

PPD Seminar

December 3, 2025

Democratising Dark-Matter Constraints through Reinterpretation and Renormalisation

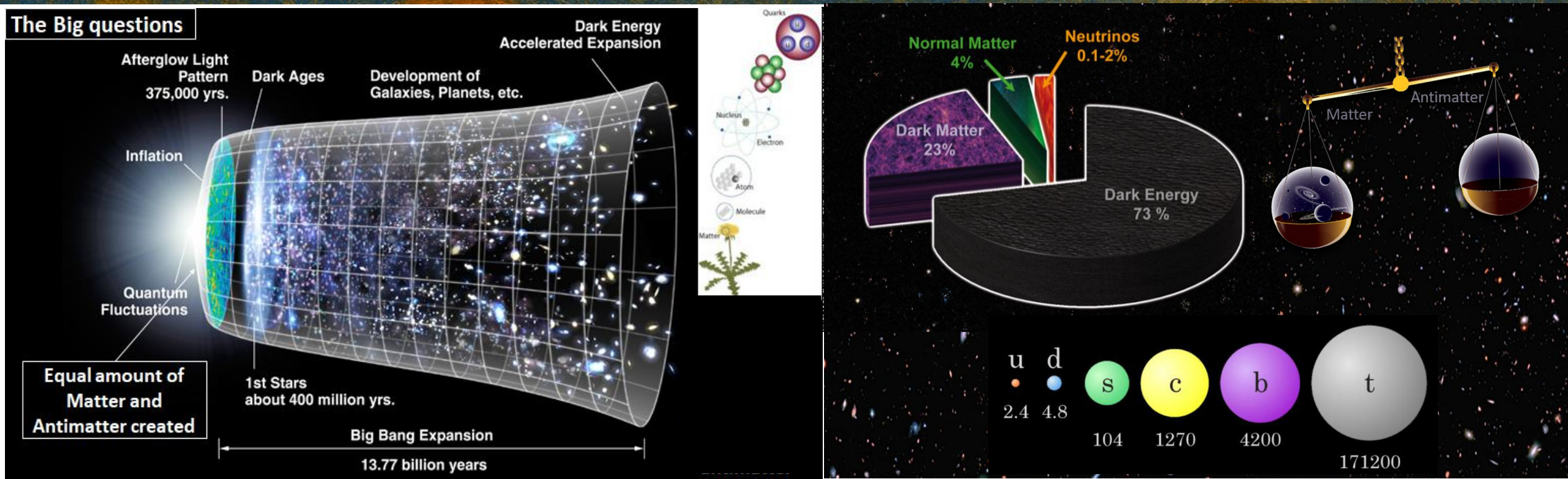
<https://darkmatter.web.cern.ch>

Brij Kishor Jashal

Particle Physics Department,
Rutherford Appleton Laboratory



Underexplored challenges: Cosmology



Friedman equations 1922 --- CMB in 1964

rotational symmetry and space time symmetry and also time translation symmetry

Do we really know that we don't know ~95% of the universe. ??

“Degree of skepticism must not only be pardonable but should be laudable”

Λ CDM concordance cosmology, based on Friedman equations(1922) recently going through a crises

$$G_{\mu\nu} + \Lambda g_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu}$$

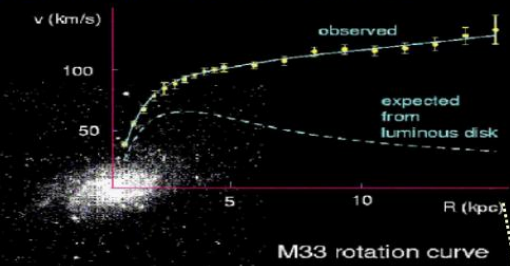
$$\left(\frac{\dot{a}(t)}{a(t)} \right)^2 = \frac{8\pi G}{3} \rho(t) - \frac{\kappa c^2}{a^2(t)} + \frac{\Lambda c^2}{3}$$

$$\frac{\ddot{a}(t)}{a(t)} = -\frac{4\pi G}{3} \left(\rho(t) + \frac{3p(t)}{c^2} \right) + \frac{\Lambda c^2}{3}$$

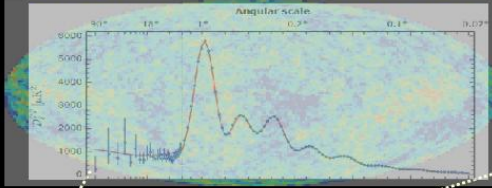
Dark matter:

Compelling physics case and huge interest of the community

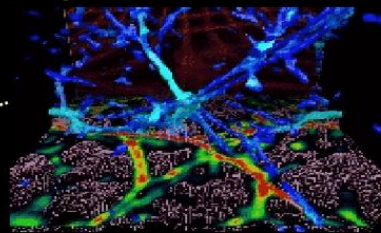
Galactic rotation curves



CMB: WMAP and PLANCK



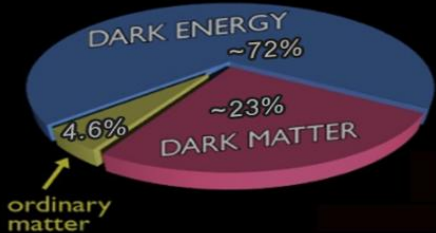
Large Scale Structures



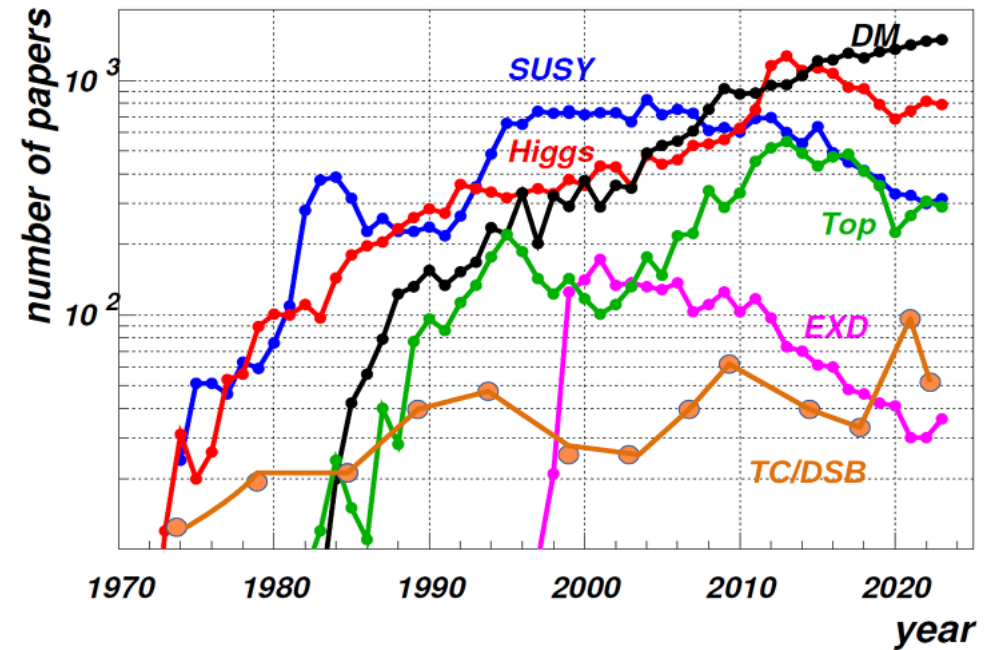
Bullet cluster



Gravitational lensing

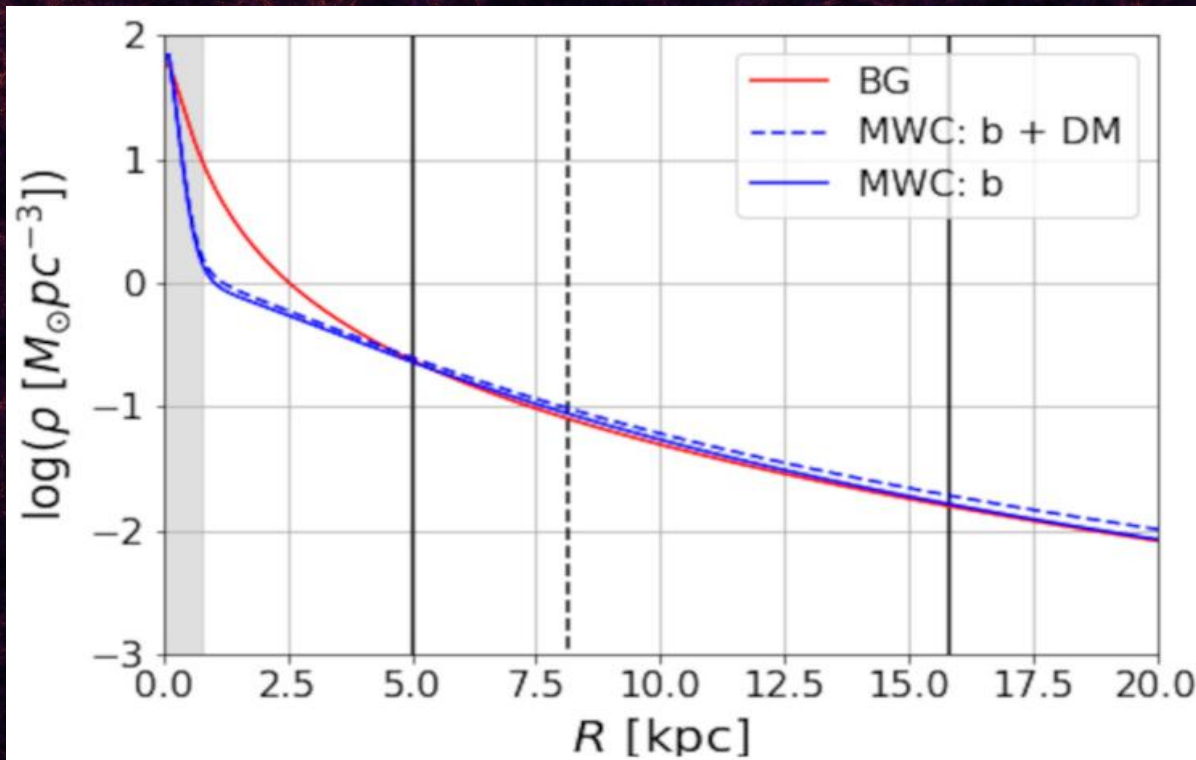


Popular directions in Particle Physics



On testing CDM and geometry-driven Milky Way rotation curve models with *Gaia* DR2

M. Crosta et al. [10.1093/mnras/staa1511](https://doi.org/10.1093/mnras/staa1511)



Balasin & Grumiller (2008, BG)

McMillan (2017), Pouliasis et al. (2017), and Eilers et al. (2019).

PAPER • OPEN ACCESS

Exploring Milky Way rotation curves with *Gaia* DR3: a comparison between Λ CDM, MOND, and general relativistic approaches

William Beordo, Mariateresa Crosta and Mario Gilberto Lattanzi

Published 11 December 2024 • © 2024 The Author(s)

[Journal of Cosmology and Astroparticle Physics](#), Volume 2024, December 2024

Citation William Beordo et al JCAP12(2024)024

DOI 10.1088/1475-7516/2024/12/024

JOURNAL ARTICLE

On testing CDM and geometry-driven Milky Way rotation curve models with *Gaia* DR2 ^{FREE}

Mariateresa Crosta ✉, Marco Giammaria, Mario G Lattanzi, Eloisa Poggio

Monthly Notices of the Royal Astronomical Society, Volume 496, Issue 2, August 2020,

Pages 2107–2122, <https://doi.org/10.1093/mnras/staa1511>

Published: 02 June 2020

Article history ▼

ABSTRACT

Flat rotation curves (RCs) in disc galaxies provide the main observational support to the hypothesis of surrounding dark matter (DM). Despite of the difficulty in identifying the DM contribution to the total mass density in our Galaxy, stellar kinematics, as tracer of gravitational potential, is the most reliable observable for gauging different matter components. From the *Gaia* second data release catalogue, we extracted parallaxes, proper motions, and line-of-sight velocities of unprecedented accuracy for a carefully selected sample of disc stars. This is the angular momentum supported population of the Milky Way (MW) that better traces its observed RC. We fitted such data to both a classical, i.e. including a DM halo, velocity profile model, and a general relativistic one derived from a stationary axisymmetric galaxy-scale metric. The general relativistic MW RC results statistically indistinguishable from its state-of-the-art DM analogue. This supports the ansatz that a weak gravitational contribution due to the off-diagonal term of the metric, by explaining the observed flatness of MW's RC, could fill the gap in a baryons-only MW, thus rendering the Newtonian-origin DM a general relativity-like effect. In the context of Local Cosmology, our findings are suggestive of the Galaxy's phase space as the exterior gravitational field in equilibrium far from a Kerr-like inner source, possibly with [no need for extra matter to account for the disc kinematics](#).

Dark matter community is huge

Showing 1–50 of 44,376 results for all: "dark matter"

Search v0.5.6 released 2020-02-24

"dark matter"

All fields



Search

☒ Show abstracts ☐ Hide abstracts

[Advanced Search](#)

Number of papers on the arXiv that mention “dark matter”, which represents 1.7% of the entire arXiv database.

Showing 1–50 of 10,750 results for all: "dark matter" AND experiment

Search v0.5.6 released 2020-02-24

"dark matter" AND experiment

All fields



Search

☒ Show abstracts ☐ Hide abstracts

[Advanced Search](#)

If you count all distinct collaborations, major phases of existing facilities, and dedicated smaller experiments (current, operational, and funded future projects), the total number of searches is easily **over 80**, and possibly **well over 100**, depending on how granular you are with distinguishing sub-experiments within a larger umbrella

Dark matter community is huge



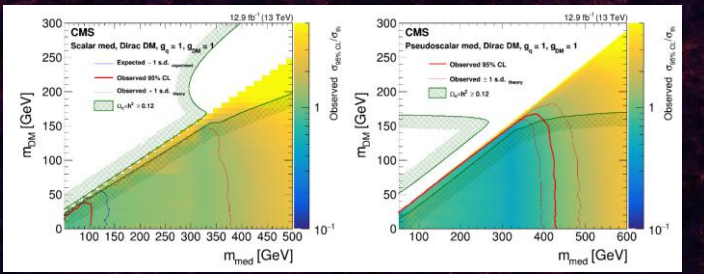
A lot of different models and couplings

No unified description for most of them!

- Different conventions for measurables
- Diverse range of experiments, from table top experiments to colliders and cosmology
- Combining constraints from different experiments is a challenging and time taking endeavor.

Dark matter community is huge

How do we build our collective understanding ?



Model Builders (Theoreticians)
Develop specific models and define the parameter space (e.g mass vs. cross-section) that experiments should target.
Output: Phase Space Maps, Target Constraints

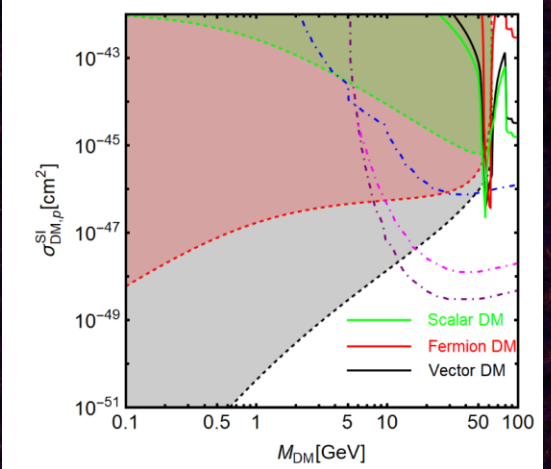
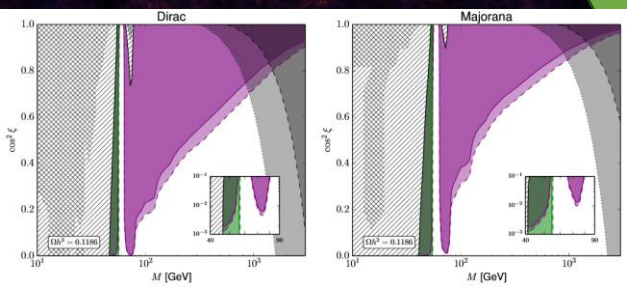
Experiment (Data Analysis & Results)
Designs, builds, and operates experiments, Performs data analysis and publishes results, setting exclusion limits across the targeted parameter spaces.
Output: Published Exclusion Limits (Experiment-Specific)

Search for dark matter with an energetic jet or a hadronically decaying W or Z boson at $s = 13$ TeV" (CMS Collaboration, arXiv:1703.01651 2017)

Phenomenology (Global Synthesis)
Take published experimental results, re-interprets them and re-normalizes them across diverse theoretical models, synthesizing the data into combined Global Exclusion Plot
Output: Global Parameter Limits, Model Testing Results

"The Higgs-portal for Dark Matter: effective field theories versus concrete realizations" (arXiv:2101.02507 2022)

"The Fermionic Dark Matter Higgs Portal: an effective field theory approach" (arXiv:1404.2283) (2014)

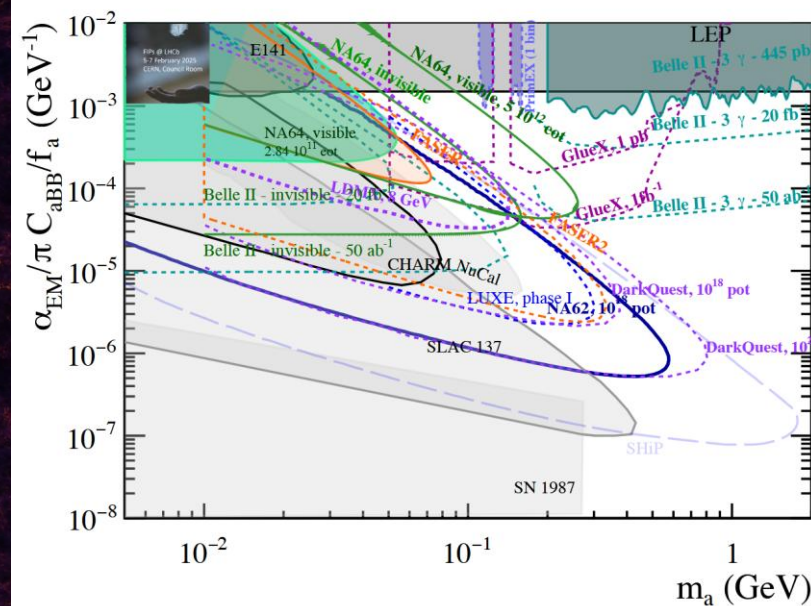
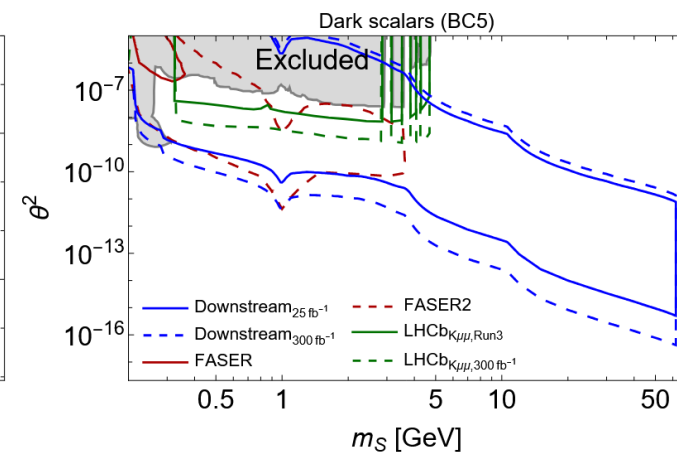
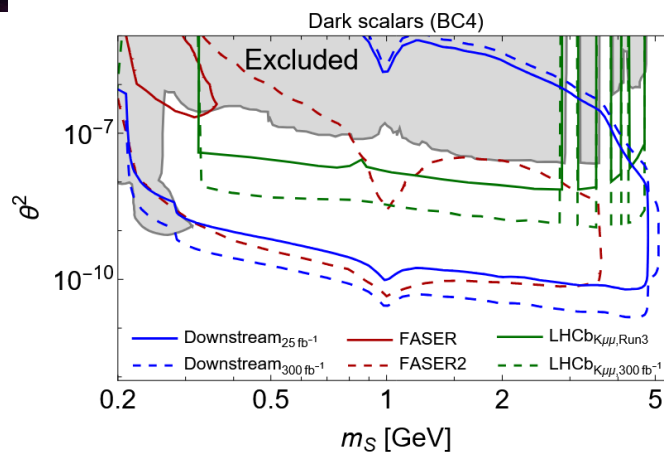
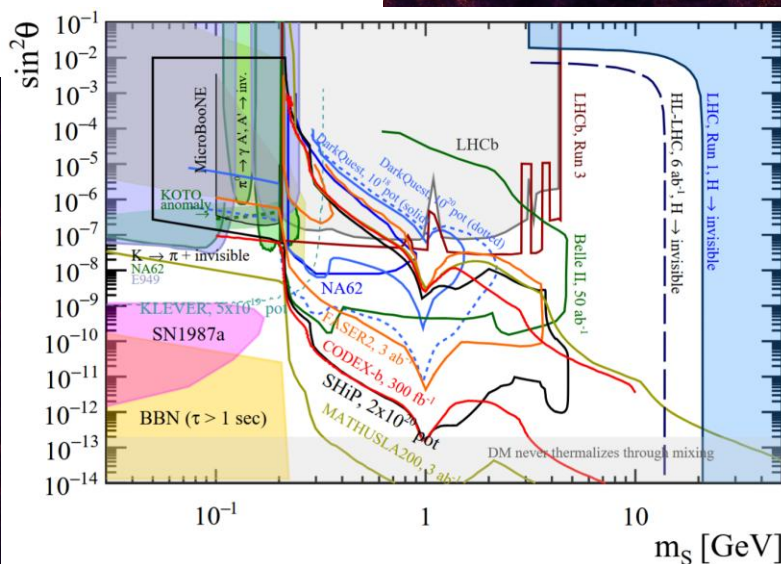
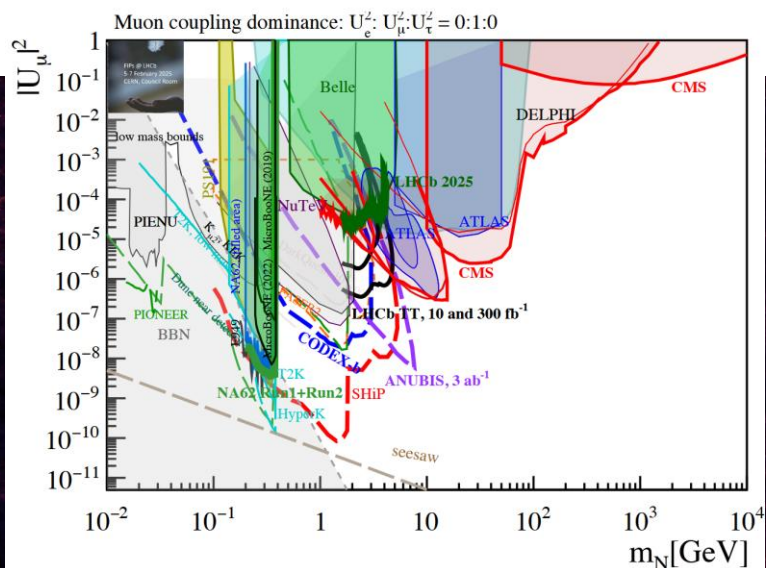


<https://arxiv.org/pdf/2510.05257>



Feebly-Interacting Particles: FIPs at LHCb — Workshop Report 2025 Edition

J. Alimena¹, J. Boyd², G. Cacciapaglia³, A. Casais Vidal^{4,*}, X. Cid Vidal⁵, S. Collaviti⁶, A. De Oyanguren Campos⁷, G. Dalla Valle Garcia⁸, G. Elor⁹, G. Ferretti¹⁰, D. Gorbunov¹¹, E. Goudzovski¹², J. Hajer¹³, J. Jerhot¹⁴, B. Kishor Jashal⁷, V. Kholoimov⁷, J. Klaric¹⁵, F. Kling^{1,27}, E. Kriukova^{11,29}, Y. Kyselov¹⁶, G. Lanfranchi^{17,*}, C. Langenbruch¹⁸, S. Libralon⁷, F. Martinez Vidal⁷, A. Merli⁶, M. Ovchinnikov², J. Pfaller¹⁹, G. Perez²⁰, P. Reimitz^{21,28}, I. Sanderswood⁷, L. Shchutska⁶, V. Svintozelsky⁷, E. Torro Pastor²², Y. Tsai²³, A. Usachov^{24,*}, L. Vale Silva²⁵, C. Vázquez Sierra^{26,*}, F. Volle¹², J. Zhuo⁷, J. Zurita⁷



Constraints for dark matter models

Dark matter models are typically characterized by:
the couplings ($\lambda_1, \lambda_2 \dots$) and masses ($m_1, m_2 \dots$) of the particles they introduce

Typical example of the extension of Standard Model. Scalar Higgs-portal has a form:

$$\mathcal{L}_{\text{BSM}} \supset \frac{1}{2}(\partial_\mu \chi)(\partial^\mu \chi) - \frac{1}{2}m_\chi^2 \chi^2 - \lambda \chi^2 H^\dagger H$$

Kinetic term

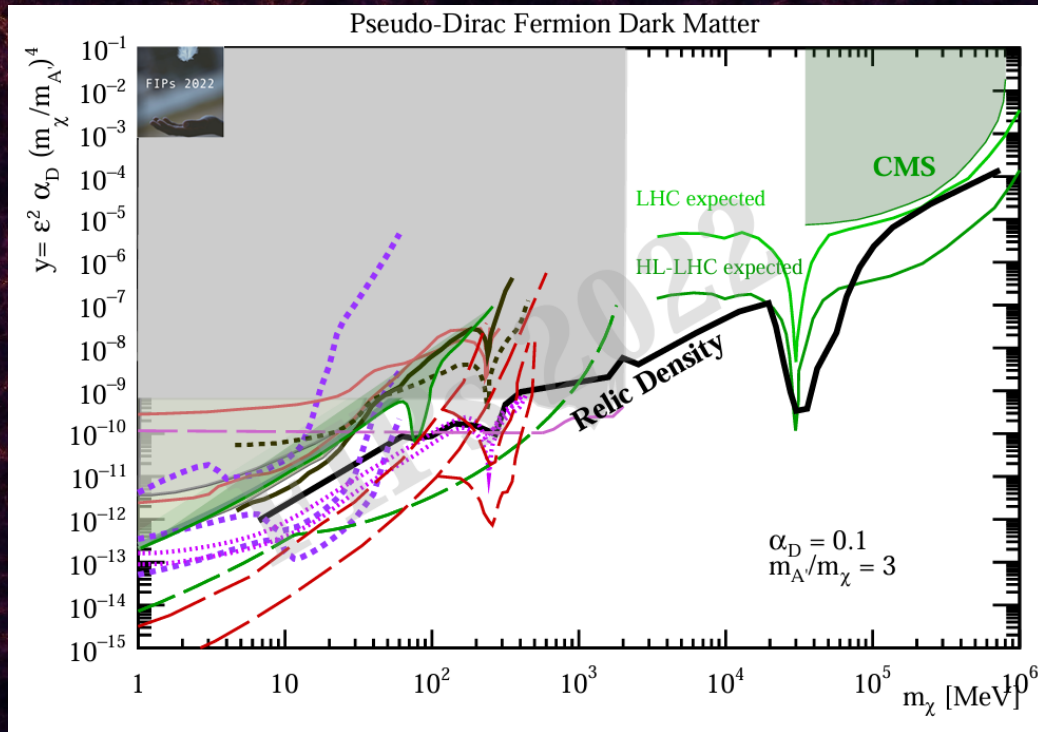
Mass term

Interaction term

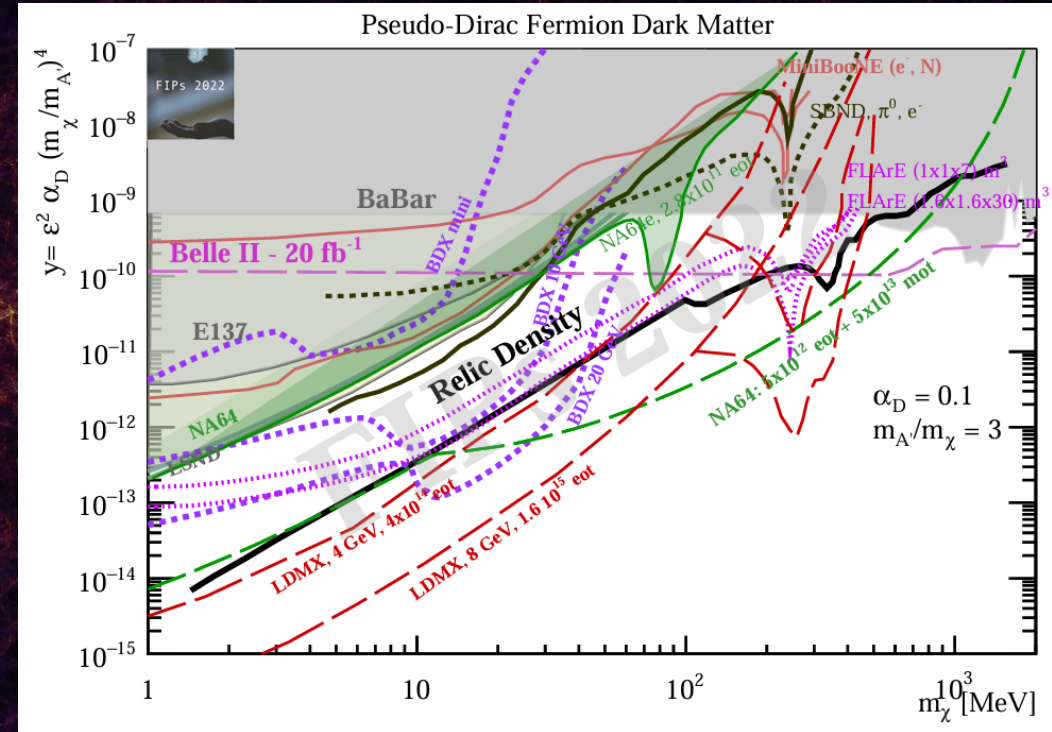
Constraints are usually shown in the coupling-mass (λ, m) parameter space

Scaling problem with global limit plots

Source



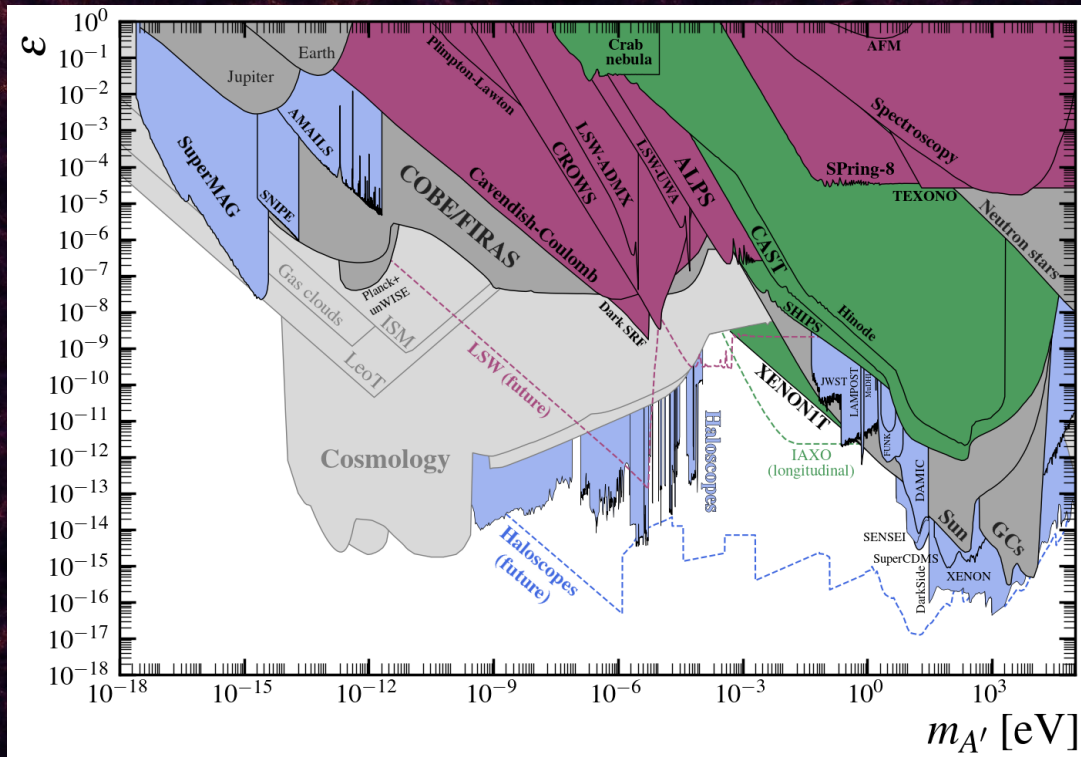
Zoom in



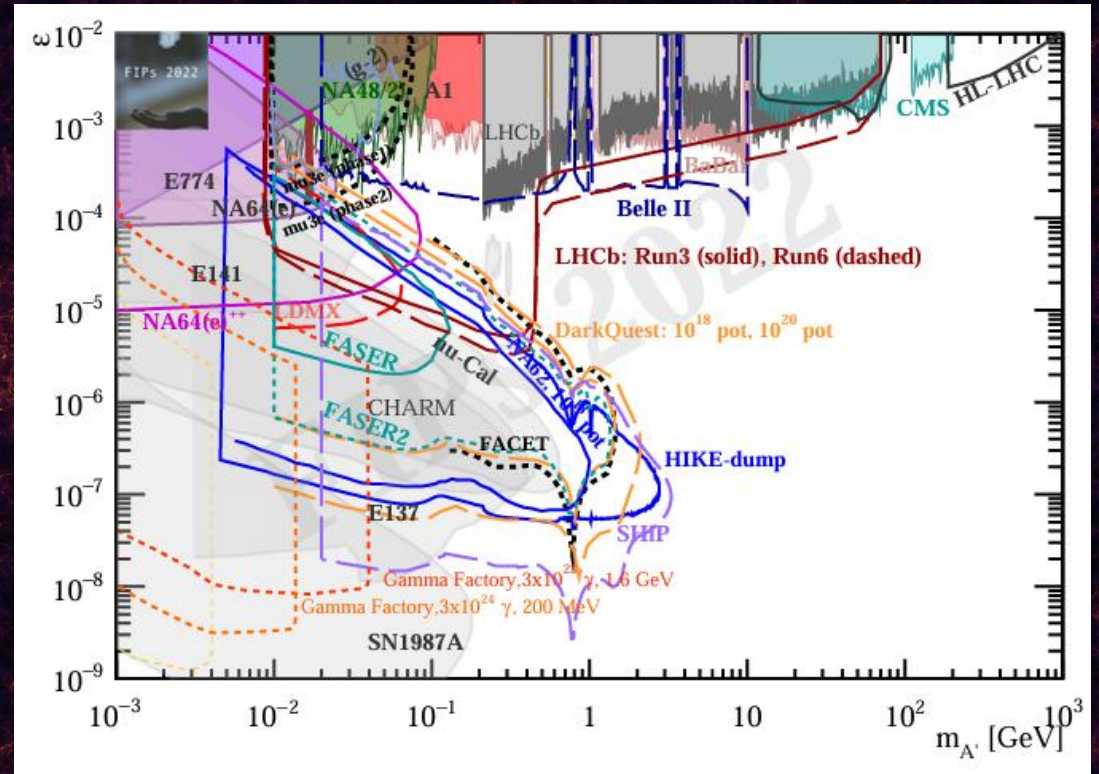
For plots with a lot of data, you often must to zoom the plot to understand what's going on

Visualisation problem of these increasingly busy global limit plots

Exclusion plot in range of 10^{-18} to 10^5 eV



Exclusion plot in range of 10^6 to 10^{12} eV



How can we properly unite these regions?

Physics Briefing Book

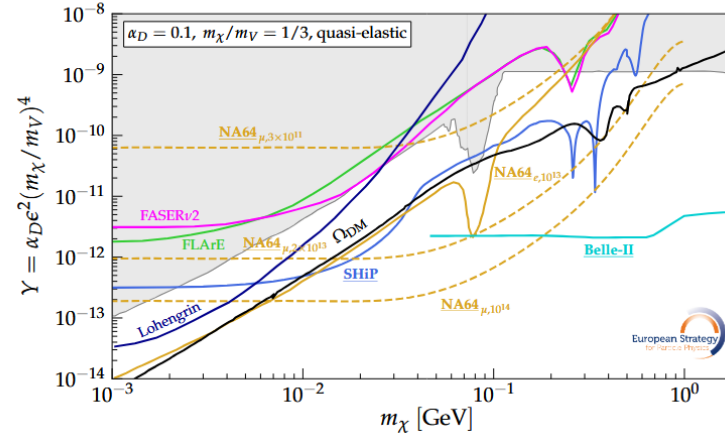
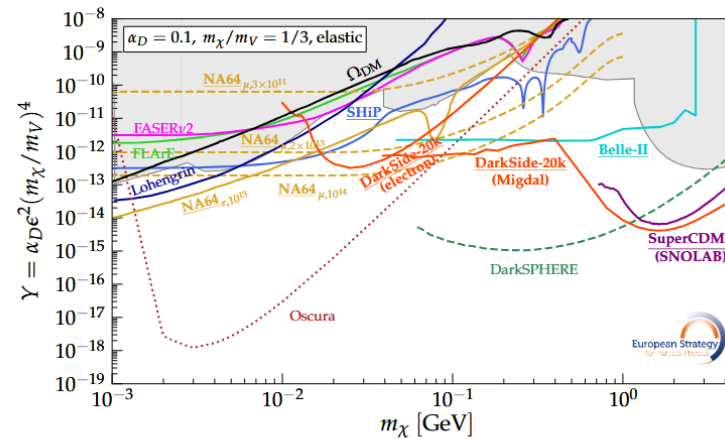
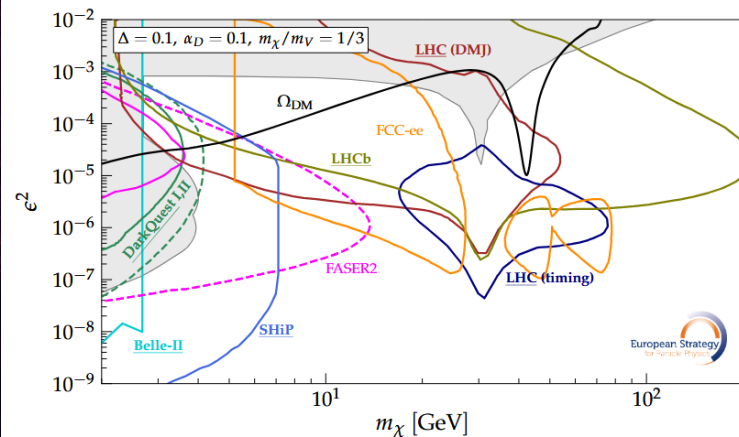
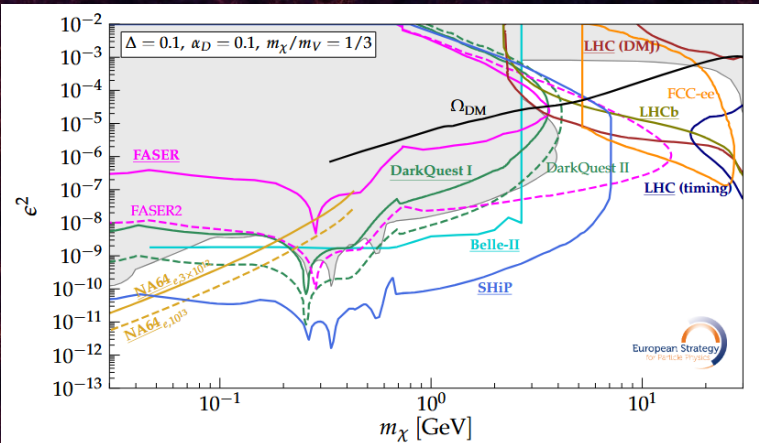
Input for the 2026 update of the European Strategy for Particle Physics

Chapter 9

Dark Matter and Dark Sector

- 333 direct references in chapter 9
<https://arxiv.org/pdf/2511.03883>

- Hundreds of individual LHC data analysis results behind each curve.



Challenges in the Dark-Matter Interpretation Process:

- Requires **deep specialized knowledge** of physics and of each model.
- **Software, tools, and scripts** used for re-interpretation and global-limit production are **hard to access, track, or reproduce**.
- Only a **small number of experts** produce global re-interpretation plots — often in narrow sub-domains — resulting in **significant, often unacknowledged effort**.
- A **sociological challenge** emerges as a highly diverse community tries to collaborate to build a shared understanding.



by wes & tony





IRIS-HEP Fellow: Andrii Anataichuk

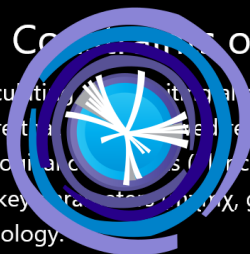


Fellowship dates: Jun – Aug, 2025

Home Institution: Taras Shevchenko National University of Kyiv

Project: Unified Cosmology on LHCb and Cosmo

The project consists of calculating... already e... results into a unified picture... regions... vertex results) with cosmological... for relic... posterior distributions for key... gDgD... to both colliders and cosmology.



fully combining these... data (AT... reference m... meter space accessible

More information: [My project proposal](#)

Mentors:

- Brij Kishor Jashal (Rutherford Appleton Laboratory)



About

Dark Matter live

Model explorer

How to add your results



Dark Matter live

Choose dark matter model

Cosmic Velocity Classes

Cold Dark Matter (CDM) —
non-relativistic

Warm Dark Matter (WDM) —
semi-relativistic

Hot Dark Matter (HDM) —

Interaction Portals

Higgs Portal: $\mathcal{L} \approx \lambda \chi^2 |H|^2$

Higgs-mixed scalar (BC4)

Higgs-mixed scalar (pair) (BC5)

Model Frameworks

Simplified: Spin-0 (φ) Higgs portal

Simplified: Spin-1/2 (ψ) Higgs /
Vector

Simplified: Spin-1 (V_μ) kinetic
mixing

Candidate Spectrum (BC Pages)

BC1 Dark Photon Minimal

BC2 Light DM + Dark Photon

BC3 Millicharged Particles

Dark Matter live

Dark Matter live

darkmatter.web.cern.ch

CERN

About Dark Matter live

Dark Matter live

<https://darkmatter.web.cern.ch>

Choose dark matter model

Cosmic Velocity Classes	Interaction Portals	Model Frameworks	Candidate Spectrum (BC Pages)
Cold Dark Matter (CDM) — non-relativistic	Higgs Portal: $\mathcal{L} \approx \lambda \chi^2 H ^2$	Simplified: Spin-0 (φ) Higgs portal	BC1 Dark Photon Minimal
Warm Dark Matter (WDM) — semi-relativistic	Higgs-mixed scalar (BC4)	Simplified: Spin-1/2 (ψ) Higgs / Vector	BC2 Light DM + Dark Photon
Hot Dark Matter (HDM) —	Higgs-mixed scalar (pair) (BC5)	Simplified: Spin-1 (V_μ) kinetic mixing	BC3 Millicharged Particles

[About](#)[Dark Matter live](#)[Model explorer](#)[How to add your results](#)

About Dark Matter live

Dark-Matter-Live is a static website project that provides interactive visualisations of experimental and observational constraints on dark-matter models. The site collects published limits and renders them as exclusion and projection curves so researchers and the public can compare results across experiments.

Goals

- Make published constraints discoverable and comparable in a single place.
- Provide an easy-to-use format for submitting new data via pull requests.
- Maintain a transparent and reproducible dataset with references to original publications.

Data formats, notation and normalisation

Results published by experimental, collider and cosmological communities are frequently reported using different conventions, units and parameterisations. Limits may appear as bounds on cross-sections, event rates, branching fractions, effective couplings or model-specific parameters (for example kinetic mixing parameters, mediator couplings, or axion-photon couplings), and different communities sometimes adopt different shorthand notation or normalisation choices. This heterogeneity makes direct, side-by-side comparison difficult without careful translation.

One of the objectives of Dark Matter live is to renormalise and map incoming results onto a consistent, model-aware parameter space so they can be compared coherently. Where possible we re-express published limits into the standard coupling and mass variables used by the broader community (following widely-adopted conventions such as those used in the Beyond Collider classification of dark-matter scenarios and related literature). The site records the original source, the assumptions made in any translation, and any additional caveats so users can trace how a displayed curve was derived.

How to contribute

To add a new result, follow the instructions on the [How to add your results](#) page. It explains required file formats, JSON fields, and validation steps. Contributions via pull request are welcome; maintainers will review and merge validated submissions.

Repository

The source code and data are available on [GitHub](#) and on the CERN GitLab mirror: [GitLab](#).

Contact

For questions or to discuss contributions, contact Brij Kishor Jashal at brij@cern.ch



How to add your results

Contributing

Thank you for contributing to **Dark-Matter-Live**. This page explains how to add new constraint curves and how to validate your data before opening a Pull Request.

Basic rules

- Only add published results. Include at least one link to the published paper (arXiv, DOI, or official experiment note).
- Add one CSV and one JSON metadata file per curve.
- Keep file names clear and lowercase (use hyphens or underscores).

Folder layout

Place files under `data/<model>/` — each model or model family gets its own folder. Put CSV and JSON pairs there.

File formats

- CSV must be a numeric two-column file with header `x,y`.
- JSON must include at least the following keys:
 - `labelName` (string)
 - `id` (string)
 - `url` (string) — relative path to the CSV file
 - `paperUrls` (array) — at least one URL to the published result

Validation

Run the validator included in `scripts/validate_data.py` before opening a PR. It checks that JSON files parse, required fields exist, the CSV file exists, and the CSV contains a header `x,y` and numeric rows.

Run (PowerShell):

Dark Matter Explorer

Classifying the invisible 27% of our Universe. Explore models based on [cosmic velocity](#), [particle interactions](#), and [theoretical frameworks](#).

1. [Cosmic Velocity](#)
2. The Portals
3. Model Frameworks
4. Candidate Spectrum

Classification by Velocity & Structure Formation

Speed in the early universe sets the free-streaming length shaping hierarchical structure. Concordance cosmology is Λ CDM.

Cold Dark Matter

Consensus

Non-Relativistic

Bottom-up halo formation; matches observations at all scales.

Warm Dark Matter

Contender

Semi-Relativistic

Suppresses smallest halos; addresses some small-scale tensions.

Hot Dark Matter

Ruled Out

Ultra-Relativistic

Erases small-scale structure; incompatible as dominant DM.

Cold Dark Matter (CDM)

Structure Formation Impact

Non-relativistic; bottom-up halo assembly matches observations.

Key Candidates

- WIMPs
- Axions/ALPs
- Primordial Black Holes

1. Cosmic Velocity

2. [The Portals](#)

3. Model Frameworks

4. Candidate Spectrum

The Portals: Interaction Mechanisms

Mediators enable Standard Model ↔ Dark Sector communication; they appear in interaction terms of the Lagrangian.

Standard Model

Visible Matter & Higgs (\$H\$)

Higgs Portal (\$H\$)

Vector Portal (\$A\$)

Axion Portal (\$a\$)

Neutrino Portal (\$N\$)

Dark Sector

DM Candidate (\$\chi\$)

SELECTED PORTAL

Higgs Portal

Coupling to Higgs field: $\mathcal{L} \supset \lambda \chi^2 |H|^2$. Natural for scalar & fermionic DM.

Mediator

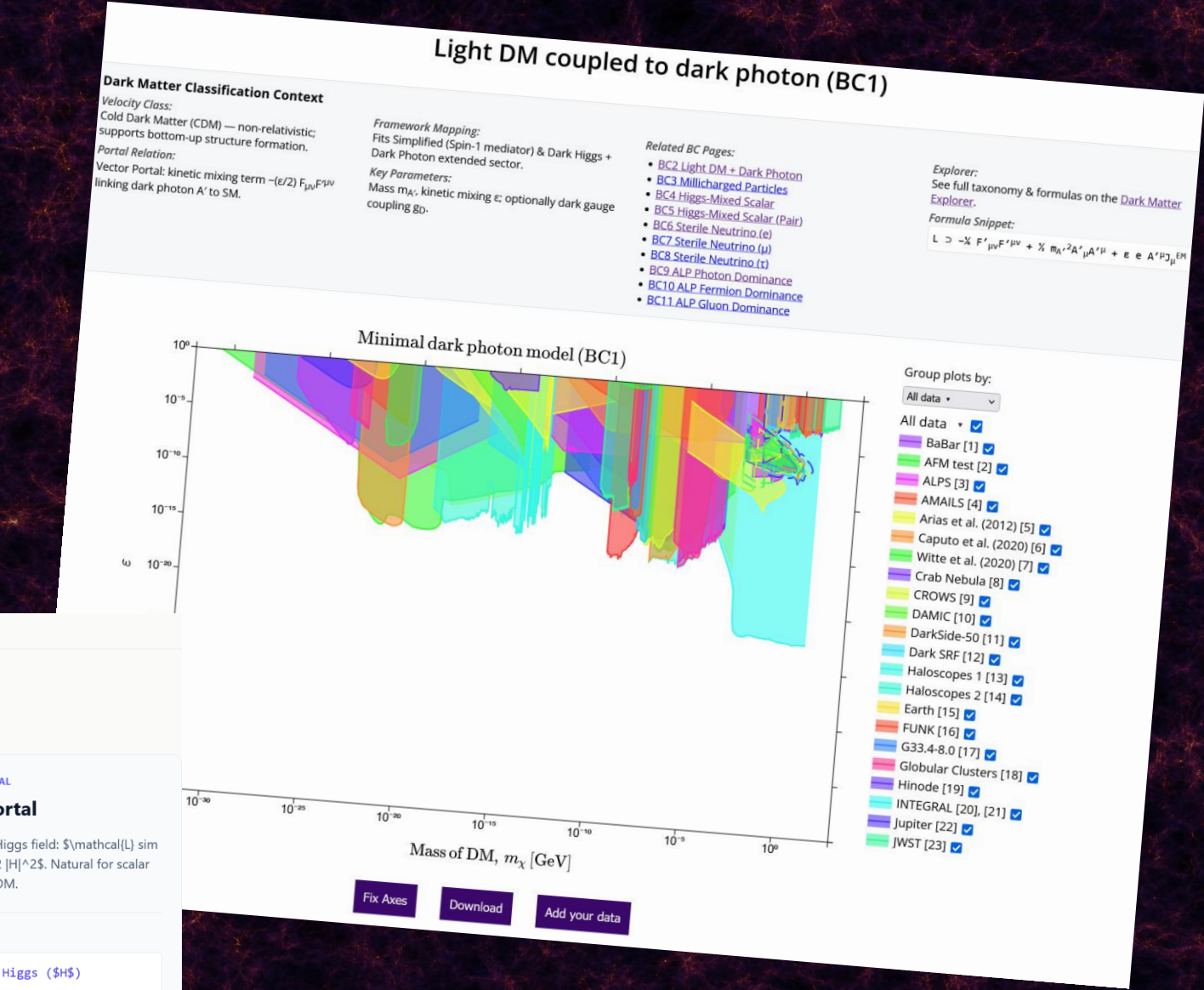
Higgs (\$H\$)

Key Candidate & Type

Scalar/Fermion WIMPs

Related Frameworks

Simplified (Spin-0, 1/2) & Extended Higgs



Light DM coupled to dark photon (BC1)

Dark Matter Classification Context

Velocity Class:

Cold Dark Matter (CDM) — non-relativistic; supports bottom-up structure formation.

Portal Relation:

Vector Portal: kinetic mixing term $-(\epsilon/2) F_{\mu\nu} F^{\prime\mu\nu}$ linking dark photon A' to SM.

Framework Mapping:

Fits Simplified (Spin-1 mediator) & Dark Higgs + Dark Photon extended sector.

Key Parameters:

Mass $m_{A'}$, kinetic mixing ϵ ; optionally dark gauge coupling g_D .

Related BC Pages:

- [BC2 Light DM + Dark Photon](#)
- [BC3 Millicharged Particles](#)
- [BC4 Higgs-Mixed Scalar](#)
- [BC5 Higgs-Mixed Scalar \(Pair\)](#)
- [BC6 Sterile Neutrino \(\$\mu\$ \)](#)
- [BC7 Sterile Neutrino \(\$\tau\$ \)](#)
- [BC9 ALP Photon Dominance](#)
- [BC10 ALP Fermion Dominance](#)
- [BC11 ALP Gluon Dominance](#)

Explorer:

See full taxonomy & formulas on the [Dark Matter Explorer](#).

Formula Snippet:

$$\mathcal{L} \supset -\frac{1}{4} F'_{\mu\nu} F^{\prime\mu\nu} + \frac{1}{2} m_{A'}^2 A'_\mu A'^\mu + \epsilon e A'_\mu J_\mu^{\text{EM}}$$

Description of the model

In the minimal dark photon framework, the Standard Model (SM) is extended by an additional $U(1)_D$ gauge symmetry under which all SM particles are neutral. The new gauge field, typically denoted A'_μ , mixes kinetically with the SM hypercharge gauge field B_μ . The most compact Lagrangian capturing this minimal extension reads:

$$\mathcal{L} \supset -\frac{1}{4} F'_{\mu\nu} F^{\prime\mu\nu} + \frac{1}{2} m_{A'}^2 A'_\mu A'^\mu + \epsilon e A'_\mu J_\mu^{\text{EM}},$$

where $F'_{\mu\nu}$ is the dark photon field strength, $m_{A'}$ is its mass (generation might be not specified, commonly accepted a Stueckelberg or dark Higgs mechanism), and ϵ parametrizes the strength of kinetic mixing with the electromagnetic current $J_\mu^{\text{EM}} = \sum_f Q_f \bar{f} \gamma_\mu f$.

The dark photon originates from the new $U(1)_D$ gauge symmetry. If $U(1)_D$ remains unbroken, the dark photon is massless and its interactions with the SM are extremely suppressed. More commonly, the symmetry is broken (e.g., via the Stueckelberg or dark Higgs mechanism), leading to a massive dark photon. The two central free parameters of the minimal model are $m_{A'}$ and ϵ .

Detection

There are two types of channels that are usually considered: visible ($m_{A'} > 2m_e$) and invisible ($m_{A'} < 2m_e$).

In the first case, seaches concentrated on detection of SM signatures related to the dark photon in detector, e.g., di-jet and missing energy/momentum searches. These experiments are usually built around colliders, like LHC, SPS, Fermilab etc.

In the second case, the dark photon, in minimal dark photon model, do not have obvious visible SM decay channels, exept neutrinos, which are suppressed and extremely hard to detect, and so-called photon trident decay ($A' \rightarrow 3\gamma$), which is one-loop processes and highly suppressed. Therefore, these particles are long-lived and escape the detector, leading to missing energy/momentum signatures, which are extremely weak compared to the background and imposible to track at current resolution.

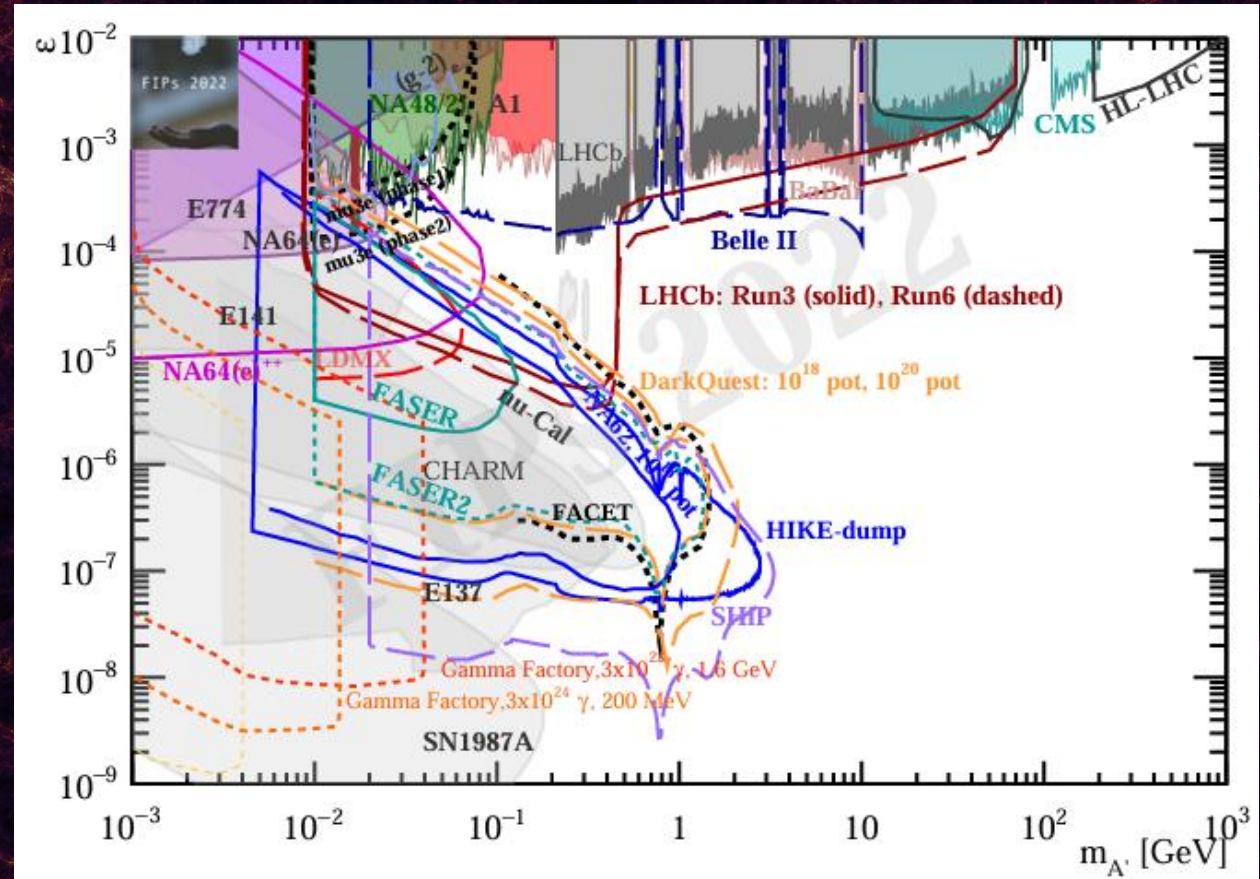
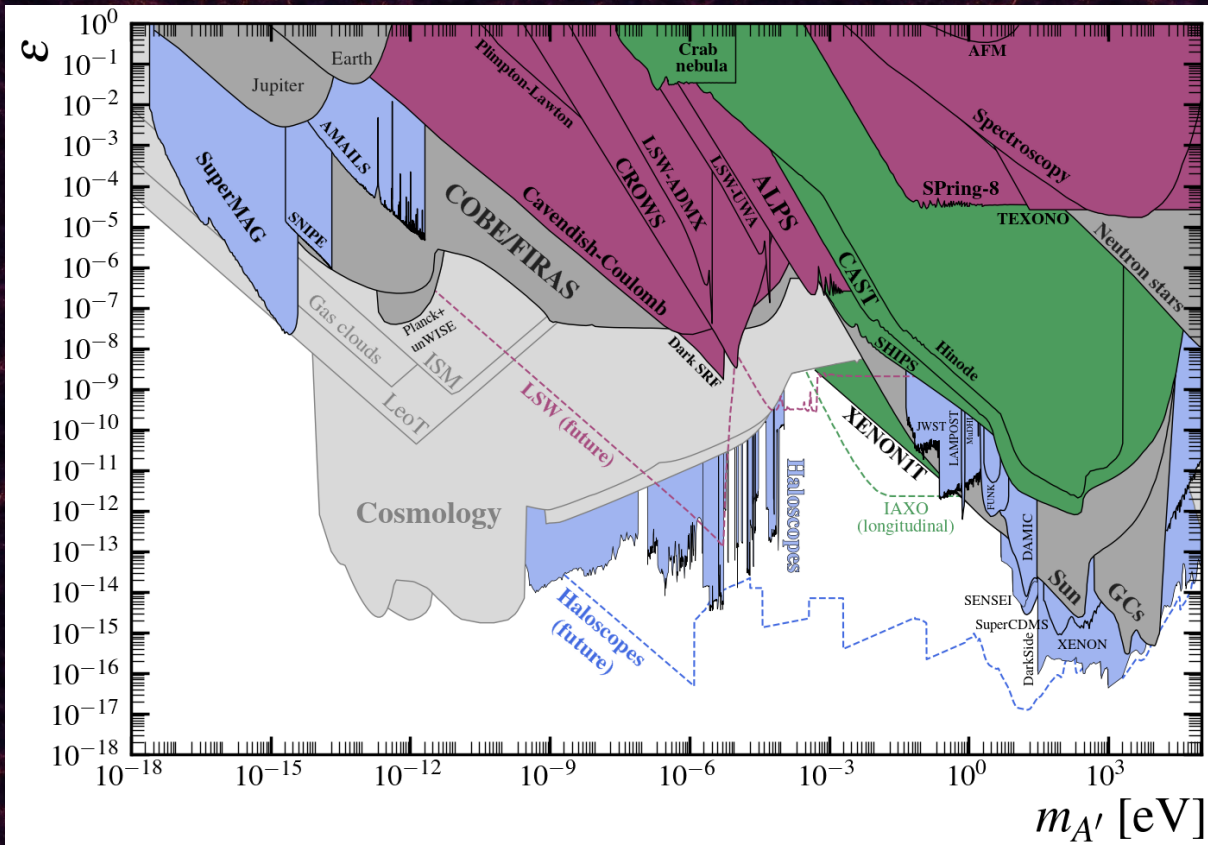
So, most seaches at sub-MeV range are based on indirect detection methods.

Explorer:

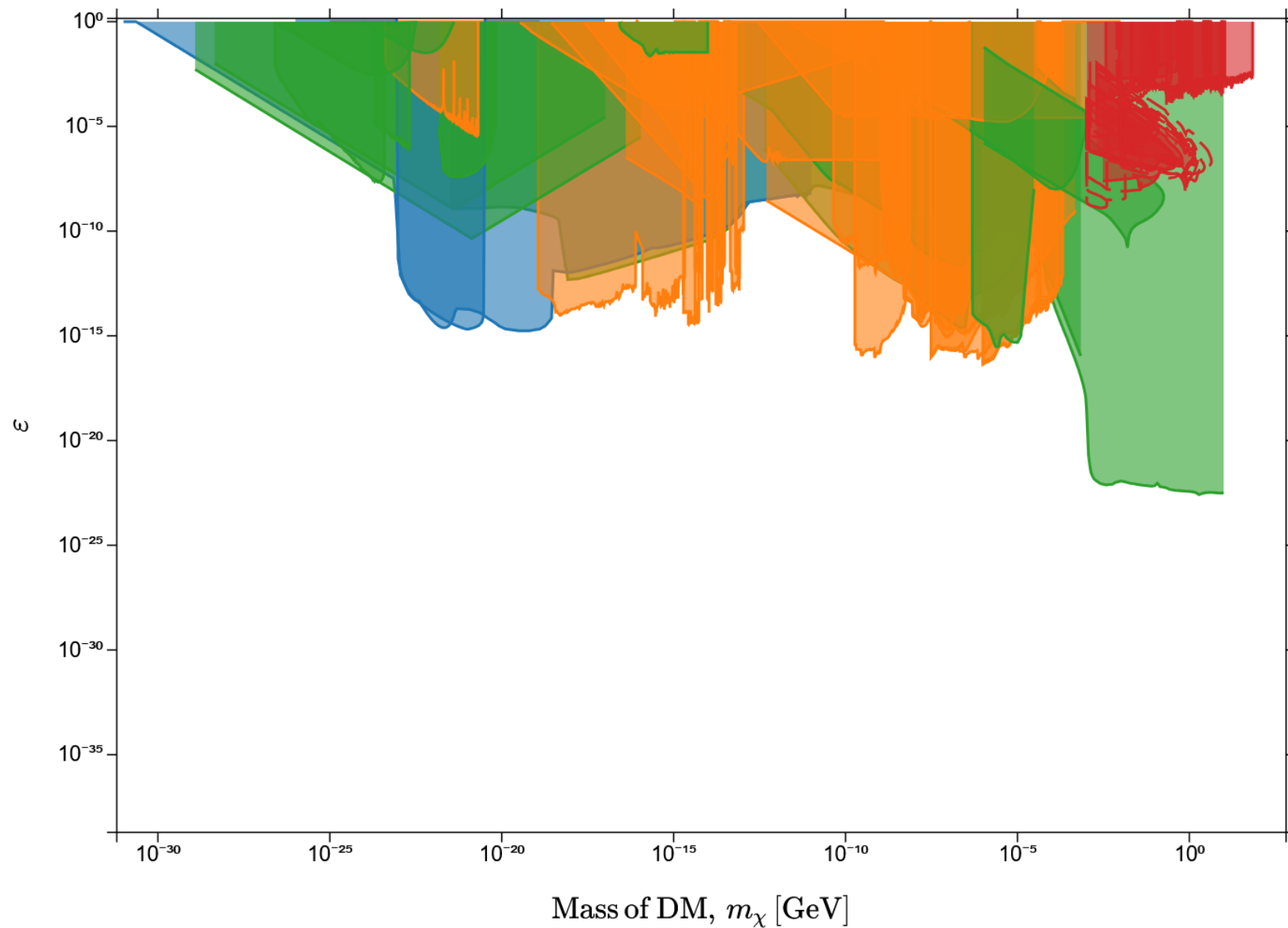
See full taxonomy & formulas on the [Dark Matter Explorer](#).

Formula Snippet:

$$\mathcal{L} \supset -\frac{1}{4} F'_{\mu\nu} F'^{\mu\nu} + \frac{1}{2} m_{A'}^2 A'_\mu A'^\mu + \varepsilon e A'_\mu j_\mu^{\text{EM}}$$



Minimal dark photon model (BC1)



Group plots by:

Experiment Type ▾

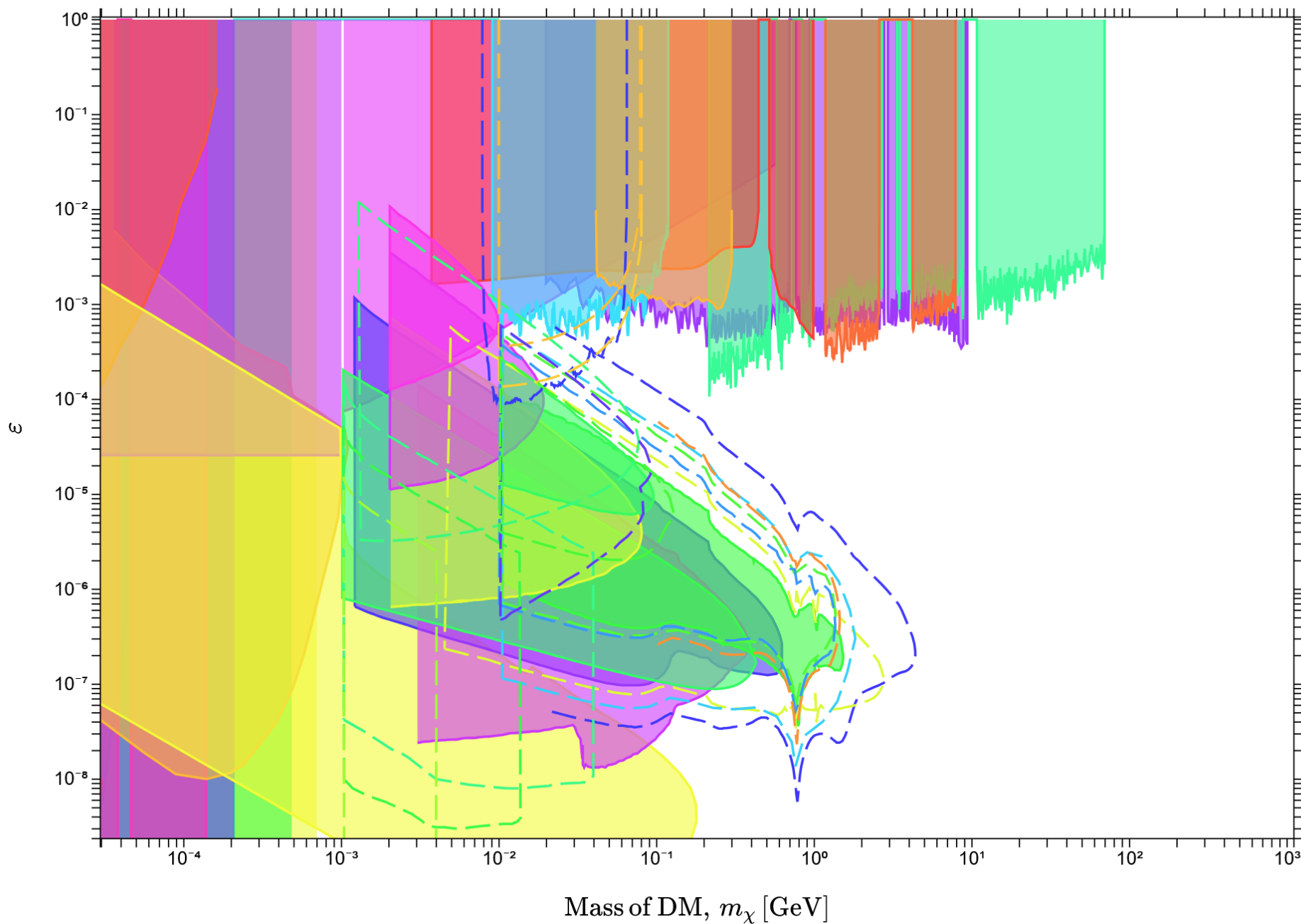
- Collider experiments ▸ ☒
- Laboratory experiments ▸ ☒
- Astrophysical observations ▸ ☒
- Cosmological measurements ▸ ☒

Fix Axes

Download

Add your data

Minimal dark photon model (BC1)

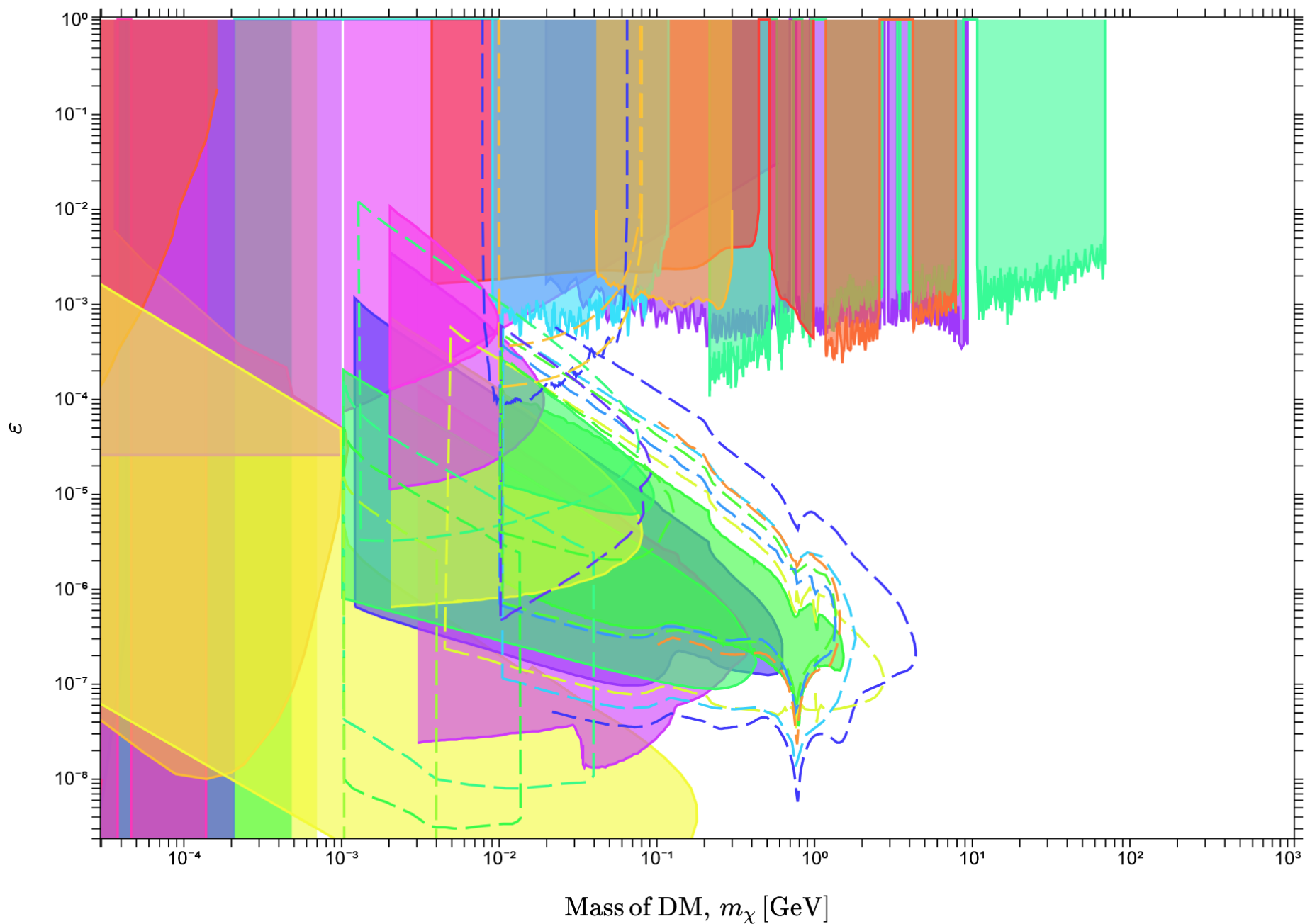


Group plots by:

All data ▾ ▾

- CROWS [9] ☒
- DAMIC [10] ☒
- DarkSide-50 [11] ☒
- Dark SRF [12] ☒
- Haloscopes 1 [13] ☒
- Haloscopes 2 [14] ☒
- Earth [15] ☒
- FUNK [16] ☒
- G33.4-8.0 [17] ☒
- Globular Clusters [18] ☒
- Hinode [19] ☒
- INTEGRAL [20], [21] ☐
- Jupiter [22] ☒
- JWST [23] ☒
- Leo T [24] ☒
- ADMX [25] ☒
- UWA [26] ☒
- MuDHI [27] ☒
- Cas A [28] ☒
- Planck + unWISE [29] ☒
- Plimpton-Lawton [30] ☒
- SENSEI [31] ☒
- SHIPS [32] ☒
- SNIPE [33] ☒
- Solar [34] ☒
- Spectroscopy [35] ☒

Minimal dark photon model (BC1)

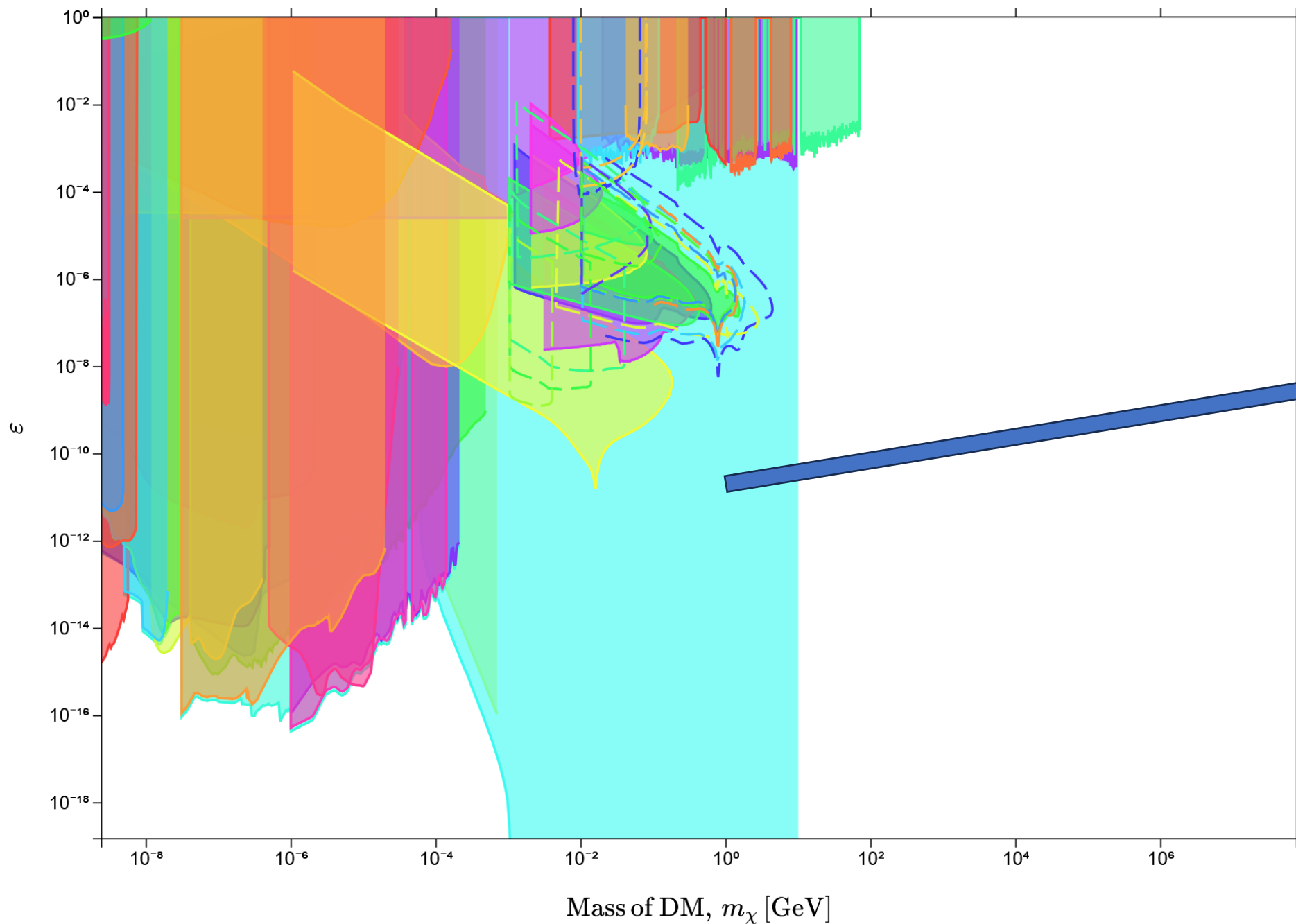


Group plots by:

All data ▾ ▾

- CROWS [9] ☒
- DAMIC [10] ☒
- DarkSide-50 [11] ☒
- Dark SRF [12] ☒
- Haloscopes 1 [13] ☒
- Haloscopes 2 [14] ☒
- Earth [15] ☒
- FUNK [16] ☒
- G33.4-8.0 [17] ☒
- Globular Clusters [18] ☒
- Hinode [19] ☒
- INTEGRAL [20], [21] ☐
- Jupiter [22] ☒
- JWST [23] ☒
- Leo T [24] ☒
- ADMX [25] ☒
- UWA [26] ☒
- MuDHI [27] ☒
- Cas A [28] ☒
- Planck + unWISE [29] ☒
- Plimpton-Lawton [30] ☒
- SENSEI [31] ☒
- SHIPS [32] ☒
- SNIPE [33] ☒
- Solar [34] ☒
- Spectroscopy [35] ☒

Minimal dark photon model (BC1)



Group plots by:

All data ▾

- CROWS [9] ✓
- DAMIC [10] ✓
- DarkSide-50 [11] ✓
- Dark SRF [12] ✓
- Haloscopes 1 [13] ✓
- Haloscopes 2 [14] ✓
- Earth [15] ✓
- FUNK [16] ✓
- G33.4-8.0 [17] ✓
- Globular Clusters [18] ✓
- Hinode [19] ✓
- INTEGRAL [20], [21] ✓
- Jupiter [22] ✓
- JWST [23] ✓
- Leo T [24] ✓
- ADMX [25] ✓
- UWA [26] ✓
- MuDHI [27] ✓
- Cas A [28] ✓
- Planck + unWISE [29] ✓
- Plimpton-Lawton [30] ✓
- SENSEI [31] ✓
- SHIPS [32] ✓
- SNIPE [33] ✓
- Solar [34] ✓
- Spectroscopy [35] ✓

[Submitted on 27 Jun 2024 (v1), last revised 21 Jul 2025 (this version, v2)]

X-Ray Constraints on Dark Photon Tridents

Tim Linden, [Thong T. Q. Nguyen](#), [Tim M. P. Tait](#)

Dark photons that are sufficiently light and/or weakly-interacting represent a compelling vision of dark matter. Dark photon decay into three photons, which we call the dark photon trident, can be the dominant channel when the dark photon mass falls below the electron pair threshold and can produce a significant flux of x-rays. We use 16 years of data from INTEGRAL/SPI to constrain sub-MeV dark photon decay, producing new worlds-best constraints on the kinetic mixing parameter for dark photon masses between 61 keV and 1022 keV, and comment on the potential for future x-ray observatories to discover the trident decay process.

Comments: 4+3 pages, 4 figures. Published version on PRD
Subjects: **High Energy Physics - Phenomenology (hep-ph)**; High Energy Astrophysical Phenomena (astro-ph.HE)
Report number: UCI-HEP-TR-2024-10
Cite as: [arXiv:2406.19445 \[hep-ph\]](#)
(or [arXiv:2406.19445v2 \[hep-ph\]](#) for this version)
<https://doi.org/10.48550/arXiv.2406.19445> ⓘ
Journal reference: Phys.Rev.D 112 (2025) 2, 023026
Related DOI: <https://doi.org/10.1103/37gn-x3y1> ⓘ

Submission history

From: Tran Quang Thong Nguyen [[view email](#)]
[v1] Thu, 27 Jun 2024 18:00:01 UTC (323 KB)
[v2] Mon, 21 Jul 2025 16:45:13 UTC (323 KB)

[Submitted on 29 Nov 2024]

Strong Constraints on Dark Photon and Scalar Dark Matter Decay from INTEGRAL and AMS-02

[Thong T.Q. Nguyen](#), [Isabelle John](#), [Tim Linden](#), [Tim M.P. Tait](#)

We investigate the decay of bosonic dark matter with masses between 1 MeV and 2 TeV into Standard Model final states. We specifically focus on dark photons that kinetically mix with the Standard Model, as well as scalar dark matter models that have Yukawa couplings with the Standard Model. Using INTEGRAL and AMS-02 data, we constrain the dark matter decay lifetime into final states that include photons or positrons, setting strong constraints on the dark matter lifetime that reach 10^{25} s for dark matter below 10 GeV and up to 10^{29} s for dark matter above 10 GeV.

Comments: 13 pages, 8 figures. Appendix: 2 pages, 1 figure. Comments are welcome!
Subjects: **High Energy Physics - Phenomenology (hep-ph)**; High Energy Astrophysical Phenomena (astro-ph.HE)
Report number: UCI-HEP-TR-2024-19
Cite as: [arXiv:2412.00180 \[hep-ph\]](#)
(or [arXiv:2412.00180v1 \[hep-ph\]](#) for this version)
<https://doi.org/10.48550/arXiv.2412.00180> ⓘ

Submission history

From: Tran Quang Thong Nguyen [[view email](#)]
[v1] Fri, 29 Nov 2024 19:00:00 UTC (300 KB)

Group plots by:

- All data ▾ ▾
- CROWS [9] ✓
- DAMIC [10] ✓
- DarkSide-50 [11] ✓
- Dark SRF [12] ✓
- Haloscopes 1 [13] ✓
- Haloscopes 2 [14] ✓
- Earth [15] ✓
- FUNK [16] ✓
- G33.4-8.0 [17] ✓
- Globular Clusters [18] ✓
- Hinode [19] ✓
- INTEGRAL [20], [21] ✓
- Jupiter [22] ✓
- MAST [23] ✓

E [29] ✓
n [30] ✓

35] ✓

So how can we have a Open, Transparent, and Collaborative Global-Limit Framework

Motivation: Lessons from Software Development

- **Git** to manage the growing Linux kernel (40 Million lines of code), enabling **distributed collaboration**, **transparent history**, and **community-driven review**.

Public and Open Repositories:

- The source code and data are available on GitHub and on the CERN GitLab mirror: **CERN GitLab**.
- Designed to ensure **collaboration**, **reproducibility**, and **shared ownership**.

The screenshot shows the GitHub interface for the repository 'NewPhysicsLive / DarkMatterLive'. The repository is public and has 1 star and 0 forks. The main branch is 'main' with 2 branches and 0 tags. The repository has 46 commits and was last updated 5 hours ago. The repository description is 'No description, website, or topics provided.' The repository has a README, Apache-2.0 license, and contributing guidelines. The repository is a static website project hosted at <https://darkmatter.web.cern.ch> that provides interactive, ...

Name	Last commit	Last update
.github/workflows	precompilation of preview for fully static preview link hover f...	2 months ago
data	fix previews	2 months ago
pages	update layout 2	5 hours ago
scripts	precompilation of preview for fully static preview link hover f...	2 months ago
CONTRIBUTING.md	add structure	3 months ago
LICENSE	Initial commit	4 months ago
README.md	add structure	3 months ago
health.html	Important updates for portal	3 months ago
index.html	Important updates for portal	3 months ago

Dark-Matter-Live

Dark-Matter-Live is a static website project (hosted at <https://darkmatter.web.cern.ch>) that provides interactive, ...

The screenshot shows the CERN GitLab interface for the repository 'DarkMatterLive'. The repository is public and has 0 stars and 0 forks. The main branch is 'main' with 2 branches and 0 tags. The repository has 46 commits and was last updated 5 hours ago. The repository description is 'No description, website, or topics provided.' The repository has a README, Apache License 2.0, and contributing guidelines. The repository is a static website project hosted at <https://darkmatter.web.cern.ch> that provides interactive, ...

Name	Last commit	Last update
.github/workflows	precompilation of preview for fully st...	1 month ago
data	fix previews	1 month ago
pages	update layout 2	5 hours ago
scripts	precompilation of preview for fully st...	1 month ago
CONTRIBUTING.md	add structure	2 months ago
LICENSE	Initial commit	3 months ago
README.md	add structure	2 months ago
health.html	Important updates for portal	2 months ago
index.html	Important updates for portal	2 months ago

Project information

- 46 Commits
- 2 Branches
- 0 Tags
- 27.3 MiB Project Storage

Project information

- README
- Apache License 2.0
- CONTRIBUTING
- + Add CHANGELOG
- + Enable Auto DevOps
- + Add Kubernetes cluster
- + Set up CI/CD
- + Configure Integrations

Created on

September 30, 2025

Transparent Contribution Workflow

- New data points enter the global-limit framework via **Pull Requests (PRs)** or **Merge Requests (MRs)**.
- Expert review happens in the open, with discussions **publicly documented**.
- Use GIT raise issue feature to track requests for new features, bug fixes or corrections

Open Tools and Automated Pipelines

- Interpretation scripts and global-exclusion-plot algorithms become part of the repo as CI/CD code.
- A **CI/CD pipeline** automates processing when new PRs/MRs update results (for e.g., coupling vs mass for a particular model), ensuring consistent and reproducible outputs.

Versioning and Citation

- Each **tagged version** of the project is archived on **Zenodo**, generating a **DOI** for long-term preservation and citation.
Contributors of the project will automatically become part of author list.

Track bugs, plan features, and organize your work with issues

Use issues (also known as tickets or stories on other platforms) to collaborate on ideas, solve problems, and plan your project.

[New item](#)[Import issues](#) ▾

Demo

<https://darkmatter.web.cern.ch>

Challenges:

- Huge model parameter space.
- Model classification is challenging
- How do we account for uncertainties in these exclusion plots
- We need to be very careful with what and how we are excluding a region.

Thank you