

DarkBit/CosmoBit

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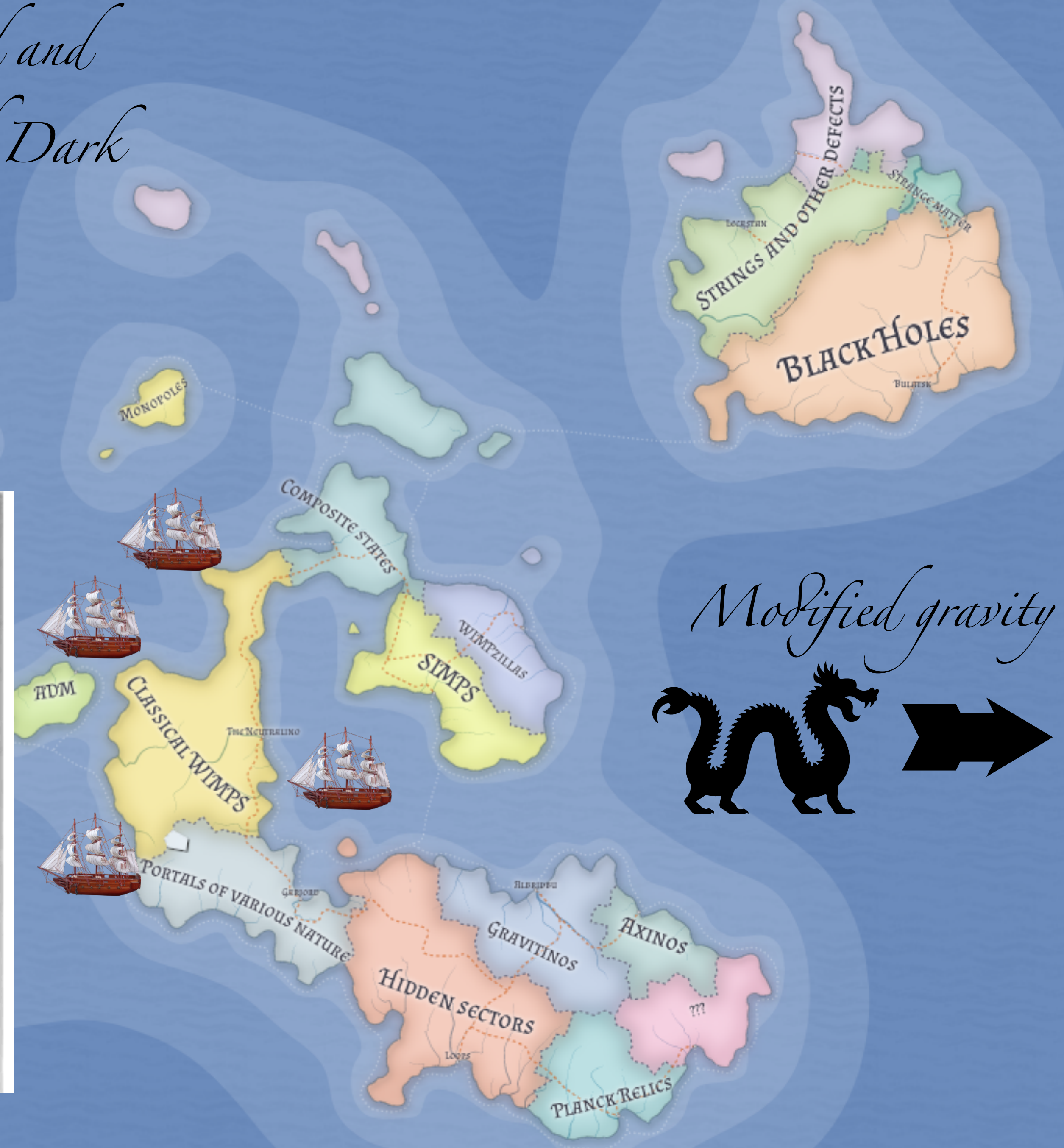
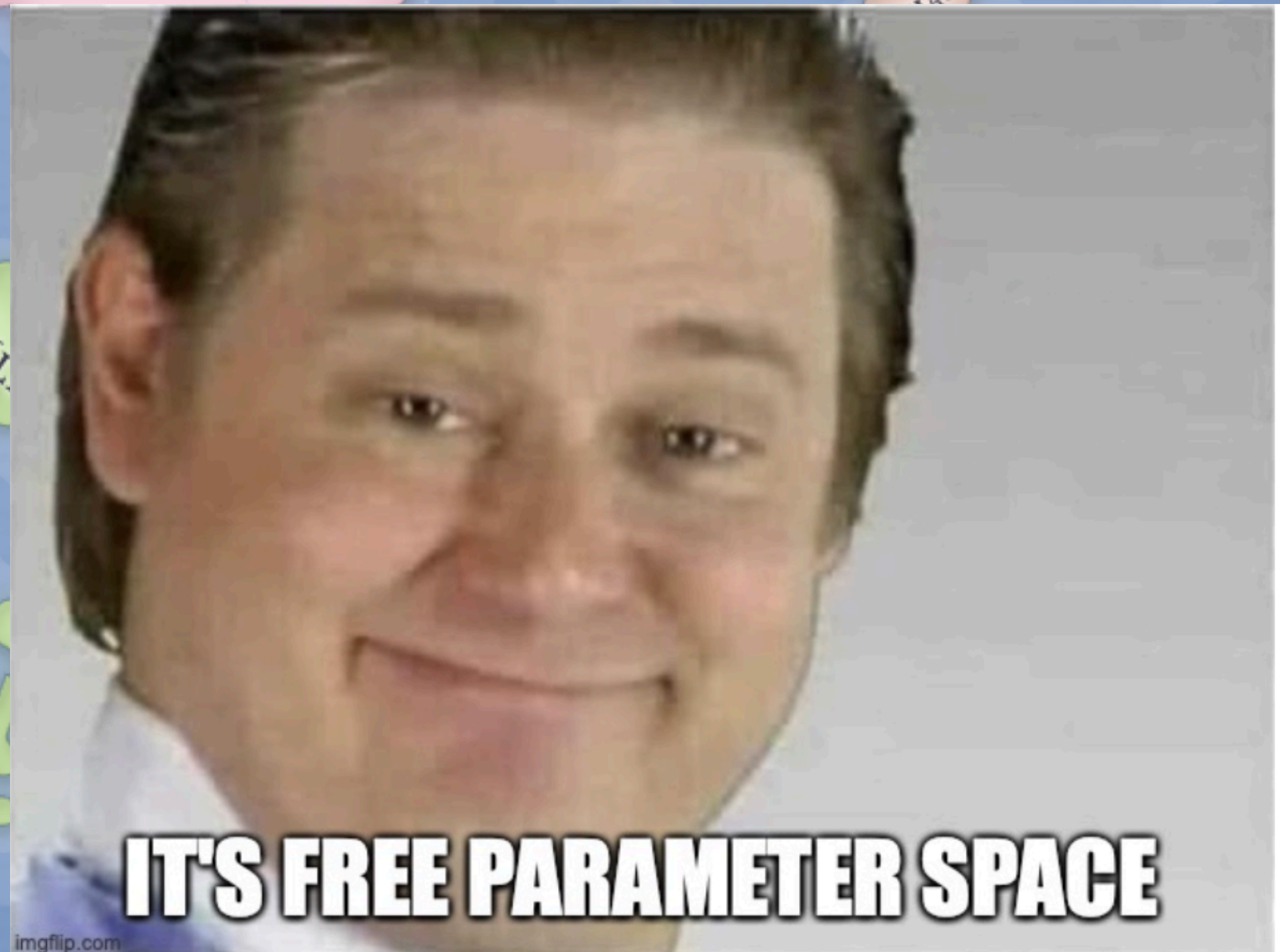
1. Ana Liang
2. Aaron Vincent
3. Adil Jueid
4. Alex Woodcock
5. Anders Kvellestad
6. Andrew Fowlie
7. Ankit Beniwal
8. Andre Scaffidi
9. Ben Farmer
10. Joachim Brod
11. Cullan Howlett
12. Christopher Weniger
13. Chris Chang
14. Jan Conrad
15. Csaba Balazs
16. David Marsh
17. Joachim Edsjö
18. Eliel Camargo
19. Fruzsina Agocs
20. Inigo Casares
21. Janina Renk
22. Jonathan Cornell
23. Julia Harz
24. Felix Kahlhoefer
25. Lukas Hergt
26. Michele Lucente
27. Nazila Mahmoudi
28. Markus Prim
29. Martin White
30. Masen Pitts
31. Pat Scott
32. Peter Athron
33. Sebastian Hoof
34. Sanjay Bloor
35. Selim Hotinli
36. Sowmiya Balan
37. Patrick Stoecker
38. Timon Emken
39. Tomas Gonzalo
40. Torsten Bringmann
41. Patrick Tunney
42. Will Handley

Conveners

Will Handley

Aaron Vincent

A Map of The Charted and Uncharted Territories of Dark Matter and its Theories



Recent work

Short author successes

Global fits of simplified models for dark matter with GAMBIT

I. Scalar and fermionic models with s -channel vector mediators

Christopher Chang^{1,a}, Pat Scott², Tomás E. Gonzalo^{3,4}, Felix Kahlhoefer^{3,4},
Anders Kvellestad⁶, Martin White⁵

Global fits of simplified models for dark matter with GAMBIT

II. Vector dark matter with an s -channel vector mediator

Christopher Chang^{1,a}, Pat Scott², Tomás E. Gonzalo³, Felix Kahlhoefer³, Martin White⁴

**Fast and accurate AMS-02 antiproton
likelihoods for global dark matter fits**

Sowmiya Balan,^{a,b,1} Felix Kahlhoefer,^{a,b} Michael Korsmeier,^c Silvia
Manconi^{a,d} and Kathrin Nippel^{a,1}

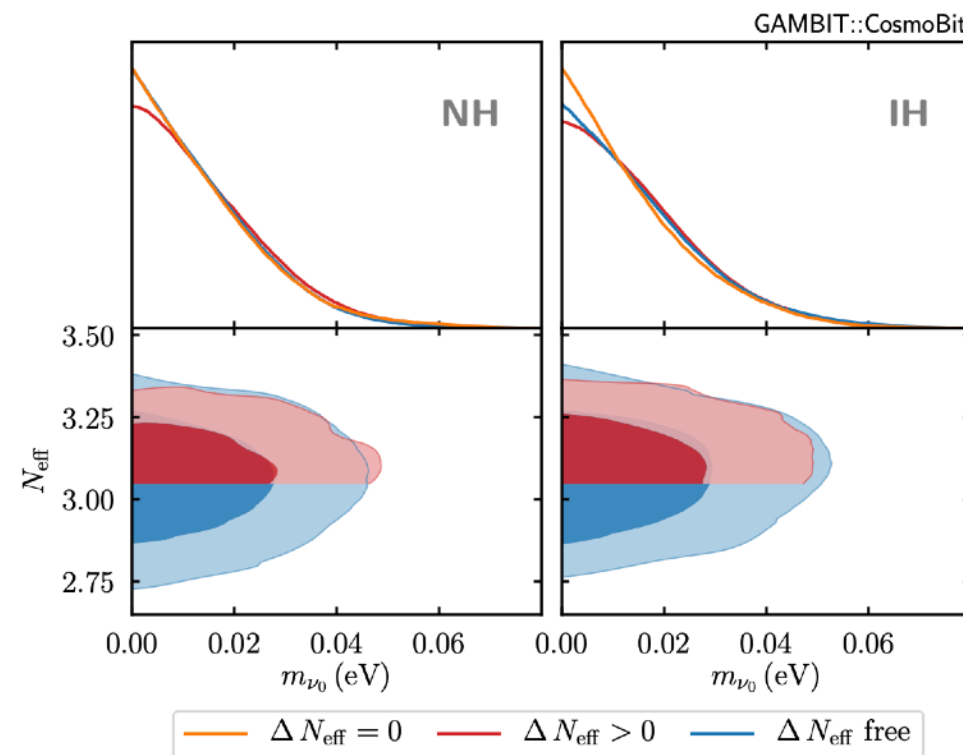
CosmoBit: A GAMBIT module for computing cosmological observables and likelihoods

The GAMBIT Cosmology Workgroup: Janina J. Renk,^{1,2,3} Patrick Stöcker,⁴ Sanjay Bloor,^{1,2} Selim Hotinli,¹ Csaba Balázs,⁵ Torsten Bringmann,⁶ Tomás E. Gonzalo,⁵ Will Handley,^{7,8,9} Sebastian Hoof,¹⁰ Cullan Howlett,² Felix Kahlhoefer,⁴ Pat Scott,^{1,2} Aaron C. Vincent^{11,12,13} and Martin White¹⁴

- Inflation
- Big bang nucleosynthesis
- CMB
- Large scale structure

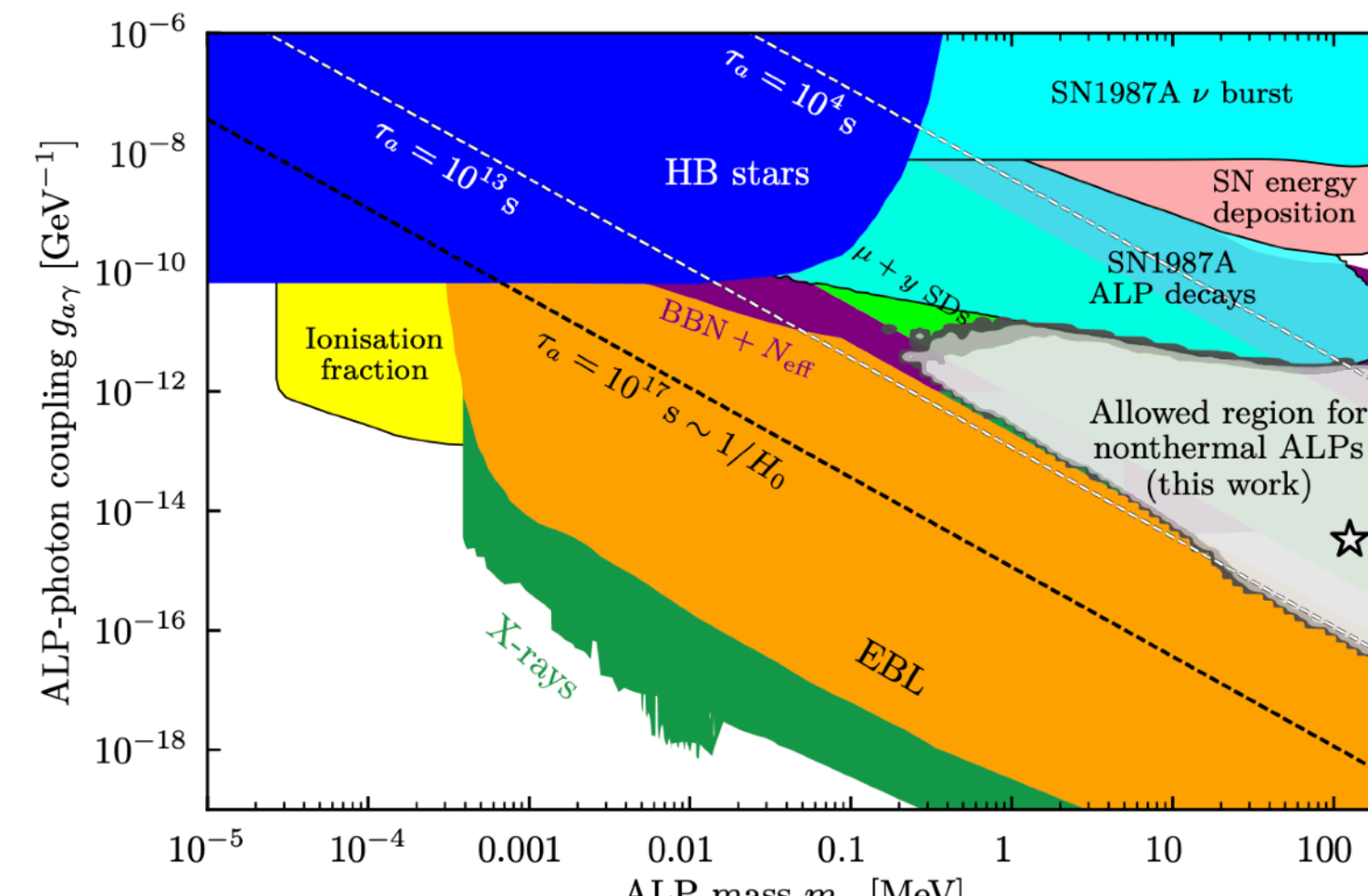
Strengthening the bound on the mass of the lightest neutrino with terrestrial and cosmological experiments

The GAMBIT Cosmology Workgroup: Patrick Stöcker,^{1,*} Csaba Balázs,² Sanjay Bloor,^{3,4} Torsten Bringmann,⁵ Tomás E. Gonzalo,² Will Handley,^{6,7,8} Selim Hotinli,⁴ Cullan Howlett,^{3,†} Felix Kahlhoefer,¹ Janina J. Renk,^{3,4,9,‡} Pat Scott,^{3,4,§} Aaron C. Vincent,^{10,11,12} and Martin White¹³



Cosmological constraints on decaying axion-like particles: a global analysis

Csaba Balázs,¹ Sanjay Bloor,² Tomás E. Gonzalo,^{3,4} Will Handley,^{5,6} Sebastian Hoof,^{4,7} Felix Kahlhoefer,^{3,4} Marie Lecroq,^{1,8} David J. E. Marsh,⁹ Janina J. Renk,^{2,10,11} Pat Scott^{2,11} and Patrick Stöcker^{3,12}



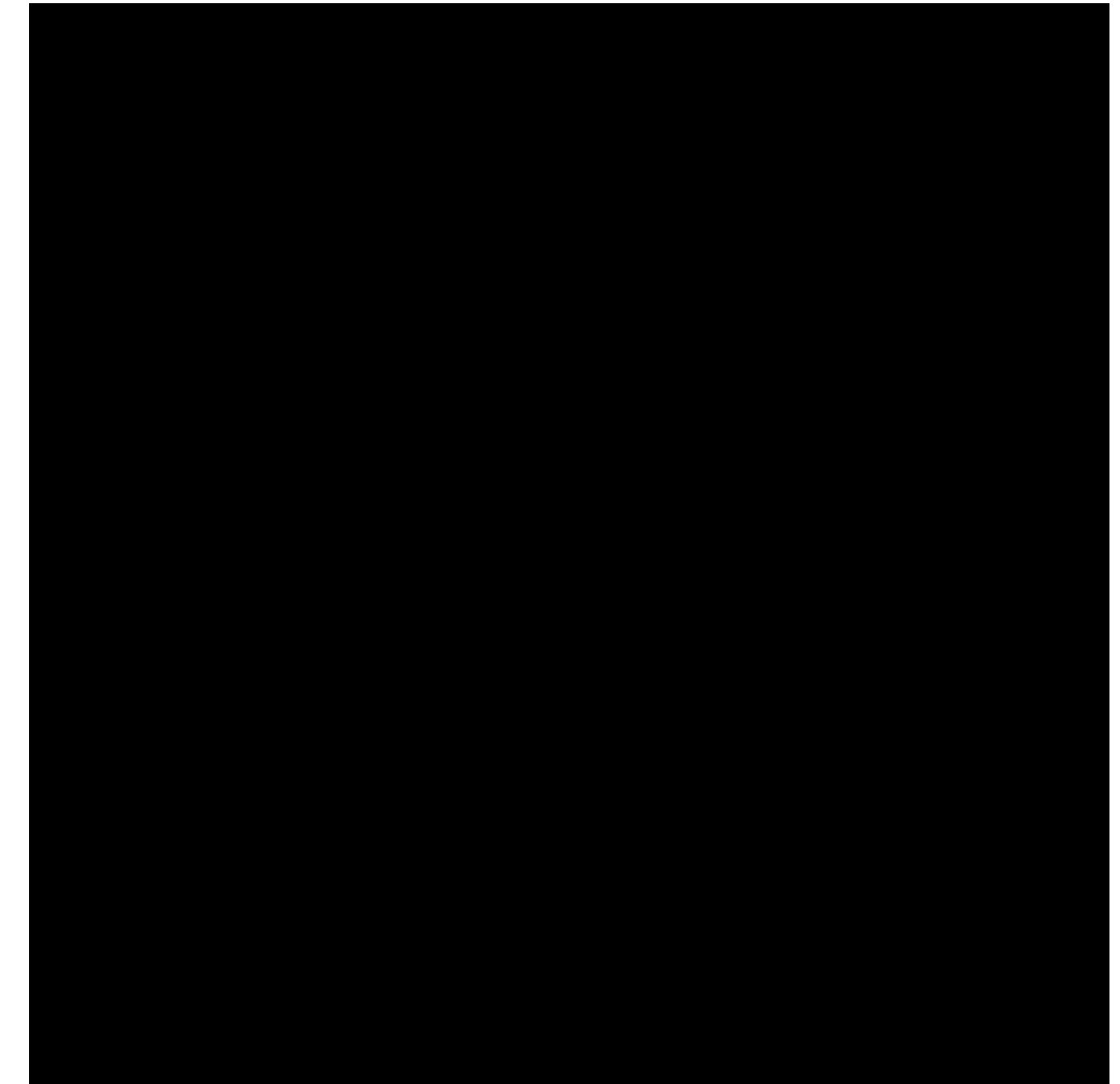
Current projects

Sub-GeV dark matter (shortish author)

Taylor update right after this

Annual modulation (shortish author)

- DAMA ...
- COSINE-100 and ANAIS have released data (they did not find dark matter)
- Currently being done with dimension 6 EFT operators:
 - Run scans with all coefficients turned on + nuisance parameters -- supposed to give a state-of-the-art work on annual modulation + event-based experiments;
 - Modulation experiments only, Mod + rate experiments



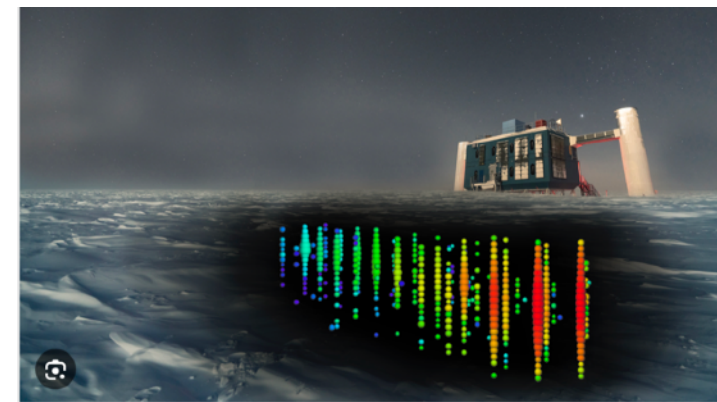
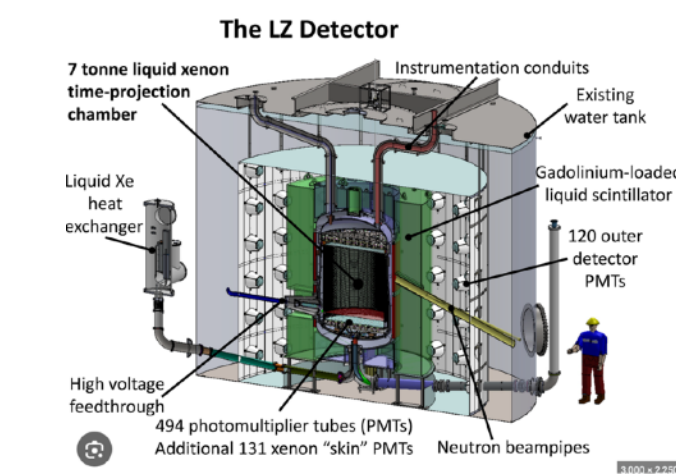
Annual modulation

- More work?
 - Likelihoods for ANAIS and COSINE are currently energy-binned results of their modulation fit. COSINE recently sent us time-stamped events. Do we update our likelihoods?
 - Isospin violation?

Non-relativistic effective operators (short author)

Neal, Aaron, Pat, ?

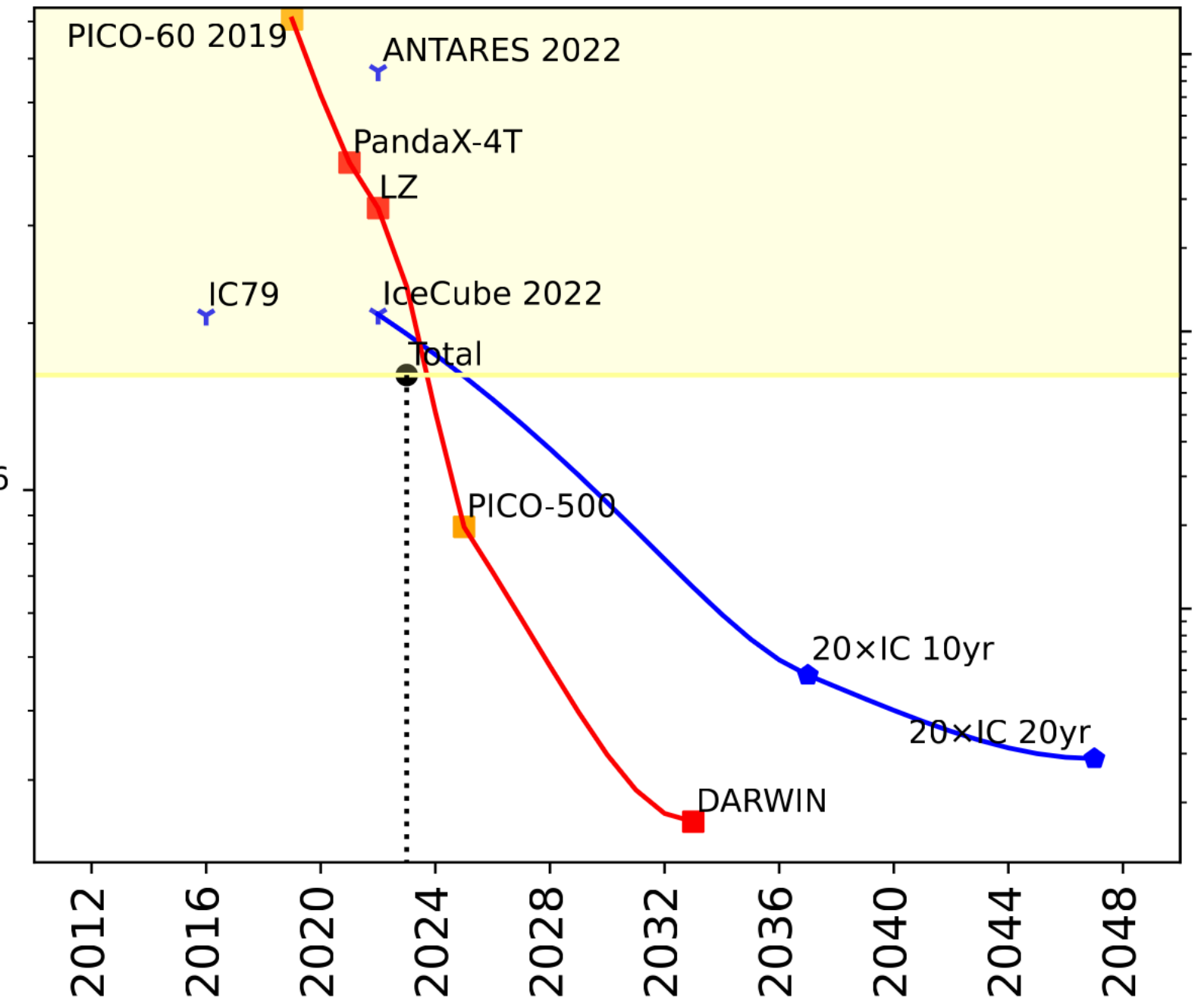
$$\begin{aligned}
 \hat{O}_1 &= \mathbb{1}_{\chi N} & \hat{O}_9 &= i\hat{\mathbf{S}}_\chi \cdot (\hat{\mathbf{S}}_N \times \frac{\hat{\mathbf{q}}}{m_N}) \\
 \hat{O}_3 &= i\hat{\mathbf{S}}_N \cdot (\frac{\hat{\mathbf{q}}}{m_N} \times \hat{\mathbf{v}}^\perp) & \hat{O}_{10} &= i\hat{\mathbf{S}}_N \cdot \frac{\hat{\mathbf{q}}}{m_N} \\
 \hat{O}_4 &= \hat{\mathbf{S}}_\chi \cdot \hat{\mathbf{S}}_N & \hat{O}_{11} &= i\hat{\mathbf{S}}_\chi \cdot \frac{\hat{\mathbf{q}}}{m_N} \\
 \hat{O}_5 &= i\hat{\mathbf{S}}_\chi \cdot (\frac{\hat{\mathbf{q}}}{m_N} \times \hat{\mathbf{v}}^\perp) & \hat{O}_{12} &= \hat{\mathbf{S}}_\chi \cdot (\hat{\mathbf{S}}_N \times \hat{\mathbf{v}}^\perp) \\
 \hat{O}_6 &= (\hat{\mathbf{S}}_\chi \cdot \frac{\hat{\mathbf{q}}}{m_N}) (\hat{\mathbf{S}}_N \cdot \frac{\hat{\mathbf{q}}}{m_N}) & \hat{O}_{13} &= i (\hat{\mathbf{S}}_\chi \cdot \hat{\mathbf{v}}^\perp) (\hat{\mathbf{S}}_N \cdot \frac{\hat{\mathbf{q}}}{m_N}) \\
 \hat{O}_7 &= \hat{\mathbf{S}}_N \cdot \hat{\mathbf{v}}^\perp & \hat{O}_{14} &= i (\hat{\mathbf{S}}_\chi \cdot \frac{\hat{\mathbf{q}}}{m_N}) (\hat{\mathbf{S}}_N \cdot \hat{\mathbf{v}}^\perp) \\
 \hat{O}_8 &= \hat{\mathbf{S}}_\chi \cdot \hat{\mathbf{v}}^\perp & \hat{O}_{15} &= - (\hat{\mathbf{S}}_\chi \cdot \frac{\hat{\mathbf{q}}}{m_N}) \left[(\hat{\mathbf{S}}_N \times \hat{\mathbf{v}}^\perp) \cdot \frac{\hat{\mathbf{q}}}{m_N} \right]
 \end{aligned}$$



+

$c_4^0 \neq 0$ to W^+W^- for $m_\chi = 500$ GeV

Coupling Strength [GeV⁻²]

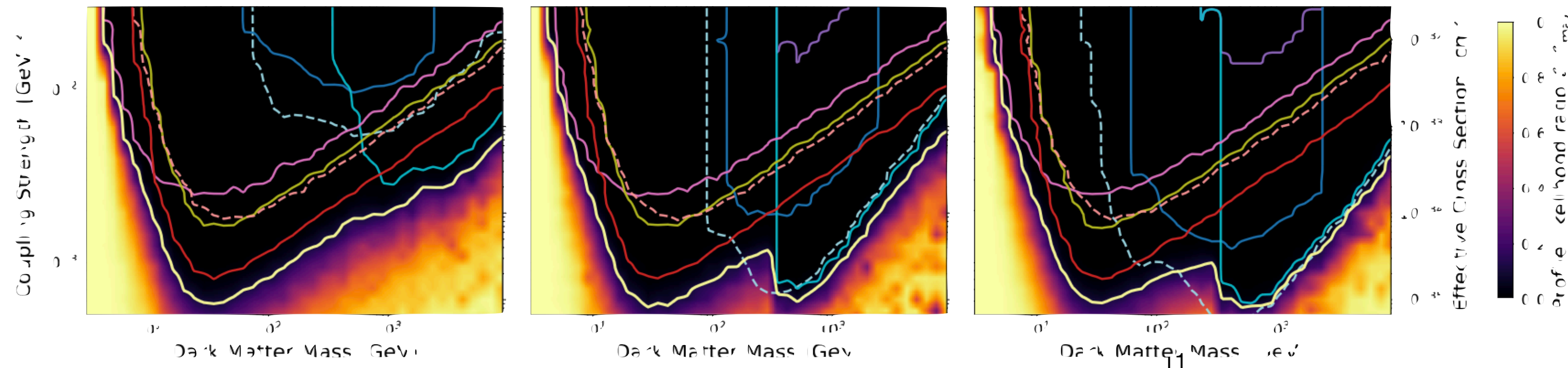


Effective Cross Section [cm²]

$c_4^0 \neq 0$ to $\mu\mu$

$c_4^0 \neq 0$ to W^+W^-

$c_4^0 \neq 0$ to $\tau^+\tau^-$



The bright future


Dark matter

CDM	Still great!
WIMPs	Still great!
Sterile neutrinos	Maybe?
Ultralight DM	In danger?
Primordial black	Maybe?
...?	??

Cosmology

Inflation	Still great!
Baryogenesis	Still untestable!
Hubble tension	Still annoying!
Dark Energy	Still boring!
Phase transitions	Still fun!
...?	??

We need more flagship projects

- Asymmetric DM (subsumed in SubGeV?)
- Indirect detection
- Early universe stuff?
- Low energy/mass searches
- NanoGrav 
- Gravitational portal dark matter
- Cosmic neutrinos?
- ?



Bye