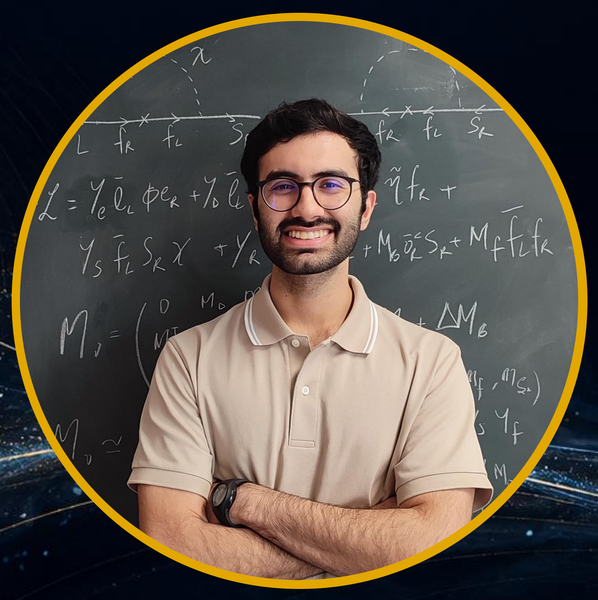


Is there a new 17 MeV particle?

A. Batra, F.R. Joaquim, H. Prajapati, R. Srivastava

ADITYA BATRA

PhD Student @ CFTP (2023-2027)

Centro de Física Teórica de Partículas (CFTP)

FCT PhD Grant: UI/BD/154391/2023
aditya.batra@tecnico.ulisboa.pt

PhD Programme: Neutrinos: a window to the Universe

Supervisors:

Filipe Joaquim (CFTP/IST)
Rahul Srivastava (IISER Bhopal)
José W. F. Valle (IFIC, València)

2022: MSc in Physics

MSc Thesis:
h to ϒγ as a Novel Probe for New Physics

Supervisor:
Rahul Srivastava

MSc Thesis

Highlighted Publications:

- **Sterile neutrino dark matter in the minimal Dirac seesaw**
  J. Adhikary, A. Batra, K. Deka, F.R. Joaquim
  Published in: Phys.Lett.B 880 (2026) 140728
- **Axion paradigm with color-mediated neutrino masses**
  A. Batra, H.B. Câmara, F.R. Joaquim, R. Srivastava, J.W.F. Valle
  Published in: Phys.Rev.Lett. 132 (2024) 5, 051801
- **Dark linear seesaw mechanism**
  A. Batra, H.B. Câmara, F.R. Joaquim
  Published in: Phys.Lett.B 843 (2023) 138012
- **Phenomenology of the simplest linear seesaw mechanism**
  A. Batra, P. Bharadwaj, S. Mandal, R. Srivastava, J.W.F. Valle
  Published in: JHEP 07 (2023) 221
- **h→ϒγ Decay: Smoking Gun Signature of Wrong-Sign hbb Coupling**
  A. Batra, S. Mandal, R. Srivastava
  e-Print: 2209.01200 [hep-ph]

Full Publication List

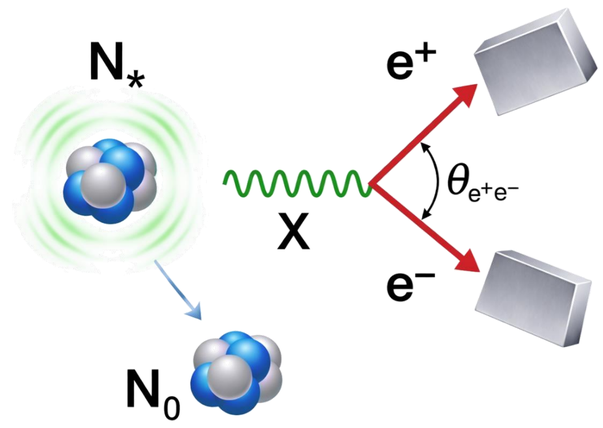
Talks at international conferences:

- **PLANCK2026** - The 28th International Conference "From the Planck Scale to the Electroweak Scale" (CERN, Geneva, Switzerland)
- **FLASY 2025** - 11th Workshop on Flavour Symmetries and Consequences in Accelerators and Cosmology (Roma Tre, Rome, Italy)
- **Corfu2024** - Workshop on Standard Model and Beyond (Corfu, Greece)
- **ISAPP 2024** - Particle Candidates for Dark Matter (SGGS, Padua, Italy)

Fundação para a Ciência e a Tecnologia
UID/00777/2025, UI/BD/154391/2023
REPÚBLICA PORTUGUESA
COMPETE 2020
PORTUGAL 2020

The *X*17 Puzzle

- The ATOMKI Collaboration observed unexpected excesses of electron-positron pairs in several nuclear transitions.
- These excesses are kinematically consistent with a new boson ***X*** of mass **17 MeV**.
- Signals have been reported in excited states of **^{8}Be**, **^{4}He** and **^{12}C** (more theoretically uncertain).



Why is it so challenging to explain?

Different spin-parity assignments for the new particle face different problems:

Excited nucleus	Possibilities for X			
	Scalar	Pseudoscalar	Vector	Axial-Vector
^{8}Be (18.15), ^{8}Be (17.64)	×	✓	✓	✓
^{4}He (20.21)	✓	×	✓	×
^{4}He (21.01)	×	✓	×	✓
^{12}C (17.23)	✓	×	✓	✓

- **Scalar:** cannot explain the **^{8}Be** anomaly.
- **Pseudoscalar:** cannot account for the **^{12}C** anomaly.
- **Pure vector:** faces strong constraints from pion-decay searches.
- **Axial-vector, or mixed vector-axial interactions:** currently provide the most promising interpretation.

Our framework

We consider a **gauged, chiral and flavor-specific** extension of the Standard Model.

$$\mathrm{SU(3)_c} \otimes \mathrm{SU(2)_L} \otimes \mathrm{U(1)_Y} \otimes \mathbf{U(1)_X} \longrightarrow$$ introduces a light neutral gauge boson ***X***

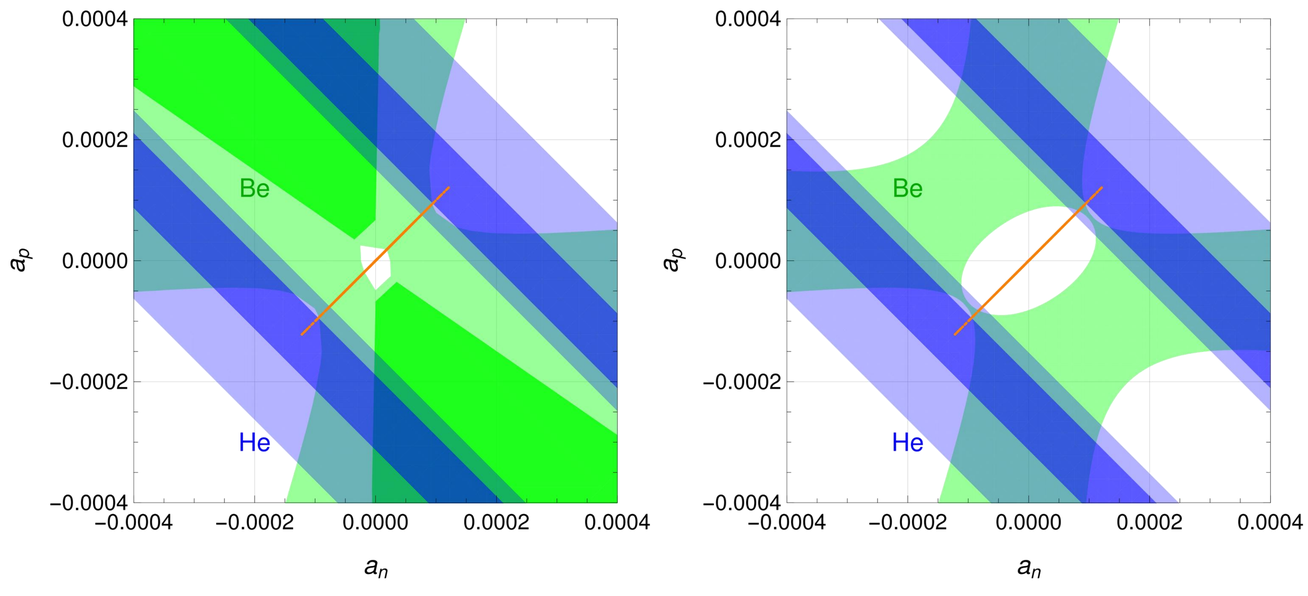
- We introduce **two Higgs doublets (2HDM)** to allow nonzero axial couplings while maintaining fermion mass generation.
- Chiral, flavor-specific **U(1)$_X$** charge assignments ensuring **gauge anomaly cancellation** allow the required interaction structure.
- This makes it possible to generate **axial-vector couplings** of the required magnitude: $a_n, a_p \sim 10^{-4} - 10^{-3}$.

Experimental constraints

Any viable 17 MeV gauge boson must satisfy a large number of laboratory constraints:

- ✓ **Atomic parity violation**
- ✓ **Parity-violating Møller scattering**
- ✓ **Electron and muon anomalous magnetic moments:** $(g-2)_e$ and $(g-2)_\mu$
- ✓ **Beam-dump experiments**
- ✓ **Rare meson decays:** particularly pion and kaon processes
- ✓ **SINDRUM-I:** $\pi^+ \to e^+ \nu_e e^+ e^-$
- ✓ **Neutrino-electron scattering**
- ✓ **Coherent elastic neutrino-nucleus scattering (CEνNS)**
- ✓ **Neutron-lead scattering**
- ✓ **Collider searches** and **visible-resonance searches**
- ✓ The gauge boson must also **decay sufficiently promptly** inside the ATOMKI detector

The results



- The surviving parameter space is narrow and **experimentally testable**.
- The **PADME** experiment has also reported an approximately 2σ excess near **16.90 MeV**, intriguingly close to the mass suggested by ATOMKI.