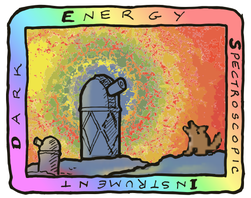

DARK ENERGY
SPECTROSCOPIC
INSTRUMENT

U.S. Department of Energy Office of Science

cea irfu

Weighing neutrinos with DESI

A frequentist approach to cosmological inference of neutrino mass

Domitille Chebat — PHENIICS Fest — 08/06/2026

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Cosmology & DESI 101

An extremely fast primer on cosmology

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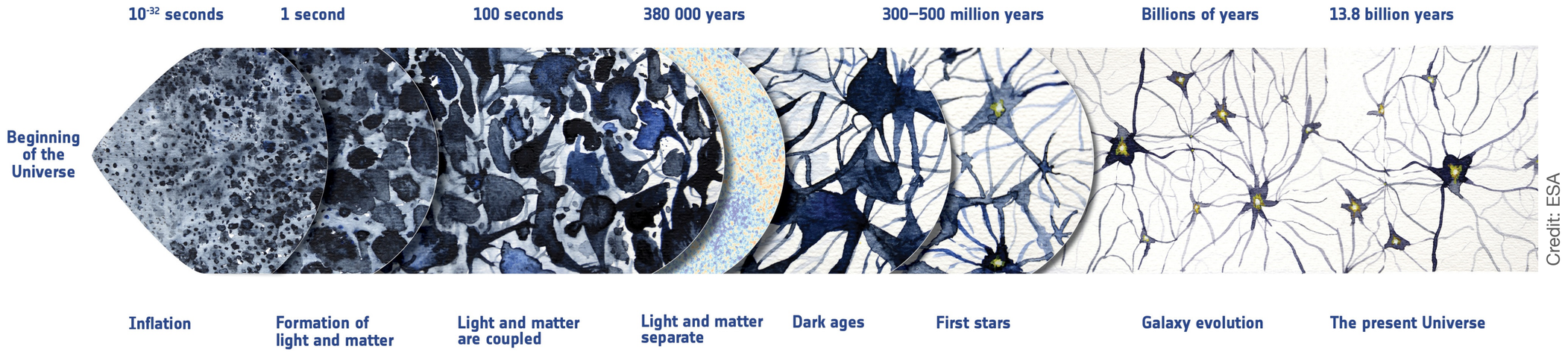

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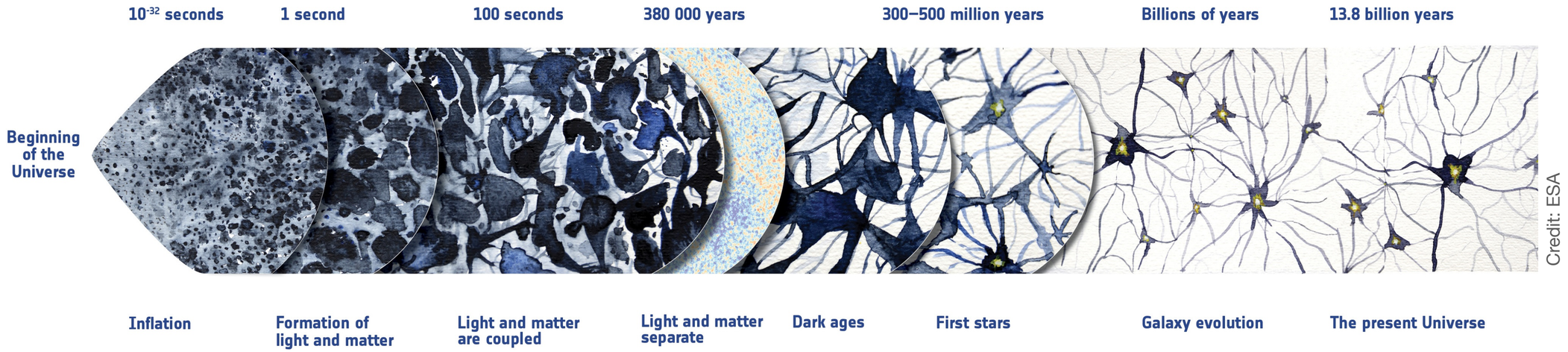

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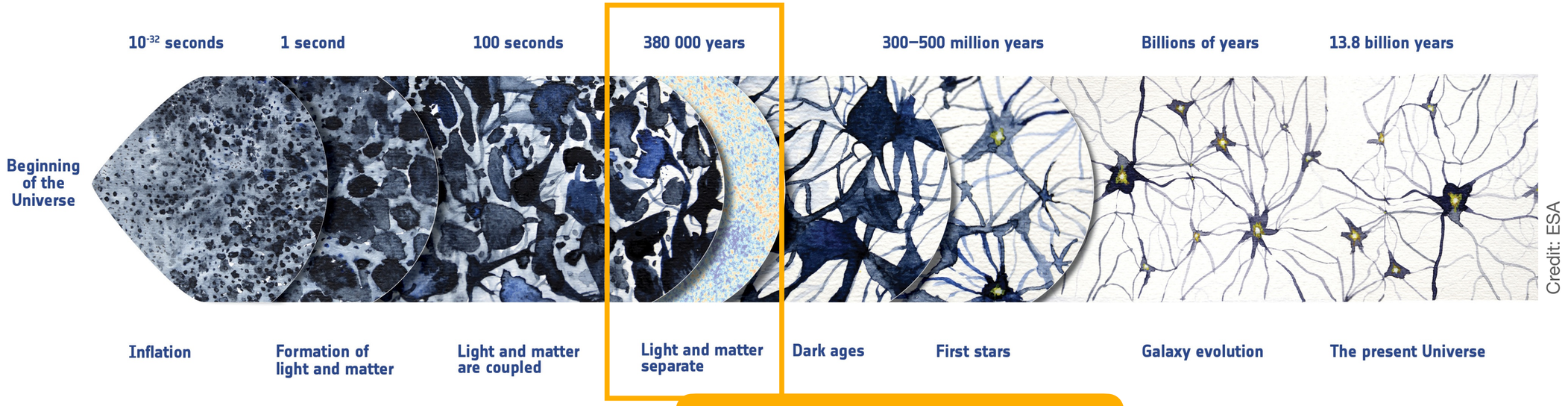

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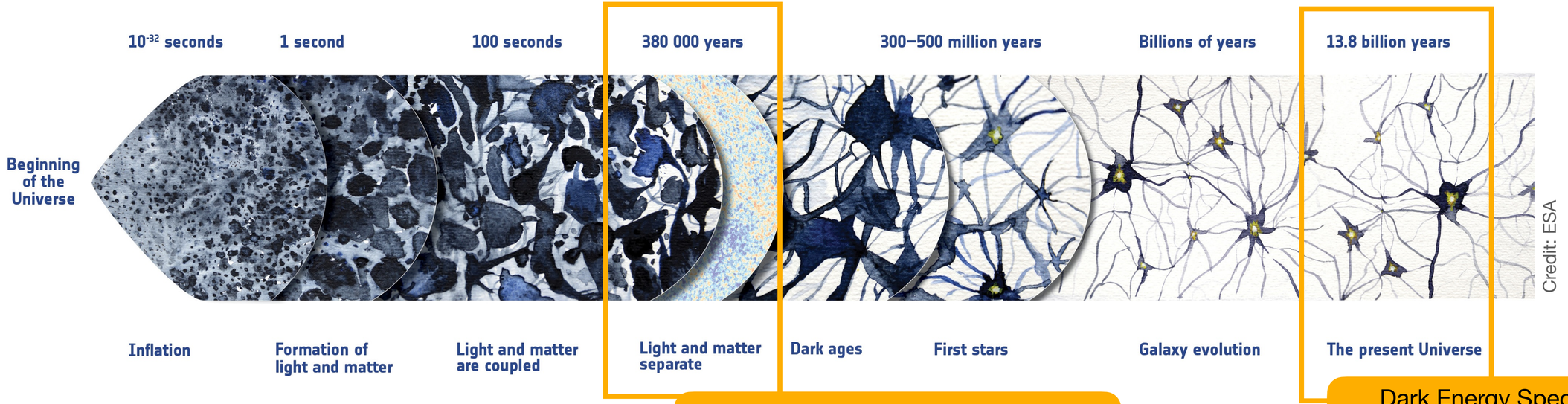

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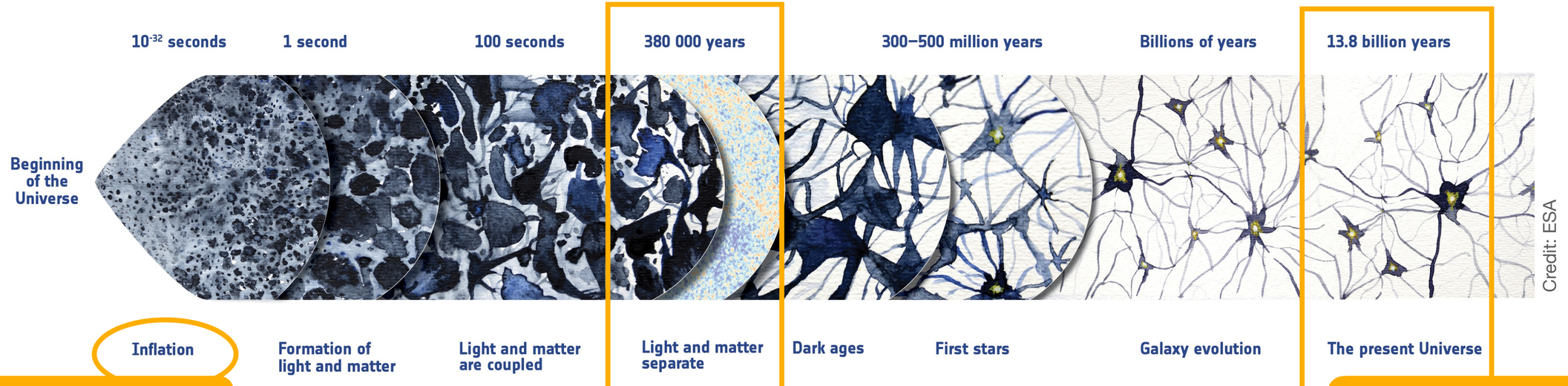

Other cool thing I'm working on and you can ask me about

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DESI: Objectively the coolest telescope around

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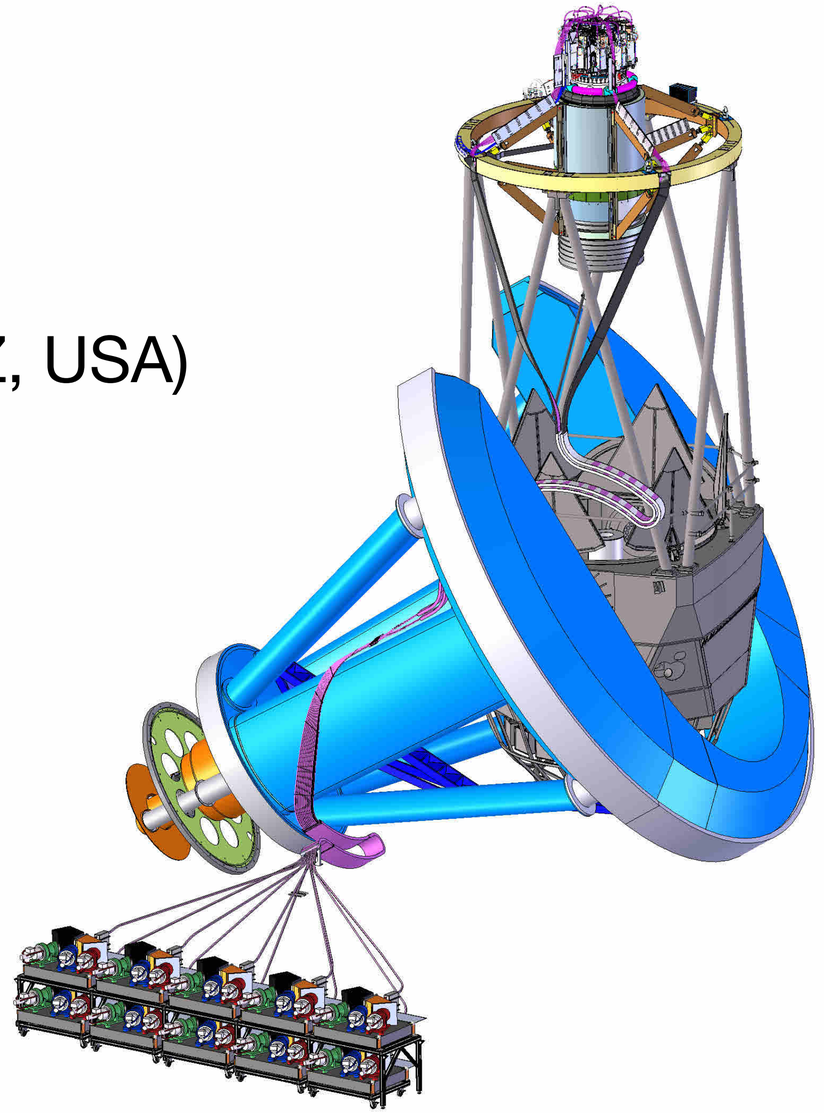

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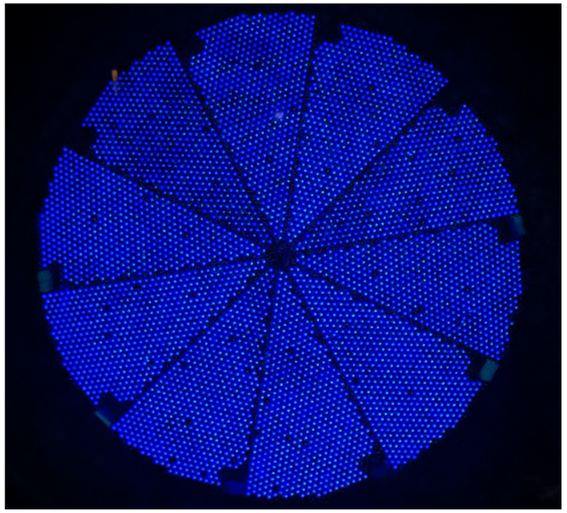

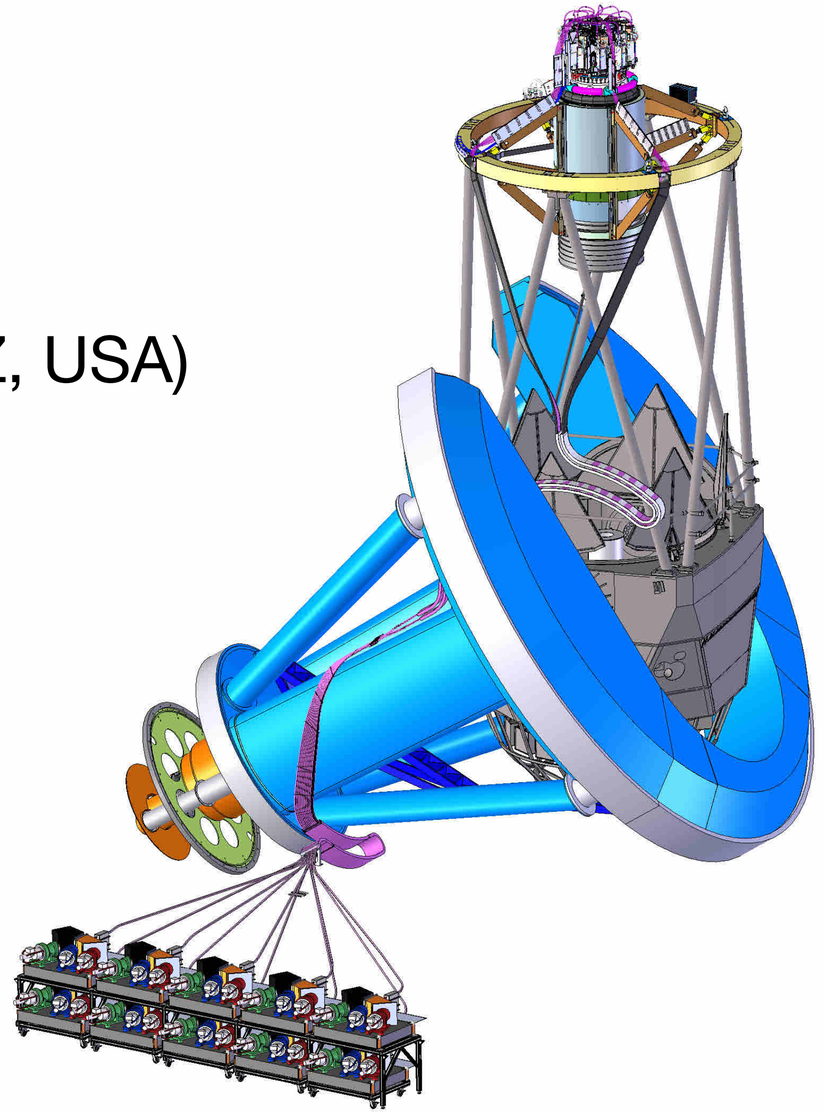

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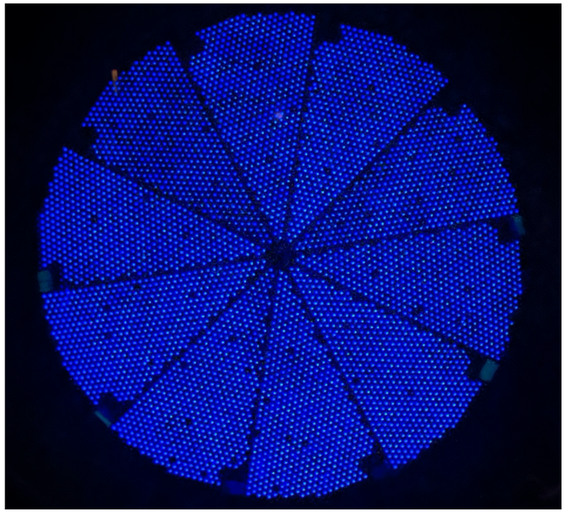
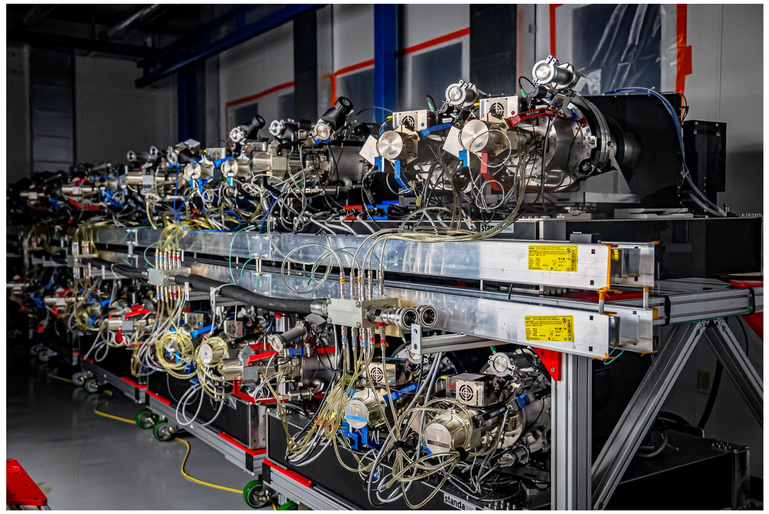
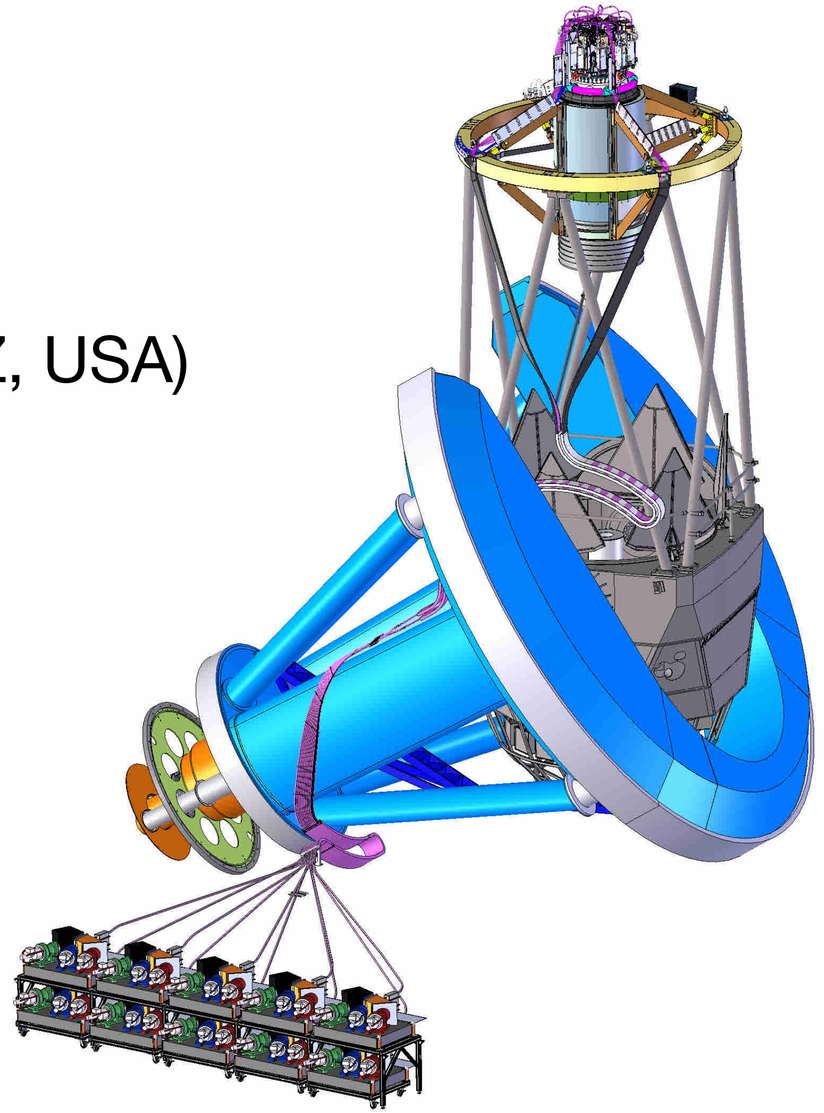




DESI Collaboration/DOE/KPNO/NOIRLab/NSF/ AURA/M. Sargent



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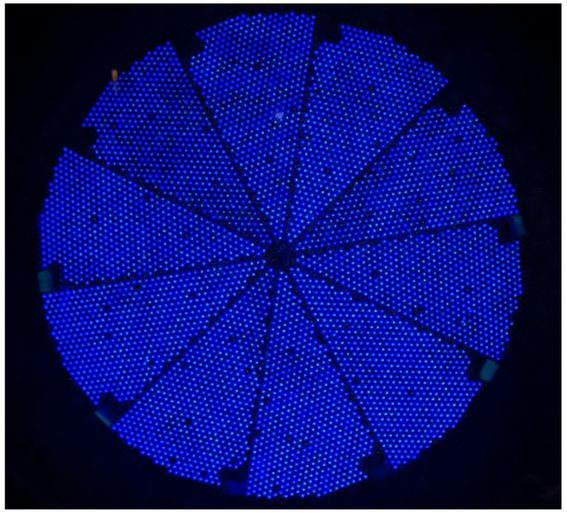

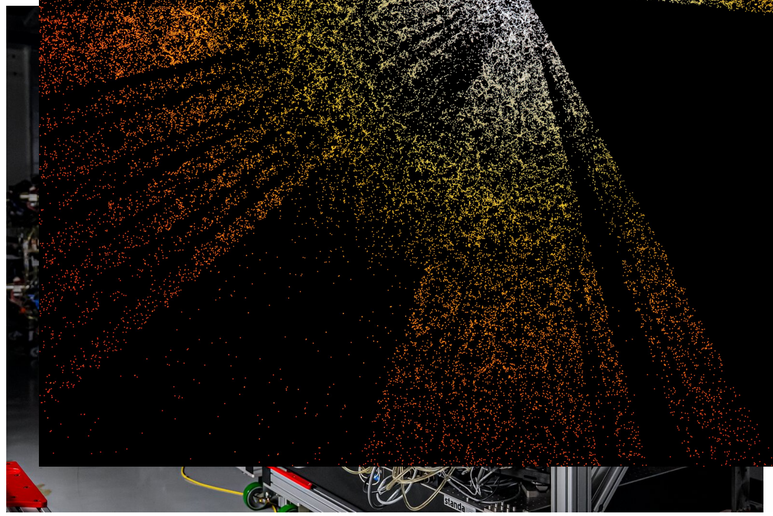

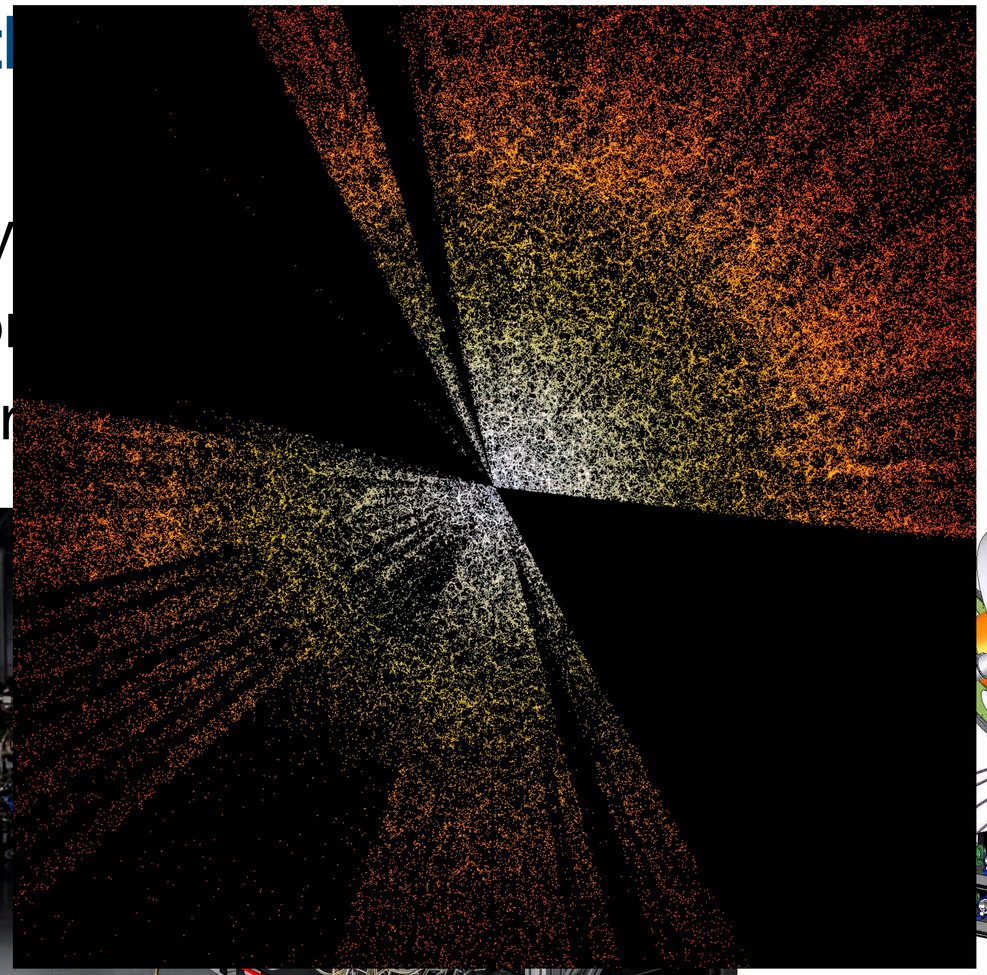

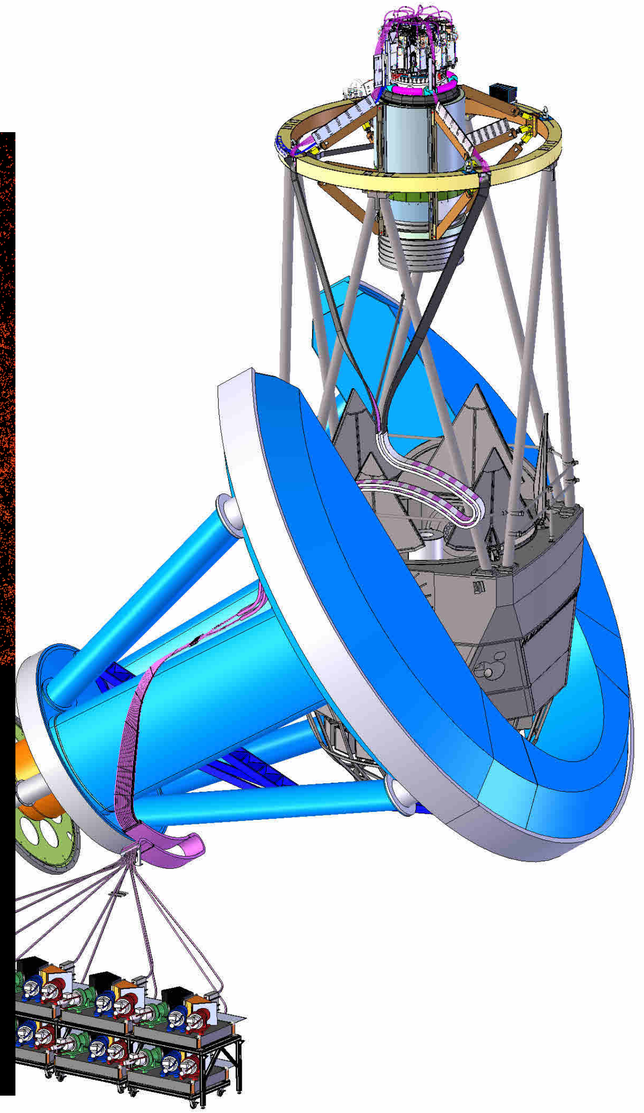

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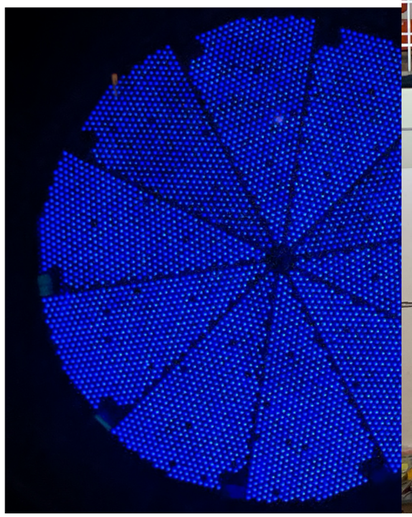

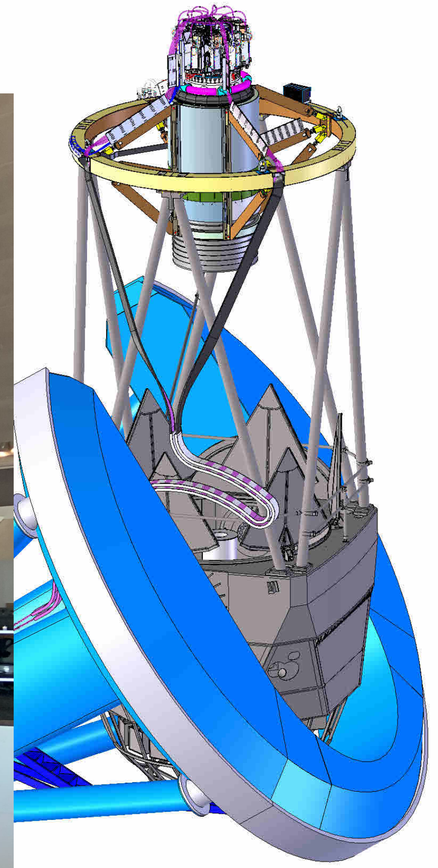

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ℹ️ Non-relativistic transition happened between the CMB and now

ℹ️ Minima available from oscillations experiments:

- $\sum m_\nu \geq$ 60meV (normal ordering) or $\sum m_\nu \geq$ 100meV (inverted ordering)

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The geometrical effect

- Matter / radiation contribute to expansion of the Universe differently
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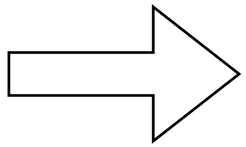

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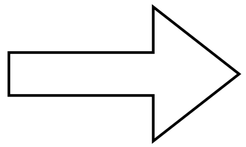

Adjust neutrino mass in expansion model to make them match

- *Indirect*, inherently *model-dependent* measurement

Weighing neutrinos in cosmology

The free-streaming effect

Weighing neutrinos in cosmology

The free-streaming effect

- Non-relativistic neutrinos are affected by gravitational pull
- Contribute to formation of large structures in Universe
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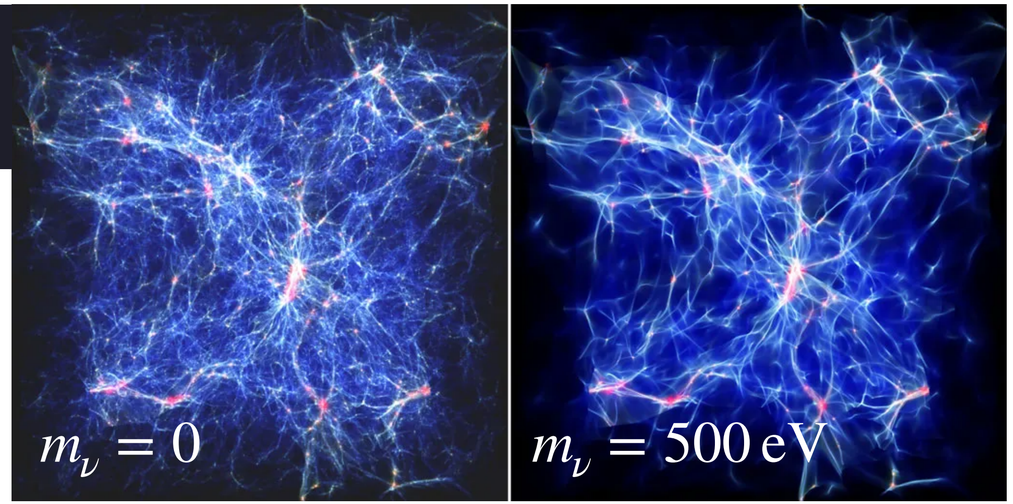

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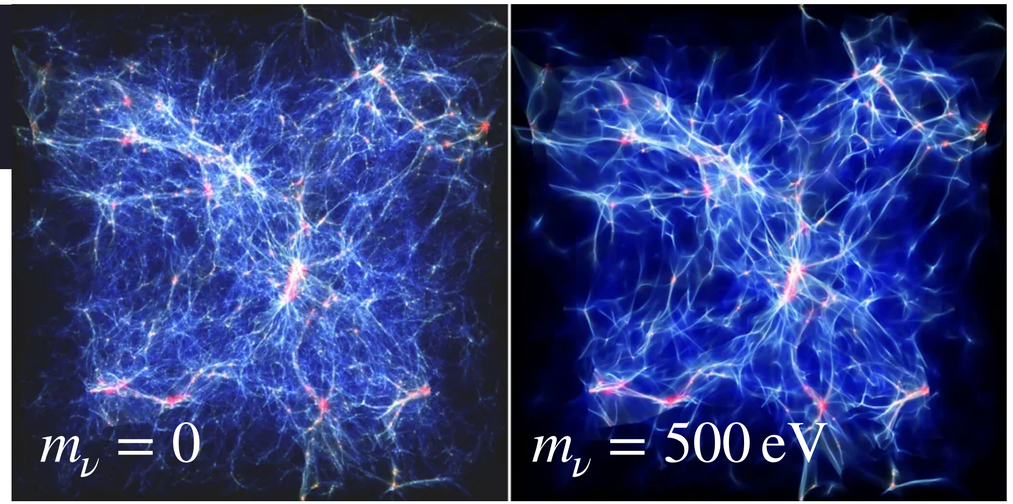
- Can also get from DESI / CMB / DESI+CMB
- *Indirect*, less model-dependent, *weaker*



Current measurements in cosmology

Or “why am I doing things the frequentist way”

- Latest constraints from DESI DR2 + Planck:

$$\Sigma m_\nu \leq 64\,\mathrm{meV}$$ (95% C.L.)

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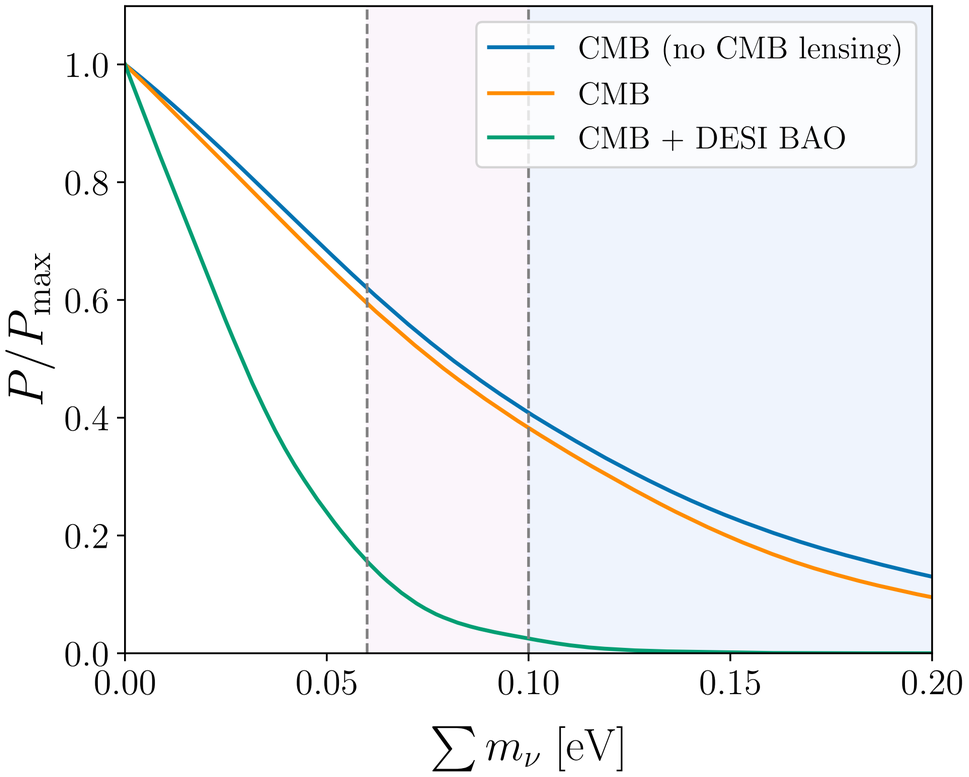

DESI 2024 VI, fig 11: marginalized 1D posterior constraints on Σm_ν

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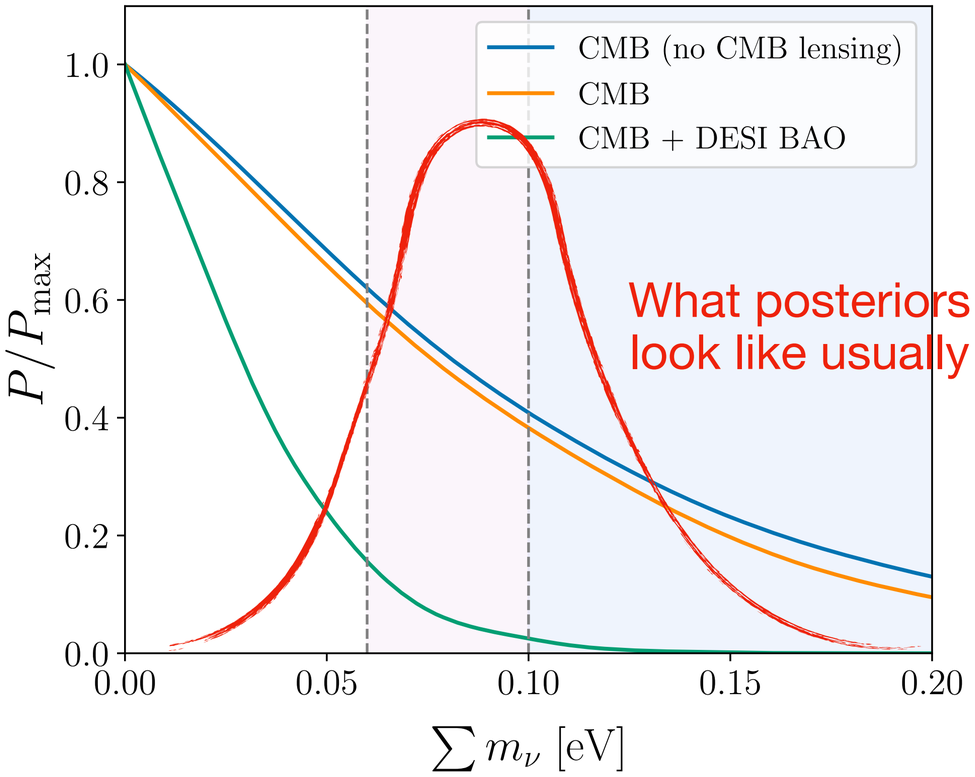

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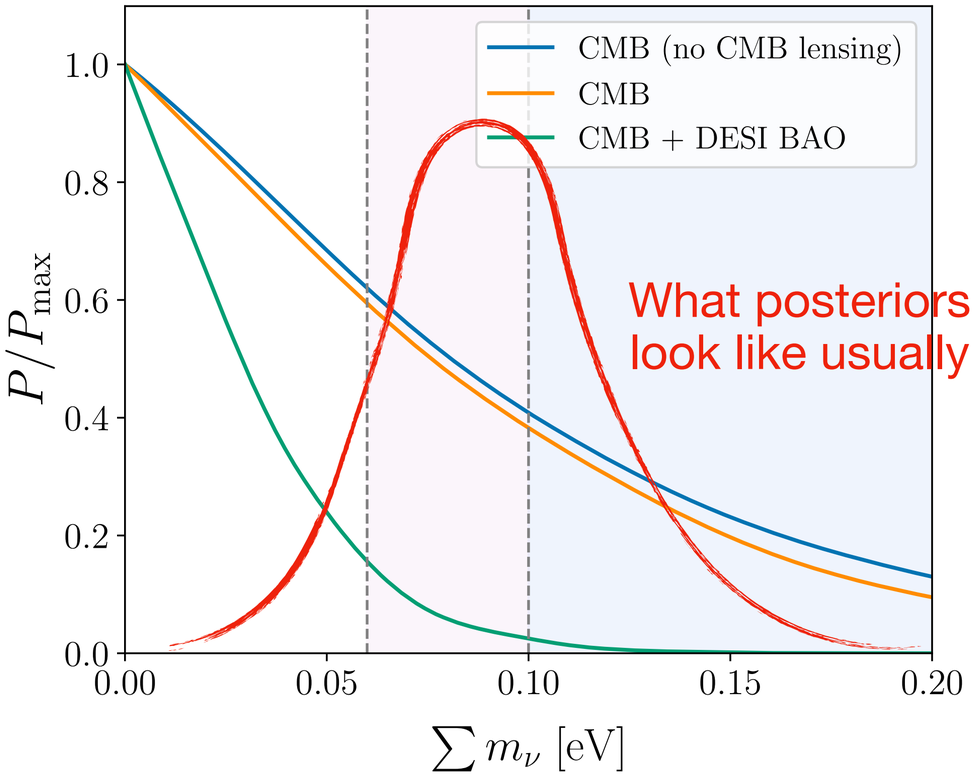
- Concerned by prior projection/volume effects
- Let’s try something else: **profile likelihoods**



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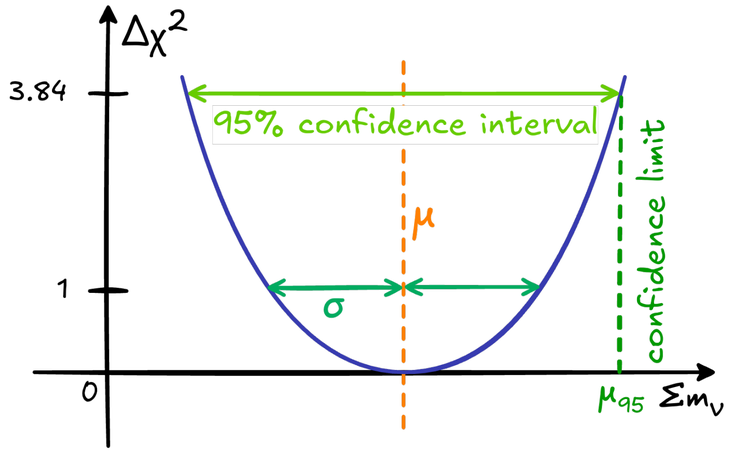

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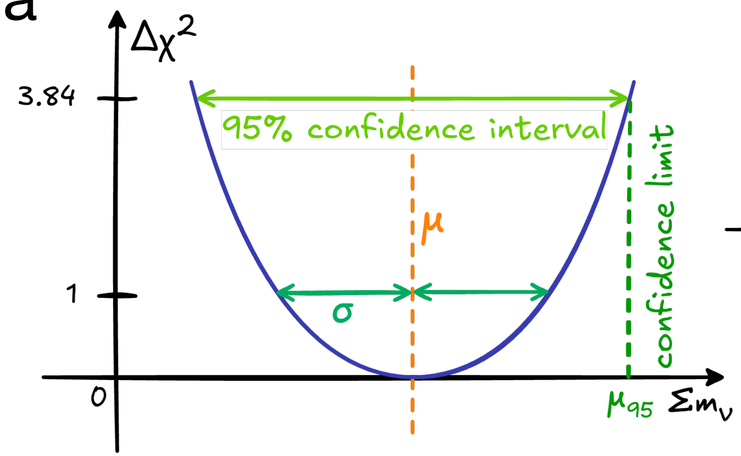

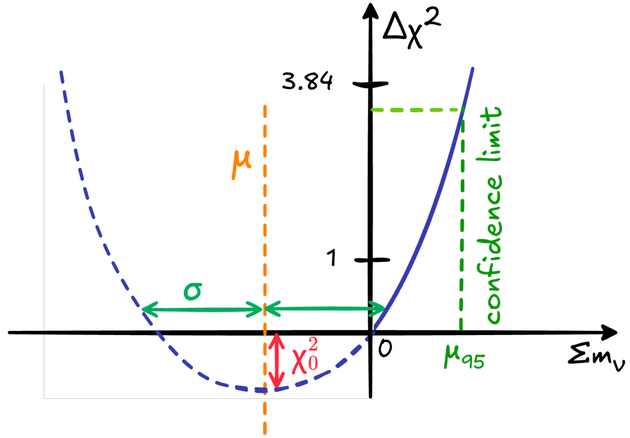

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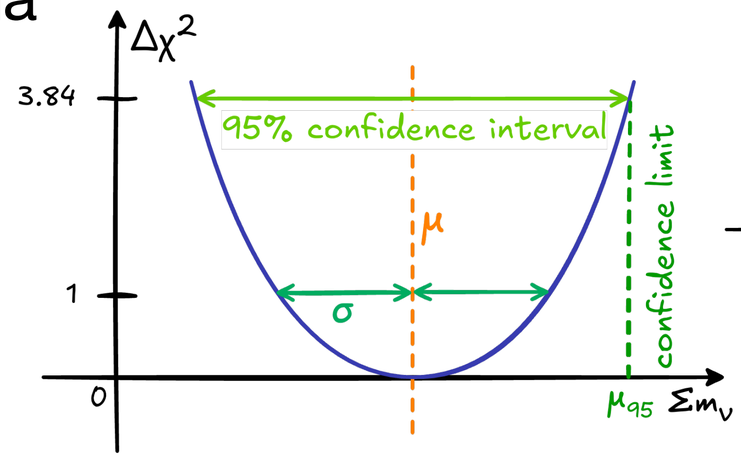

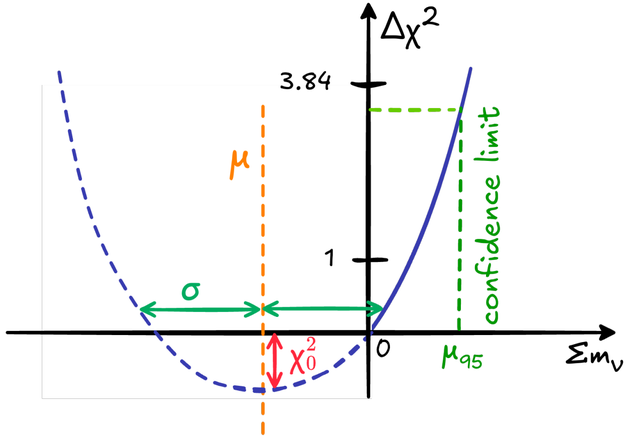

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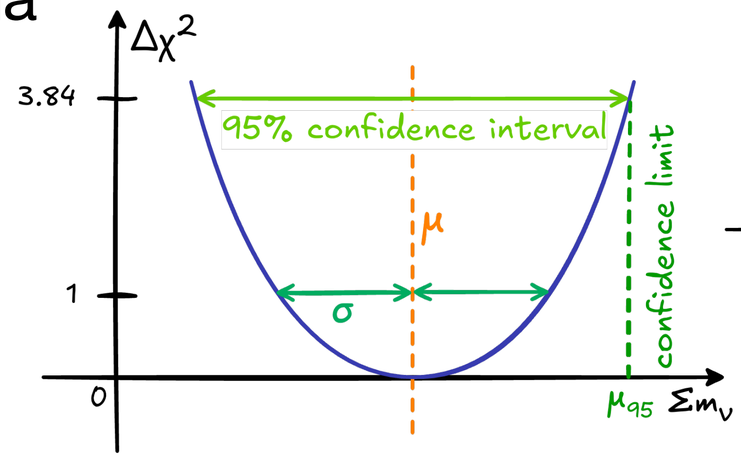

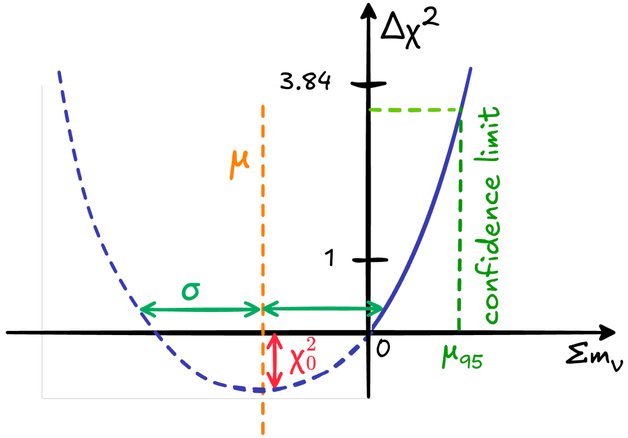

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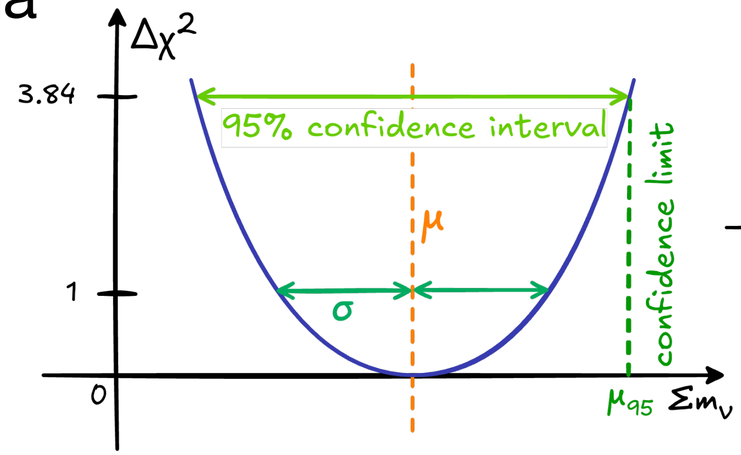
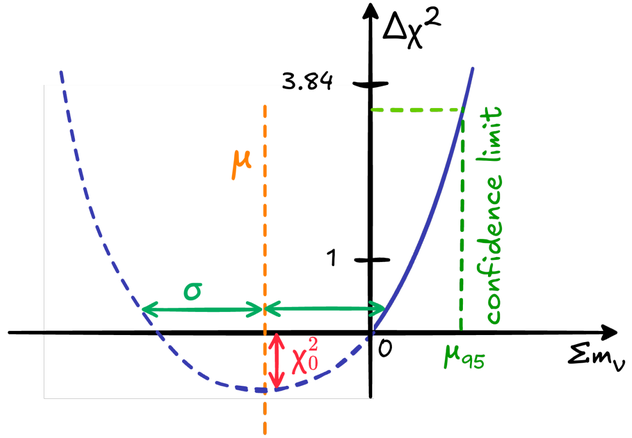
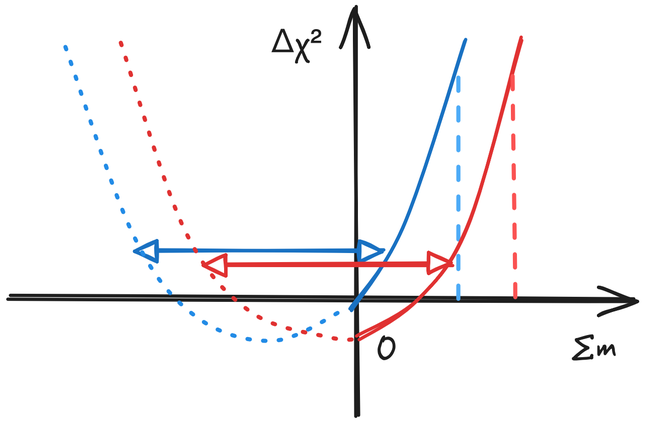
- Intuitive visual comparison

Planck 2013 XVI, *Naredo-Tuedo+ 2024*, *Herold+ 2025*







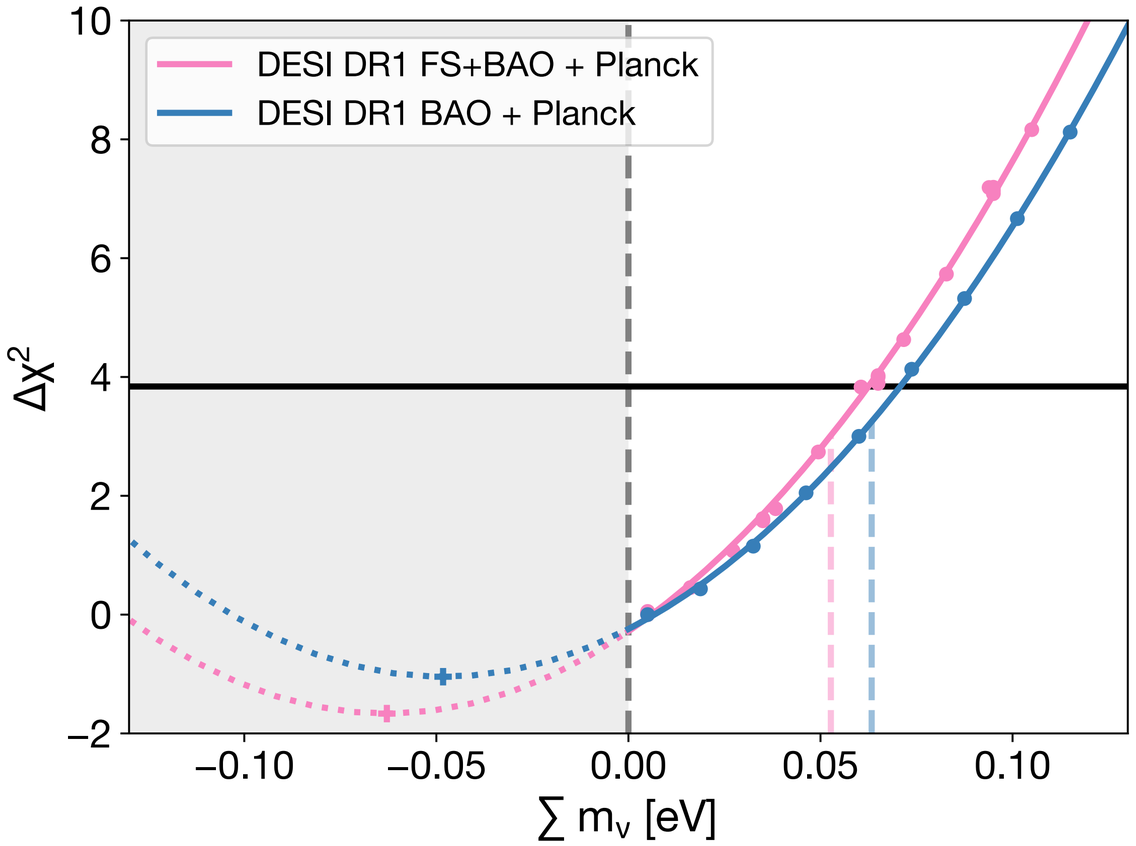
Some pretty cool* results

(*) The opinions expressed in this presentation are solely those of the author and do not reflect the views of any sane individual, organization, or sentient being. Side effects may include uncontrollable laughter, mild confusion, or an sudden urge to question life choices. Not responsible for lost productivity, existential crises, or spontaneous dance breaks. By reading this, you agree to release the author from all liability, including but not limited to boredom, enlightenment, or the sudden realization that this disclaimer is longer than the actual content.

Results I: free-streaming from DESI

Lower limits are not always more constraining

- Add free-streaming measurement from DESI to geometrical effect one



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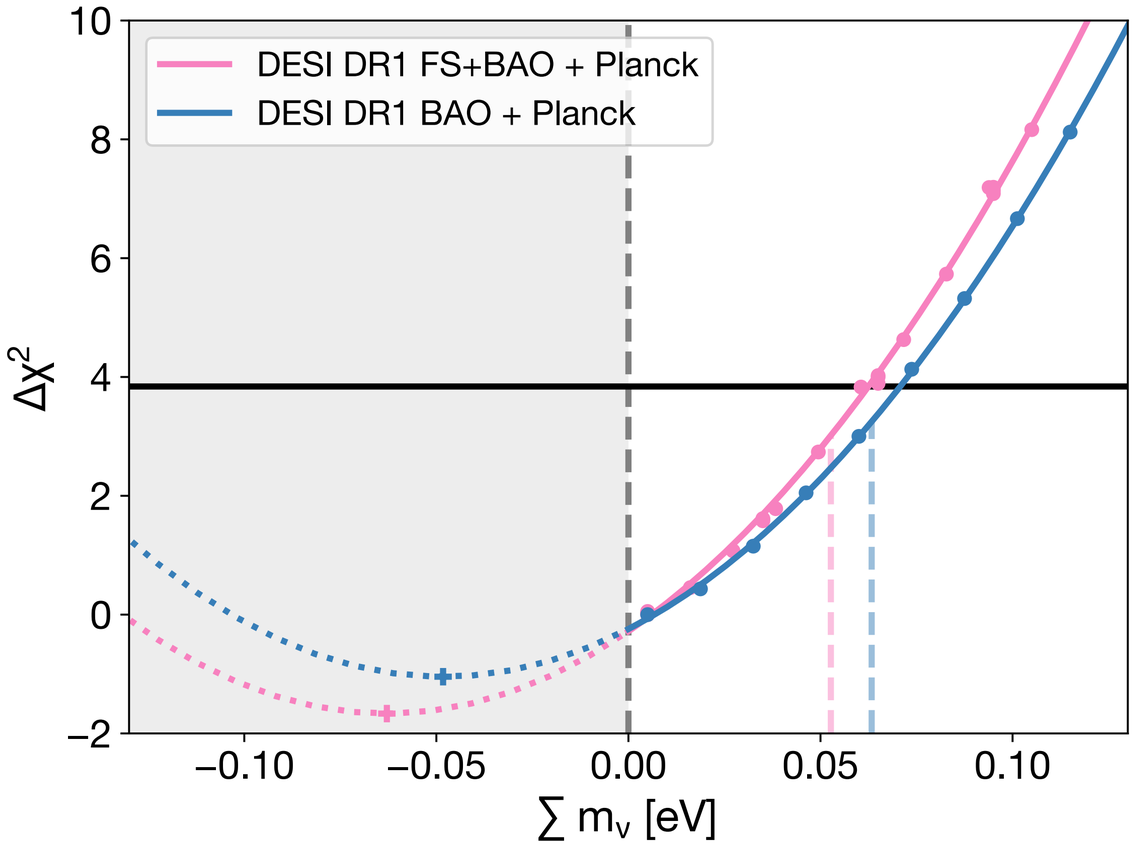

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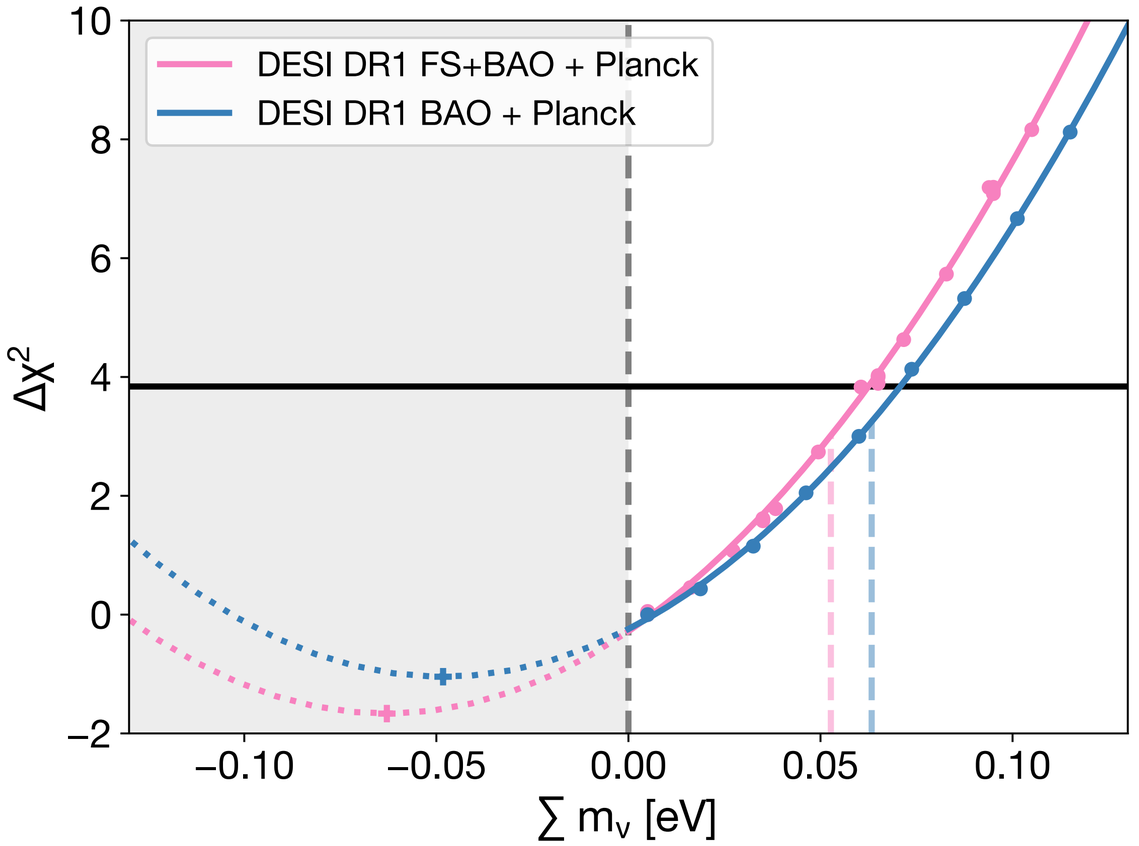

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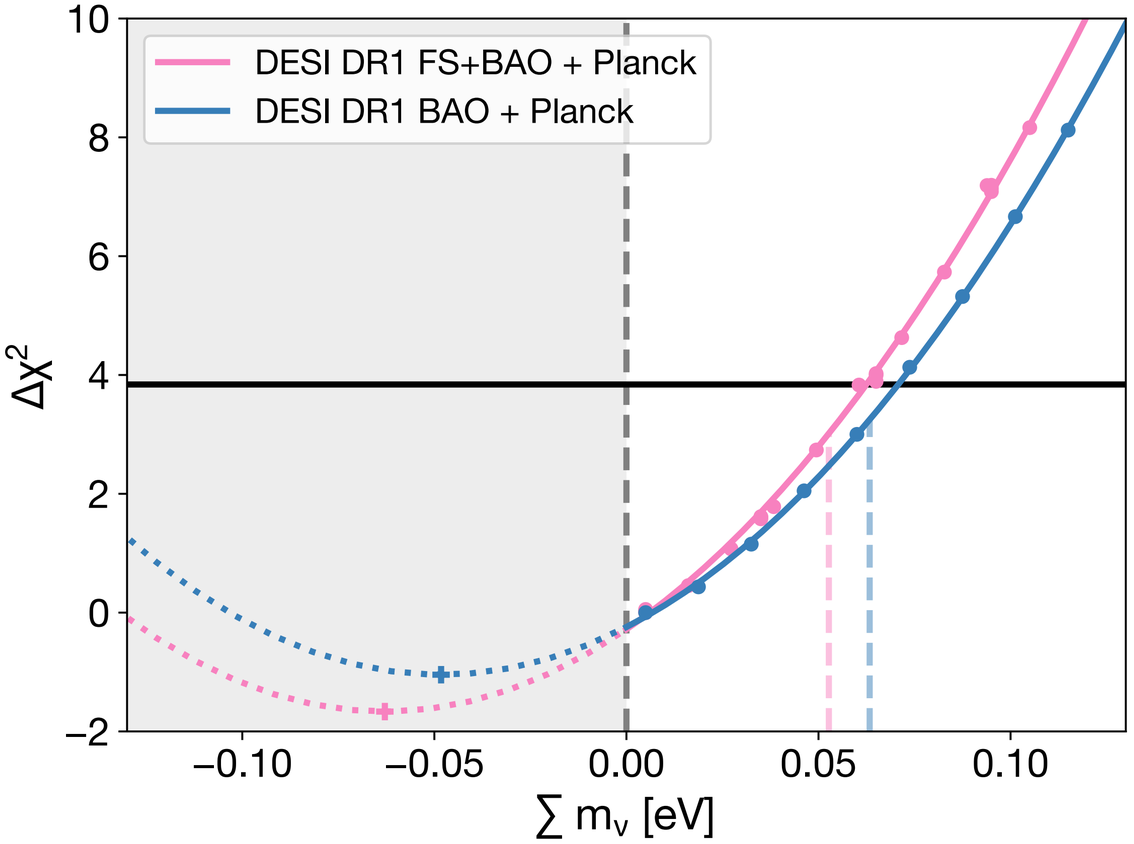

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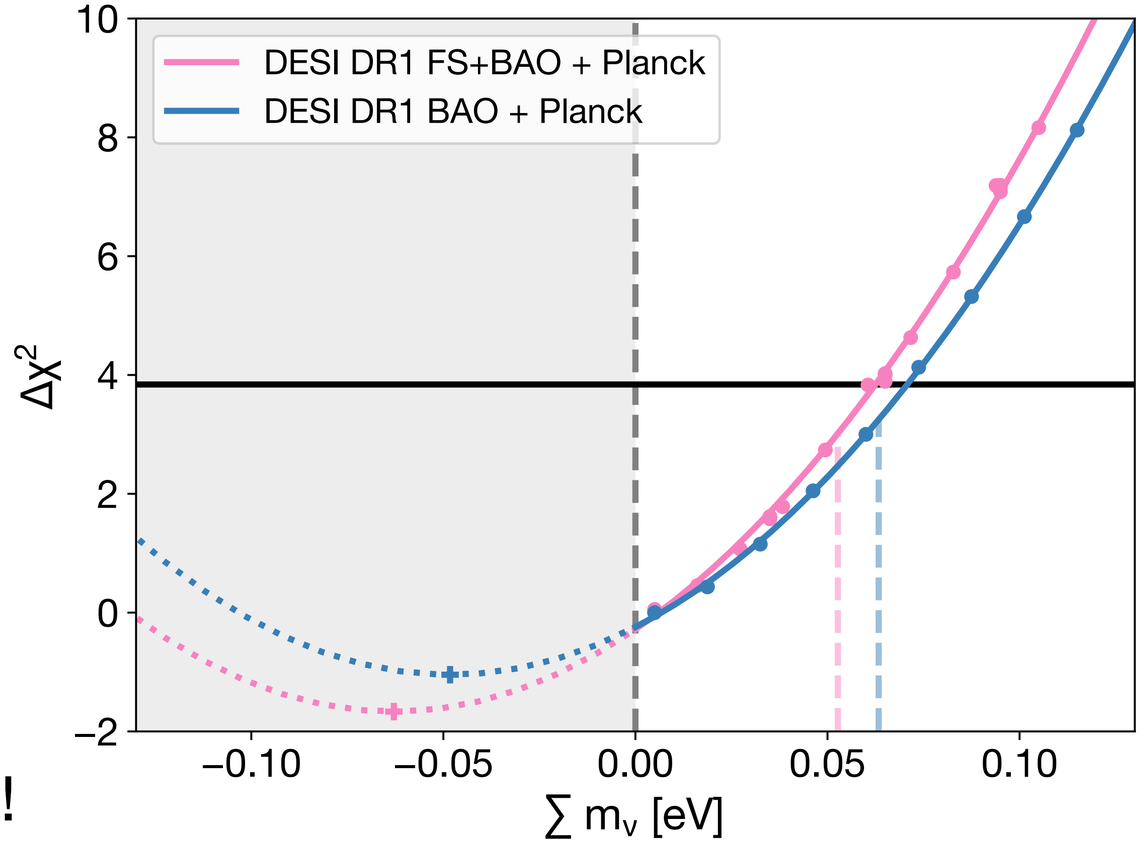
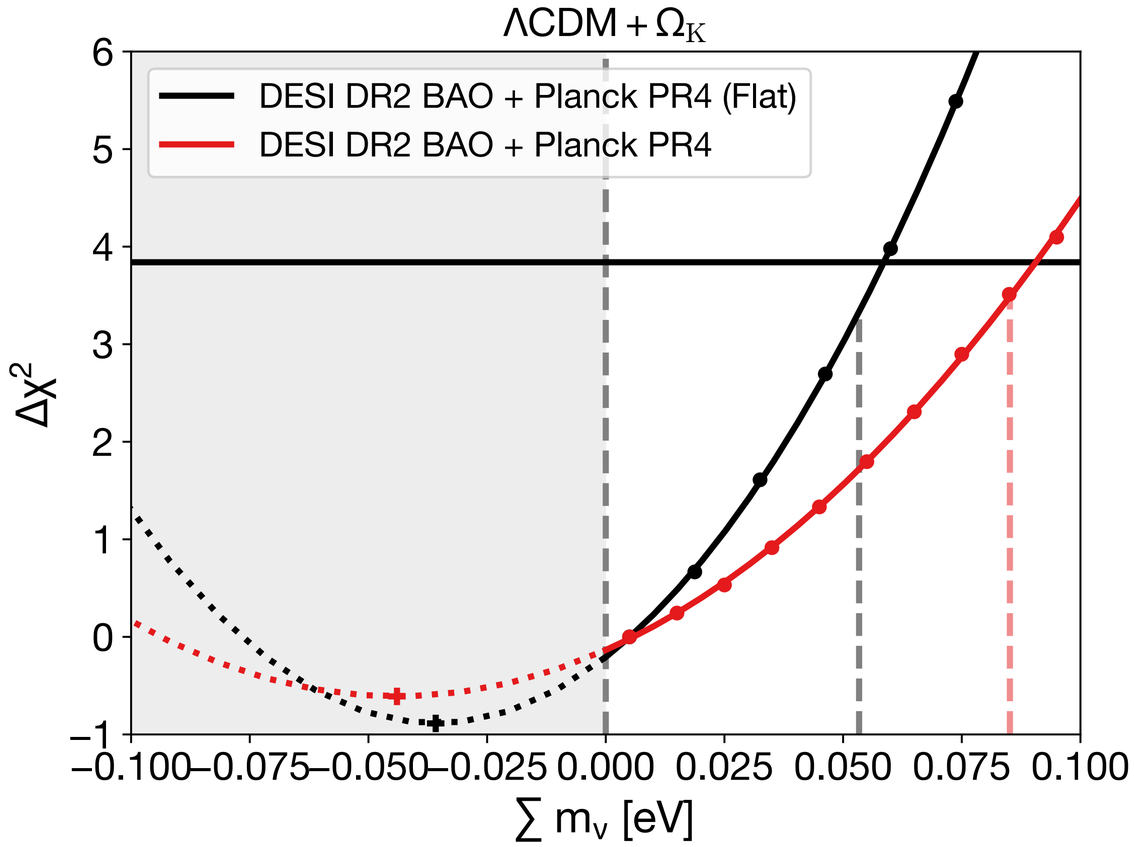
FS+BAO + Planck	53	-63	53

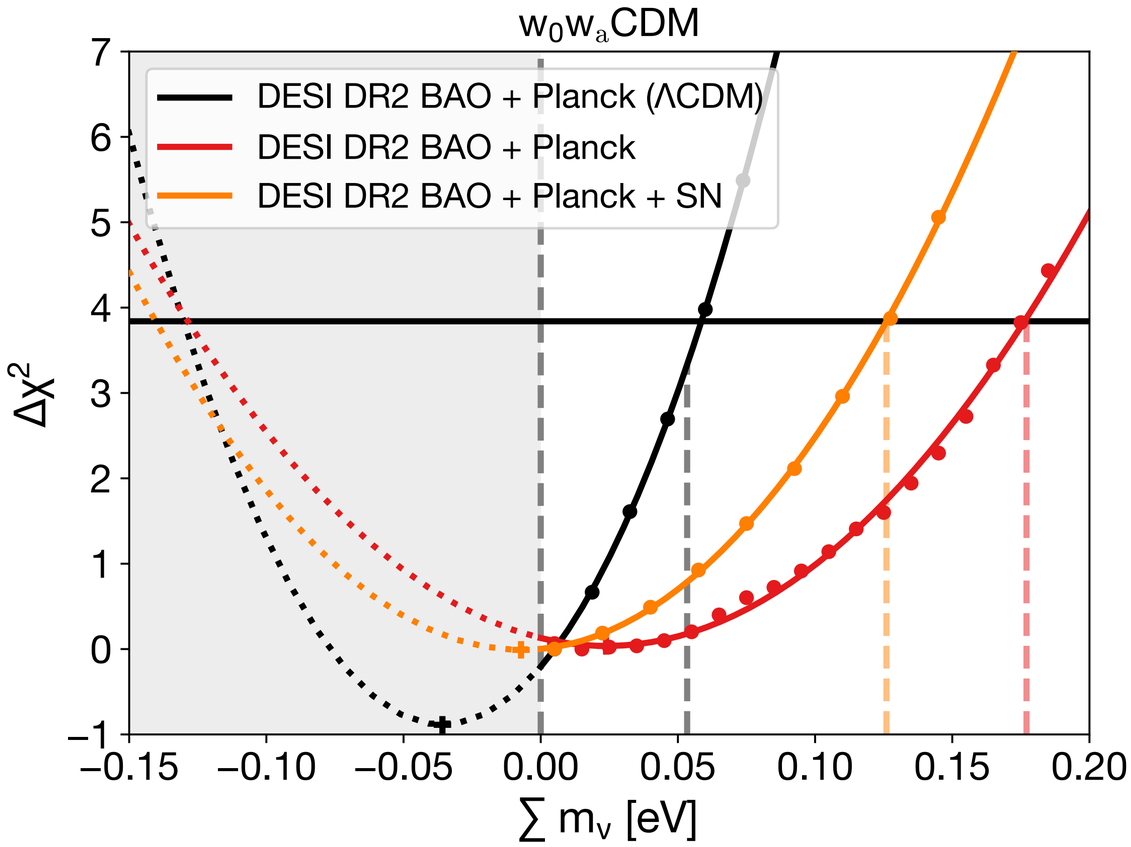
- DESI free-streaming not competitive yet!



Results II: is ΛCDM the issue ?

Solving neutrino mass “tension” with ΛCDM extensions





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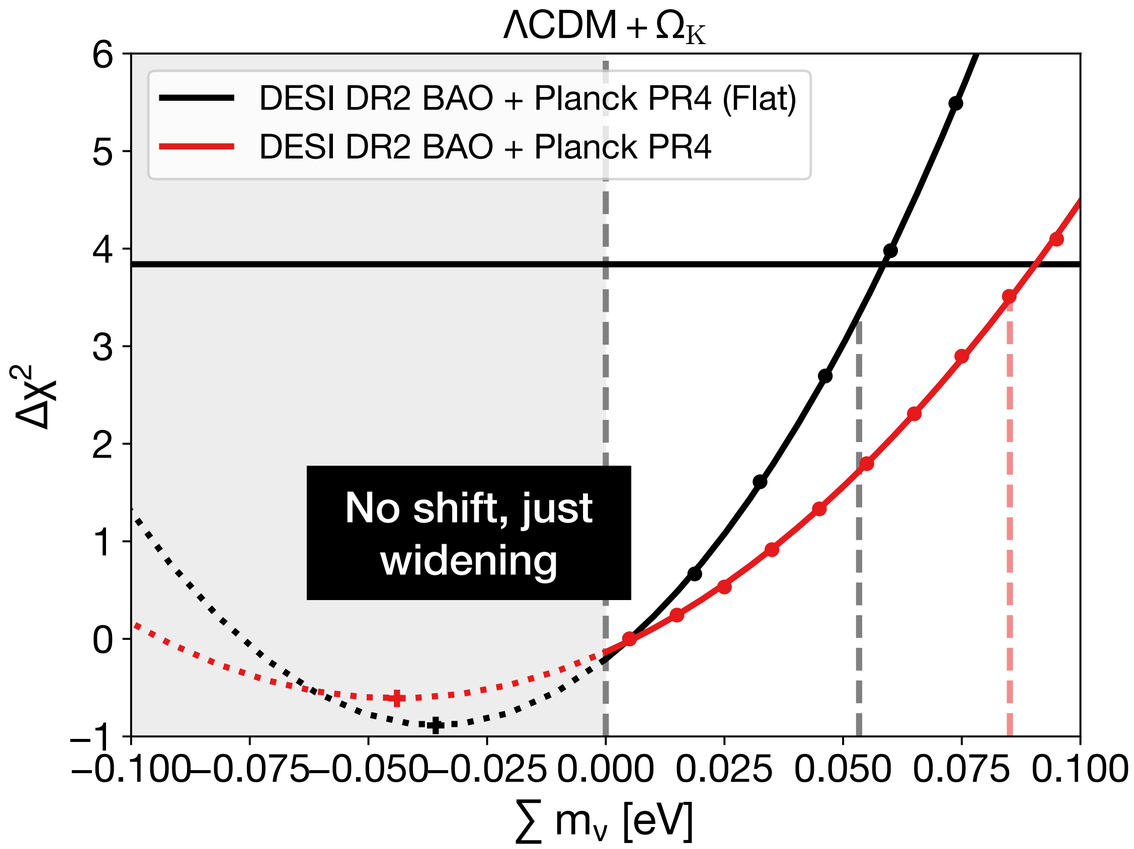

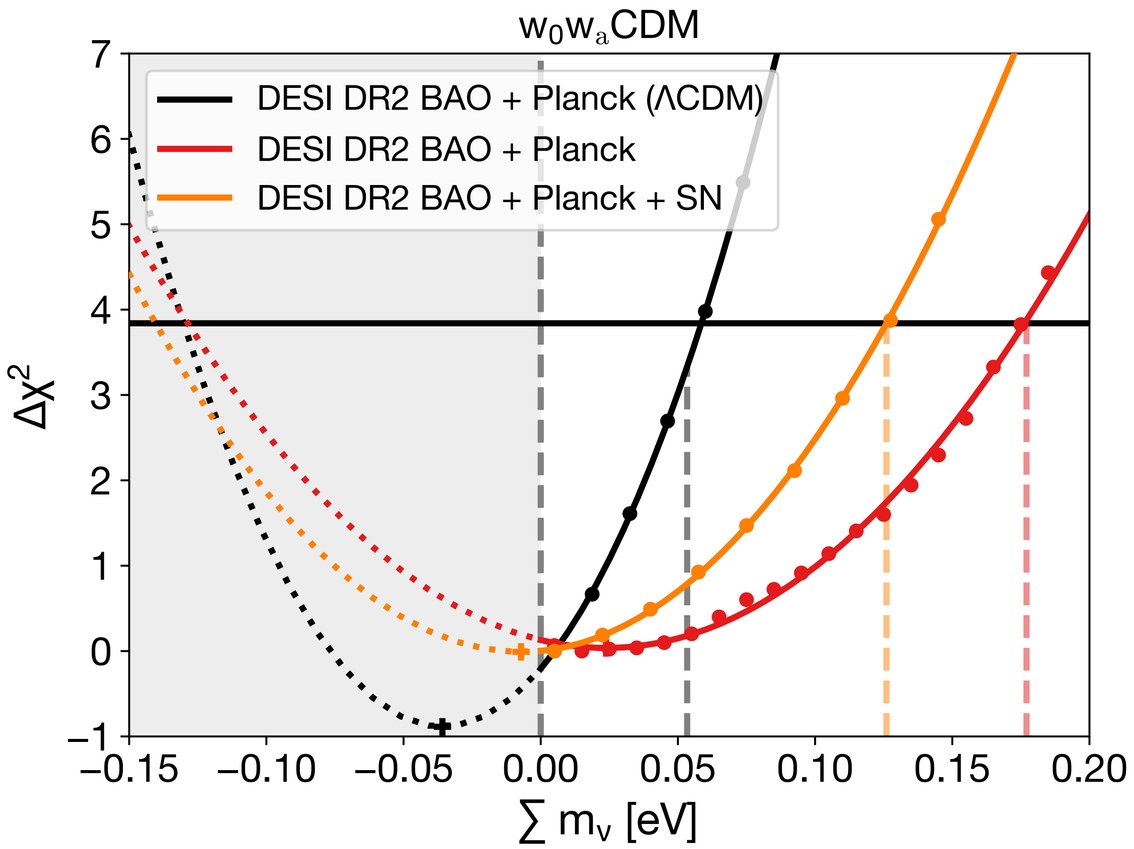

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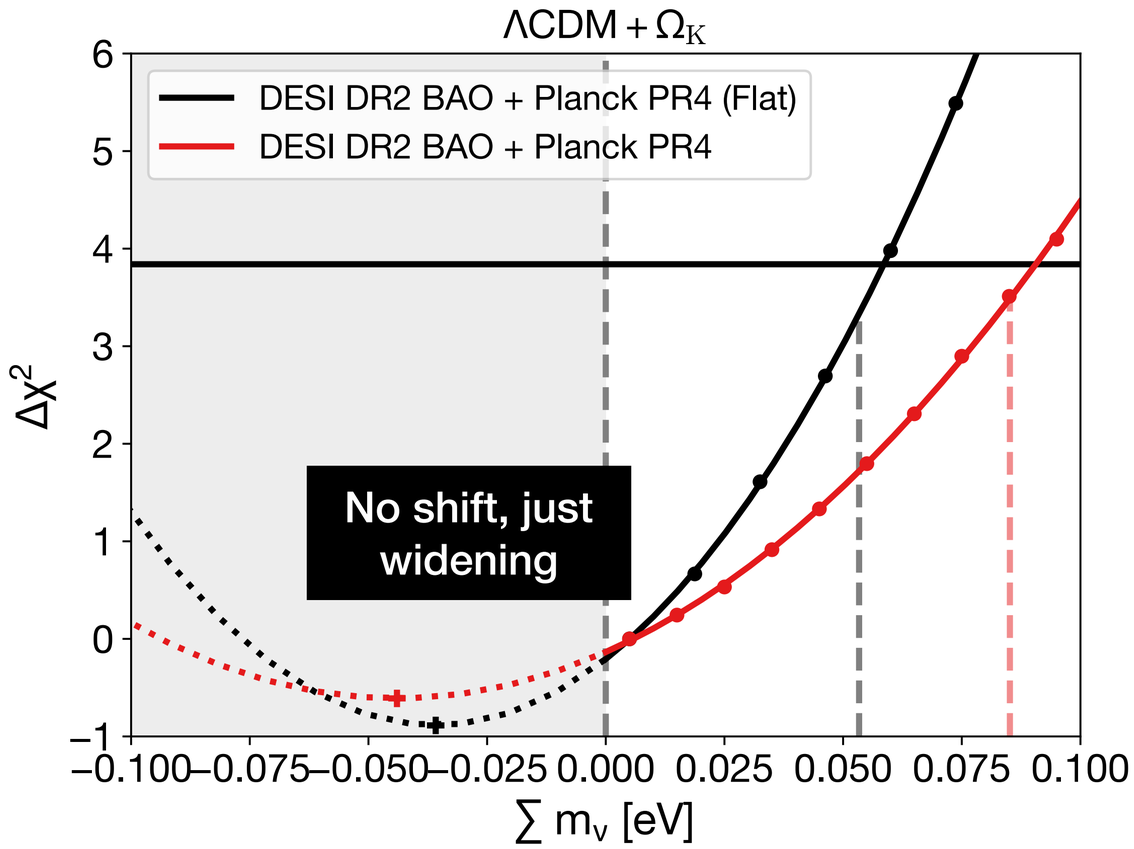

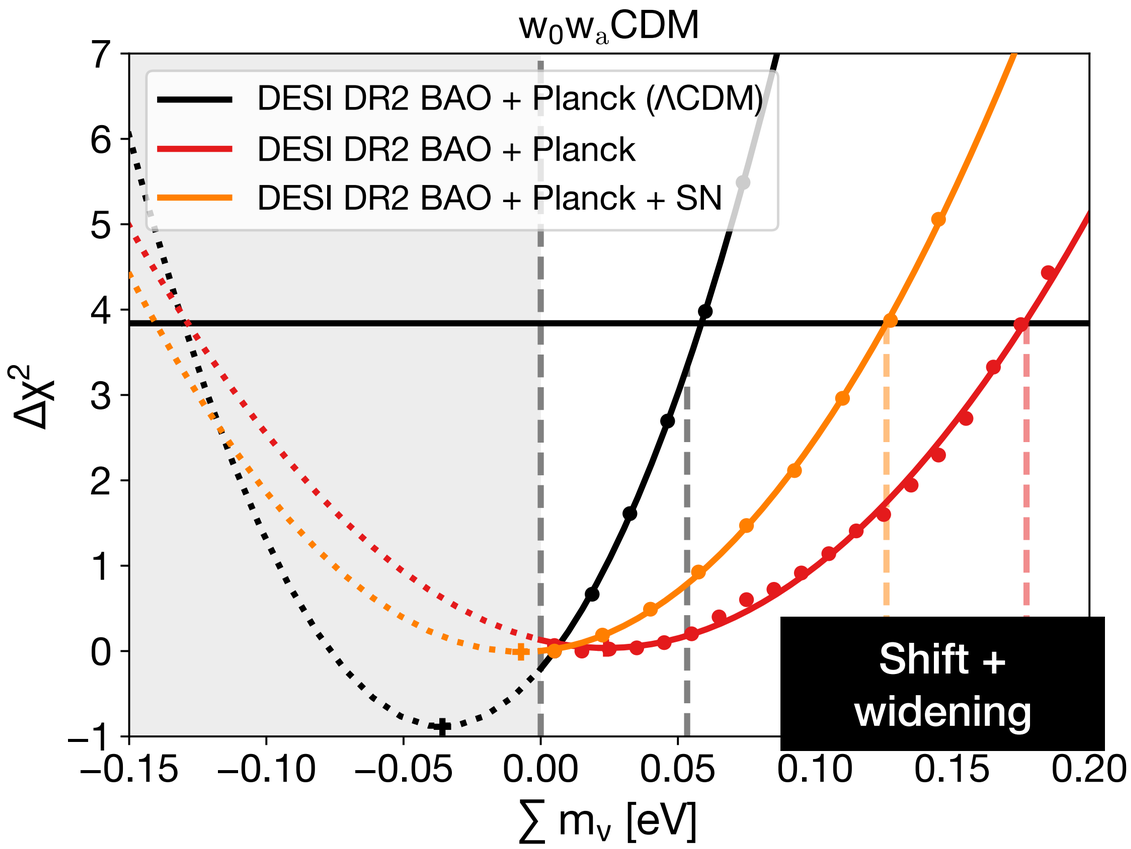

Conclusion

Bear with me, almost done!

Conclusion

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2507.12401

More data combinations
Non-degenerate masses
Lightest neutrino mass…

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Non-degenerate masses
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- Cosmological data are sensitive to **total neutrino mass**
  - *Geometrical* effect & *free-streaming* effect
- DESI enables precise measurements, slight tension with oscillation experiments
- Profile likelihoods are a **pedagogical, visual tool** to navigate data combinations, cosmological models and constraining effects

Conclusion

Bear with me, almost

- Cosmolo
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scillation

e data

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Congratulations on making it to the coffee break!!!