

Partikeldagarna 2024, Uppsala, Sweden

# Hunting For Dark Photon Trident and Beyond

Thong T.Q. Nguyen





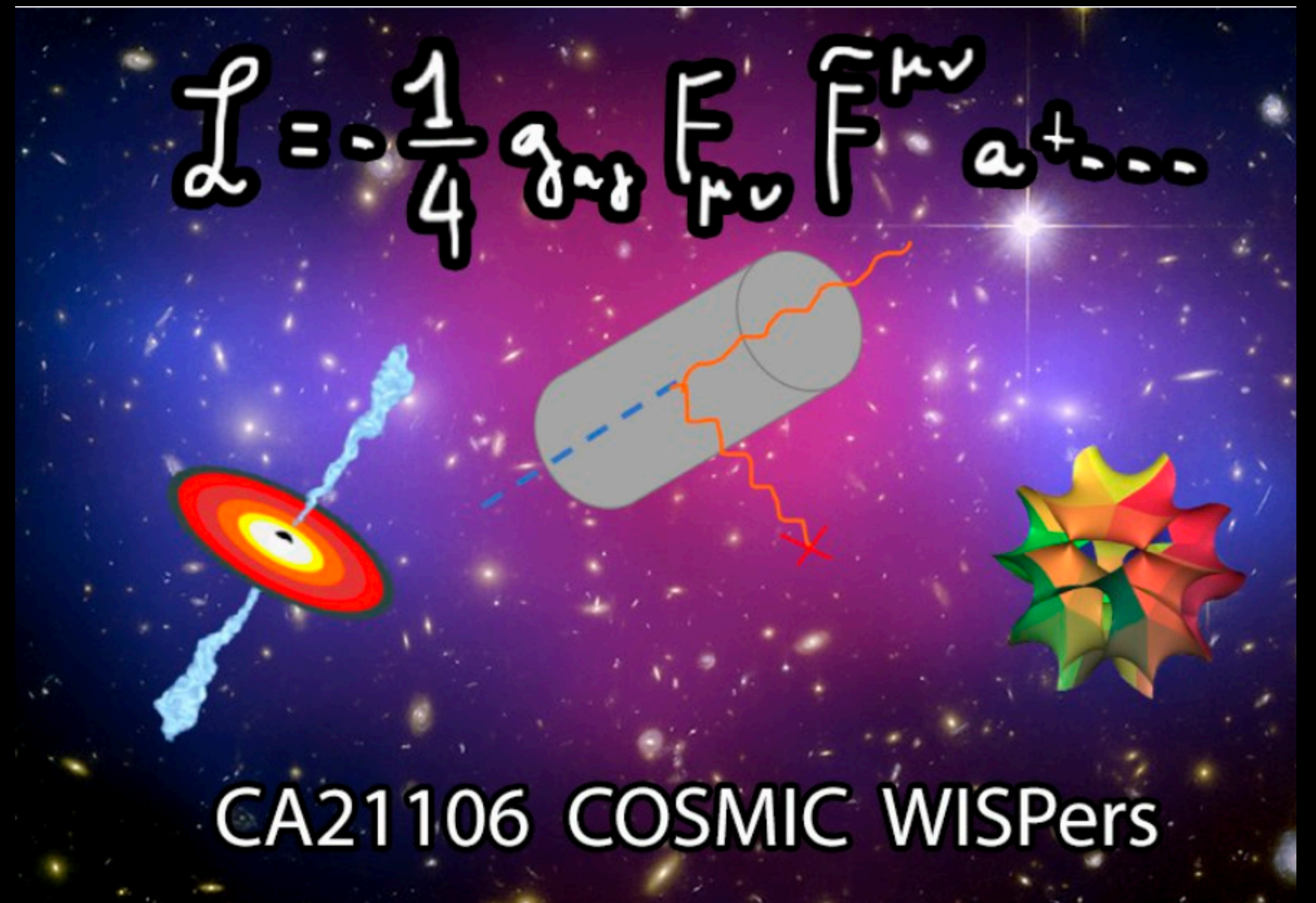
## Based on

- Tim Linden, **TTQN**, Tim Tait, *X-Ray Constraints on Dark Photon Tridents*, (arXiv:[2406.19445](#))
- **TTQN**, Isabelle John, Tim Linden Tim Tait, *Strong Constraints on Dark Photon and Scalar Dark Matter Decay from INTEGRAL and AMS-02*, in prep. ([2411.xxxx](#))
- **TTQN**, Pedro De la Torre Luque, in prep.



# WISPs: Weakly Interacting Slim Particles

- Beyond Standard Models + DM
- Sub-GeV particles
- Axion, Axion-Like-Particle, **Dark Photon**, Sterile Neutrino, ...







**Axion**

**Physicist**

**Dark Photon**



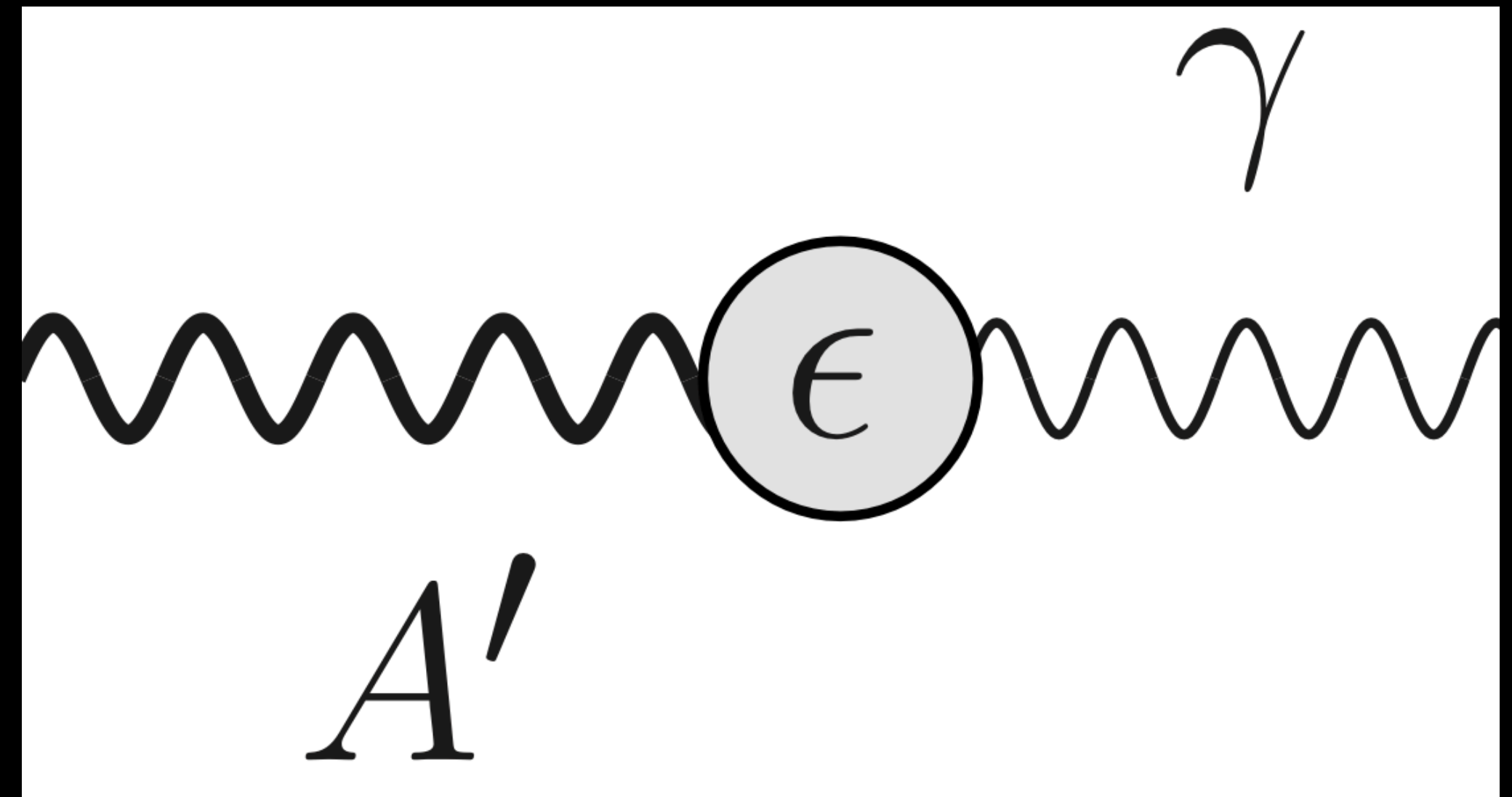
# Dark Photon

$$\mathcal{L} \supset -\frac{1}{4}F'_{\mu\nu}F'^{\mu\nu} - \frac{1}{2}m_{A'}^2 A'_\mu A'^\mu - \frac{\epsilon}{2}F'_{\mu\nu}F^{\mu\nu}$$



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# Dark Photon

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## The Dark Photon

Marco Fabbrichesì (INFN, Trieste), Emidio Gabrielli (Trieste U. and NICPB, Tallinn), Gaia Lanfranchi (Frascati)

May 4, 2020

70 pages

ISBN: 9783030625184

Published: by SpringerBriefs in Physics

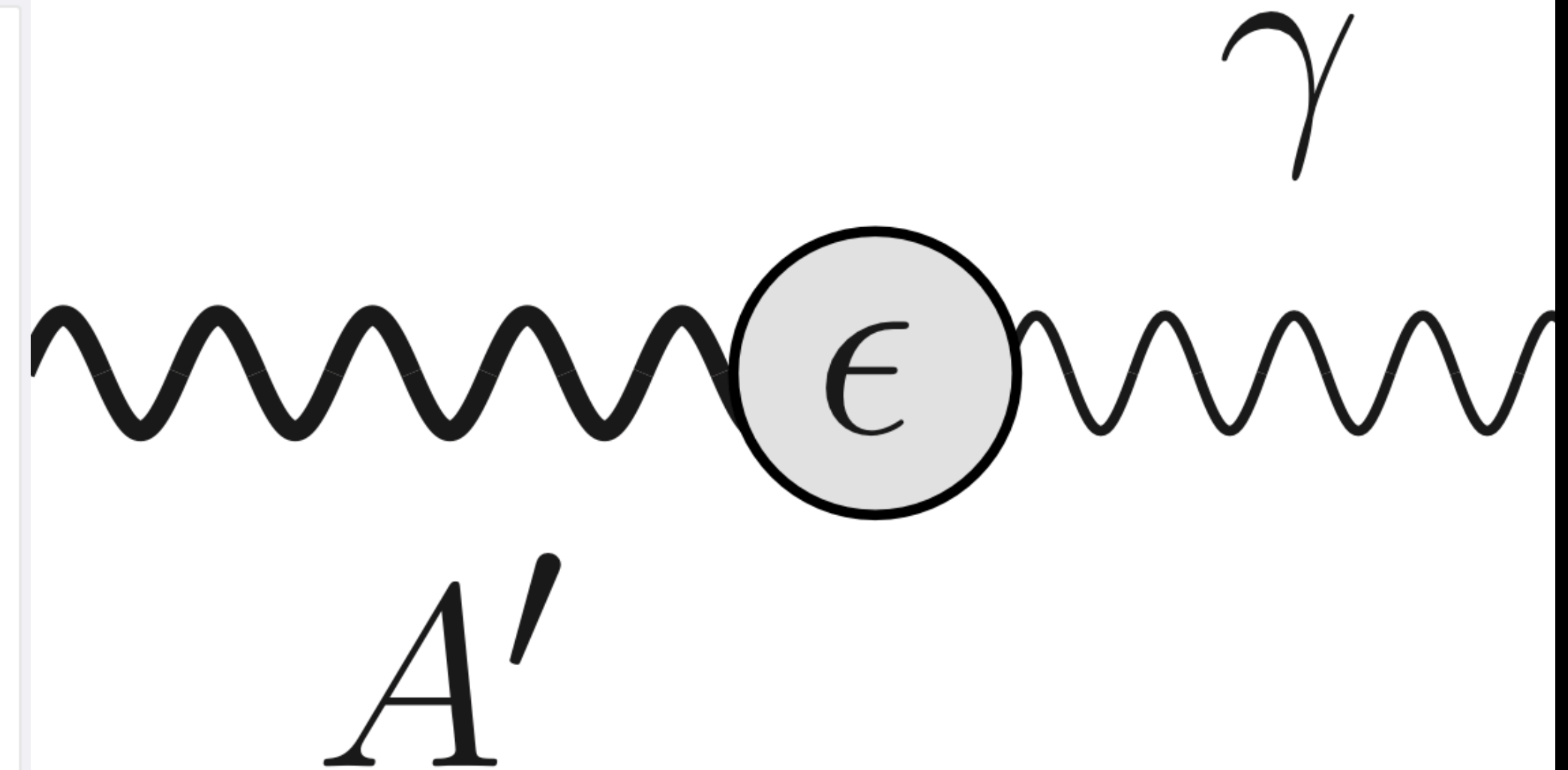
e-Print: [2005.01515](#) [hep-ph]

DOI: [10.1007/978-3-030-62519-1](#) (publication)

View in: [AMS MathSciNet](#), [ADS Abstract Service](#)

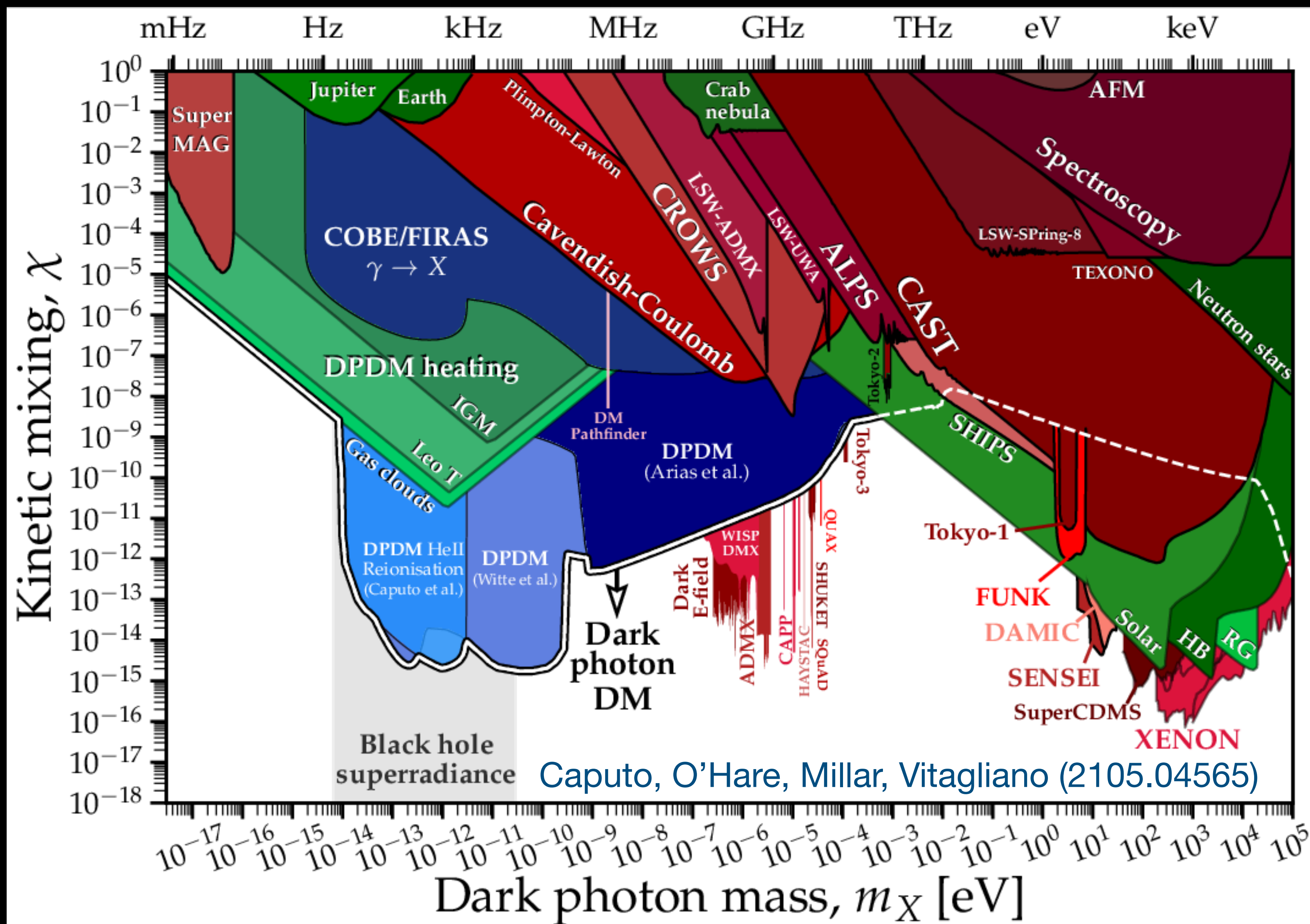
[pdf](#) [cite](#) [claim](#)

[reference search](#) [345 citations](#)



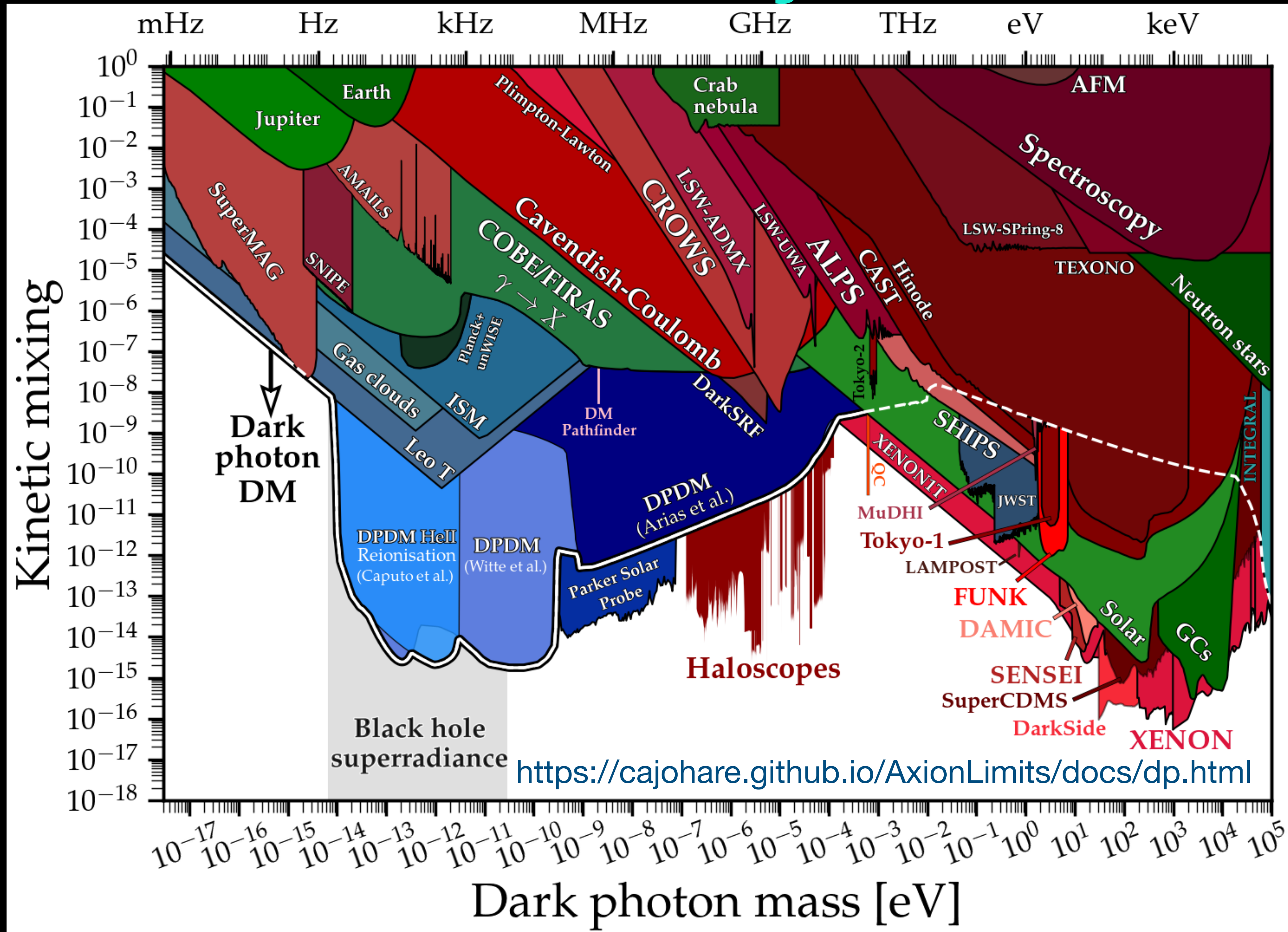


# Dark Photon Status: 2021



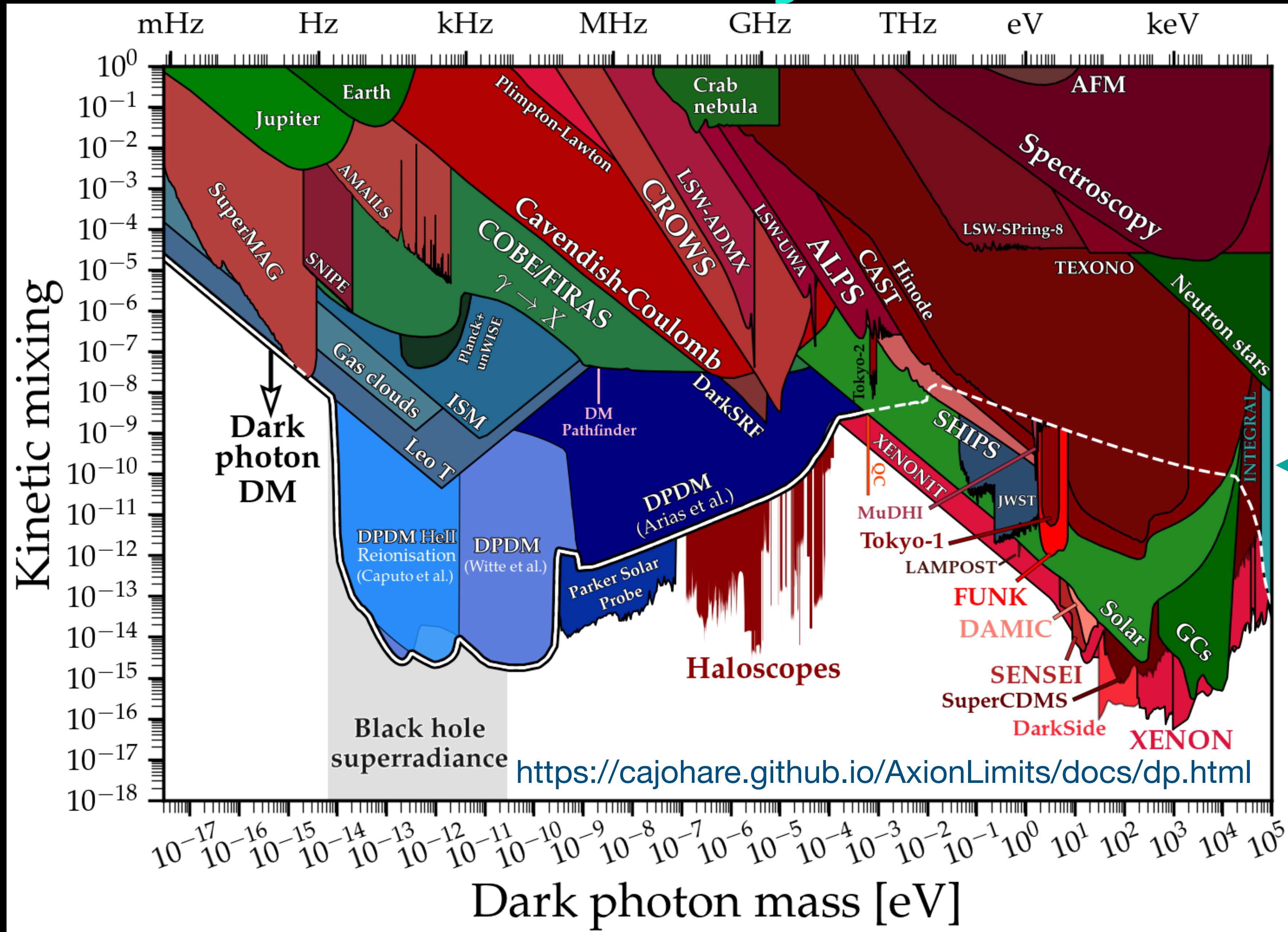


# Dark Photon Status: today





# Dark Photon Status: today





# The Dark Photon Trident

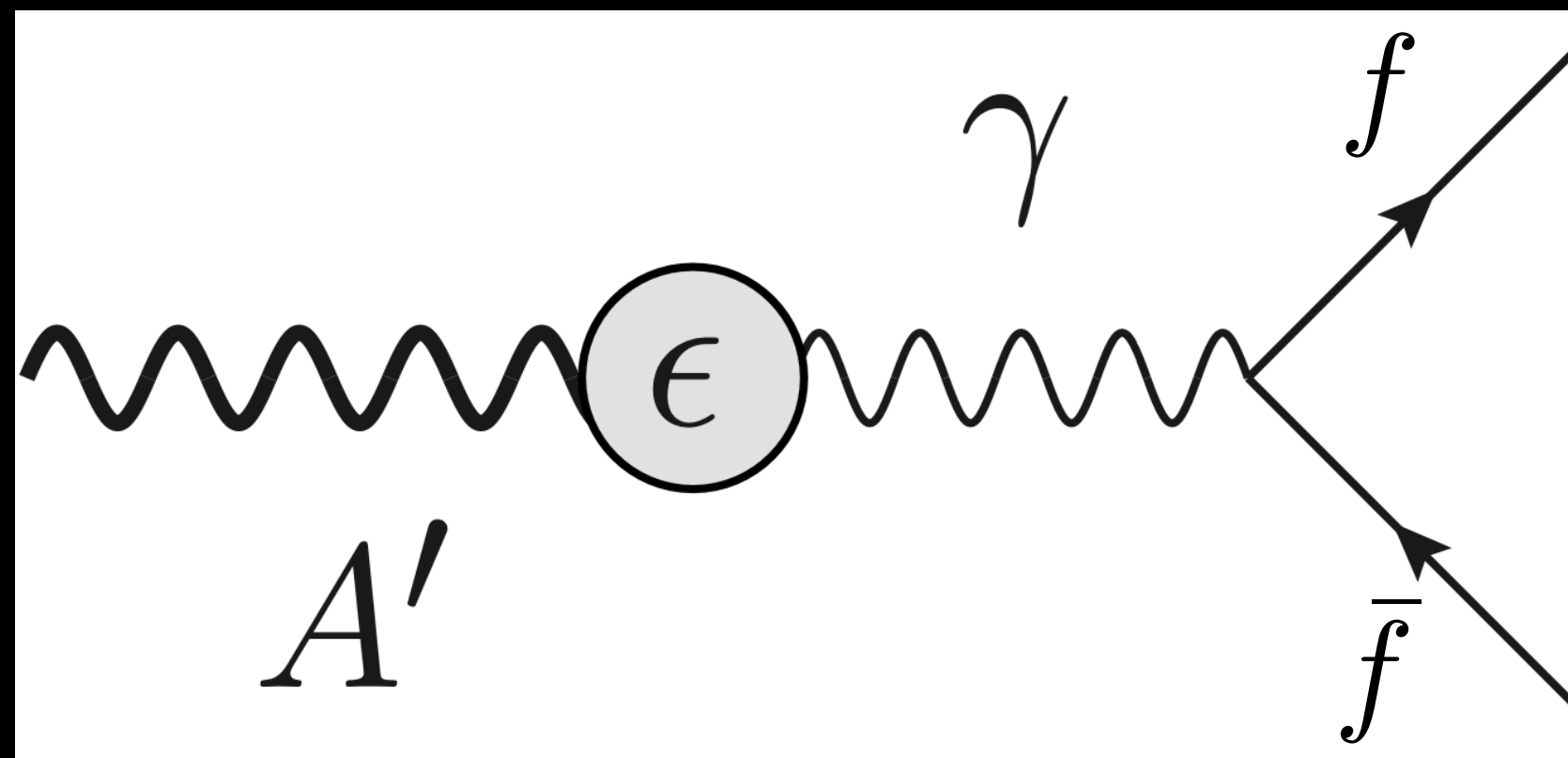
**Dark Photon decay**



# The Dark Photon Trident

Dark Photon decay

$$m_{A'} > 2m_f$$

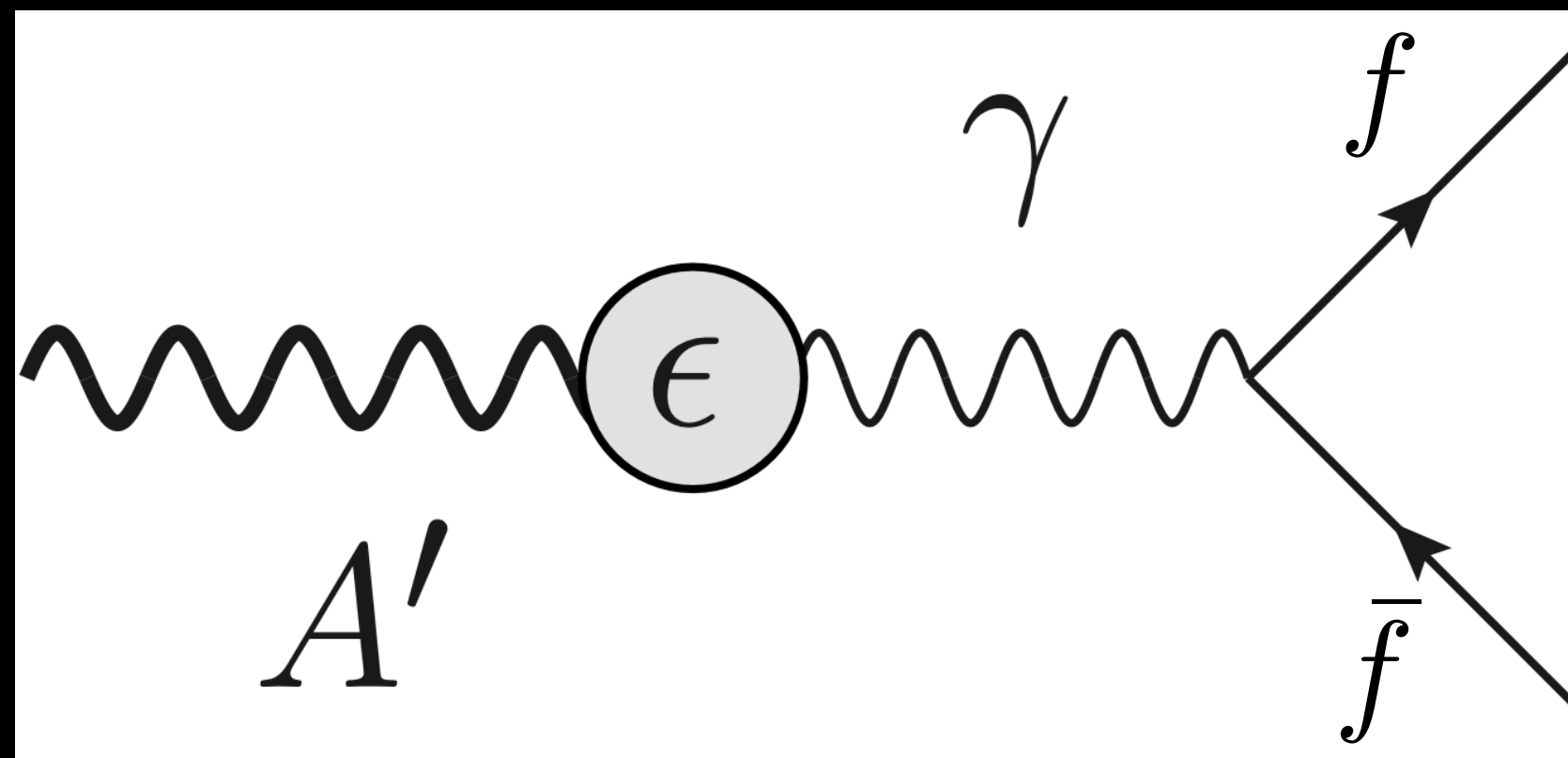




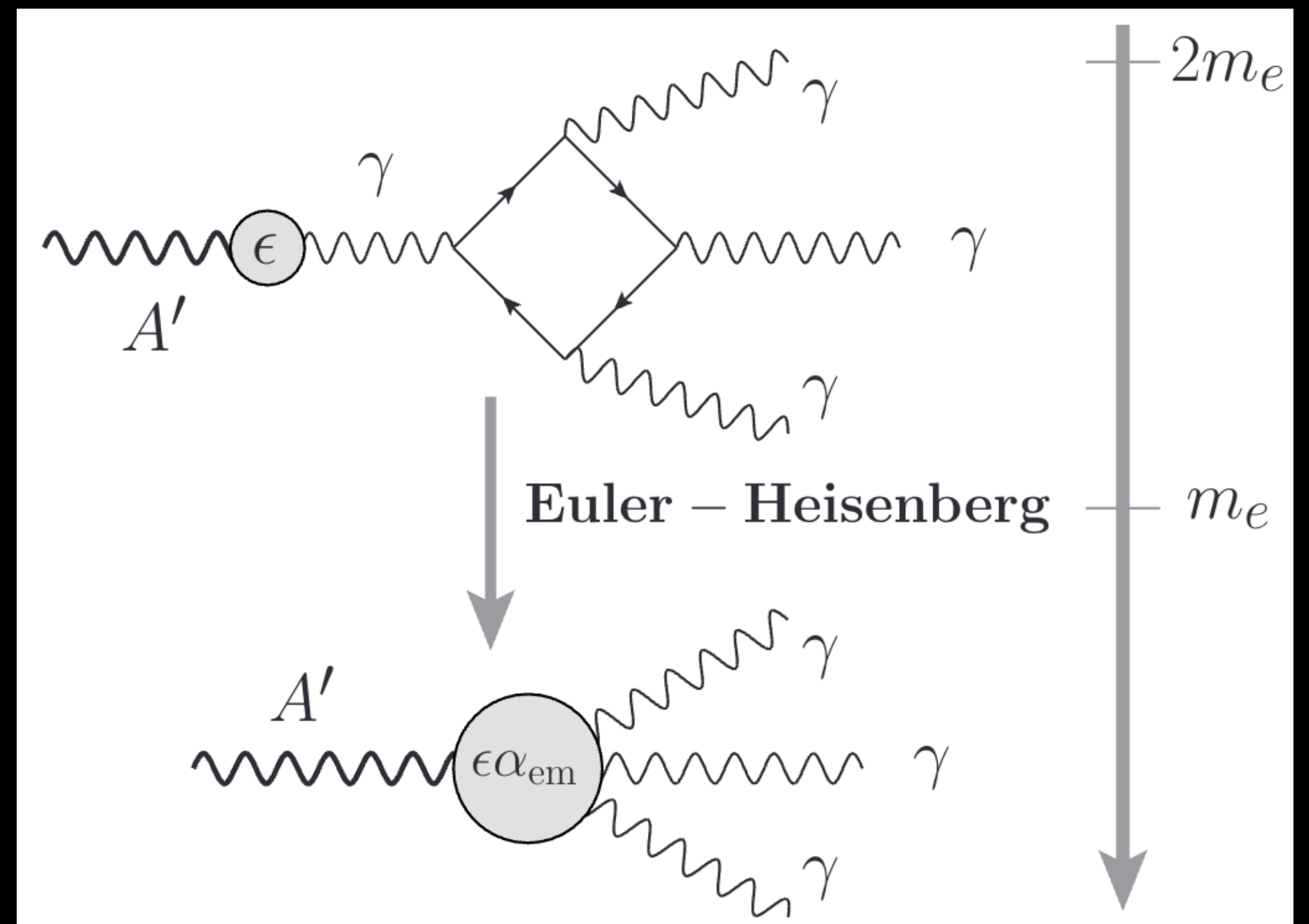
# The Dark Photon Trident

## Dark Photon decay

$$m_{A'} > 2m_f$$



$$m_{A'} \leq 2m_e$$



- Pospelov (0811.1030)
- Postma, Redondo (0811.0326)



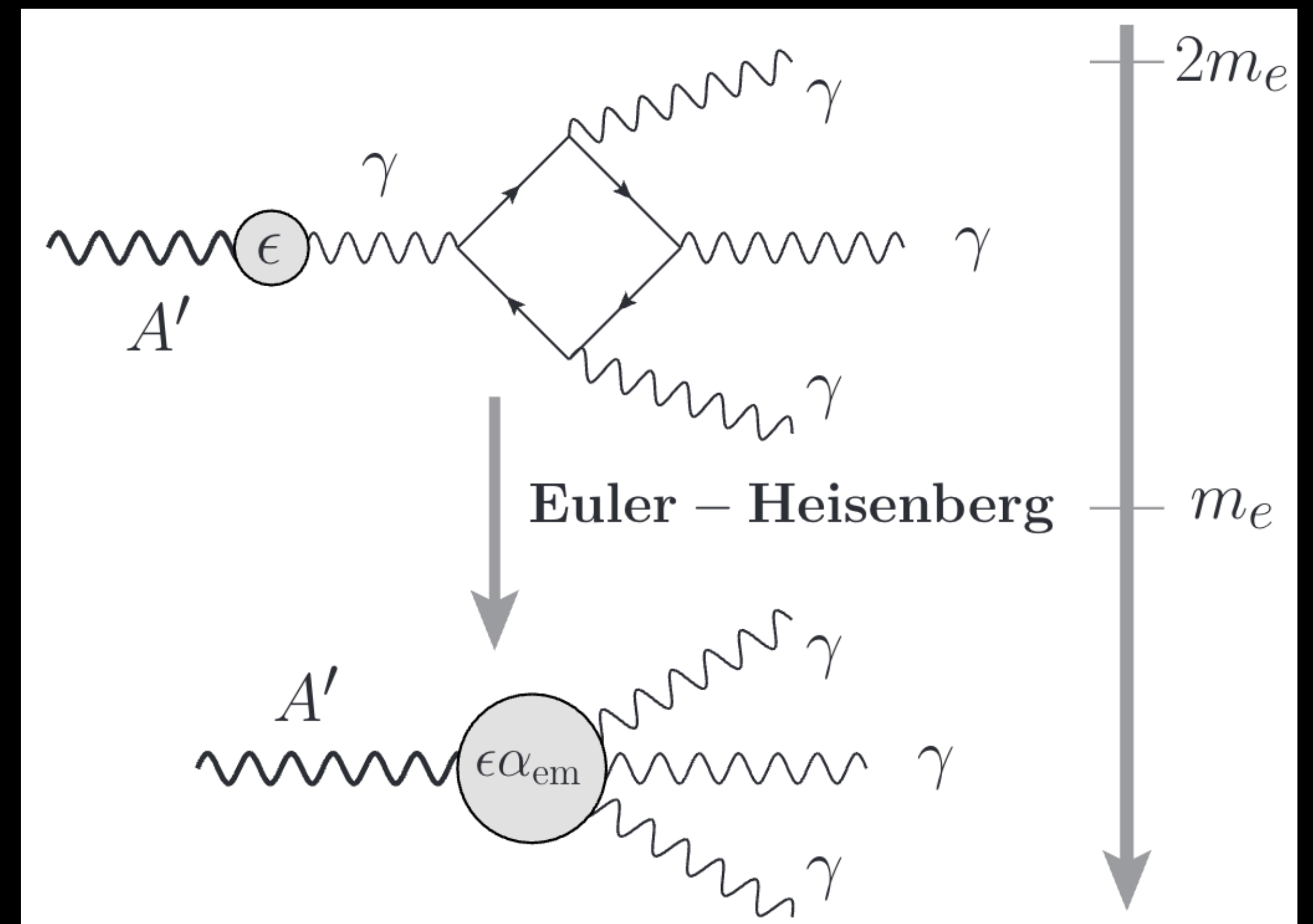
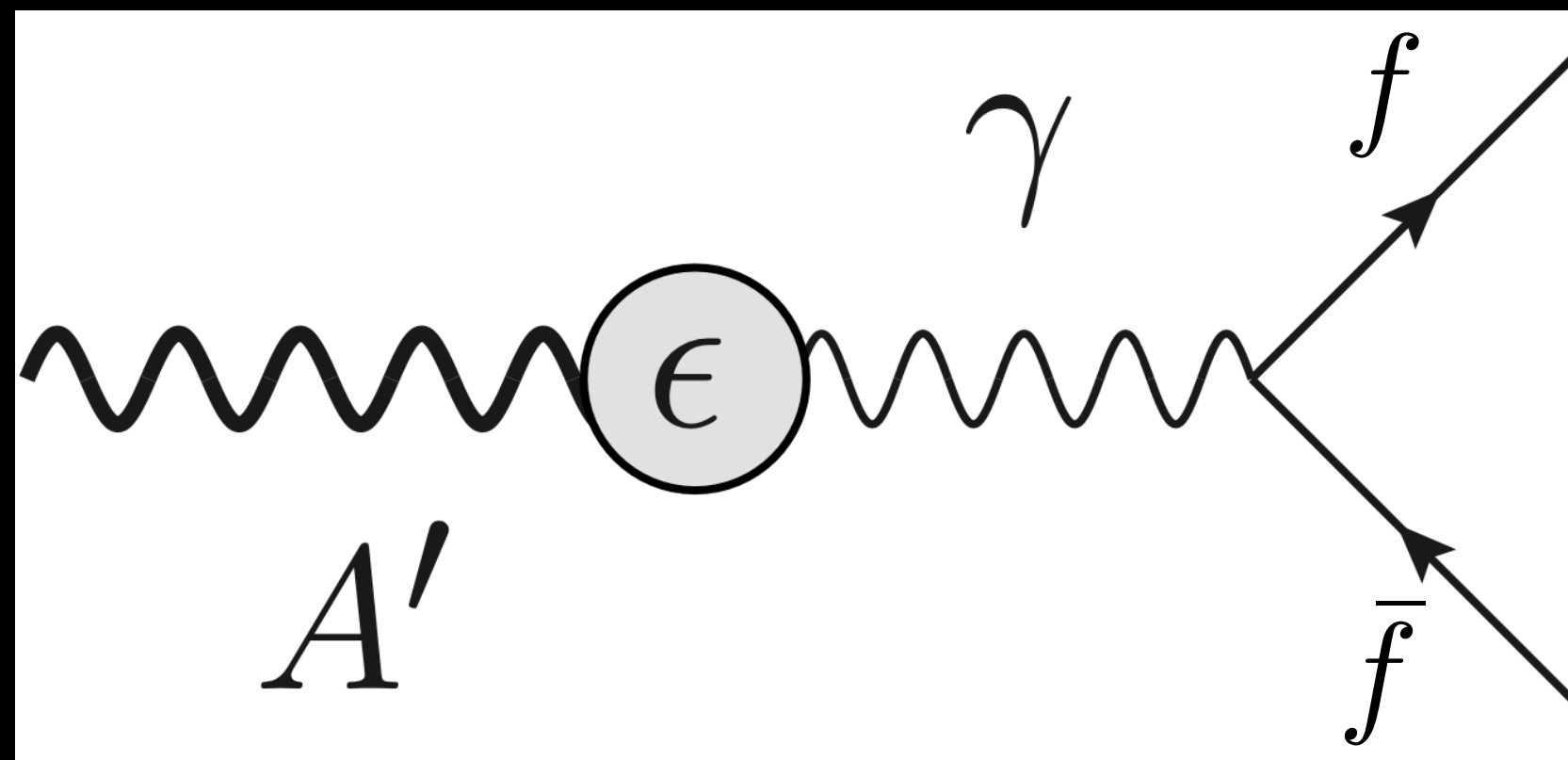
# The Dark Photon Trident



## Dark Photon decay

$$m_{A'} > 2m_f$$

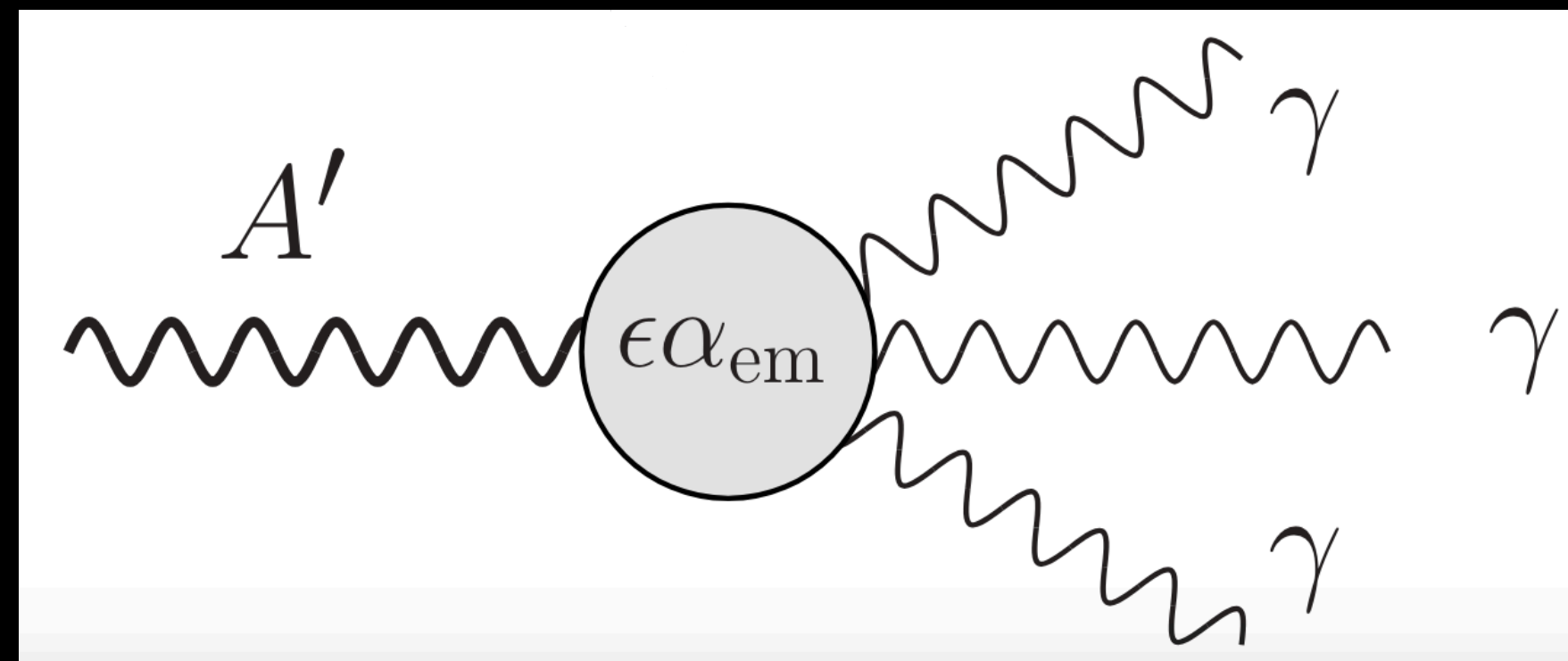
$$m_{A'} \leq 2m_e$$



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- Postma, Redondo (0811.0326)



# Dark Photon Dark Matter



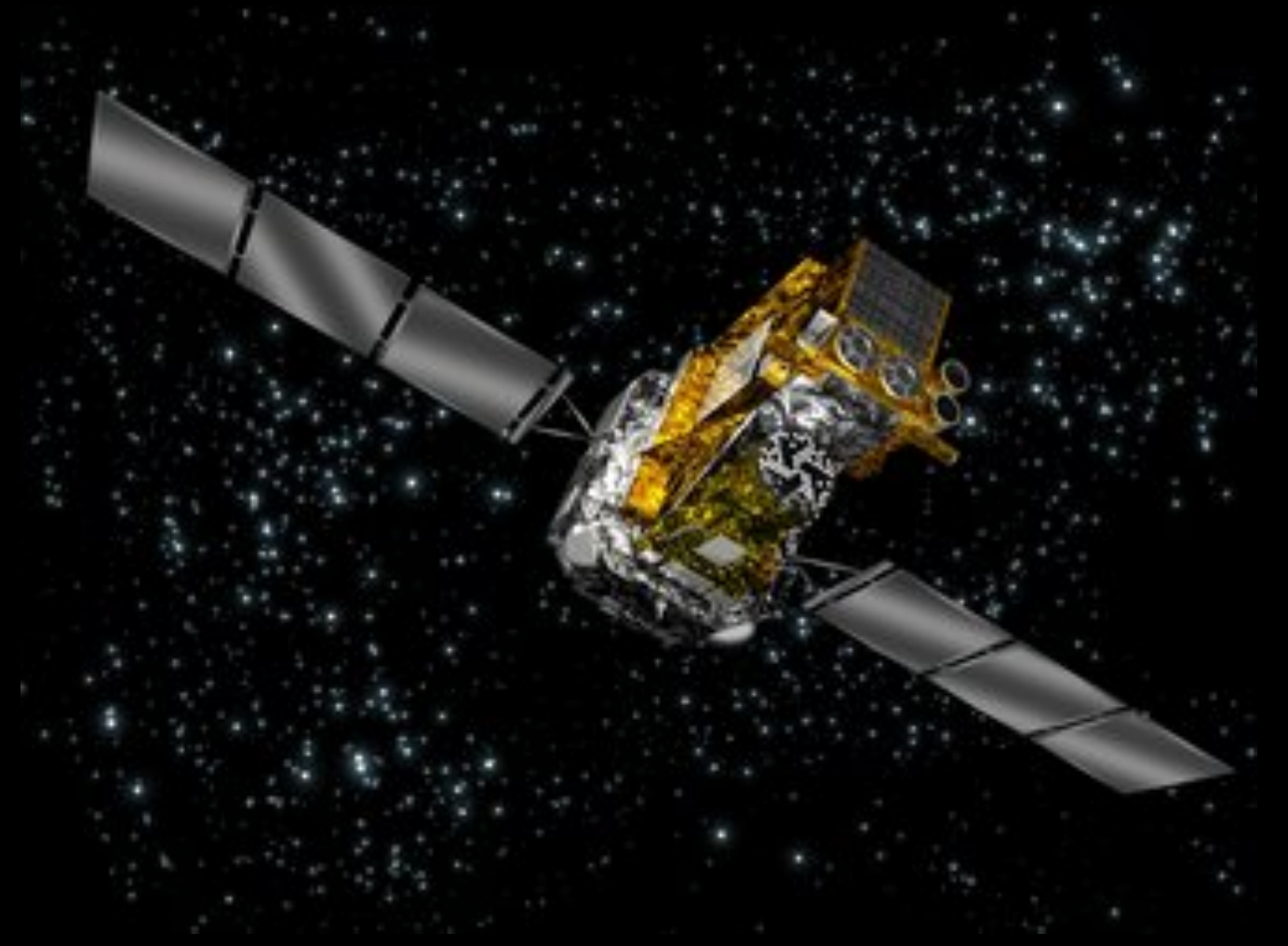


# INTEGRAL/SPI 16 years-data

The **INTE**rnational **G**amma-**R**ay

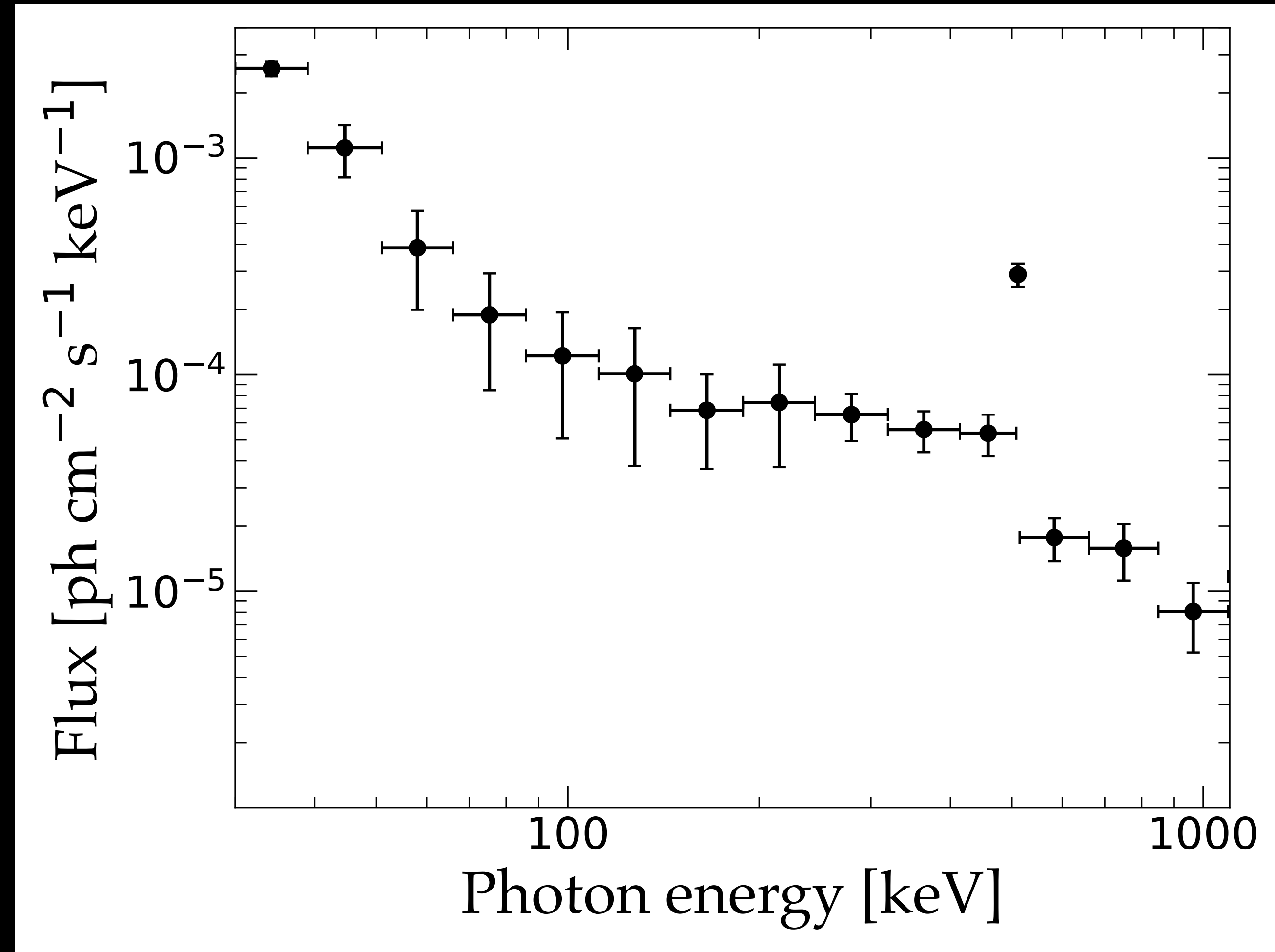
**A**strophysics **L**aboratory

$$30 \text{ keV} \leq E_{\gamma} \leq 8 \text{ MeV}$$





# INTEGRAL/SPI 16 years-data

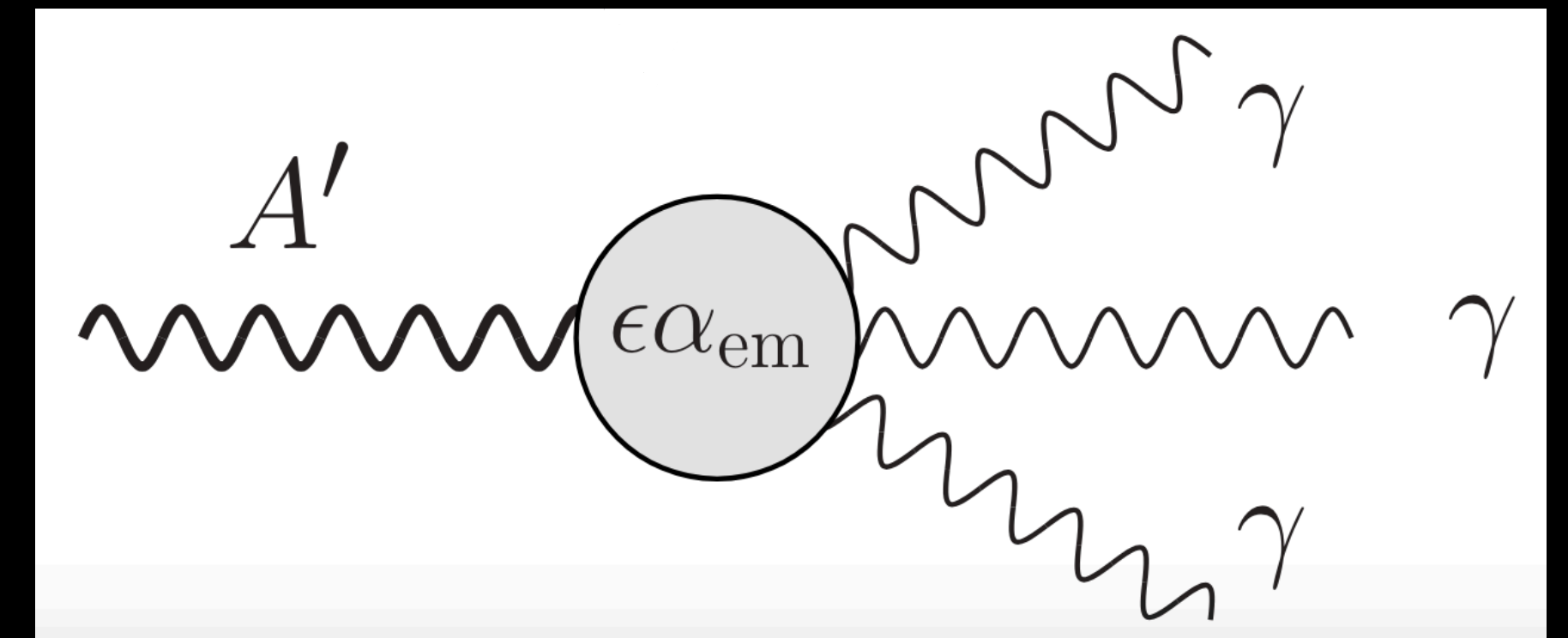
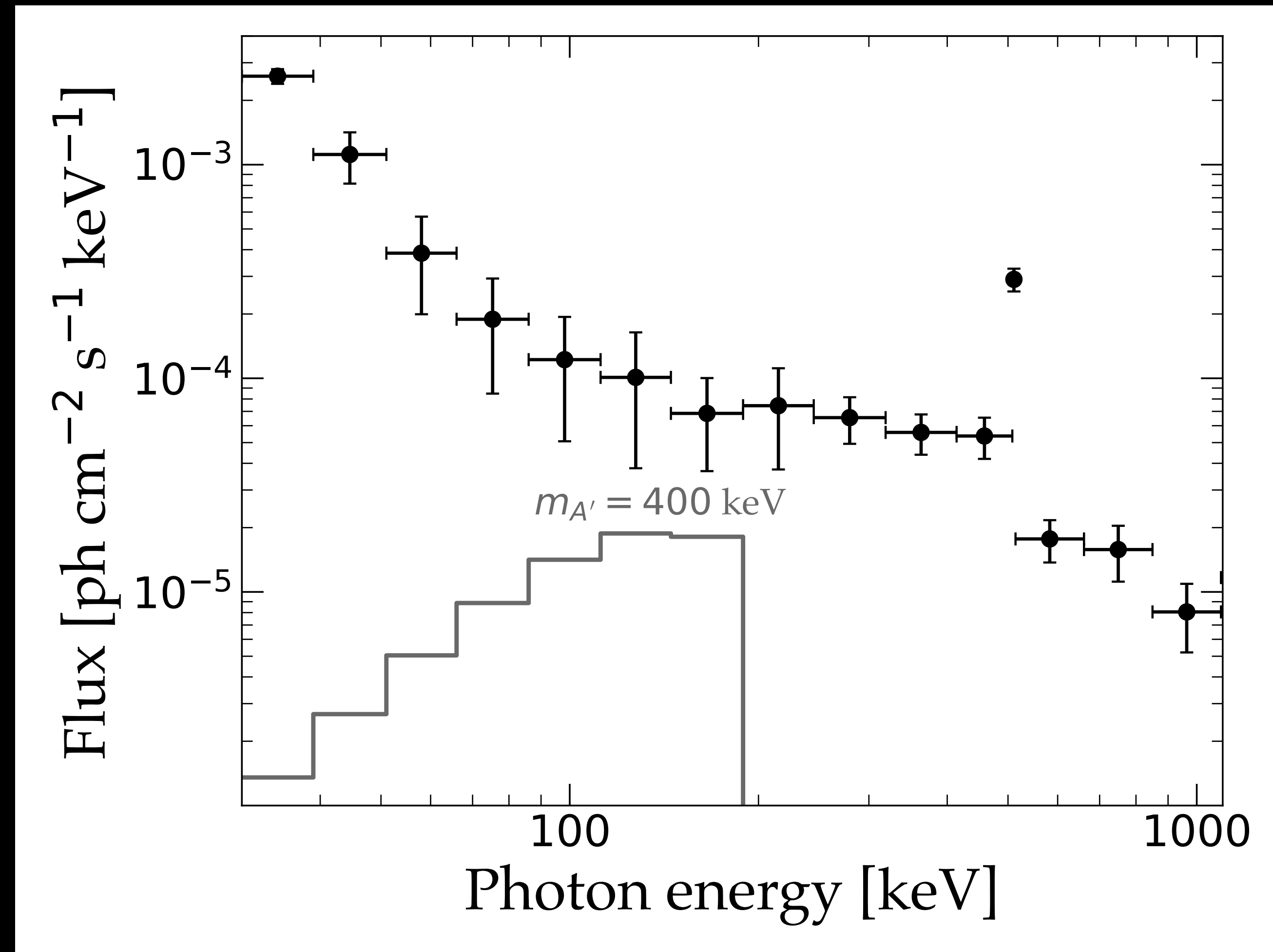


**Region of Interest (ROI):**

$$-47.5^\circ \leq l \leq 47.5^\circ$$

$$-47.5^\circ \leq b \leq 47.5^\circ$$

# INTEGRAL/SPI 16 years-data

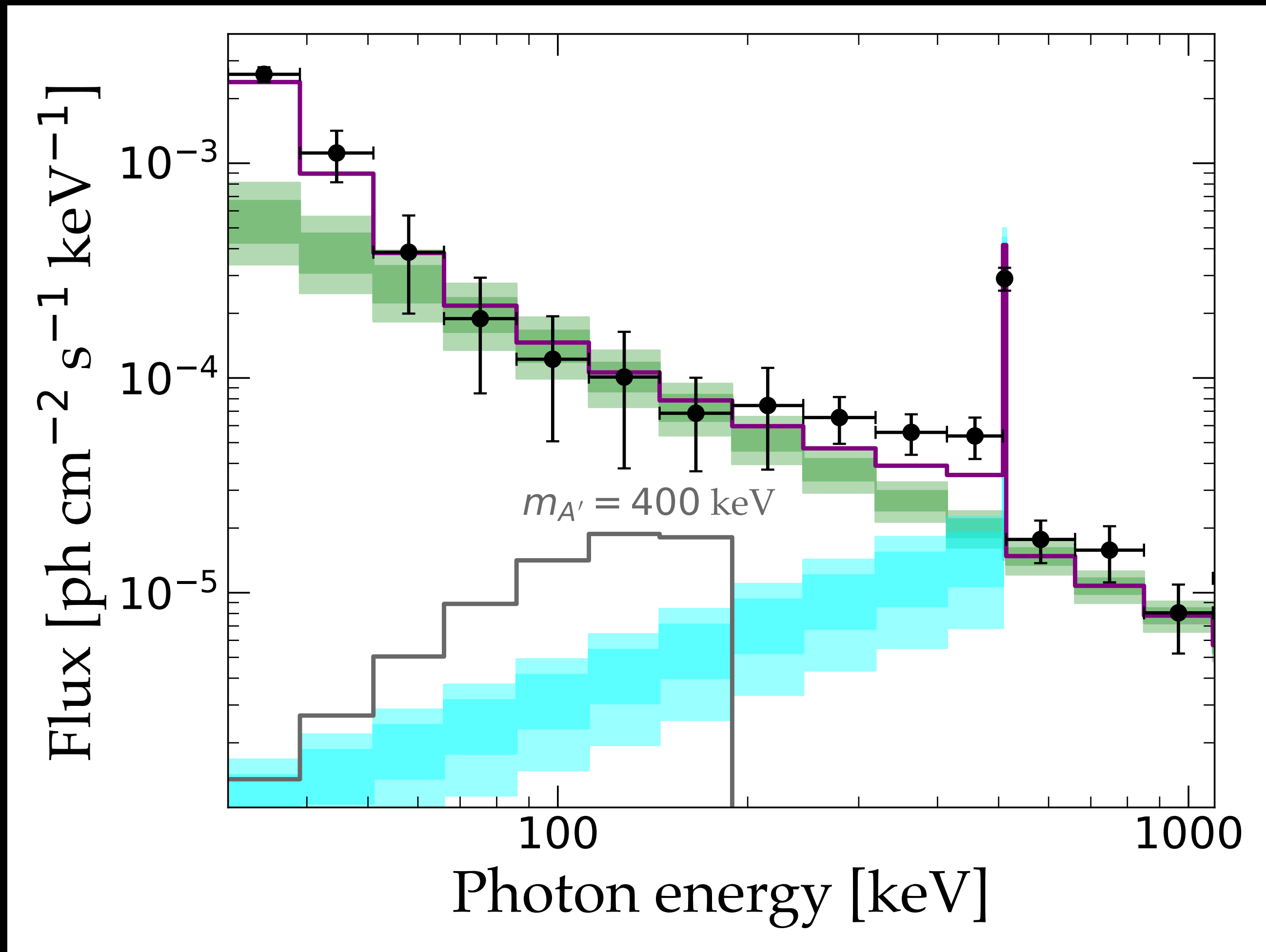
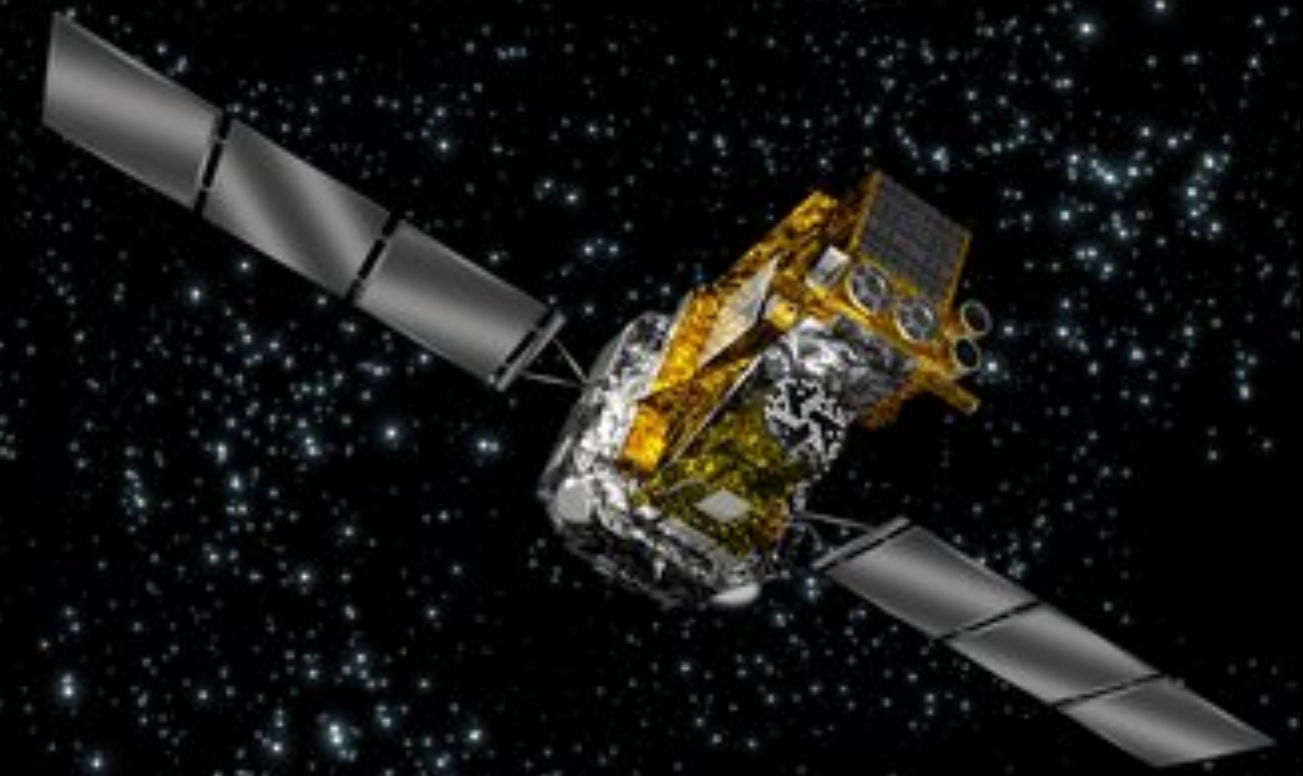


Tool: 3ML (1507.08343)

Template: Thomas Siegert, Francesca Calore, and collaborators (2209.06299, 2202.07483)



# INTEGRAL/SPI 16 years-data

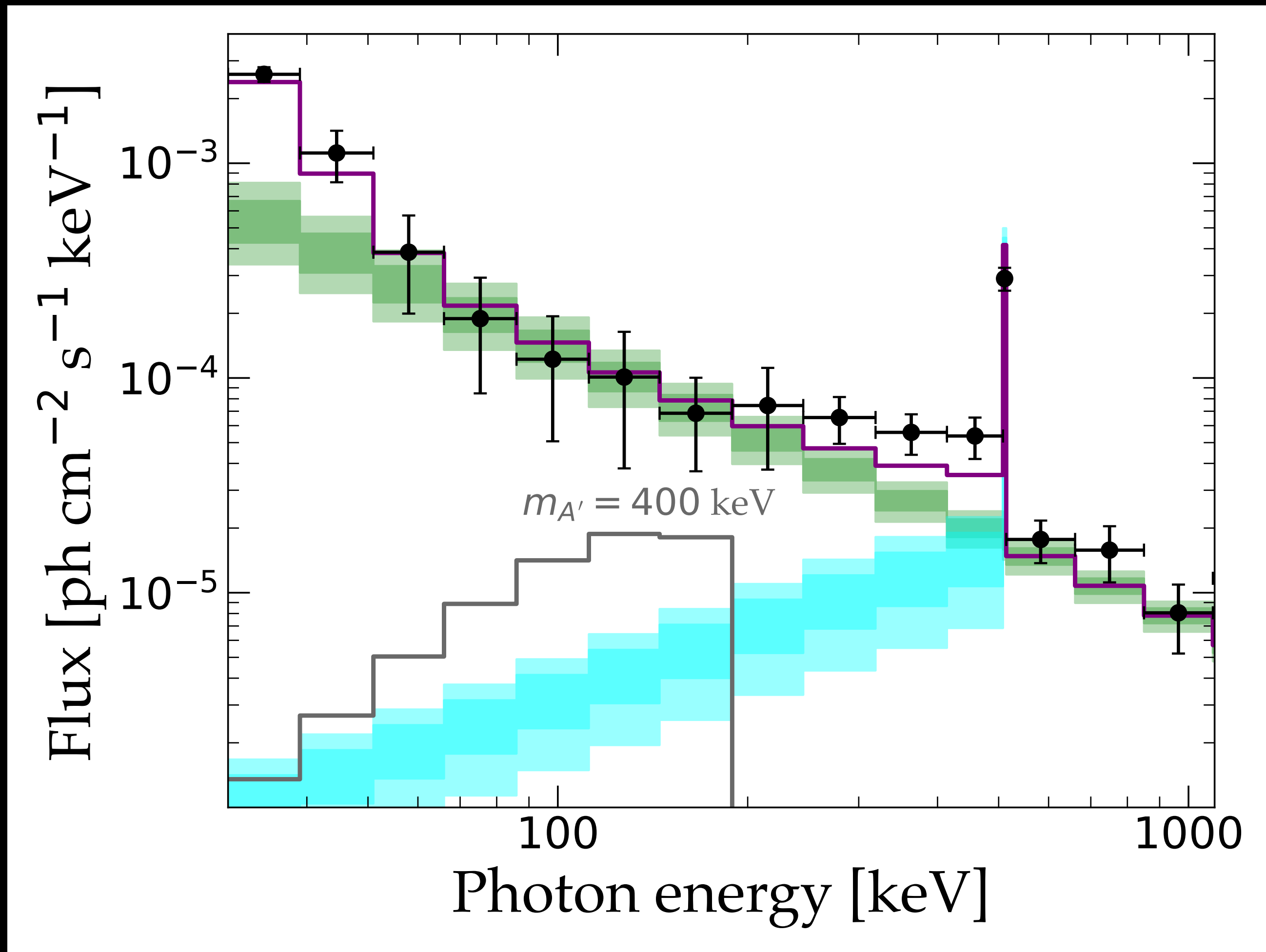
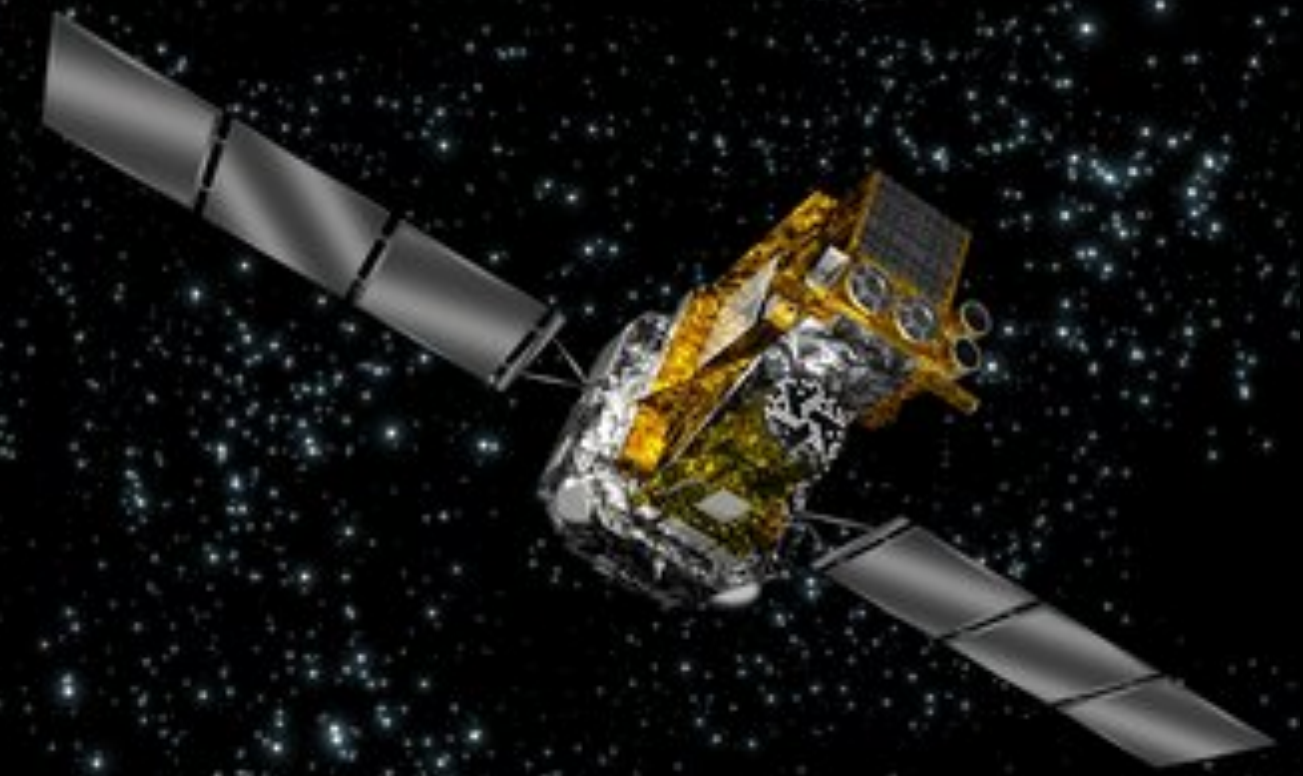


- **Unresolved sources**

Tool: 3ML (1507.08343)

Template: Thomas Siegert, Francesca Calore, and collaborators (2209.06299, 2202.07483)

# INTEGRAL/SPI 16 years-data



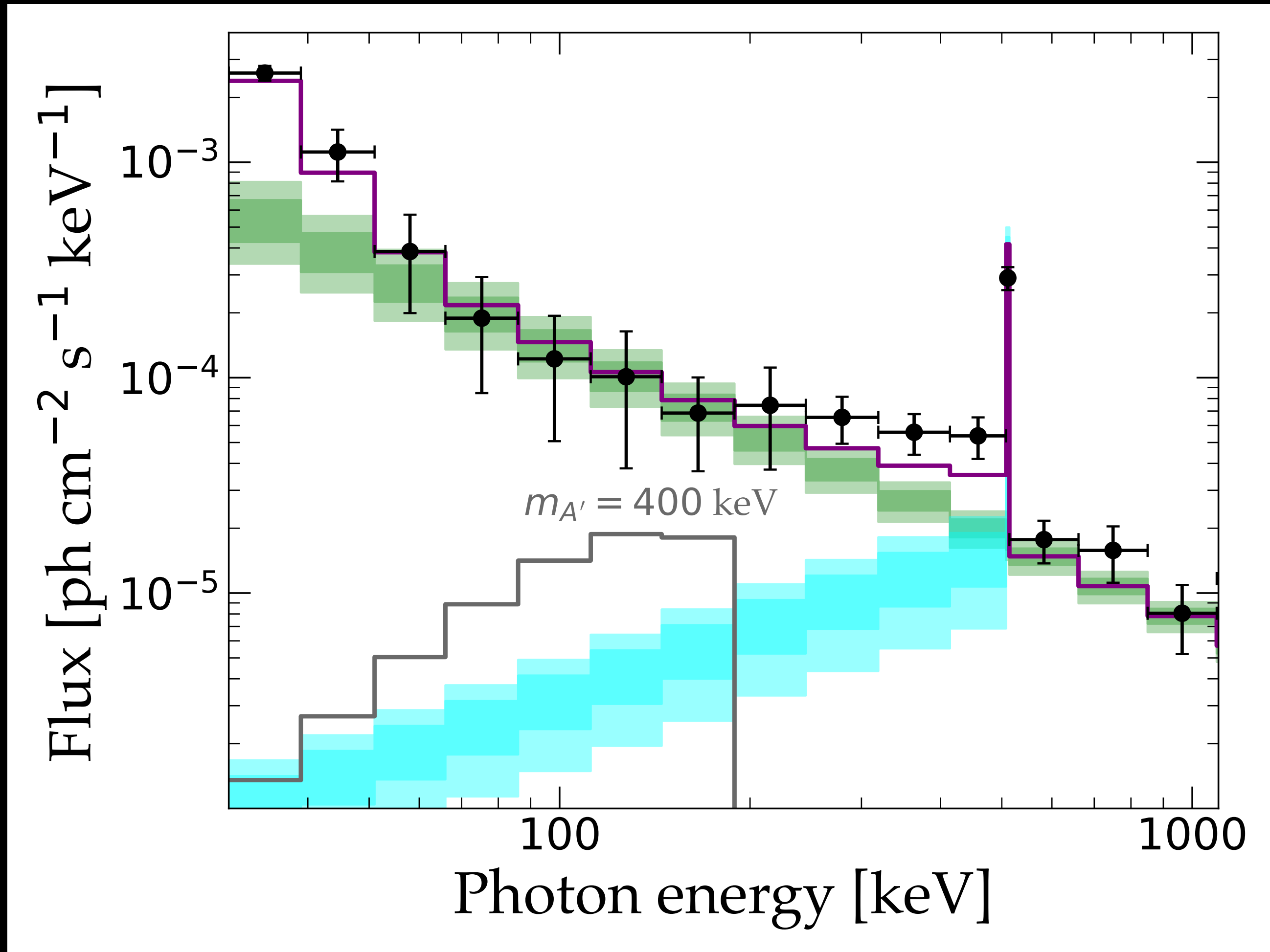
- **Unresolved sources**
- **Inverse Compton Scattering**

Tool: 3ML (1507.08343)

Template: Thomas Siegert, Francesca Calore, and collaborators (2209.06299, 2202.07483)



# INTEGRAL/SPI 16 years-data

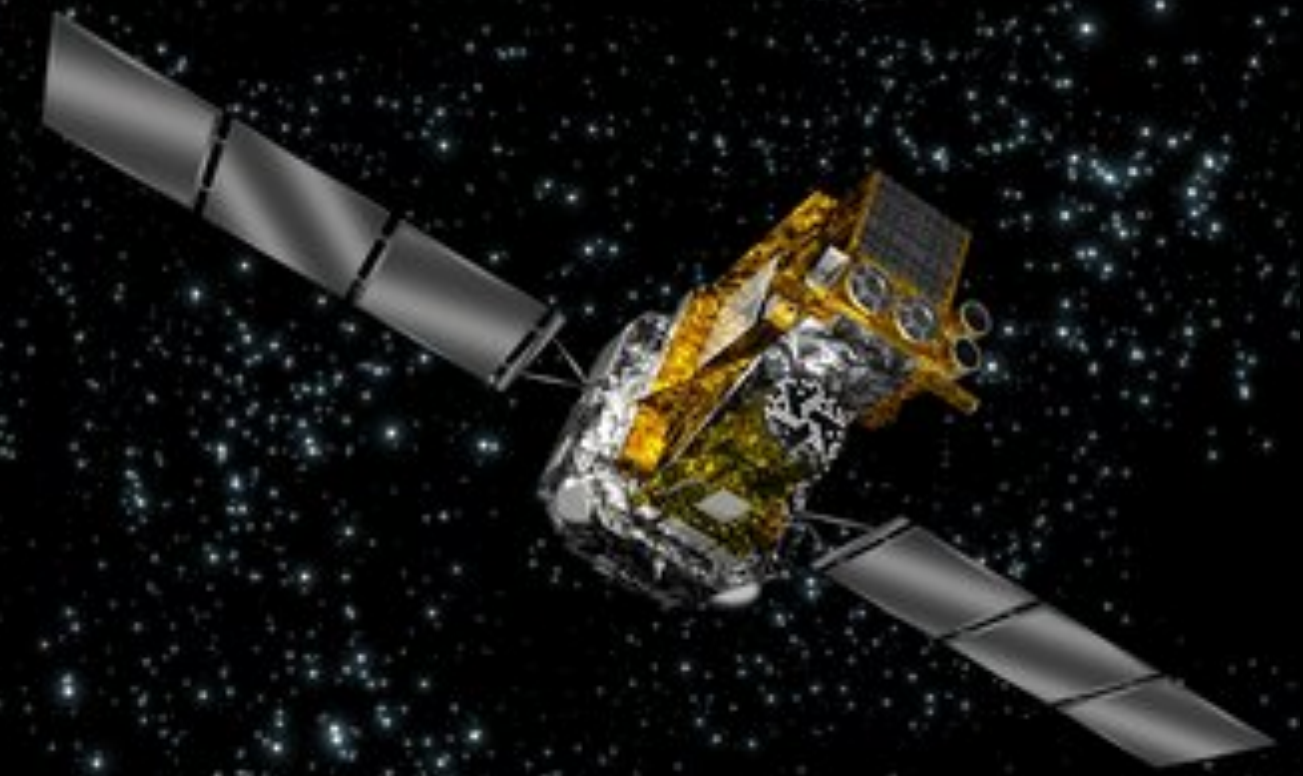


- **Unresolved sources**
- **Inverse Compton Scattering**
- **Positronium decay**

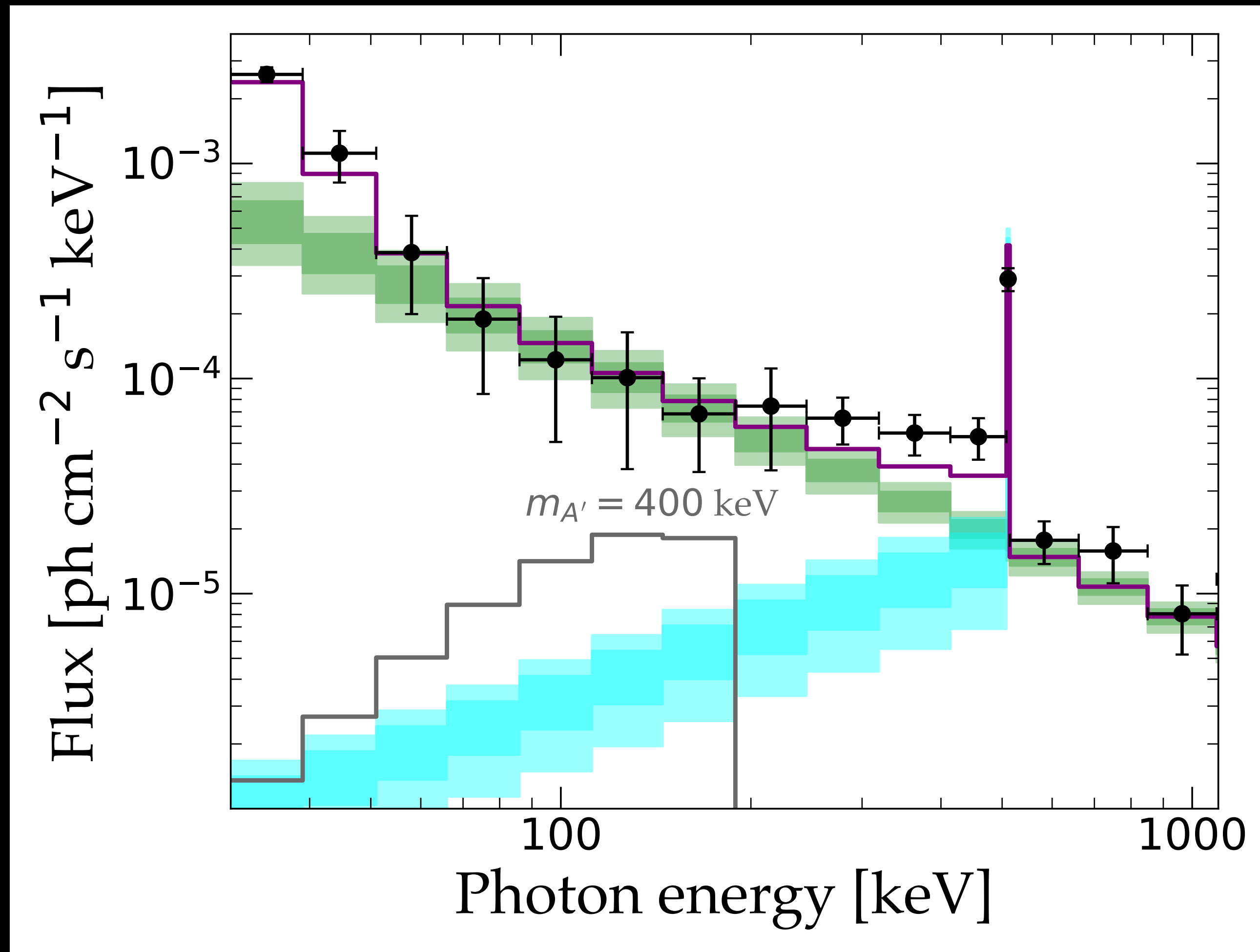
Tool: 3ML (1507.08343)

Template: Thomas Siegert, Francesca Calore, and collaborators (2209.06299, 2202.07483)

# INTEGRAL/SPI 16 years-data



- **Unresolved sources**
- **Inverse Compton Scattering**
- **Positronium decay**
- **${}^7\text{Be}$  nuclear line**

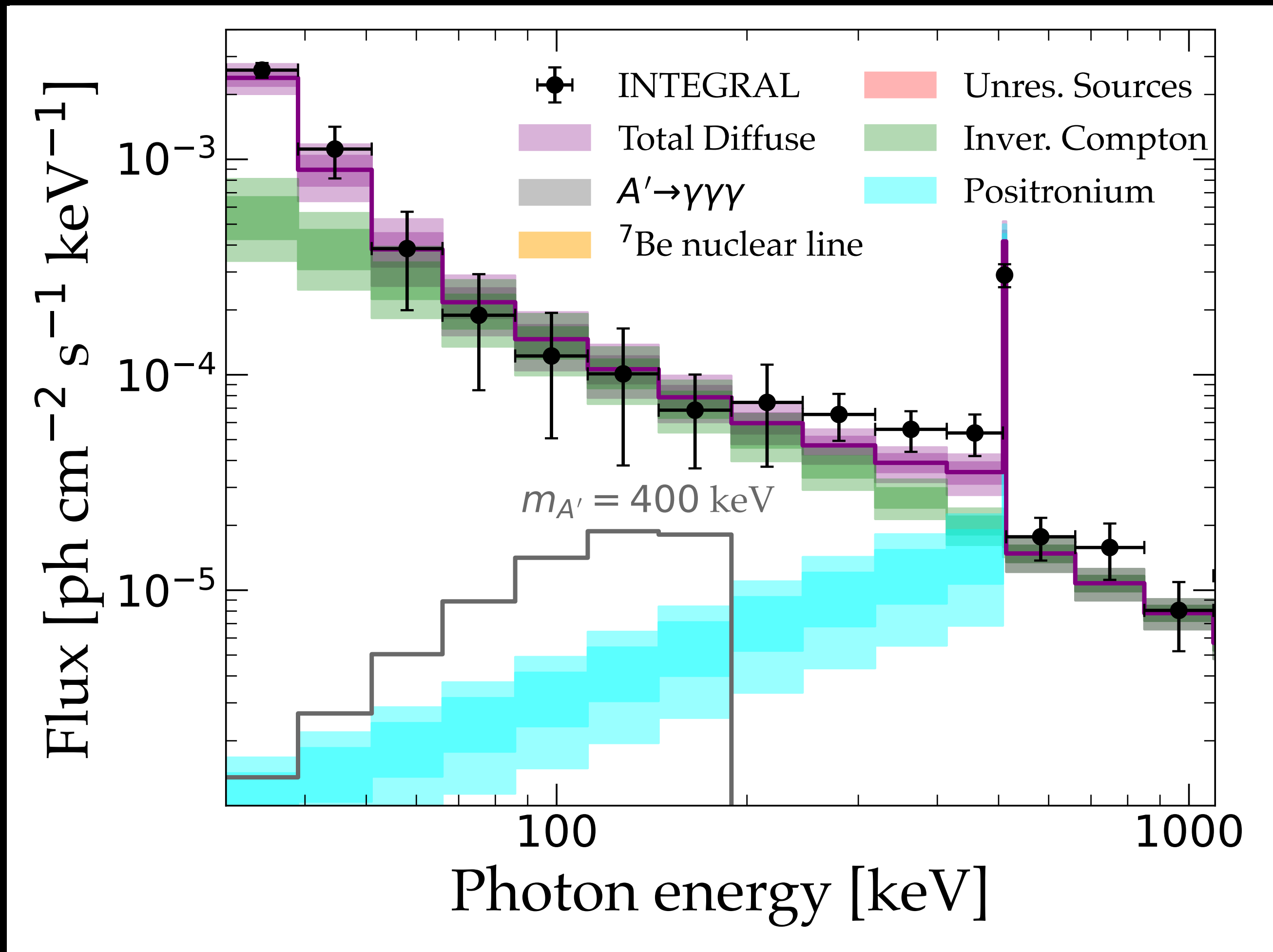


Tool: 3ML (1507.08343)

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# INTEGRAL/SPI 16 years-data



INTEGRAL and European Space  
Astronomy Center (ESAC)  
(September) Picture of the Month!



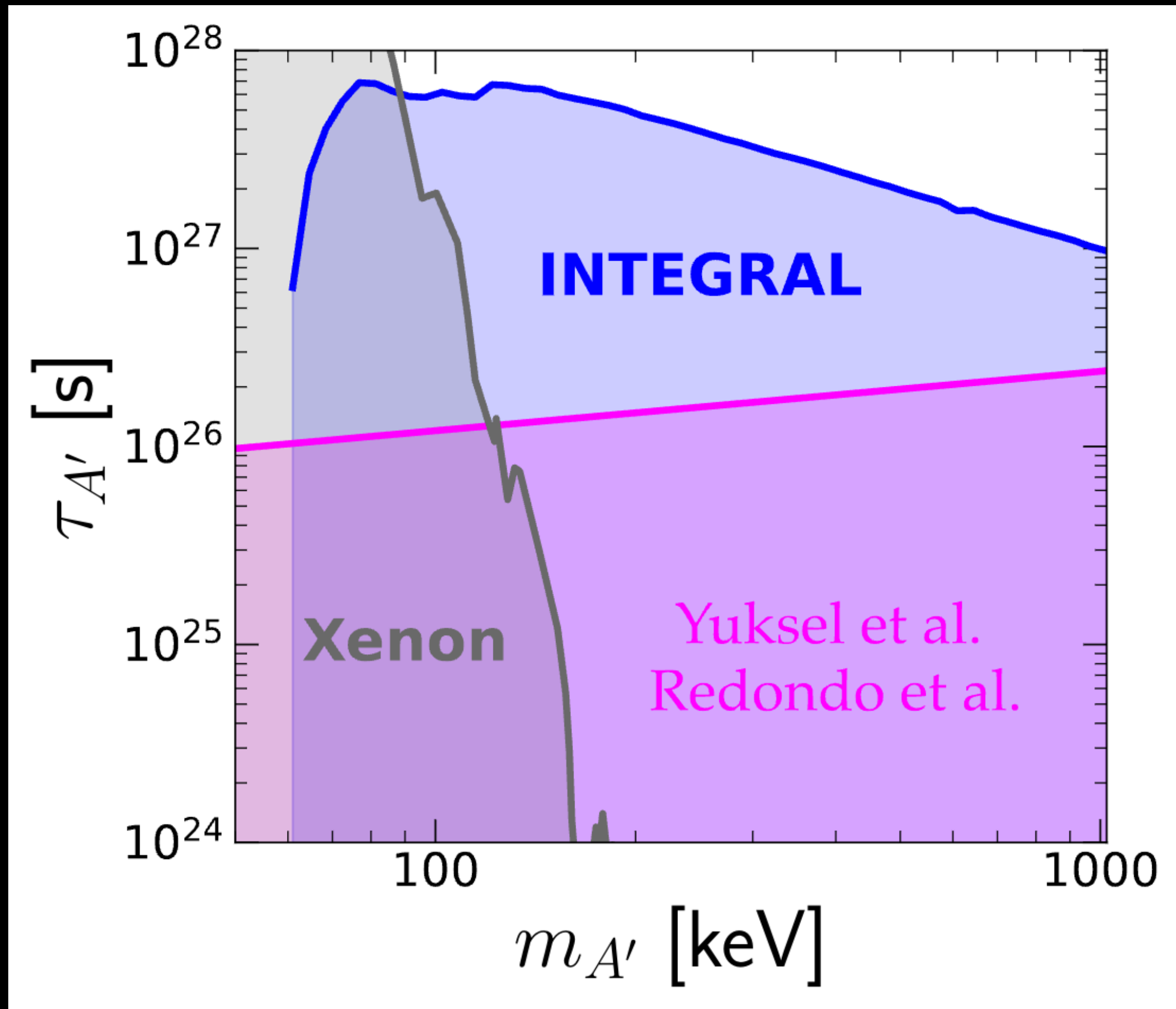
Tool: 3ML (1507.08343)

Template: Thomas Siegert, Francesca Calore, and collaborators (2209.06299, 2202.07483)

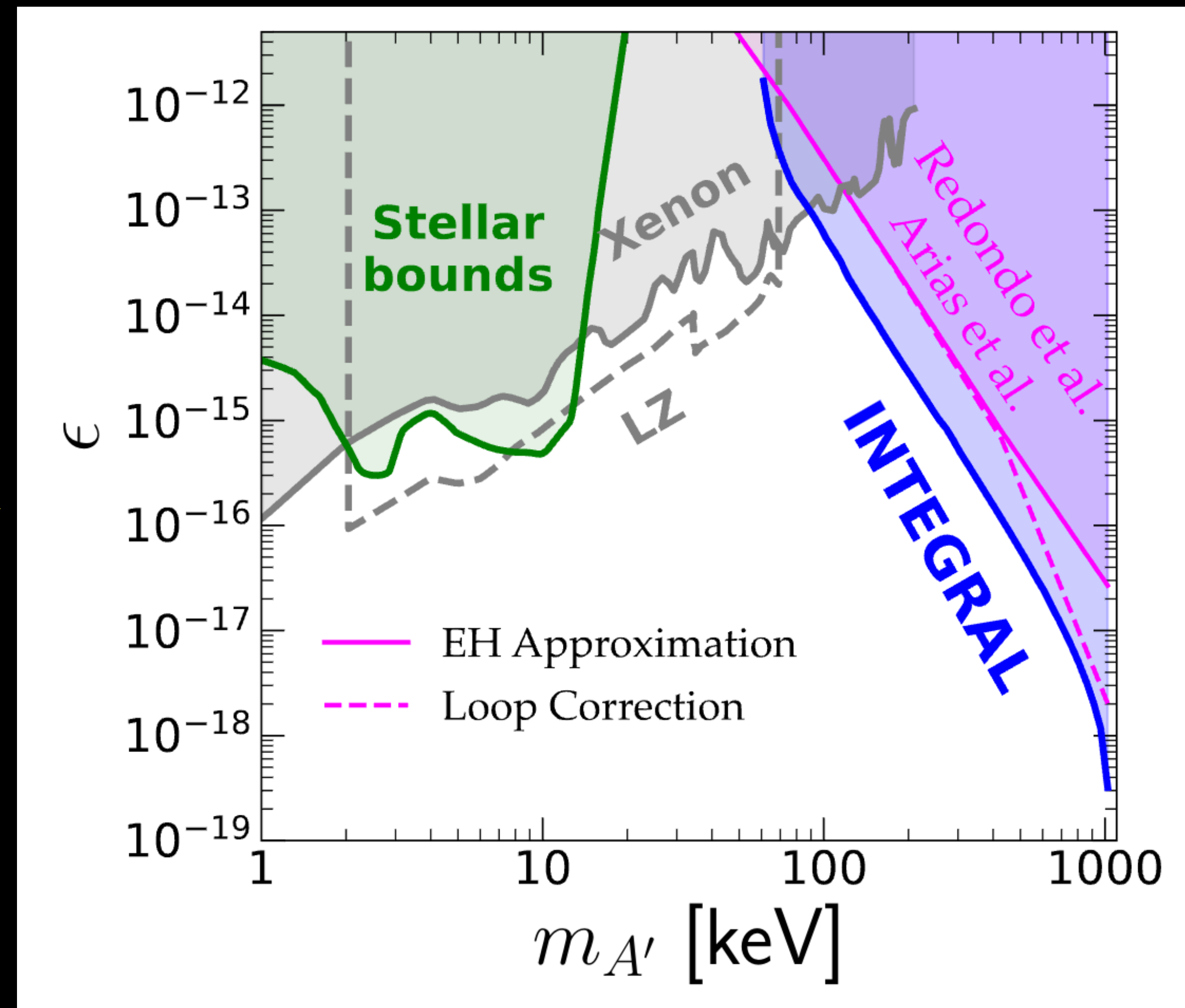
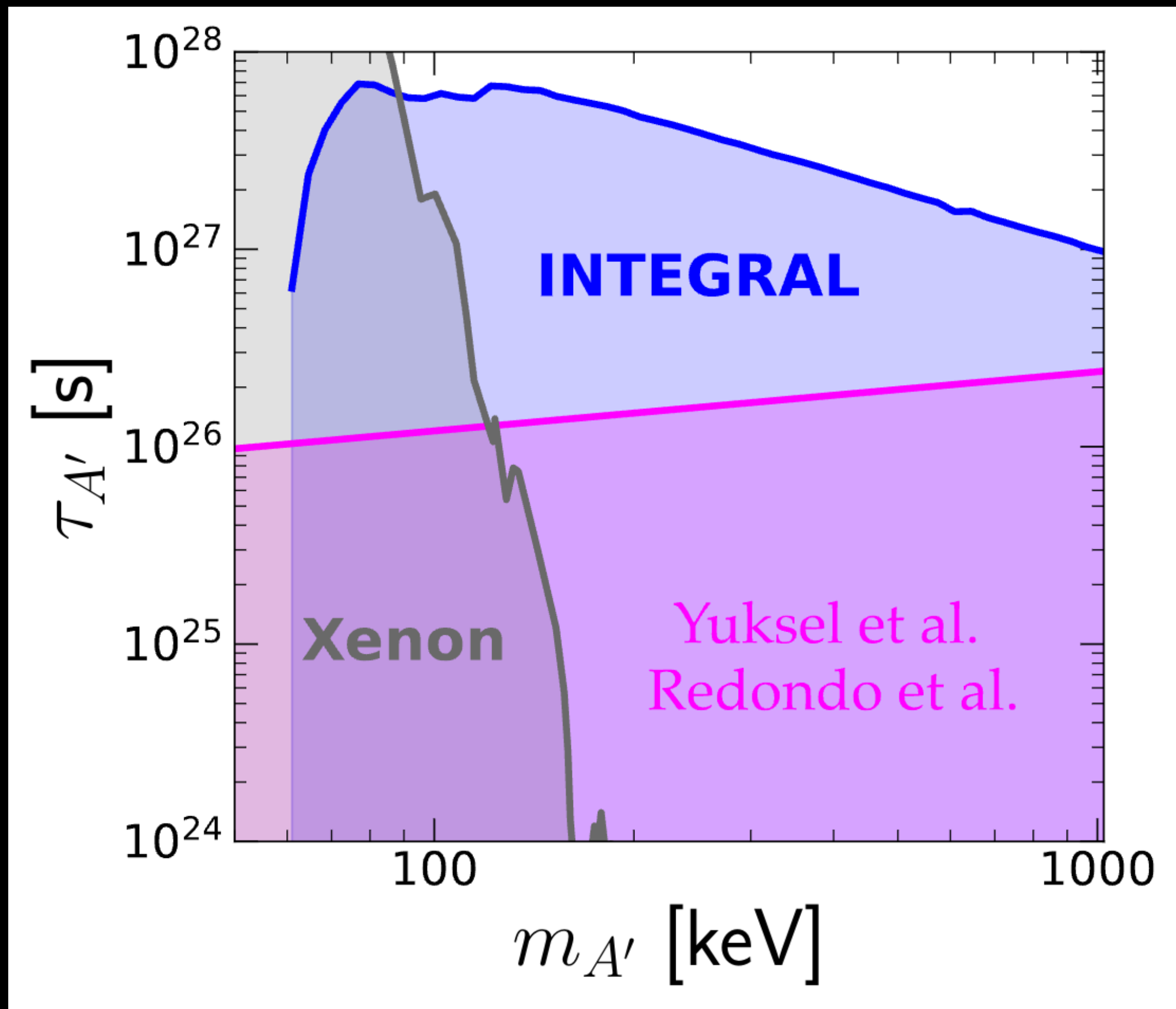
# New Constraints on the Dark Photon



# New Constraints on the Dark Photon

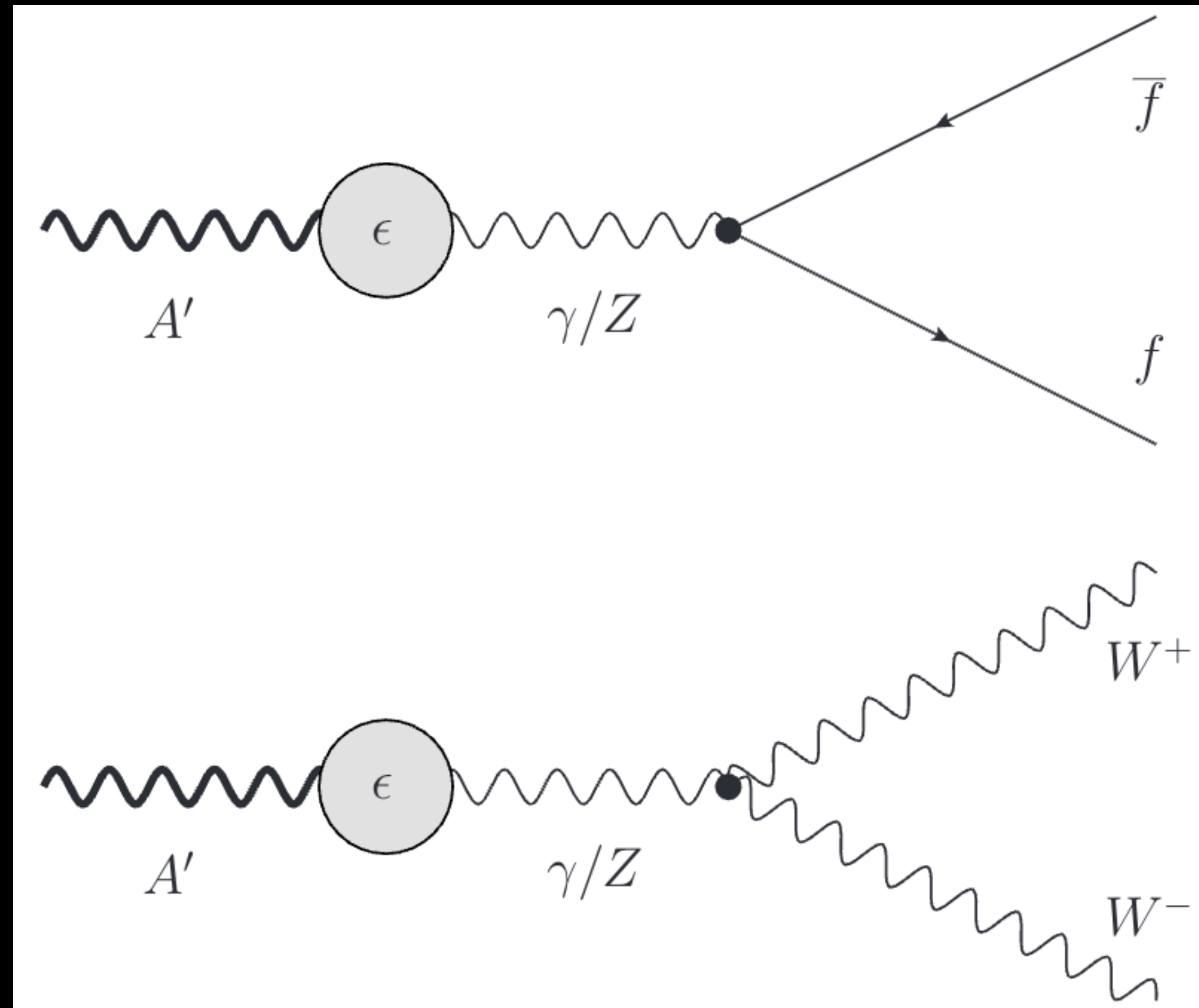


# New Constraints on the Dark Photon

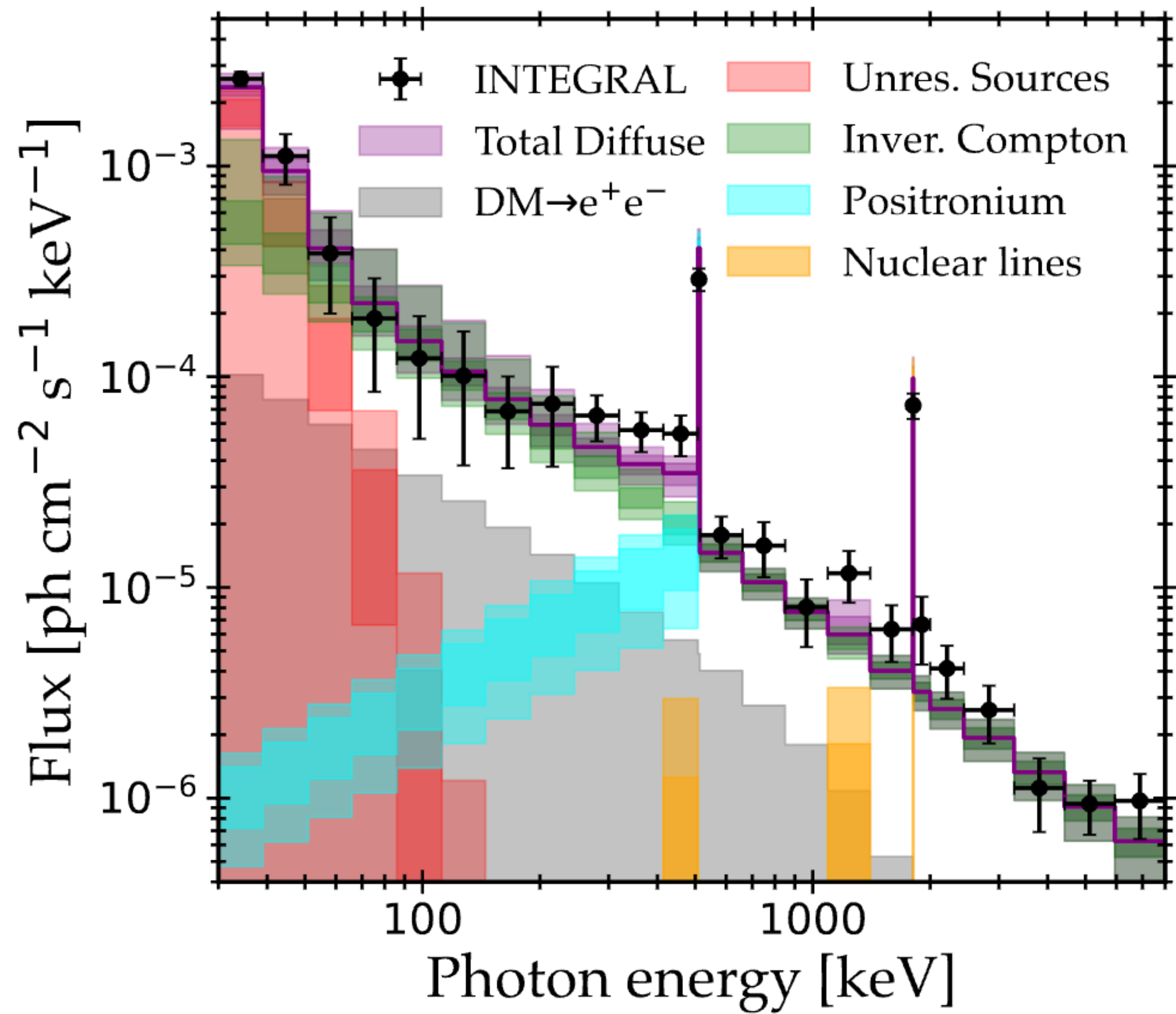




# Heavy Dark Photon Dark Matter



# INTEGRAL/SPI: X-ray background



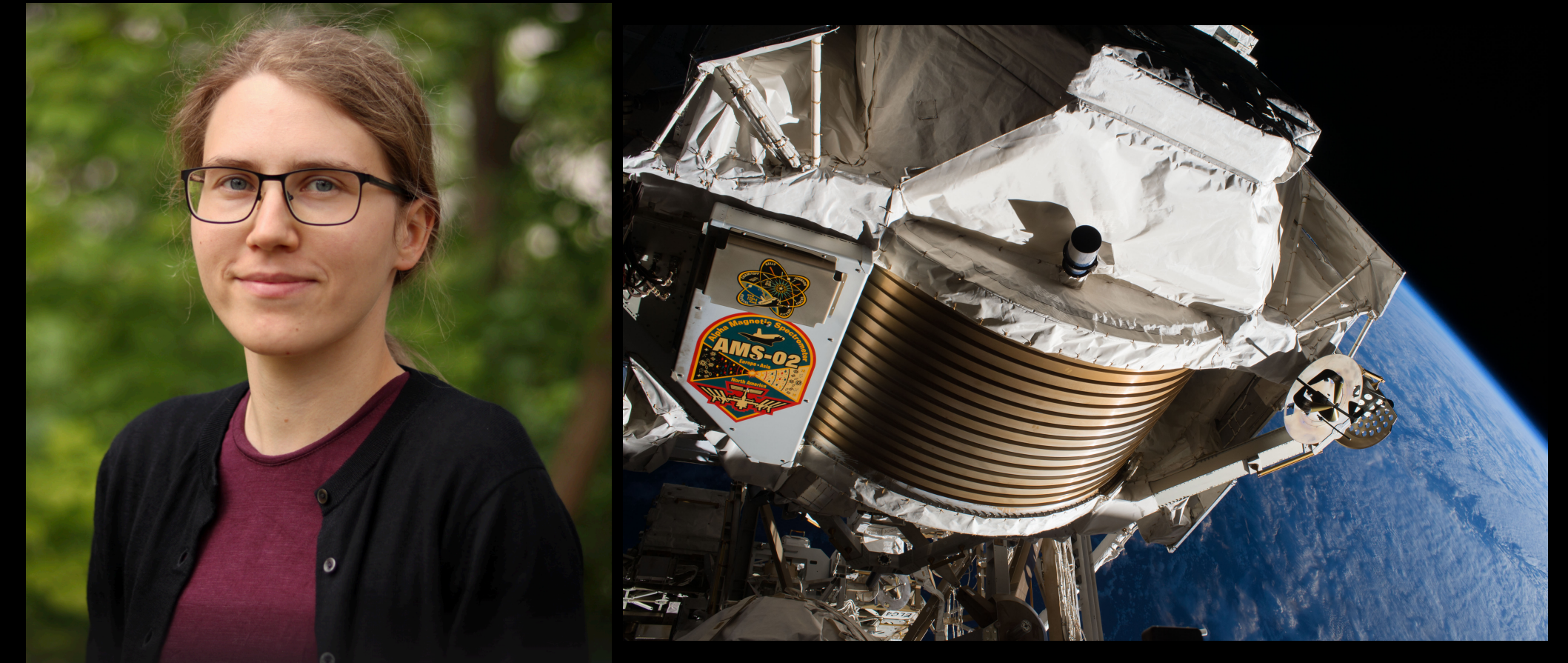
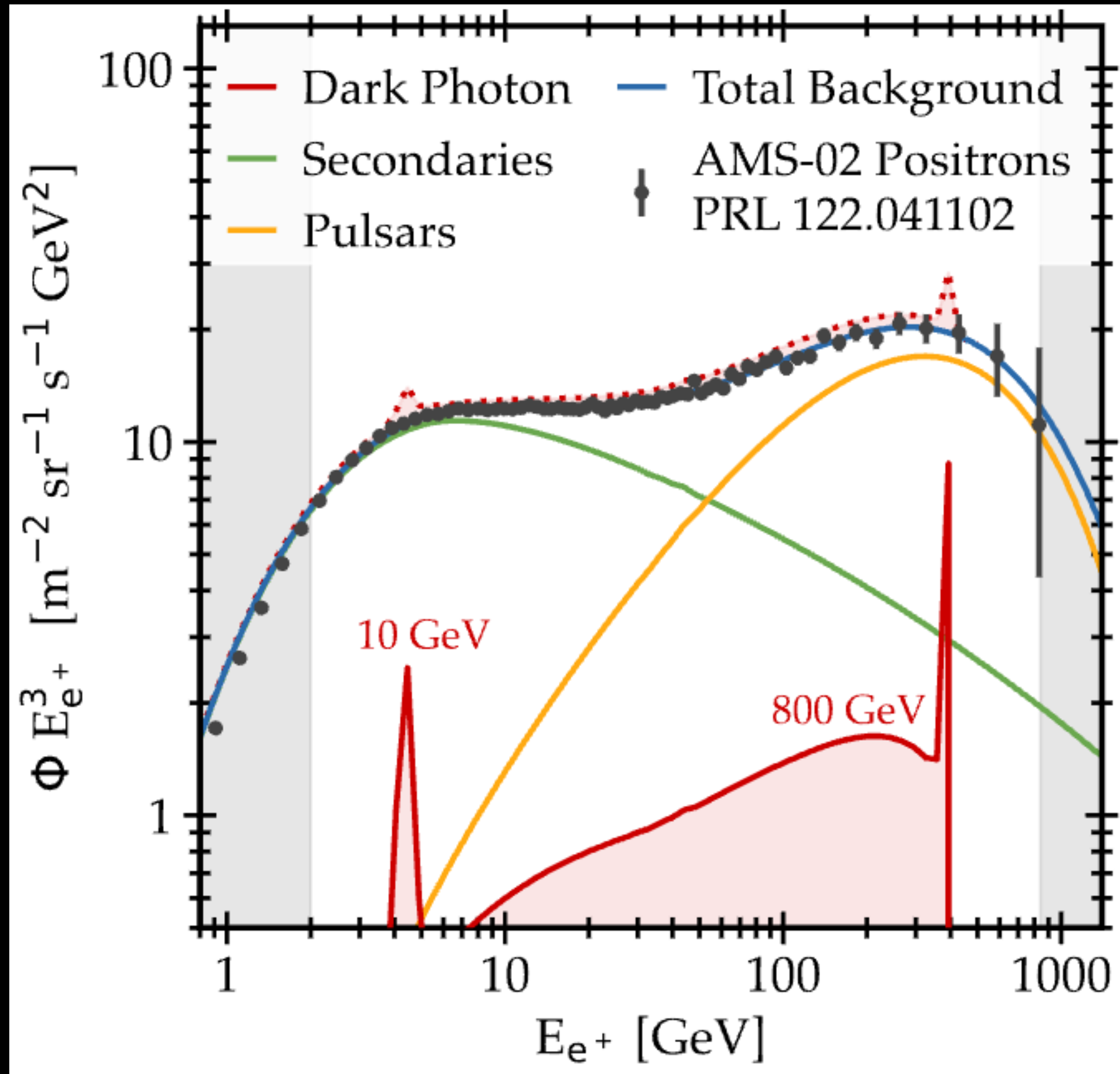
Several nuclear lines:

<sup>7</sup>Be, <sup>22</sup>Na, <sup>60</sup>Fe, <sup>26</sup>Al





# AMS-02: Positron background

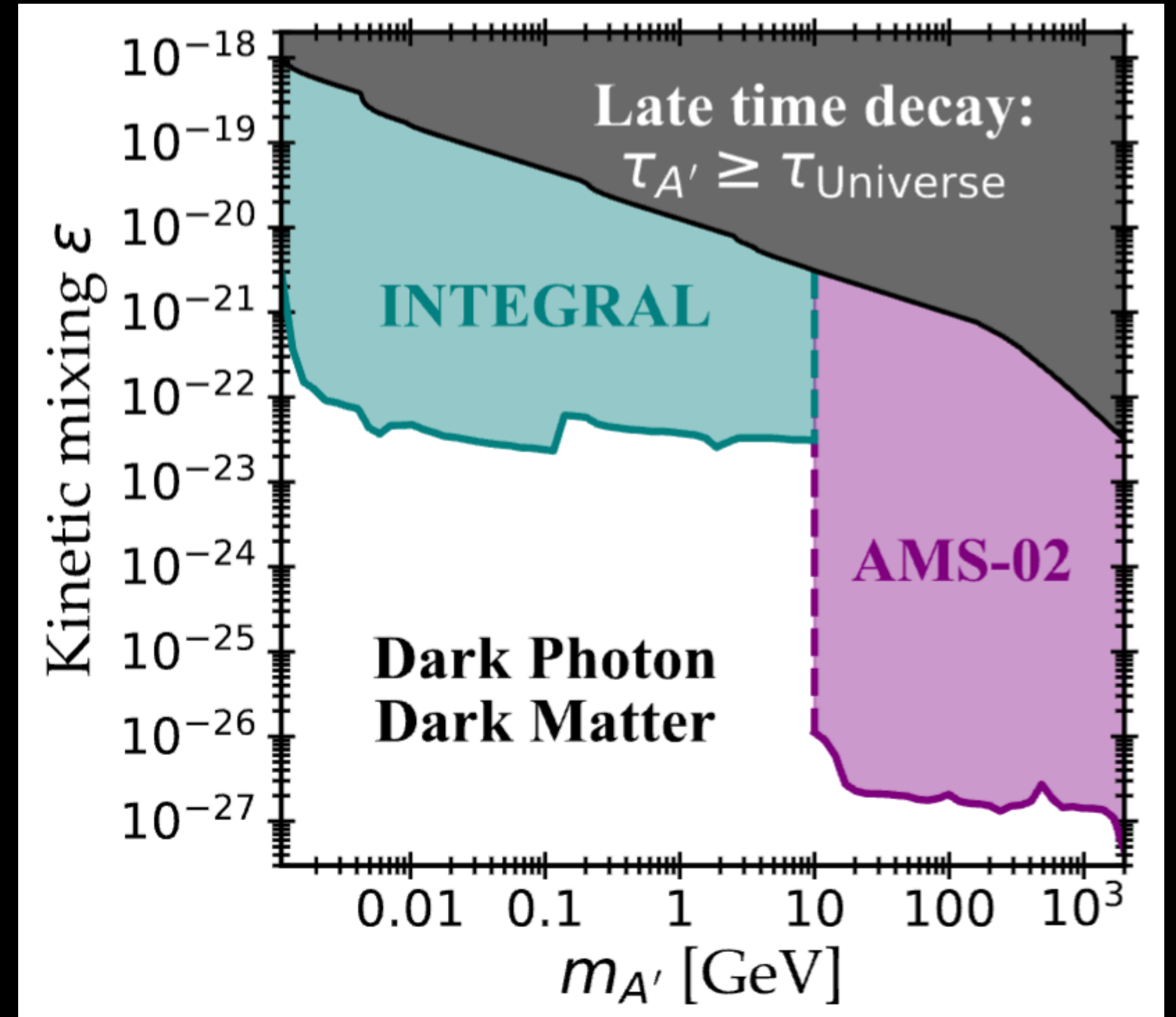
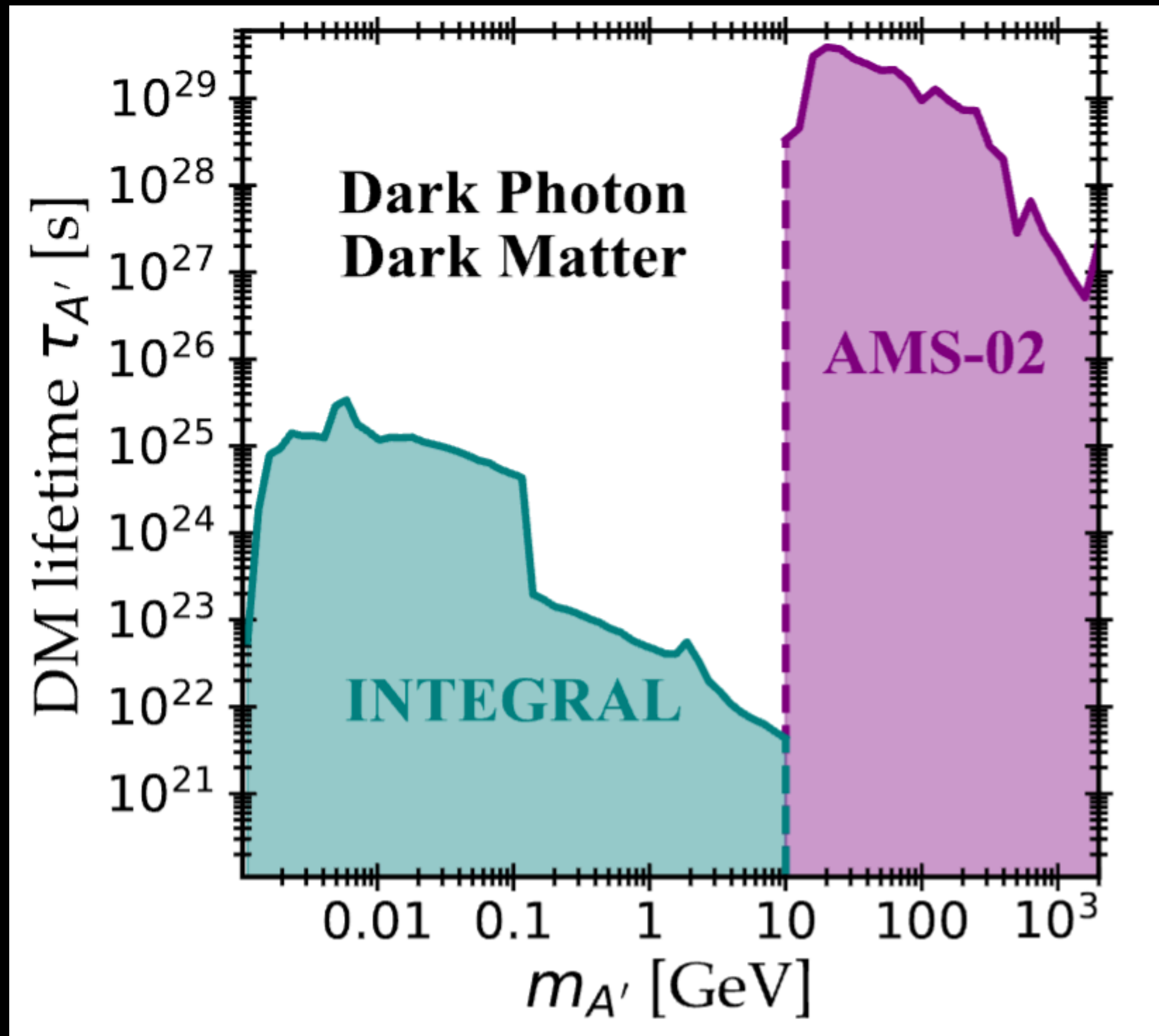


Dr. Isabelle John:

- Graduate: September 2024
- Postdoc at Turin
- Excellent CR/DM Physicist
- Excellent baker!

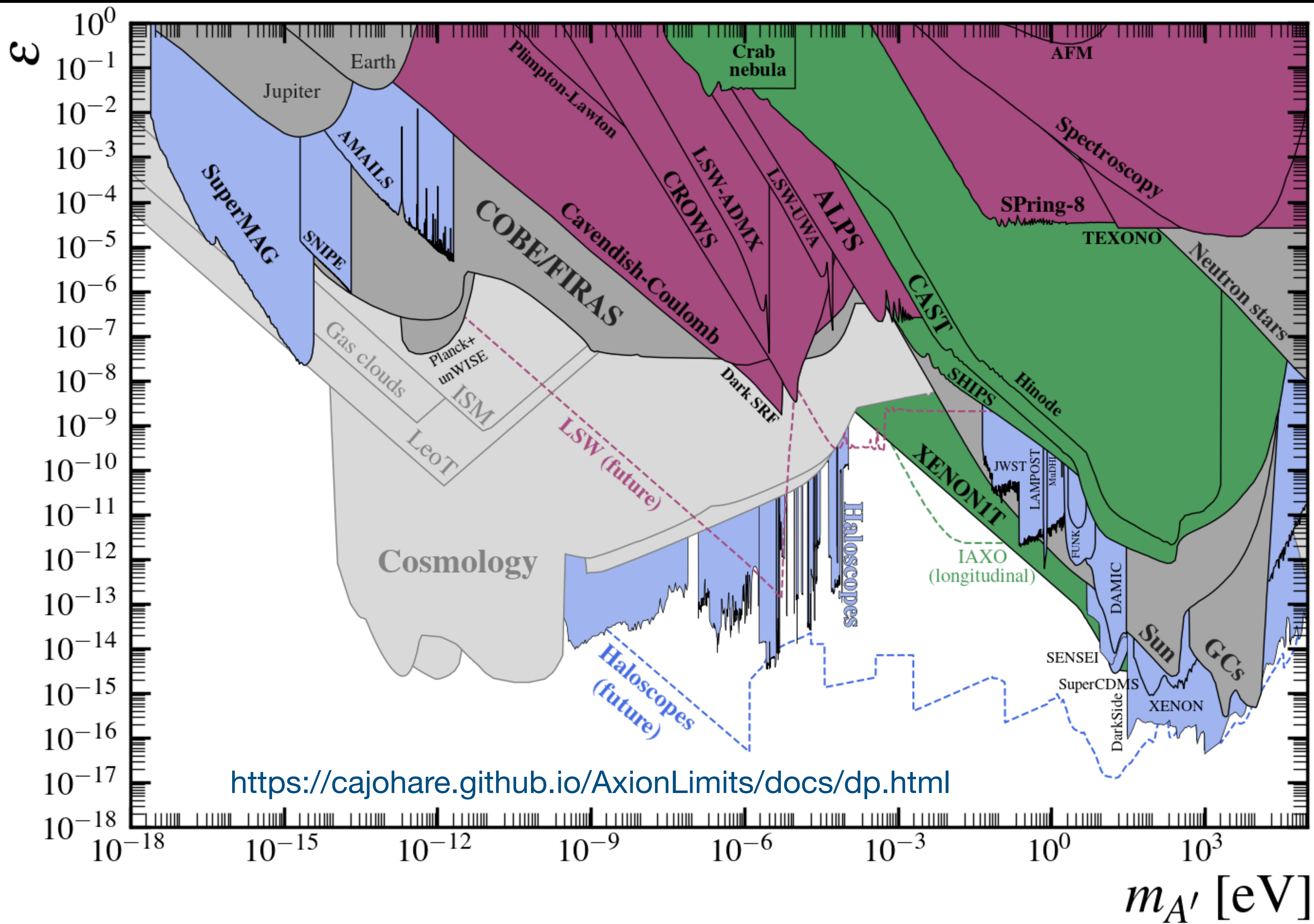


# Heavy Dark Photon Constraint

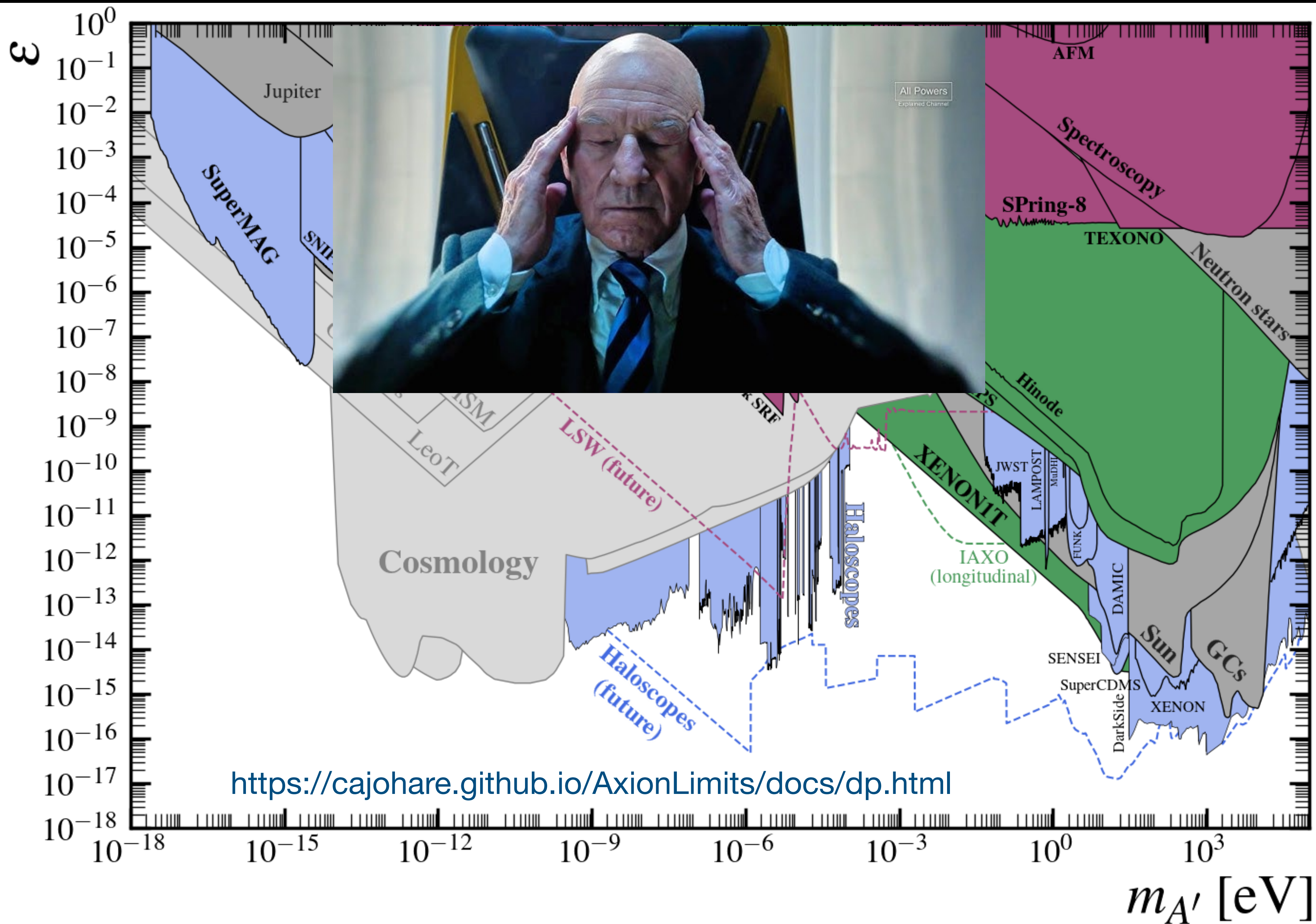




**What next?**









Thank you for listening!

Chiao is searching  
for Dog-matter  
too!

