.Rev.D 108 (2023) 9, 095003
- **Confronting the 95 GeV excesses within the U(1)'-extended next-to-minimal 2HDM**
J.A. Aguilar-Saavedra, H.B. Câmara, F.R. Joaquim, J.F. Seabra
Published in: Phys.Rev.D 108 (2023) 7, 075020
- **Axion paradigm with color-mediated neutrino masses**
A. Batra, H.B. Câmara, F.R. Joaquim, R. Srivastava, J.W.F. Valle
Accepted in Phys. Rev. Lett.
e-Print: 2309.06473 [hep-ph]

Some Talks at International Conferences

- **FLASY'22** (IST, Lisbon)
- **BLV'22** (ULB, Brussels)
- **DISCRETE'22** (KIT, Baden-Baden)
- **PLANCK'23** (Warsaw)



Full Publication List

PHYSICAL REVIEW LETTERS **132**, 051801 (2024)

Axion Paradigm with Color-Mediated Neutrino Masses

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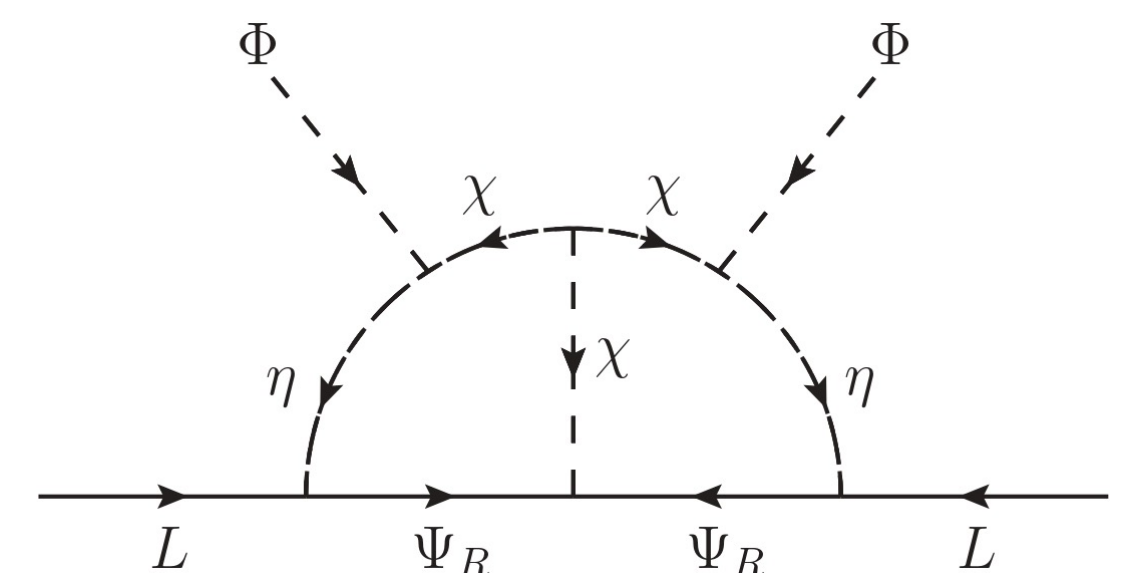
PHYSICAL
REVIEW
LETTERS

Problems that require New Physics

- **Neutrino flavour oscillations:** Imply massive neutrinos and lepton mixing;
- **Dark matter:** Requires a stable, non-baryonic, electrically neutral and cold particle to account for observed dark matter abundance;
- **Strong CP problem:** Lack of a theoretical explanation for the non-observation of the neutron electric dipole moment which indicates that strong interactions preserve matter-antimatter/CP symmetry.

Our proposed solution

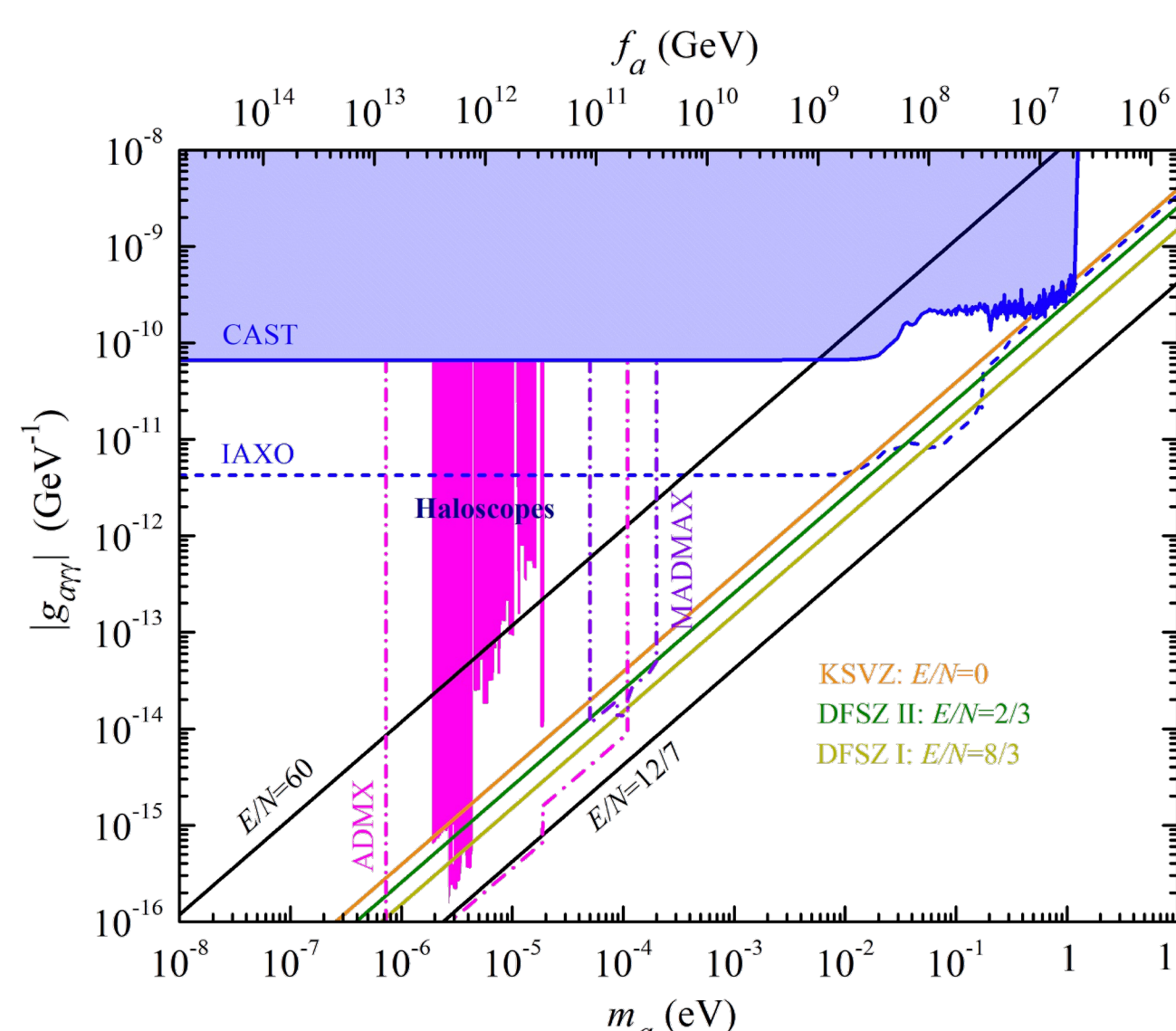
Fields	$SU(3)_c \otimes SU(2)_L \otimes U(1)_Y$	$U(1)_{PQ}$	Multiplicity
Ψ_L	$((p, q), 2n \pm 1, 0)$	ω	n_Ψ
Ψ_R	$((p, q), 2n \pm 1, 0)$	0	n_Ψ
σ	$(1, 1, 0)$	ω	1
η	$((p, q), 2n, 1/2)$	0	n_η
χ	$((p, q), 2n \pm 1, 0)$	0	n_χ



$$\frac{E}{N} = \frac{d(p, q)}{(2n \pm 1)T(p, q)} \sum_{j=0}^{2n \pm 1 - 1} \left(\frac{2n \pm 1 - 1}{2} - j \right)^2$$

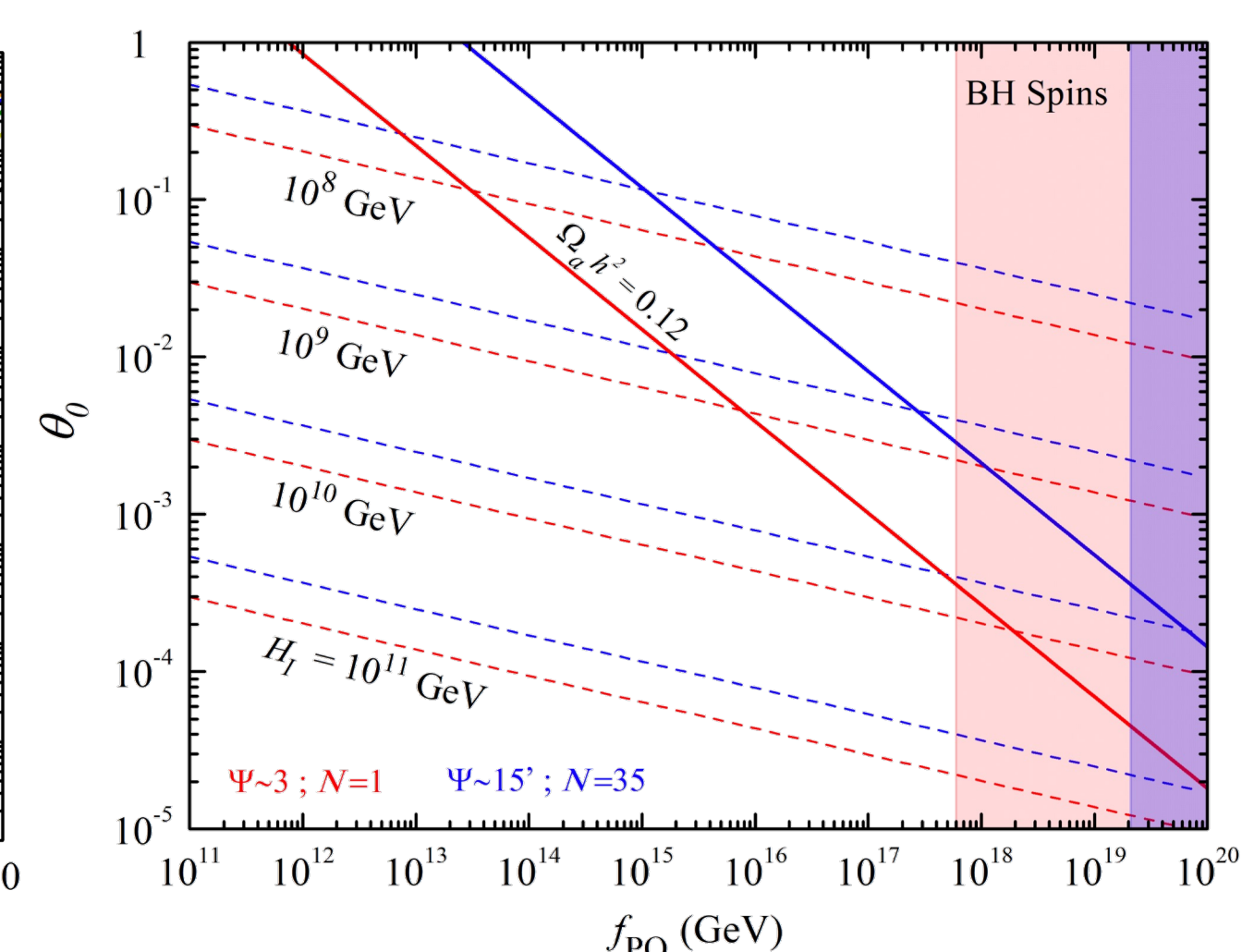
New class of **models** where **neutrino masses** are radiatively generated by **colored particles** which simultaneously solve through the Peccei-Quinn mechanism the **strong CP problem**.
The predicted **axion particle** accounts for **dark matter**.

Axion phenomenology



Axion-to-photon coupling allows to probe the different models at **helioscope** and **haloscope** experiments.

$$g_{a\gamma\gamma} = \frac{\alpha_e}{2\pi f_a} \left[\frac{E}{N} - 1.92(4) \right]$$



Axion dark matter via the misalignment mechanism in **pre-inflationary** scenario

$$\Omega_a h^2 \simeq \Omega_{\text{CDM}} h^2 \frac{\theta_0^2}{2.15^2} \left(\frac{f_a}{2 \times 10^{11} \text{ GeV}} \right)^{\frac{7}{6}}$$