Avancées en Cosmologie

Etienne Burtin - IRFU, DPhP

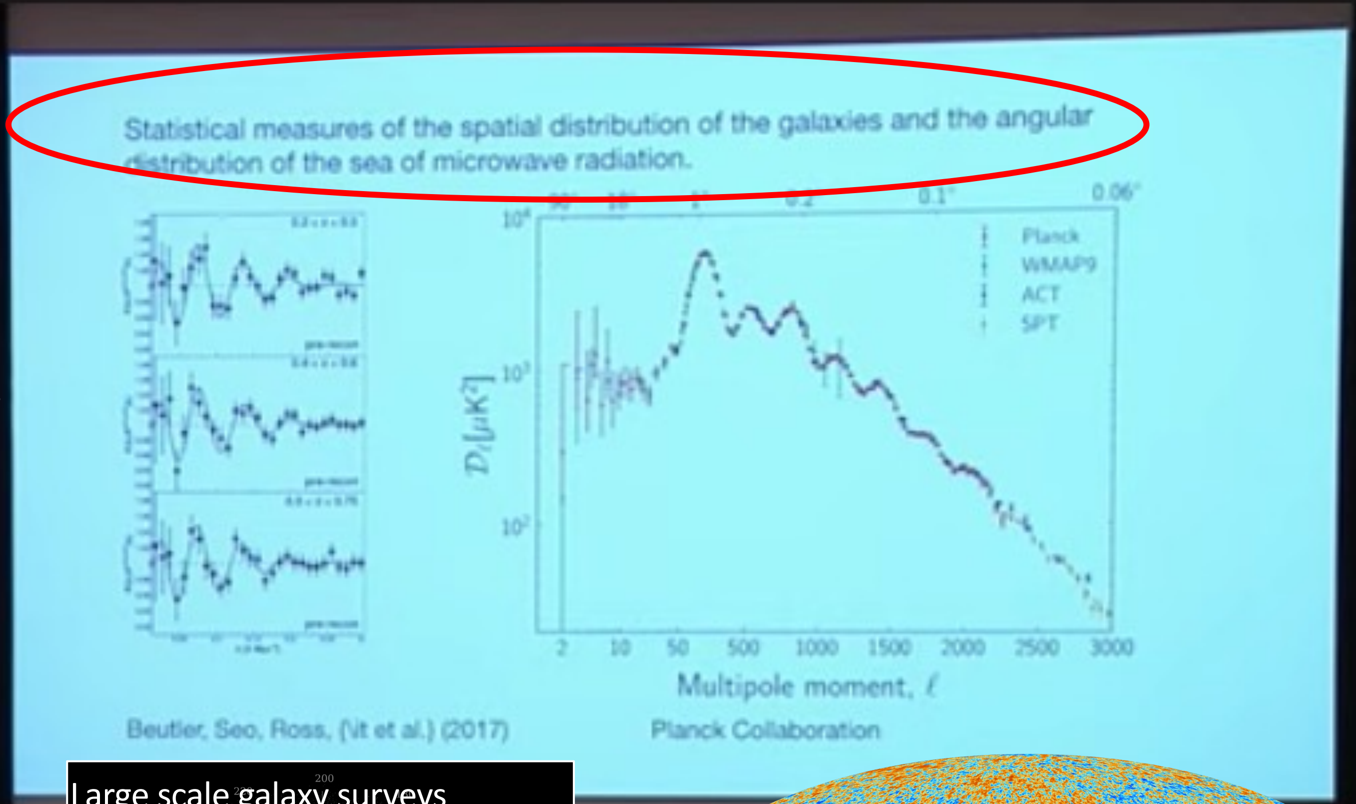
Journée P2I – Université Paris-Saclay 26/11/2025

- Cosmological Concordance Model
- Cosmic Microwave Background
  ACT, SPTO
- Large scale surveys DESI
- Cosmological constraints
- Upcoming surveys: Euclid, Rubin-LSST, Roman,
  Simons Observatory, LiteBird

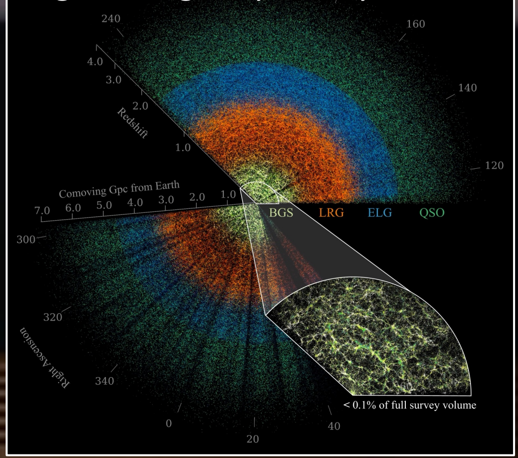
cea irfu

J. Peebles
Nobel Prize in Physics 2019
Inaugural Lecture

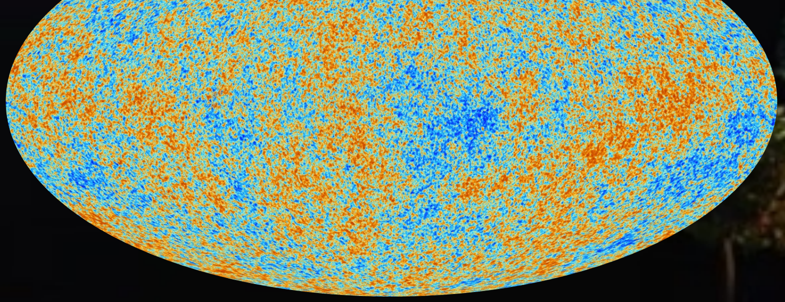
… James Peebles' theoretical framework,
developed since the mid-1960s,
is the basis of our contemporary
ideas about the universe…



Large scale galaxy surveys

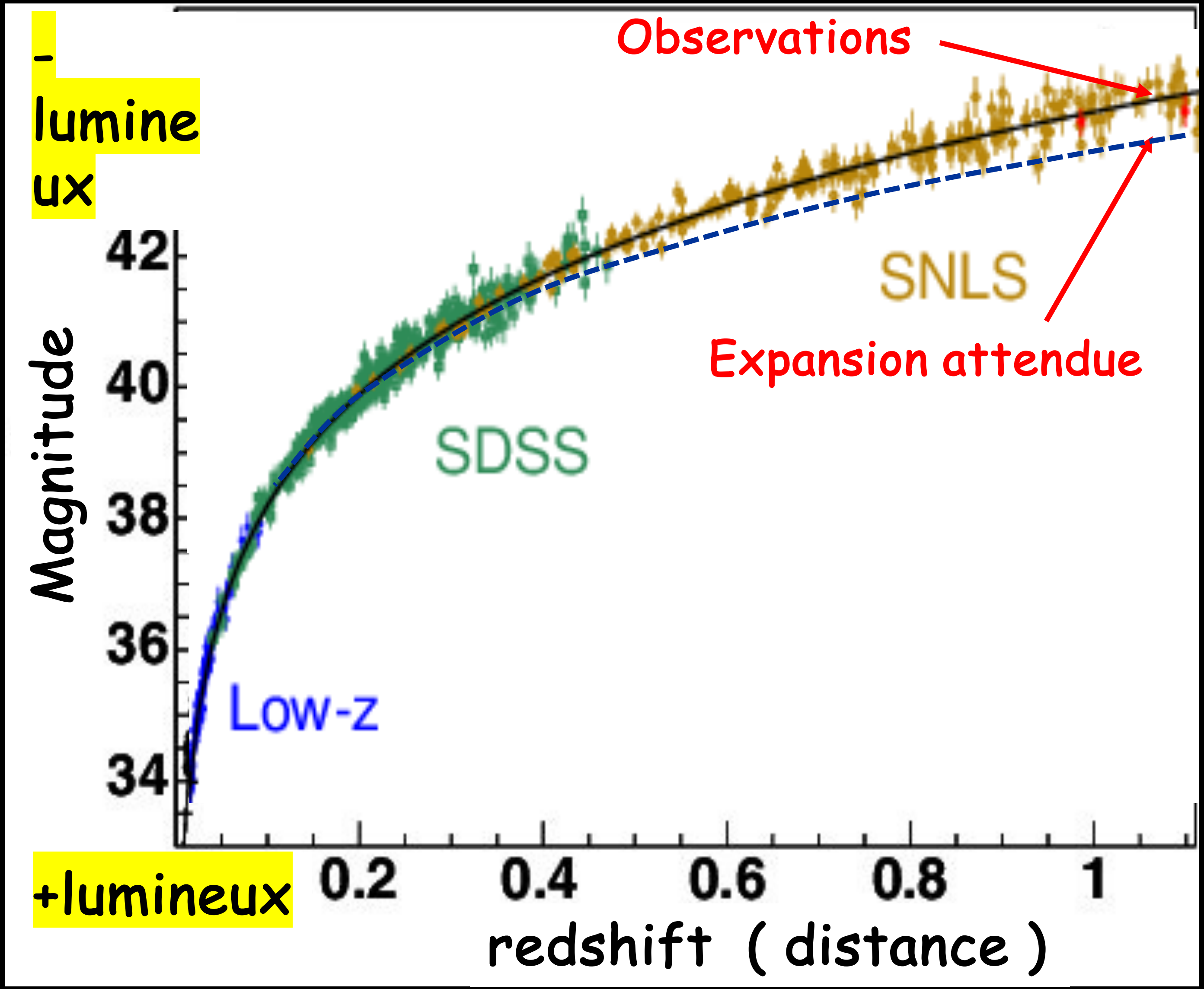


Cosmic microwave Background



And Type 1a Supernovae, weak lensing,
CMB lensing, Clusters…

Découverte de l'accélération de l'Expansion de l'Univers

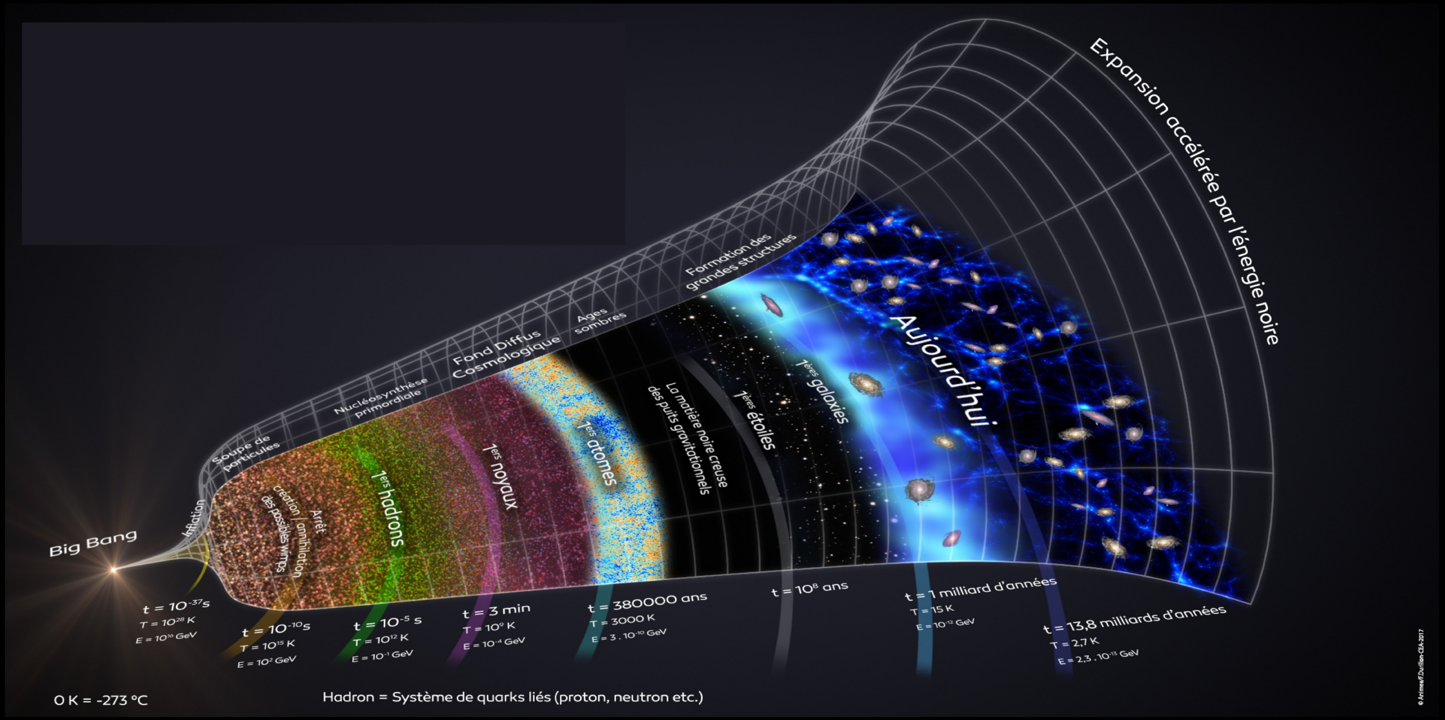


Supernovae Type 1a
Chandelles standardizable

= > Une composante nouvelle accélère l'expansion de l'Univers :
"l'énergie noire"

Prix Nobel de physique 2011
S. Perlmutter, B. Schmidt, A. Ries

Cosmological concordance model ΛCDM



The cosmological model is based upon:

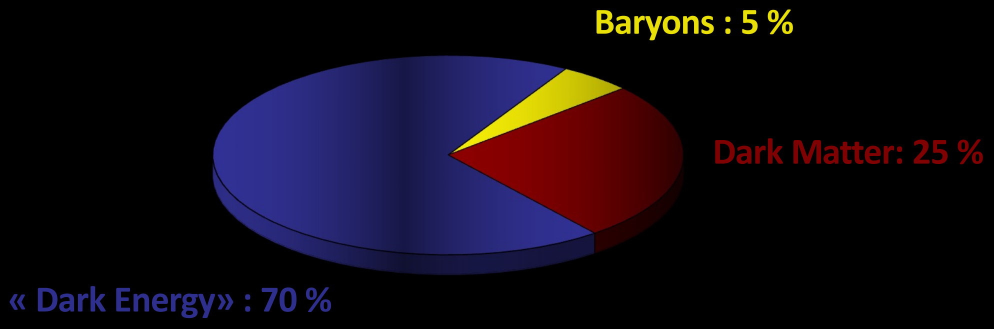
- General relativity
- Standard physics
- Ordinary matter, mostly baryons

Some unknown components

- Dark matter
- Dark Energy

Nearly scale invariant initial perturbations n_s=0.96

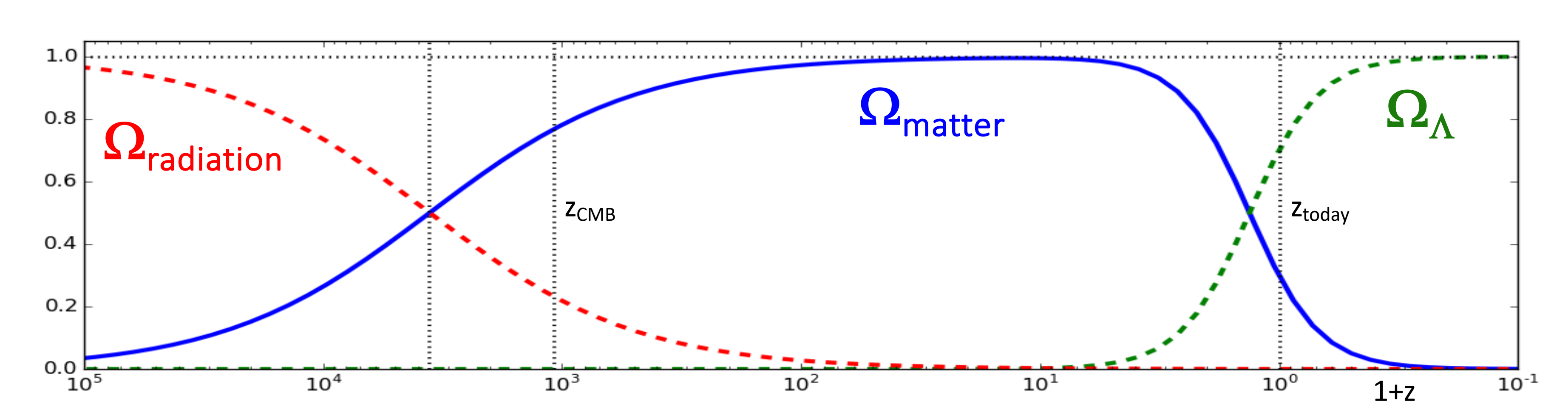
Energy content today



Dark Energy: Acceleration of the expansion of the universe

- Cosmological constant
- Modifation of gravity ?
- Scalar field, quintessence ?
- …

Model of the expansion



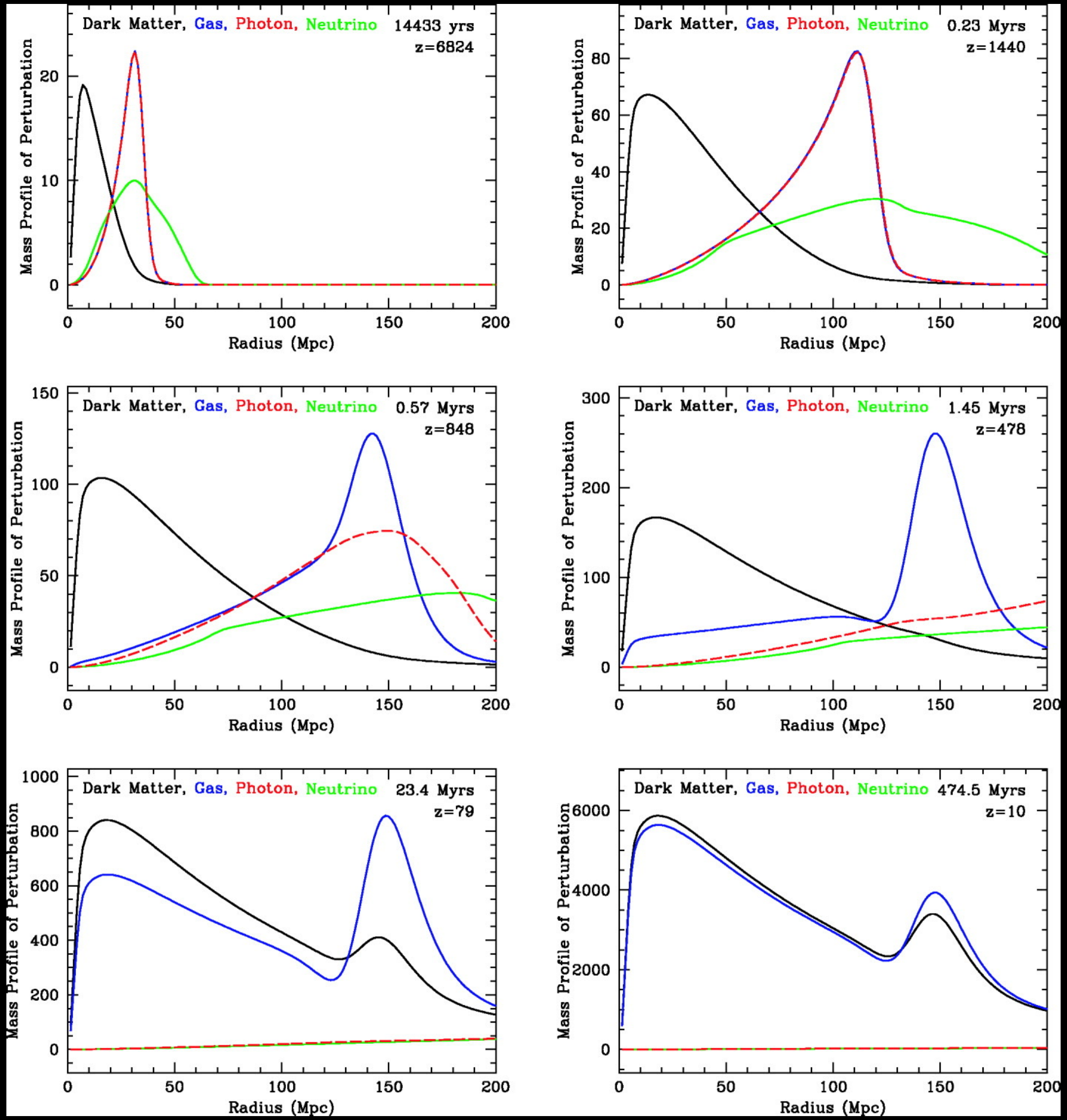
Each component acts differently on the expansion (Friedmann equation) :

$$E^2(z) = \frac{H^2(z)}{H_0^2} = \Omega_r(1+z)^4 + \Omega_m(1+z)^3 + \Omega_k(1+z)^2 + \Omega_\nu \frac{\rho_\nu(z)}{\rho_{\nu,0}} + \Omega_{DE}\frac{\rho_{DE}(z)}{\rho_{DE,0}}$$

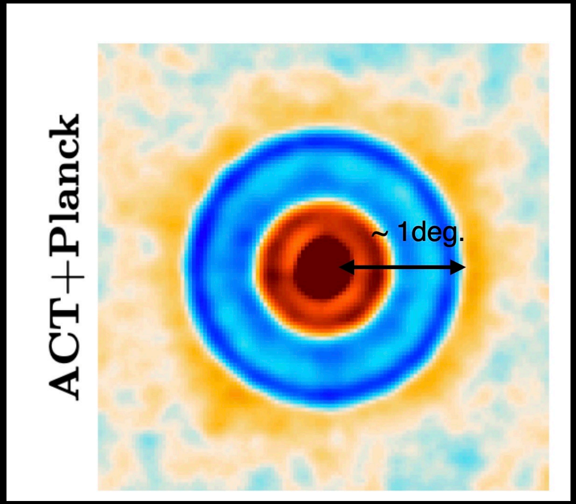
Comoving distance :

$$d(z) = \frac{c}{H_0}\int_0^z \frac{dz'}{E(z')}$$

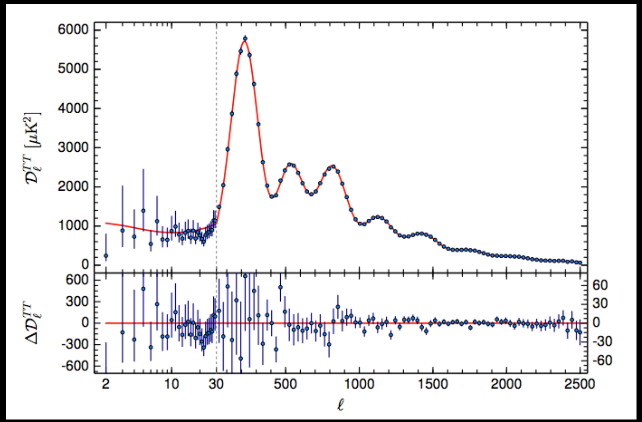
Propagation of density waves



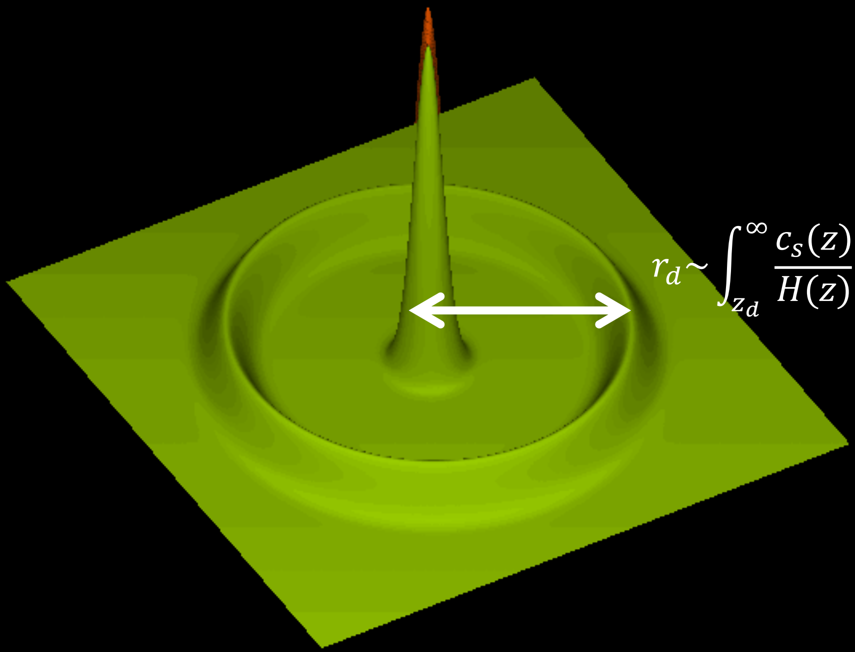
Einsentein, Seo, White (2007)



Stack of CMB maps
on temperature hotspots



BAO distance scale



$$r_d \sim \int_{z_d}^{\infty} \frac{c_s(z)}{H(z)}\, dz$$

Sound speed in primordial plasma

$$c_s(z) = \frac{c}{\sqrt{3}} \frac{1}{\sqrt{1 + \frac{3\omega_b(z)}{4\omega_\gamma(z)}}}$$

Baryons

photons

Expansion of the universe $H(z)$

r_d = 150 Mpc today (distance to Virgo cluster ~20Mpc)

Big Bang Nucleosynthesis

Abundance of light elements

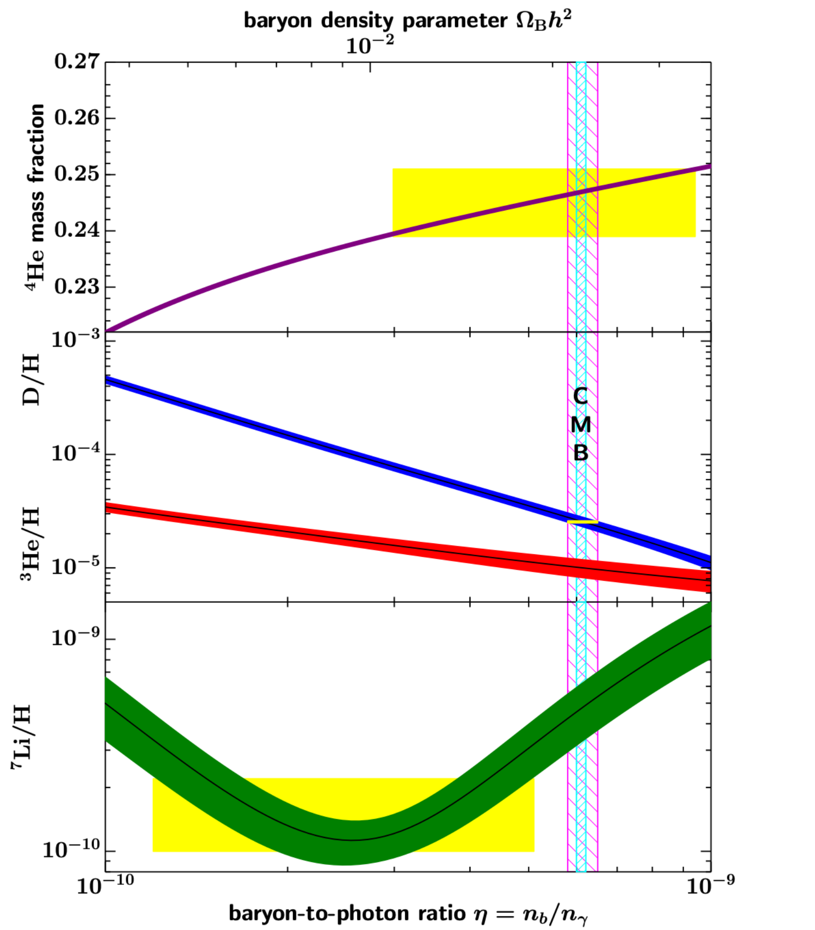
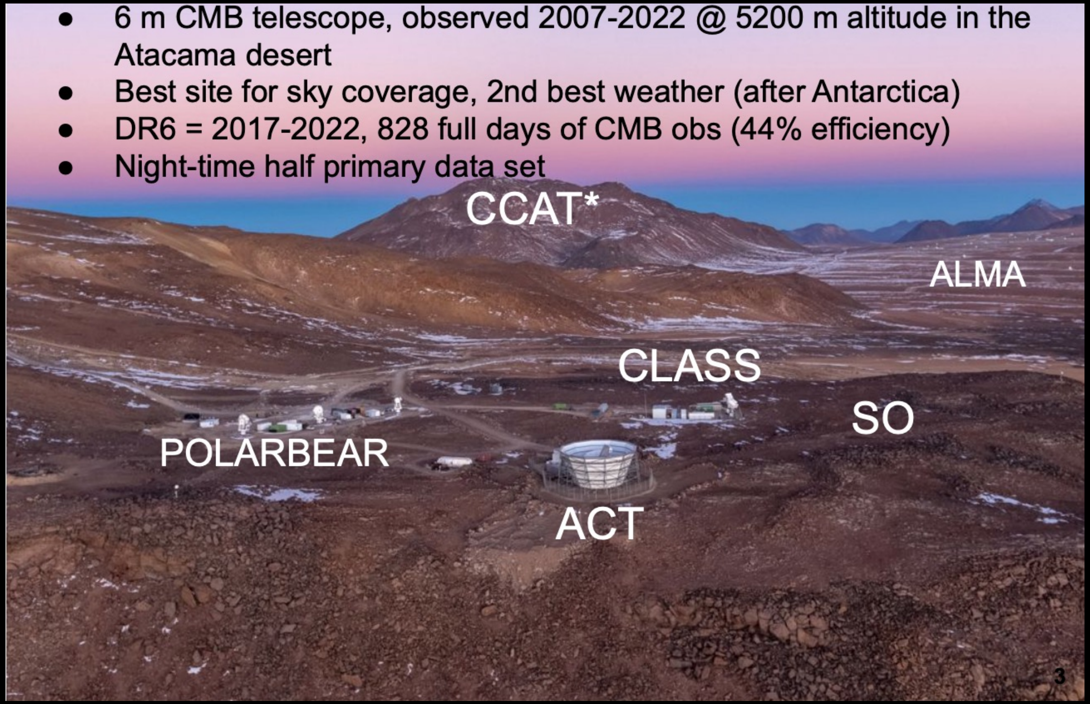


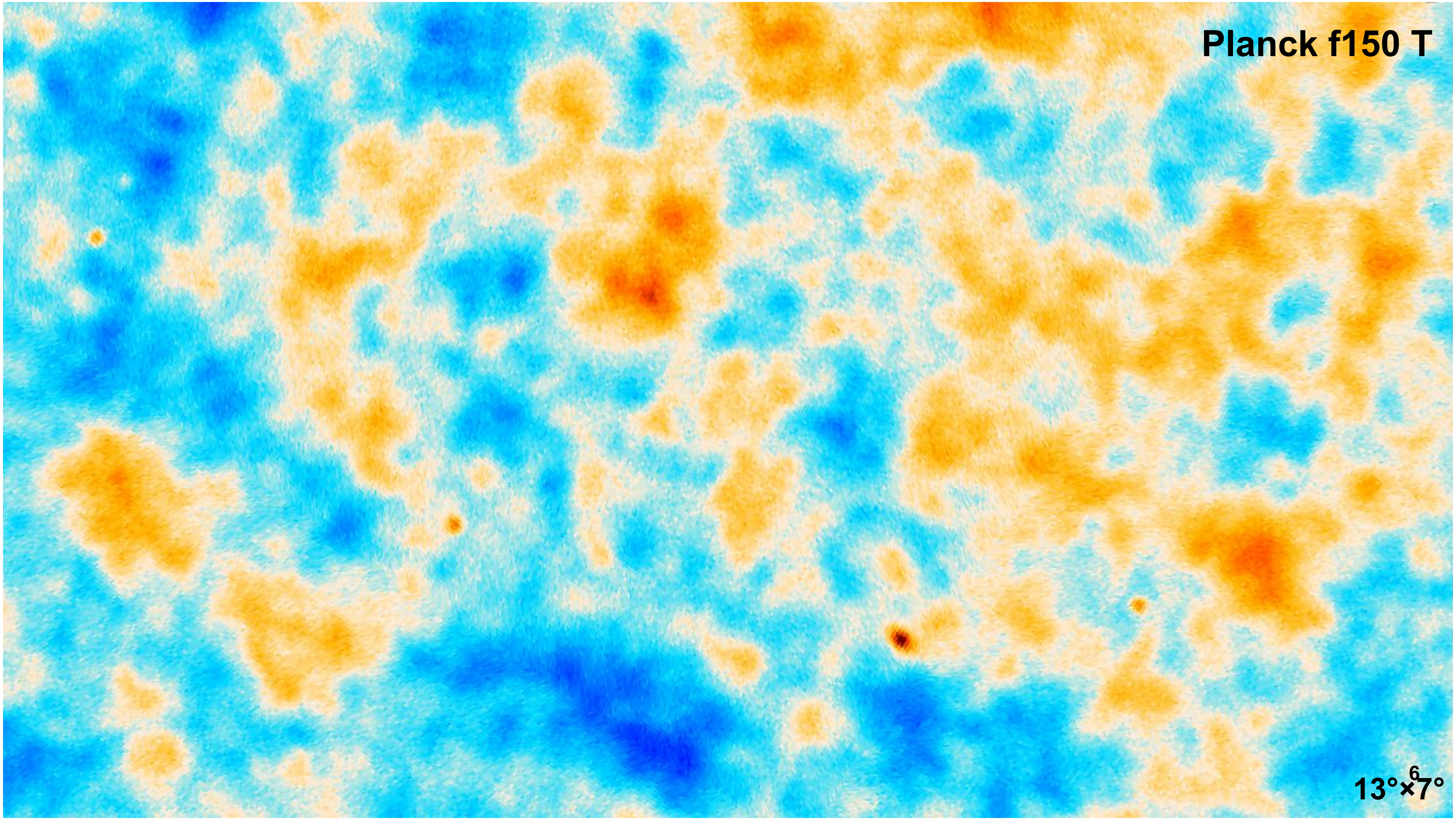
Figure 24.1: The primordial abundances of ^{4}He, D, ^{3}He, and ^{7}Li as predicted by the standard model of Big-Bang nucleosynthesis — the bands show the 95% CL range [47]. Boxes indicate the observed light element abundances. The narrow vertical band indicates the CMB measure of the cosmic baryon density, while the wider band indicates the BBN D+^{4}He concordance range (both at 95% CL).

Progrès sur la mesure du Fonds diffus Cosmologique

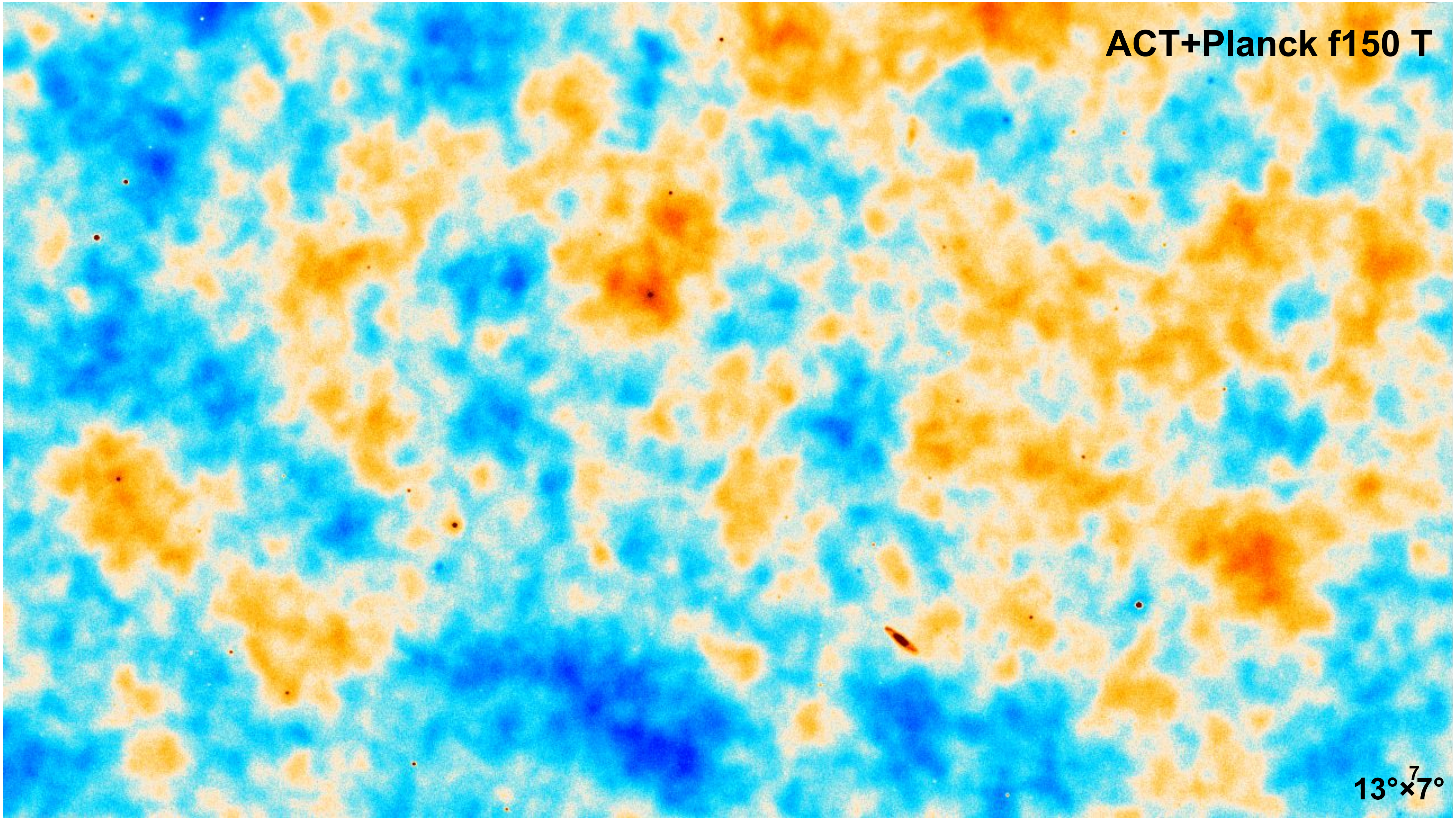
Atacama Cosmology Telescope (Inc. P2I)



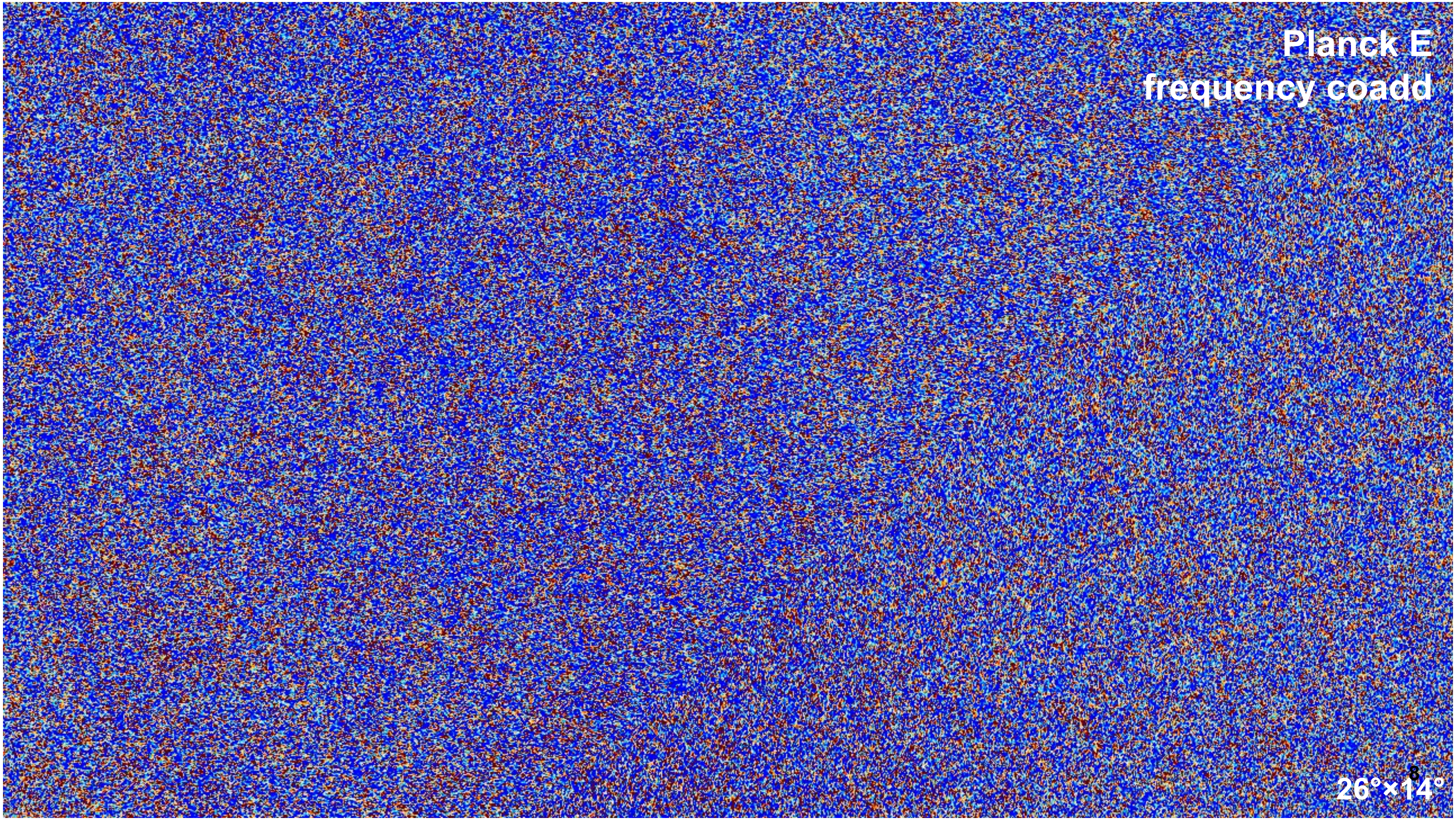
South Pole Telescope Observatory



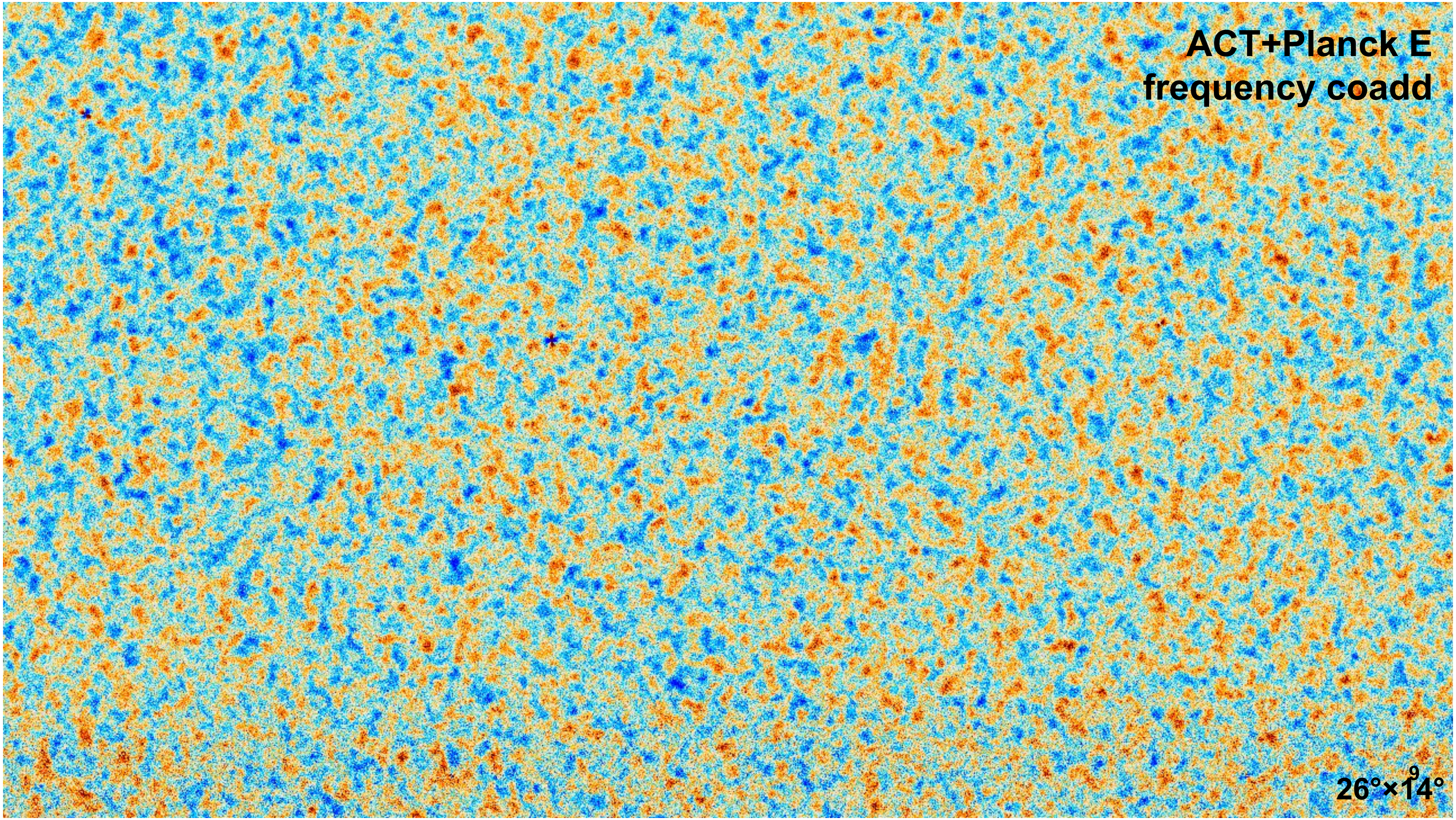
From Adrien La Posta, ACT collaboration



From Adrien La Posta, ACT collaboration



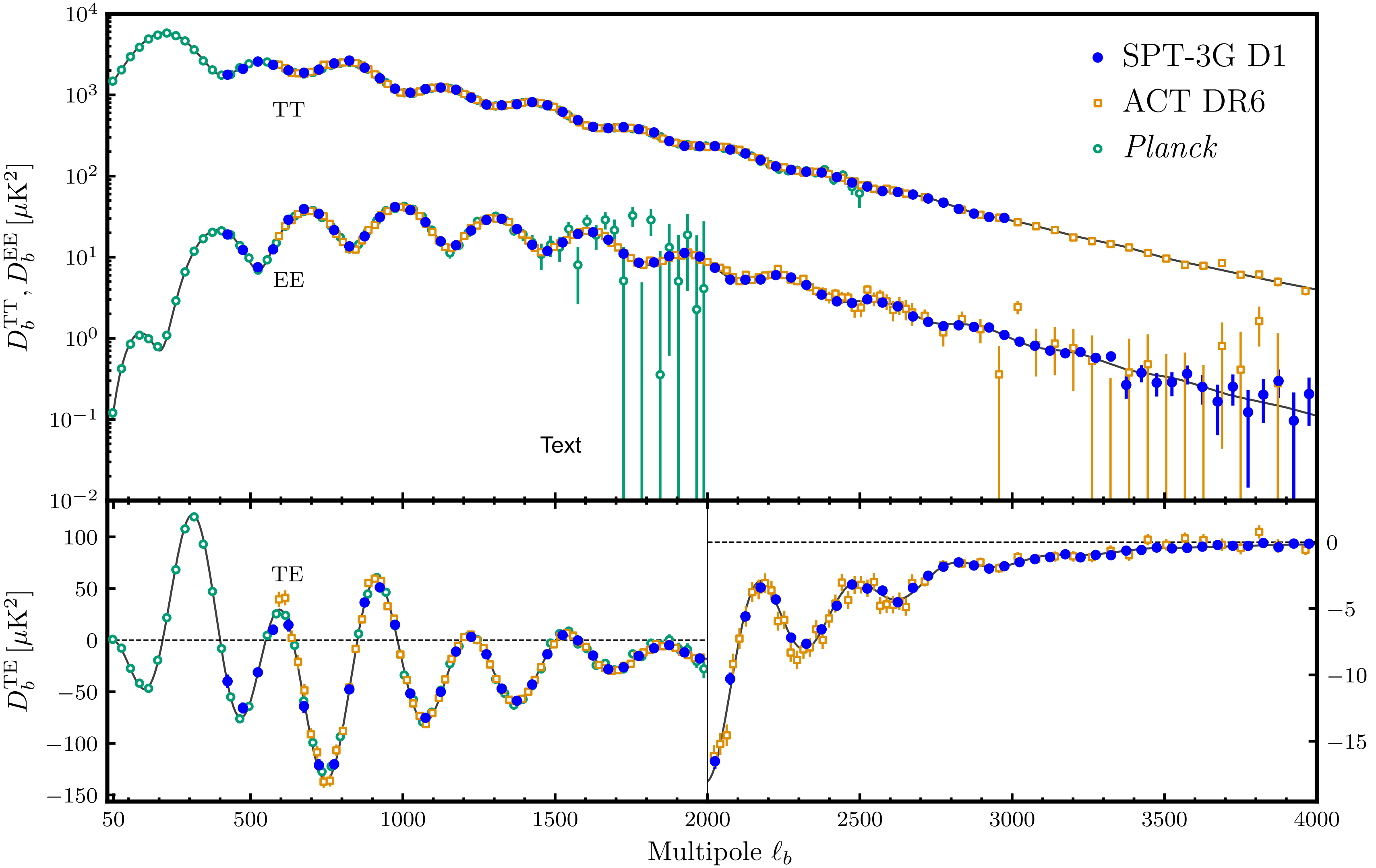
From Adrien La Posta, ACT collaboration



From Adrien La Posta, ACT collaboration

Data set extends from 400 to 3000 in TT

From 400 to 4000 in TE/EE

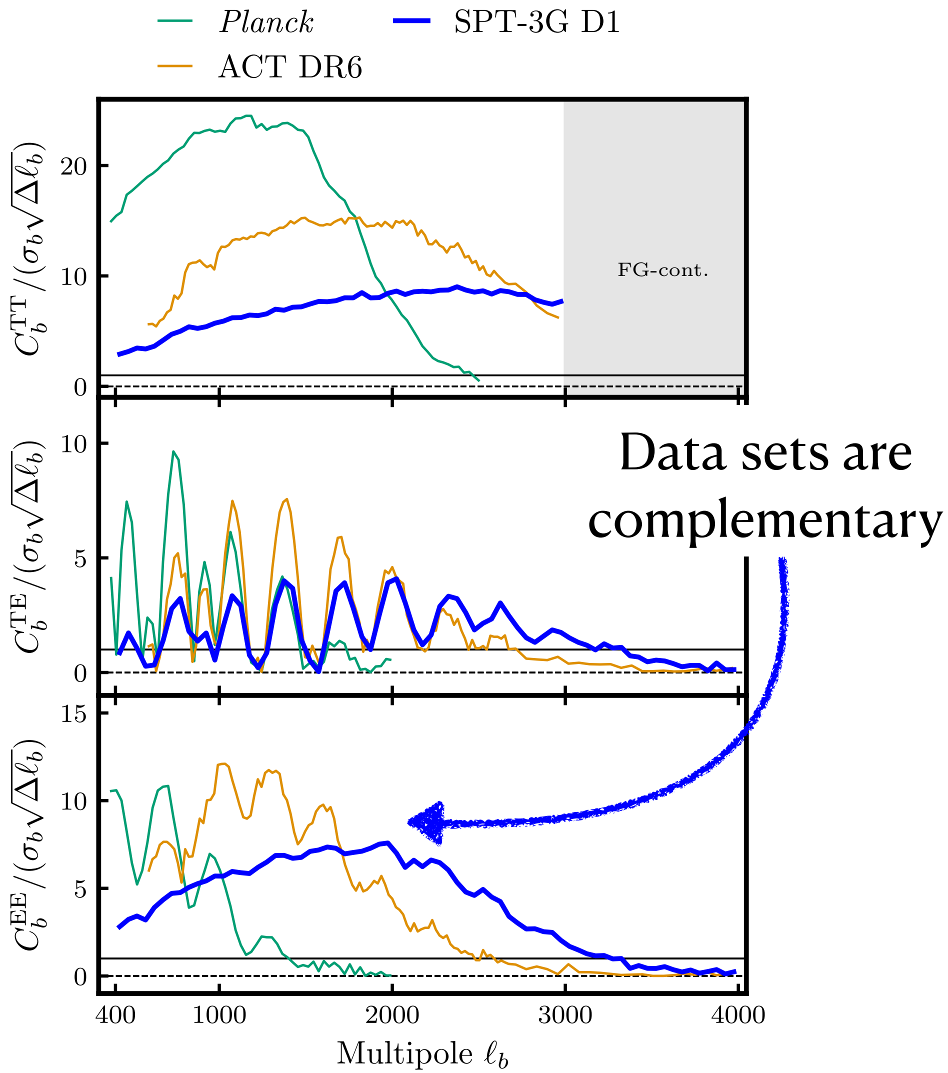


Signal-to-noise ratio

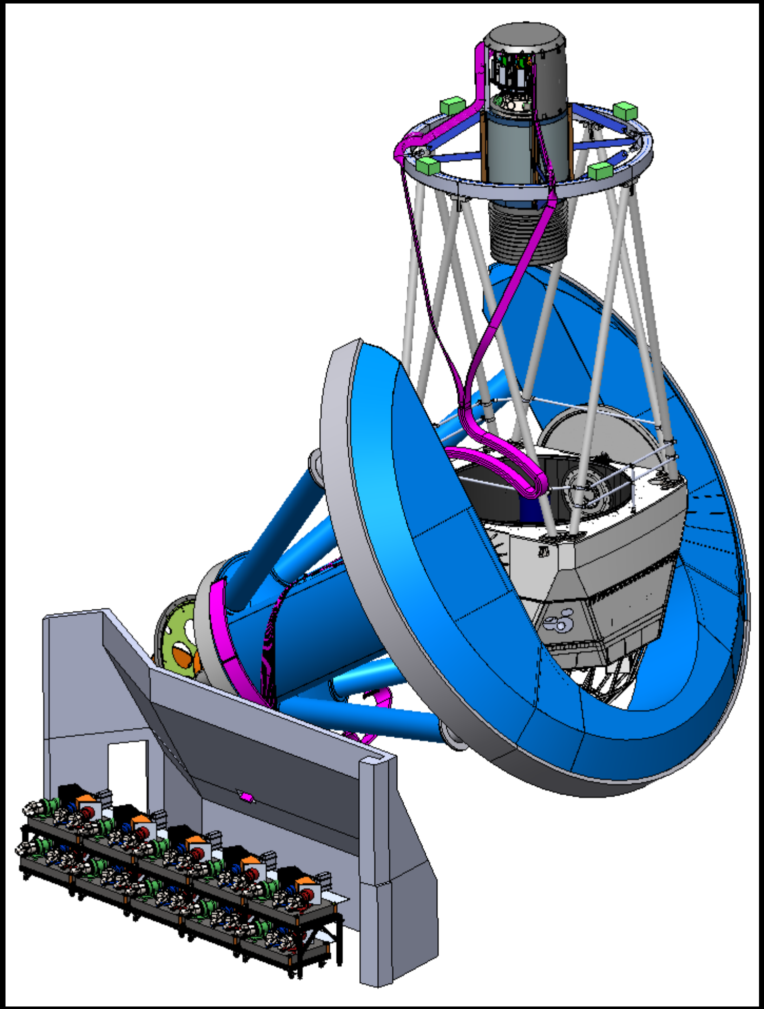
Experiment	Sky fraction [%]	Coadded noise [uK-arcmin]
Planck	100	35
ACT DR6	45	10
SPT-3G D1	4	3.3

SPT-3G D1 provides the tightest band powers:

- **In TE, at** $\ell \in [2200, 4000]$,
- **In EE, at** $\ell \in [1800, 4000]$.

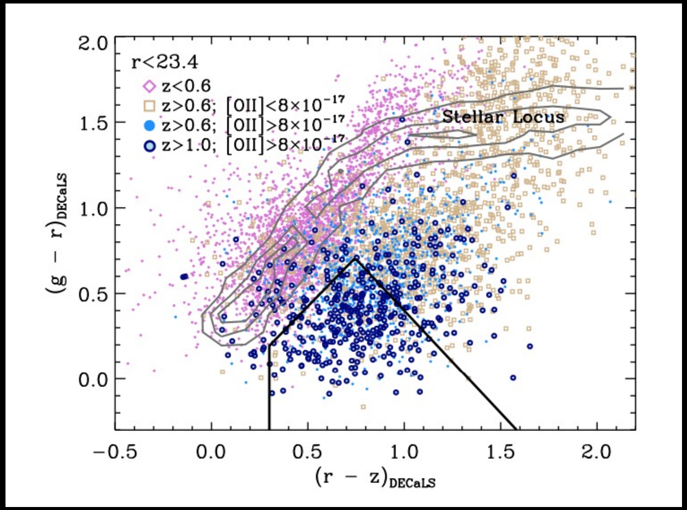


The Dark Energy Spectroscopic Instrument

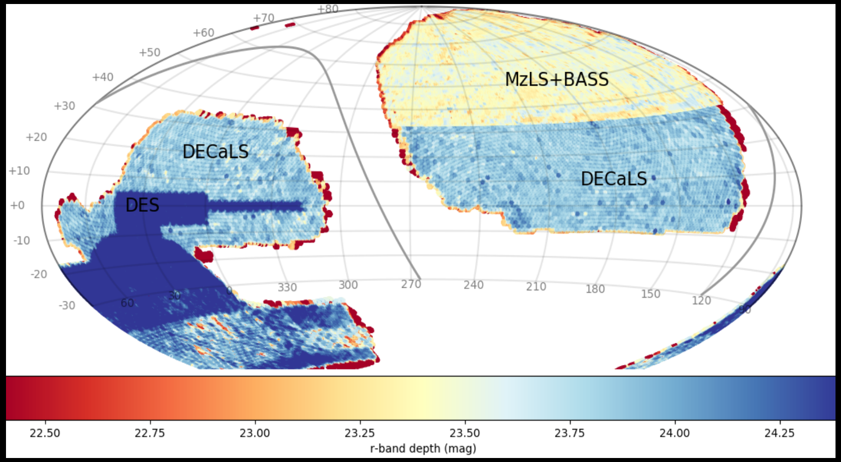


Multi-objects Large Scale Spectrocopic Survey

Target selection

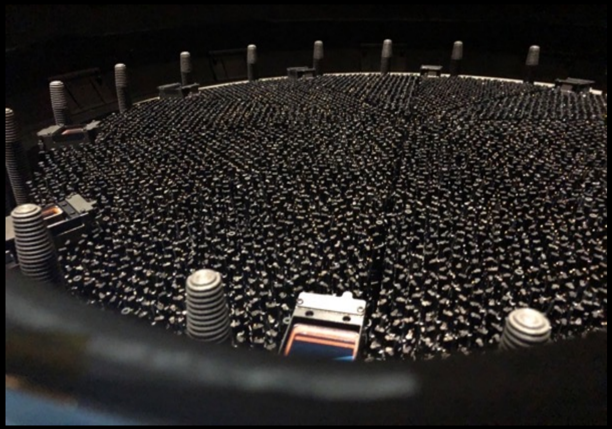


2D photometric surveys

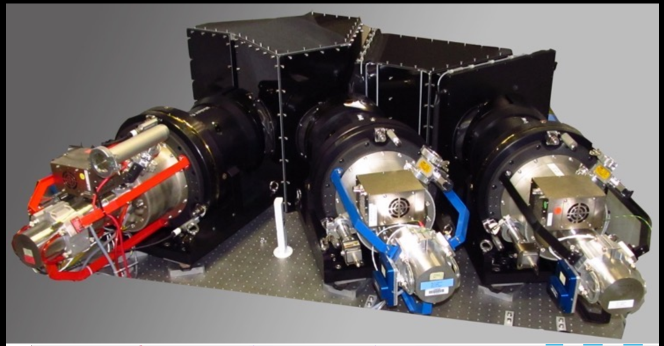


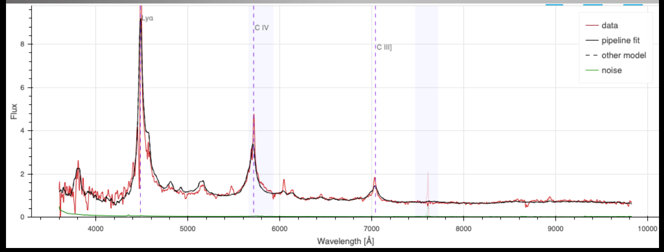
Observation…

… of 5000 targets
every ~ 20 mins…

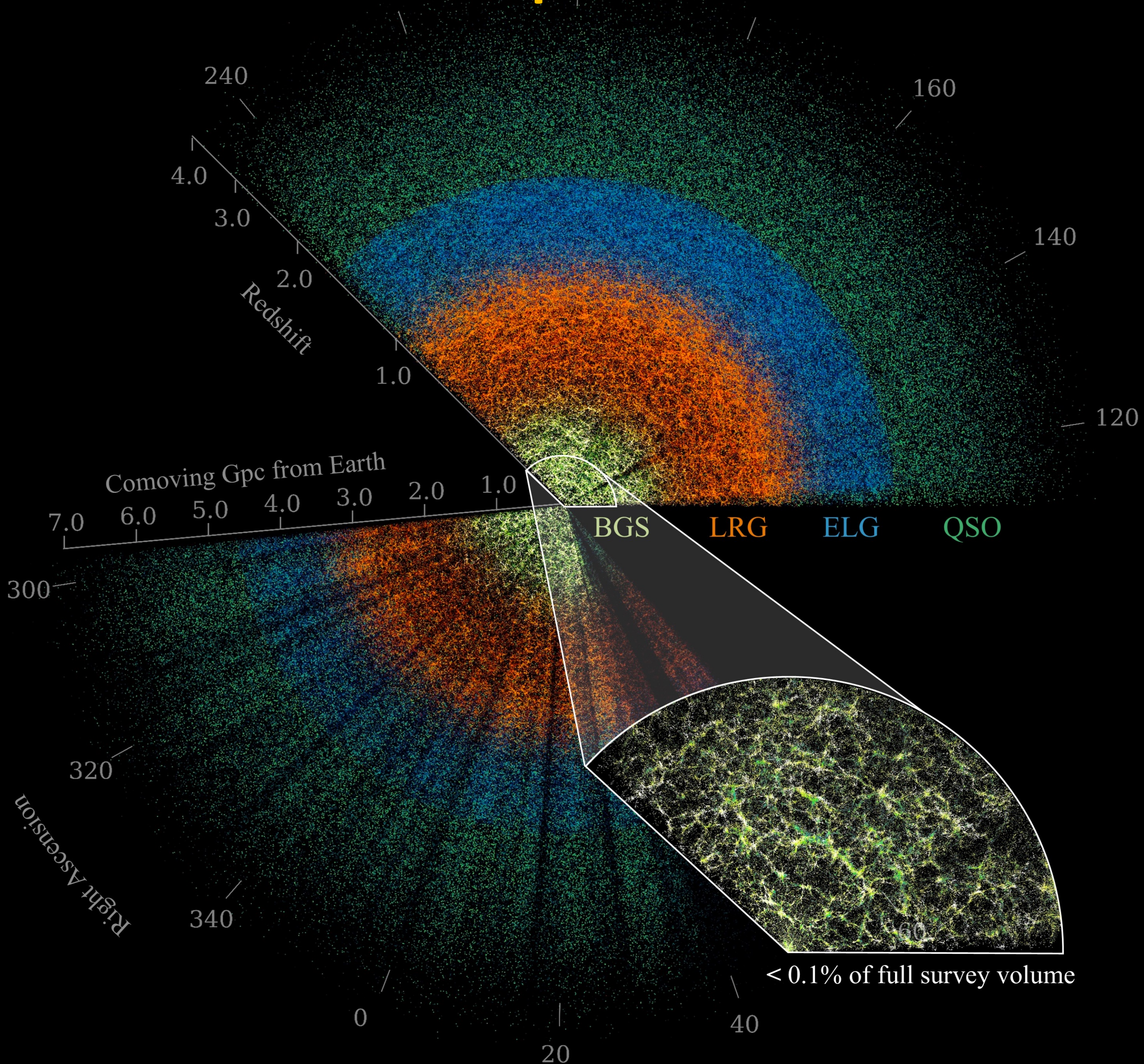


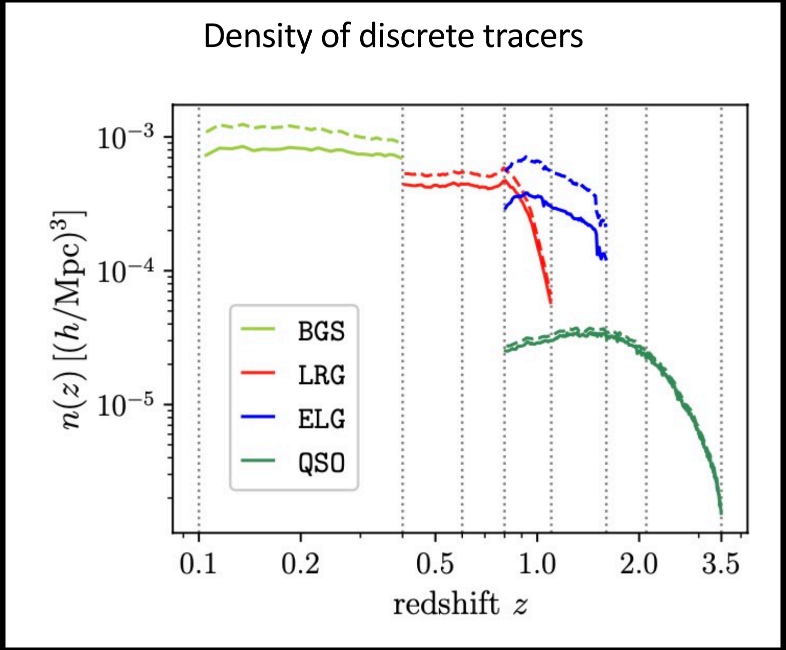
… and measure their redshift





DESI 3D map of the Universe





Tracer	DR1	**DR2**
BGS	300 043	**1 188 526**
LRG	2 138 627	**4 468 483**
ELG	2 432 072	**6 534 844**
QSO	1 223 391	**2 062 839**
Total	6 094 133	**14 254 692**

Le Monde, 21/03/2025


LE GOÛT DE M
ÉVASION
AU JAPON
SUPPLÉMENT

Le Monde

ALGÉRIE, UN « CRIME D'ÉTAT » DANS LES SECRETS DU FLN

STEPHEN KING DOUZE NOUVELLES AU NOIR

Supplément LE MONDE DES LIVRES

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Comment l'Europe entend se réarmer en cinq ans

▸ Les chefs d'Etat et de gouvernement des Vingt-Sept devaient à nouveau échanger sur la défense européenne, jeudi 20 mars, à Bruxelles

▸ Mercredi, la Commission a dévoilé une note d'intention intitulée « Etre prêt en 2030 », qui détaille les menaces et les moyens pour y répondre

▸ Bruxelles se propose de faciliter le financement de l'effort de défense par les Etats et de favoriser la réorganisation d'un marché européen fragmenté

▸ Lors d'un entretien téléphonique, mercredi, Donald Trump et Volodymyr Zelensky se sont accordés sur le principe d'un cessez-le-feu partiel

▸ La Maison Blanche a infléchi sa position sur les armes et les enfants enlevés, et exprimé des vues sur les actifs énergétiques

PAGES 3 ET 4, ET CHRONIQUE PAGE 27

Economie
Etats-Unis : la Fed anticipe un ralentissement

Les turbulences du début de mandat de Trump amènent la Réserve fédérale à revoir ses prévisions

P. 5, 14 ET TRIBUNE P. 24

Politique
Port du voile dans le sport : vers une interdiction légale

Sous la pression des ministres de l'intérieur et de la justice, l'exécutif soutient un texte sénatorial

PAGE 8

Gaza
L'armée israélienne

EXPANSION DE L'UNIVERS
UNE NOUVELLE CARTE DES GALAXIES BOUSCULE LES THÉORIES

Une collaboration internationale de 900 chercheurs constate que la dynamique de l'Univers n'est pas conforme aux prédictions

PAGE 7

La plus grande carte, à ce jour, de l'Univers, diffusée le 19 mars, où chaque point est une galaxie.

COLLABORATION DESI ET KPNO/NOIRLAB/NSF/AURA/R. PROCTOR

Retraites
La CGT se retire de la négociation

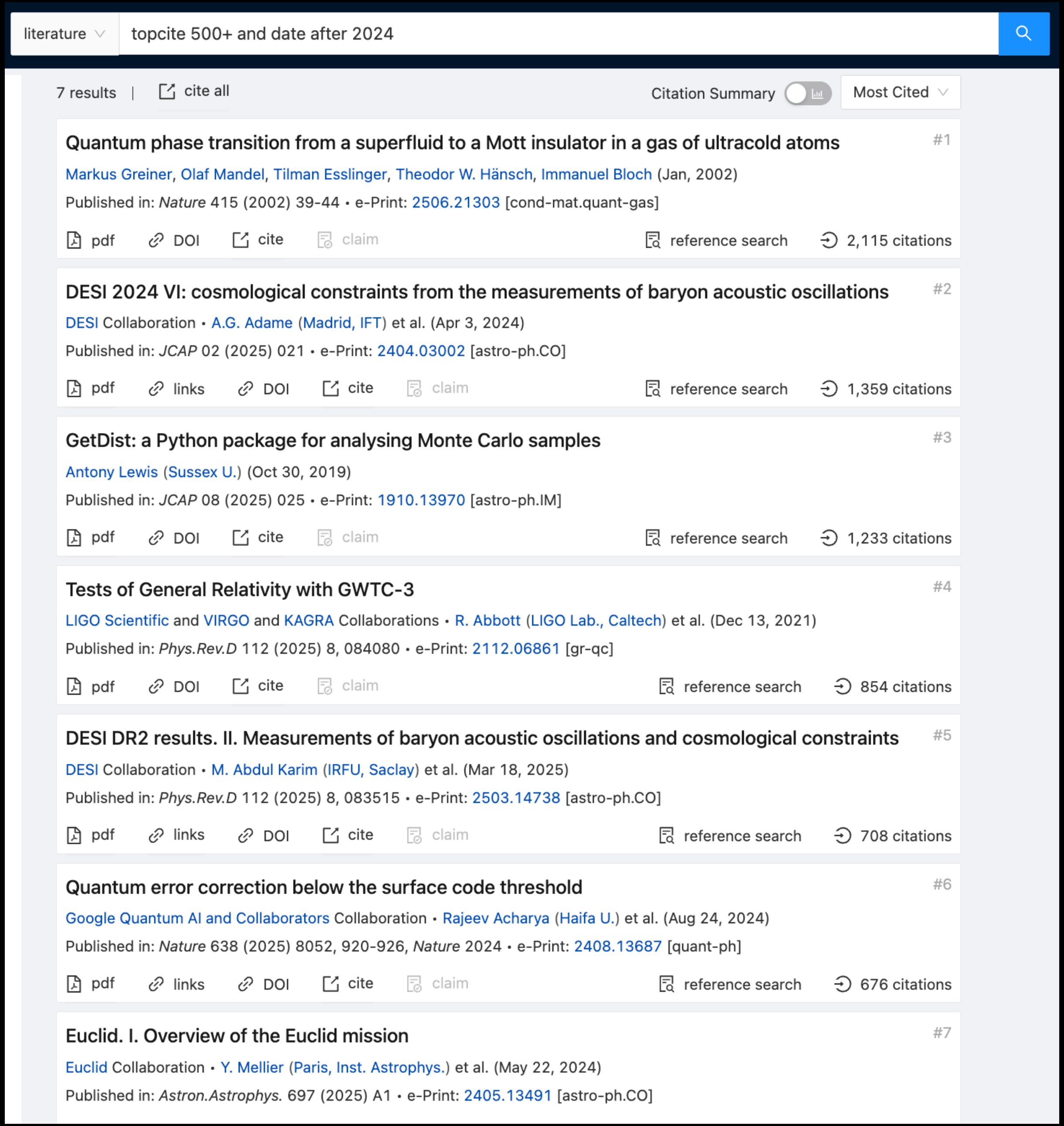
L'INCERTITUDE sur l'issue des discussions entre partenaires sociaux sur les retraites est montée d'un cran, mercredi 19 mars, avec l'annonce de la défection de la CGT, qui s'ajoute à celles de Force ouvrière et de l'Union des entreprises de proximité. Pour la secrétaire générale de la confédération, Sophie Binet, François Bayrou a « trahi sa parole » en fermant la porte, dimanche, à une baisse de l'âge légal de départ. Les cinq organisations restantes devaient se retrouver, jeudi, pour échanger sur la suite de ce « conclave ».

PAGES 8-9

ÉDITORIAL
LUTTER CONTRE LE NARCOTRAFIC, UN ENJEU VITAL POUR L'ÉTAT DE DROIT

PAGE 27

InspireHEP, 26/11/2025


literature | topcite 500+ and date after 2024

7 results | cite all — Citation Summary — Most Cited

Quantum phase transition from a superfluid to a Mott insulator in a gas of ultracold atoms #1
Markus Greiner, Olaf Mandel, Tilman Esslinger, Theodor W. Hänsch, Immanuel Bloch (Jan, 2002)
Published in: *Nature* 415 (2002) 39-44 • e-Print: 2506.21303 [cond-mat.quant-gas]
pdf | DOI | cite | claim | reference search | 2,115 citations

DESI 2024 VI: cosmological constraints from the measurements of baryon acoustic oscillations #2
DESI Collaboration • A.G. Adame (Madrid, IFT) et al. (Apr 3, 2024)
Published in: *JCAP* 02 (2025) 021 • e-Print: 2404.03002 [astro-ph.CO]
pdf | links | DOI | cite | claim | reference search | 1,359 citations

GetDist: a Python package for analysing Monte Carlo samples #3
Antony Lewis (Sussex U.) (Oct 30, 2019)
Published in: *JCAP* 08 (2025) 025 • e-Print: 1910.13970 [astro-ph.IM]
pdf | DOI | cite | claim | reference search | 1,233 citations

Tests of General Relativity with GWTC-3 #4
LIGO Scientific and VIRGO and KAGRA Collaborations • R. Abbott (LIGO Lab., Caltech) et al. (Dec 13, 2021)
Published in: *Phys.Rev.D* 112 (2025) 8, 084080 • e-Print: 2112.06861 [gr-qc]
pdf | DOI | cite | claim | reference search | 854 citations

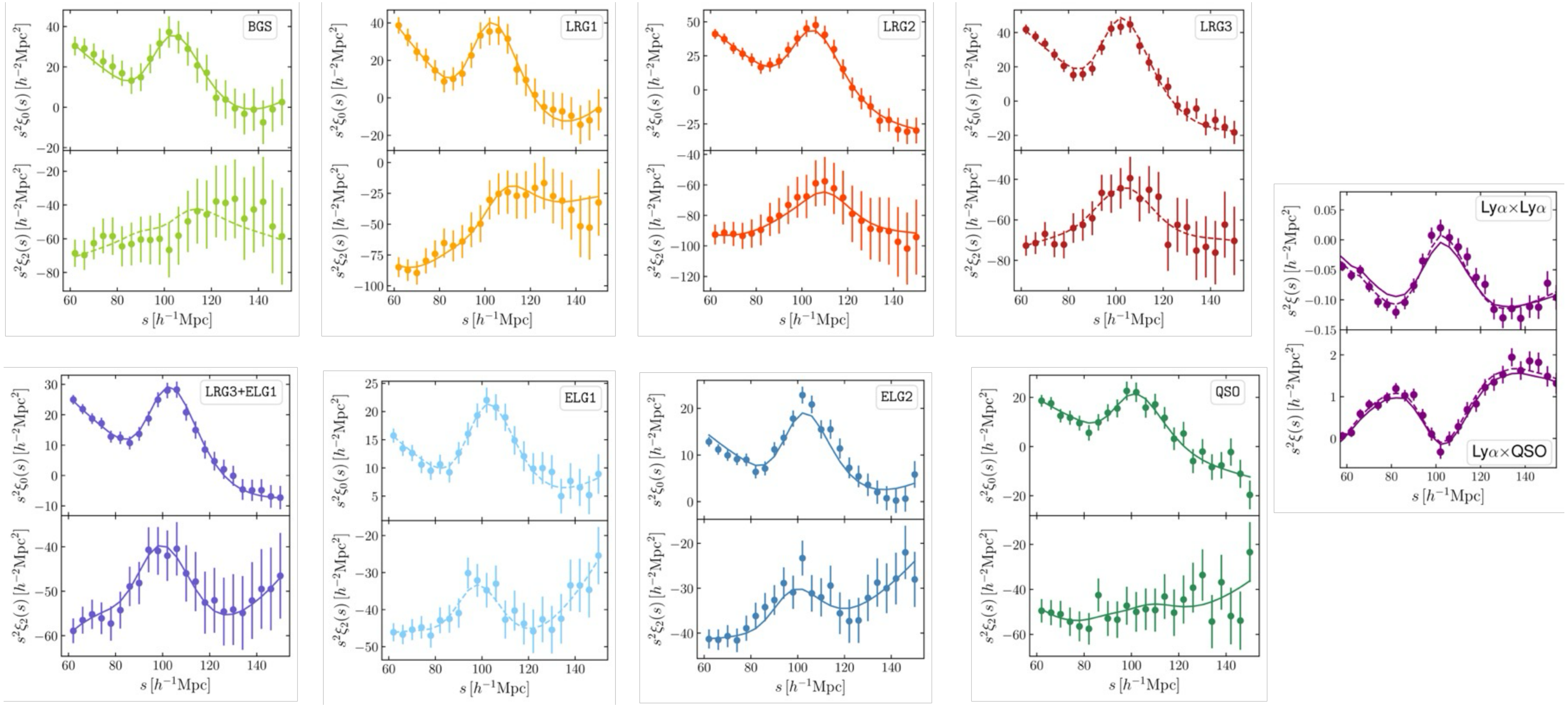
DESI DR2 results. II. Measurements of baryon acoustic oscillations and cosmological constraints #5
DESI Collaboration • M. Abdul Karim (IRFU, Saclay) et al. (Mar 18, 2025)
Published in: *Phys.Rev.D* 112 (2025) 8, 083515 • e-Print: 2503.14738 [astro-ph.CO]
pdf | links | DOI | cite | claim | reference search | 708 citations

Quantum error correction below the surface code threshold #6
Google Quantum AI and Collaborators Collaboration • Rajeev Acharya (Haifa U.) et al. (Aug 24, 2024)
Published in: *Nature* 638 (2025) 8052, 920-926, *Nature* 2024 • e-Print: 2408.13687 [quant-ph]
pdf | links | DOI | cite | claim | reference search | 676 citations

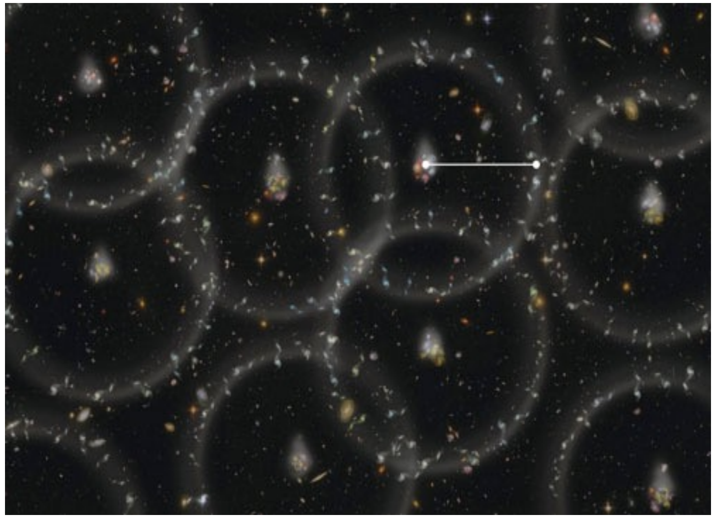
Euclid. I. Overview of the Euclid mission #7
Euclid Collaboration • Y. Mellier (Paris, Inst. Astrophys.) et al. (May 22, 2024)
Published in: *Astron.Astrophys.* 697 (2025) A1 • e-Print: 2405.13491 [astro-ph.CO]

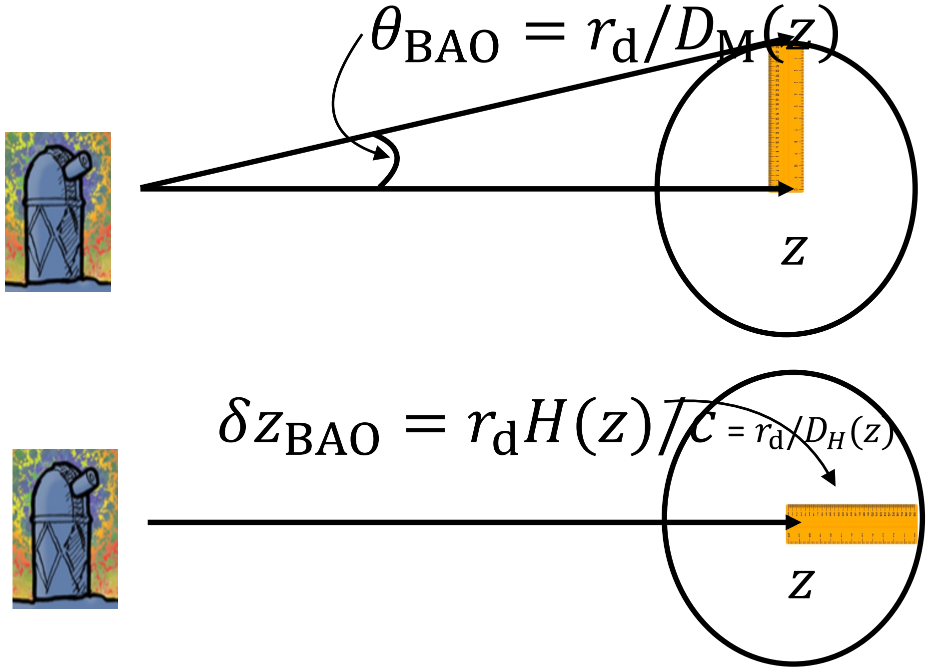
DESI DR2 2-pt statistics

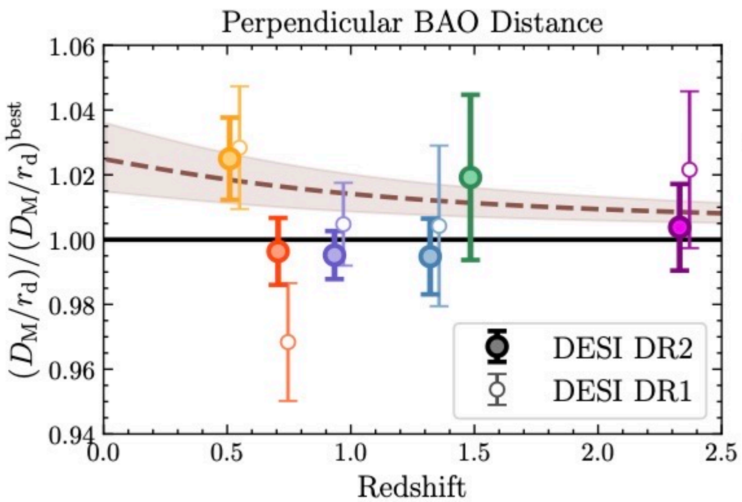
2-point correlation function : excess probability to find galaxies separated by distance *s*

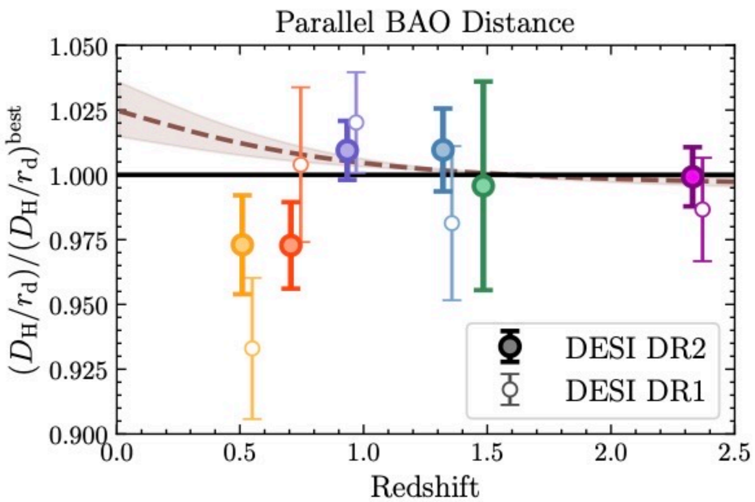


BAO inferred dilation parameters



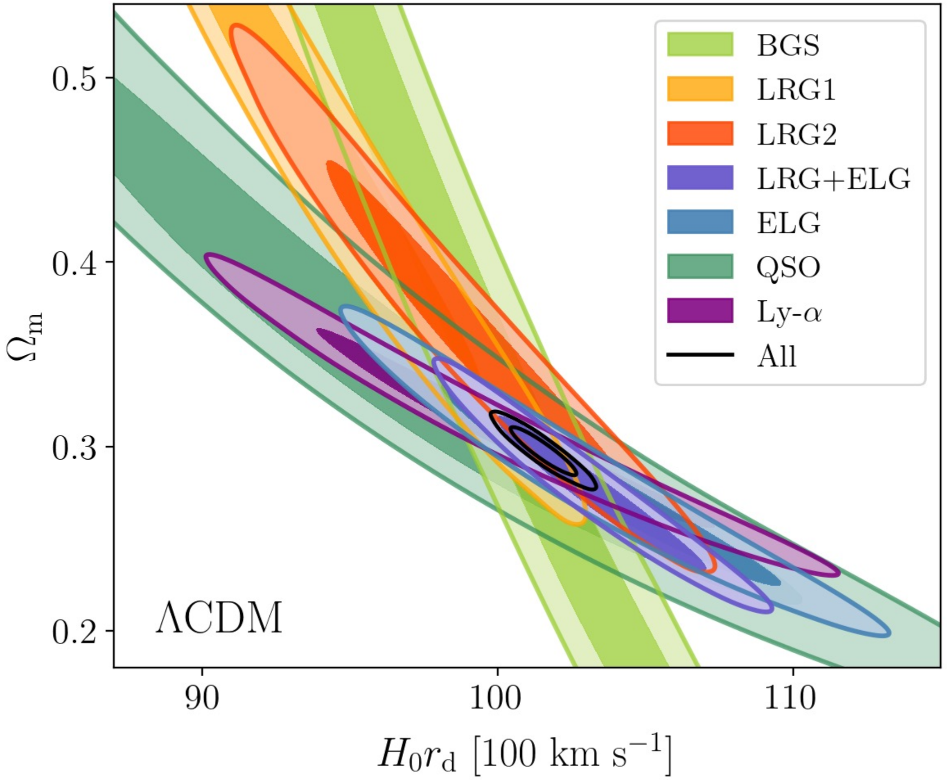


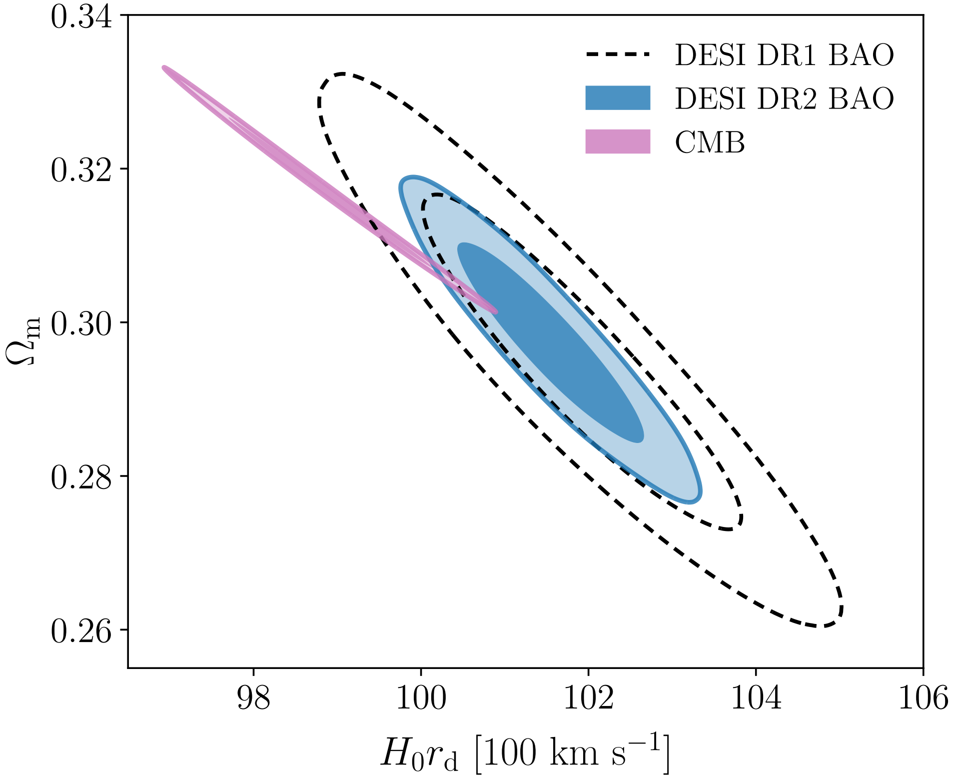




- DESI is consistent with ΛCDM
- ~2% / 2.3 σ discrepancy with Planck ΛCDM best fit

Cosmological constraints



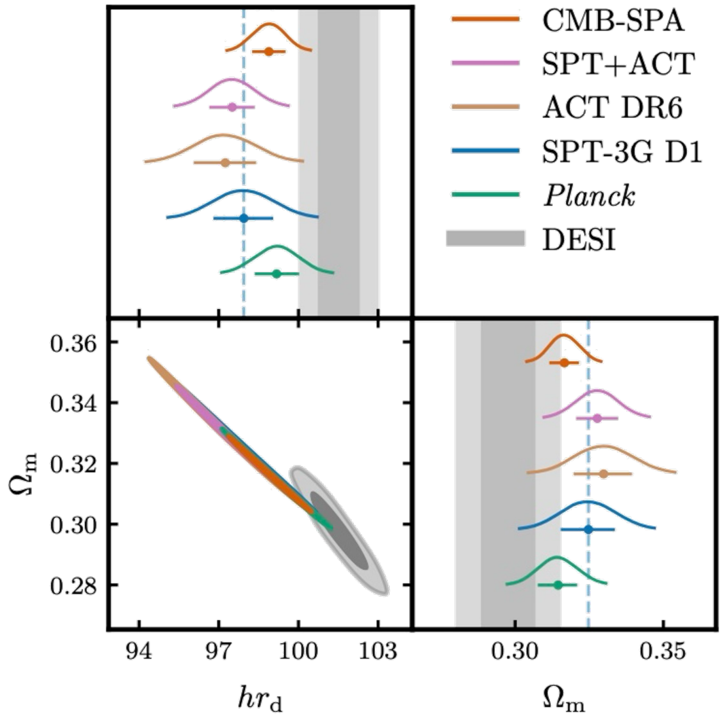


- DESI tracers are consistent
- Different degeneracy directions

- Factor 2 improvement in the Ω_m/H_0r_d plane with DR2
- 2% / **2.3 σ** discrepancy with Planck ΛCDM best fit
- CMB includes :
  - Primary CMB from Planck PR4 (camspec)
  - CMB lensing from Planck PR4 and ACT DR6

Cosmological constraints including ACT & SPT '25 results

arxiv:2506.20707



	$100\,\Omega_m$	hr_d [Mpc]	Distance to DESI
CMB-SPA	31.66 ± 0.50	98.89 ± 0.63	$2.8\,\sigma$
SPT+ACT	32.77 ± 0.72	97.51 ± 0.87	$3.7\,\sigma$
SPT+*Planck*	31.89 ± 0.54	98.63 ± 0.67	$3.0\,\sigma$
ACT DR6	33.0 ± 1.0	97.2 ± 1.2	$3.1\,\sigma$
SPT-3G D1	32.47 ± 0.91	97.9 ± 1.1	$2.5\,\sigma$
Planck	31.45 ± 0.67	99.18 ± 0.84	$2.0\,\sigma$
DESI	29.76 ± 0.87	101.52 ± 0.73	

There is now a BAO-CMB tension

arXiv:2507.12459

The BAO-CMB Tension and Implications for Inflation

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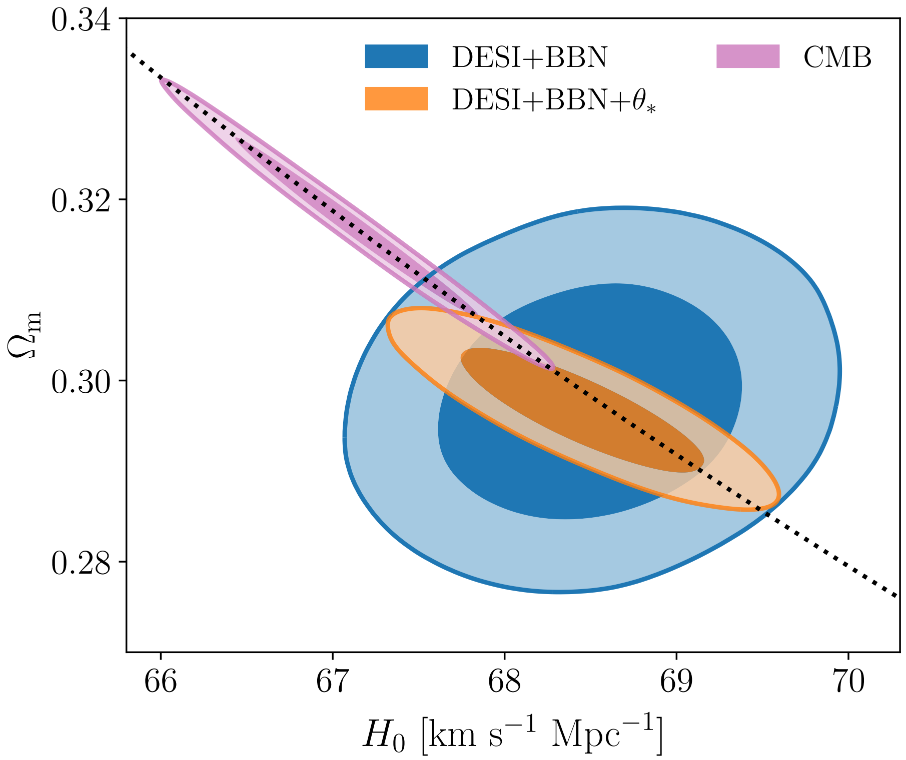
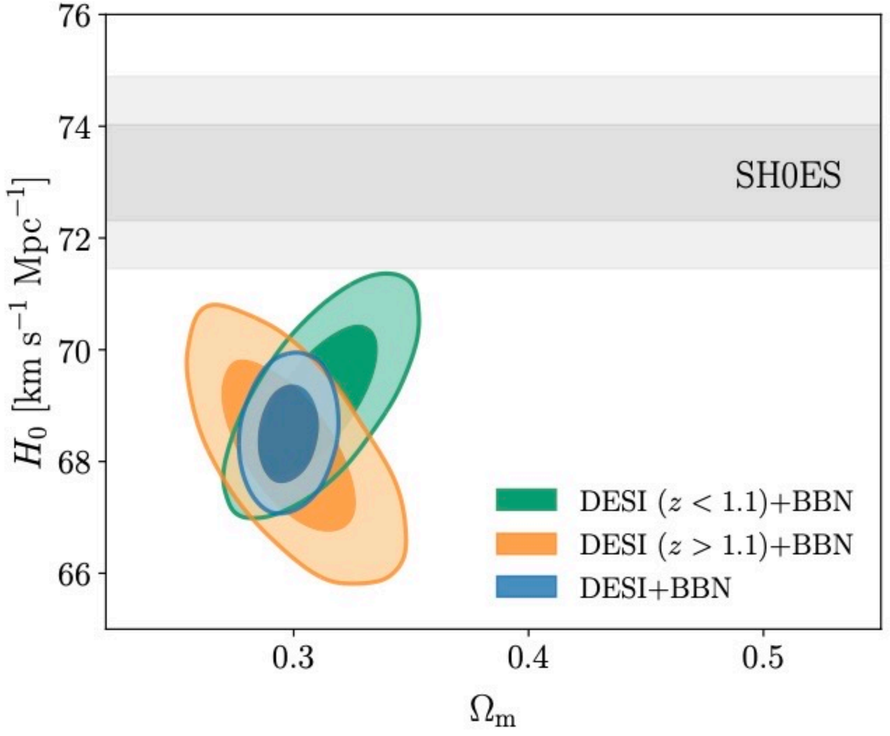
[2]*Center for Data-Driven Discovery, Kavli IPMU (WPI), UTIAS, The University of Tokyo, Kashiwa, Chiba 277-8583, Japan*
[3]*Department of Physics, University of Winnipeg, Winnipeg MB, R3B 2E9, Canada*
[4]*Sorbonne Université, CNRS, UMR 7095, Institut d'Astrophysique de Paris, 98 bis bd Arago, 75014 Paris, France*
[5]*Stanford Institute for Theoretical Physics, Stanford, CA 94305, USA*
[6]*Department of Physics and Astronomy, University of California, Davis, CA, 95616 USA*

The scalar spectral index n_s is a powerful test of inflationary models. The tightest constraint on n_s to date derives from the combination of cosmic microwave background (CMB) data with baryon acoustic oscillation (BAO) data. The resulting n_s constraint is shifted significantly upward relative to the constraint from CMB alone, with the consequence that previously preferred inflationary models are seemingly disfavored by $\gtrsim 2\sigma$. Here we show that this shift in n_s is the combined effect of a degeneracy between n_s and BAO parameters exhibited by CMB data and the tension between CMB datasets and DESI BAO data under the assumption of the standard cosmological model. Given the crucial role of n_s in discriminating between inflationary models, we urge caution in interpreting CMB+BAO constraints on n_s until the BAO-CMB tension is resolved.

Models that can relieve the BAO-CMB tension:
Dynamical DE, Modified recombination, curvature, A_{lens}, …

Constraints on the Hubble constant





- r_d calibrated using ω_b from BBN
- Complementarity of DESI tracers
- **4.5 σ** tension between DESI+BBN and SH0ES

Model/Dataset	Ω_m	H_0 [km s^{-1} Mpc^{-1}]
ΛCDM		
CMB	0.3169 ± 0.0065	67.14 ± 0.47
DESI	0.2975 ± 0.0086	—
DESI+BBN	0.2977 ± 0.0086	68.51 ± 0.58
DESI+BBN+θ_*	0.2967 ± 0.0045	68.45 ± 0.47
DESI+CMB	0.3027 ± 0.0036	68.17 ± 0.28

Constraints on Dark Energy

The nature of Dark Energy is encoded in the equation of state parameter and contribution to *H(z)* :

$$w = \frac{p}{\rho}$$

Cosmological constant: $w = -1$

Dynamical Dark Energy (Chevalier & Polarski 2001, Linder 2003)
General parametrization:

$w = w_0 + (1-a)w_a$ $\quad a = \frac{1}{1+Z}$ is the scale factor

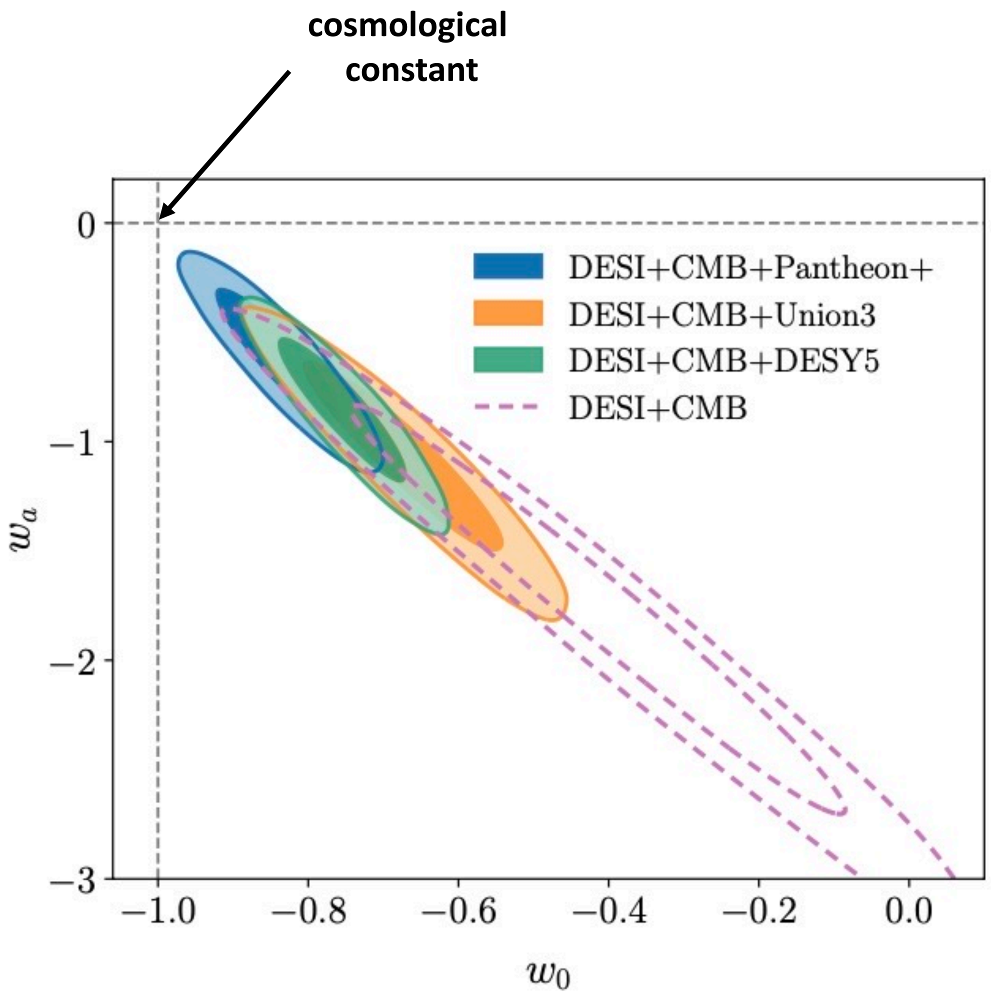
$$\frac{\rho_{\mathrm{DE}}(a)}{\rho_{\mathrm{DE},0}} = a^{-3(1+w_0+w_a)} e^{-3w_a(1-a)}$$

DESI + CMB :

3.1 σ preference for w_0w_aCDM over ΛCDM

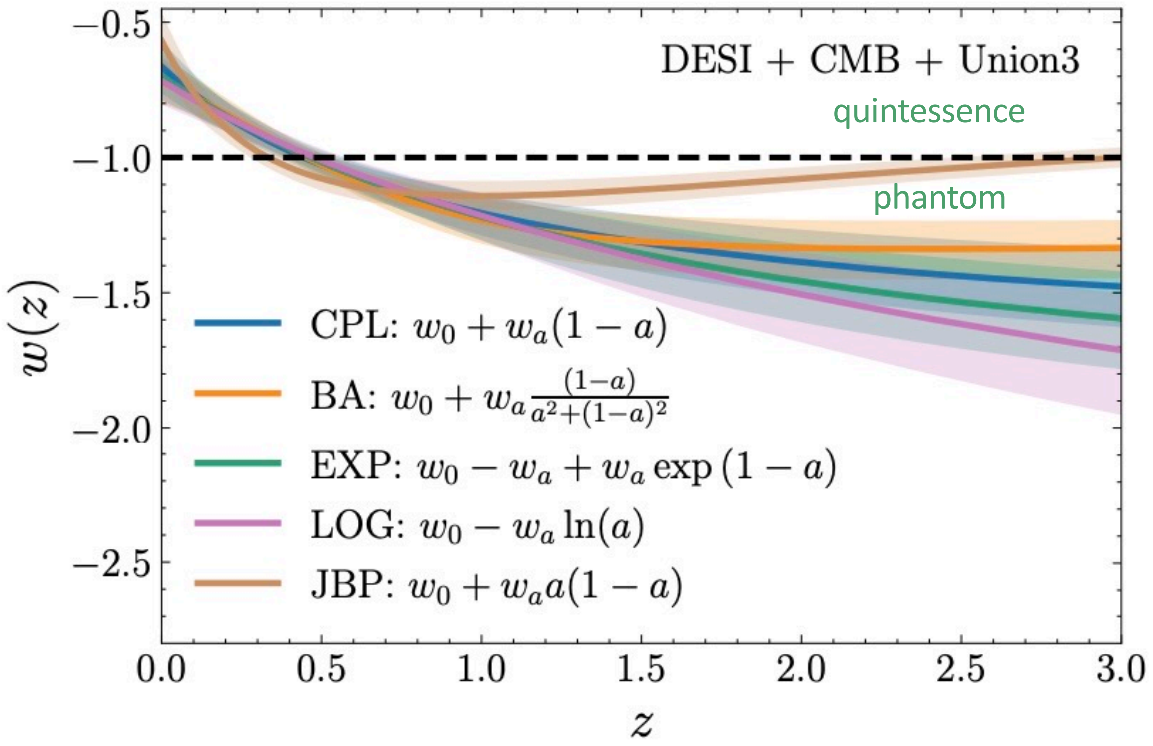
DESI + CMB + Type 1a Supernovae :

- DESI + CMB + **Pantheon+ : 2.8** σ
- DESI + CMB + **Union3 : 3.8** σ
- DESI + CMB + **DES Y5 : 4.2** σ



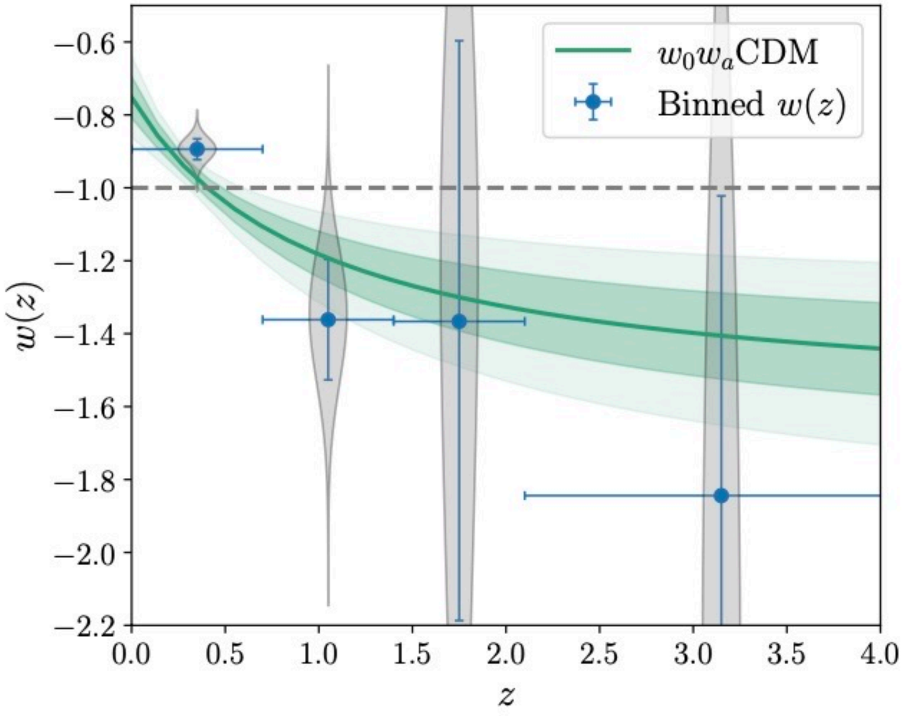
Further studies on dynamical dark energy

Changing w(a) parametrization :



- Similar results with gaussian process
- Data agrees with "mirage" DE model with <w> = -1

Binned w(z) :



- Signal is robust w.r.t. analysis choices
  - "Phantom" crossing at z ~ 0.4
  - Challenging for single scalar field DE models
- Sensitive to ~2 additional d.o.f.

Neutrinos and cosmology

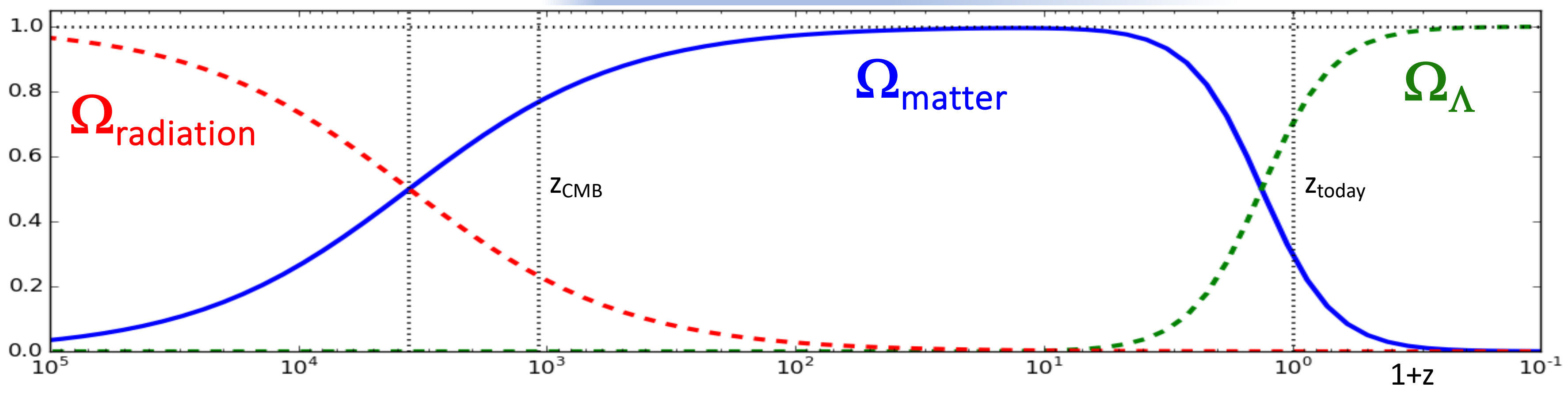
- At early times, neutrinos act as additional relativistic species

$$\frac{\rho_\nu}{\rho_\gamma} = \frac{7}{8} N_{\rm eff} \left(\frac{4}{11}\right)^{4/3}$$

- At late times, neutrinos behave as matter

- Non-relativistic transition: $z_{nr} \sim 1900 \frac{m_\nu}{1\,\mathrm{eV}}$

Latest KATRIN results m_{eff}<0.45 eV => z_{nr} < 800
N.O. lower value (degenerate mass) => z_{nr} > 40

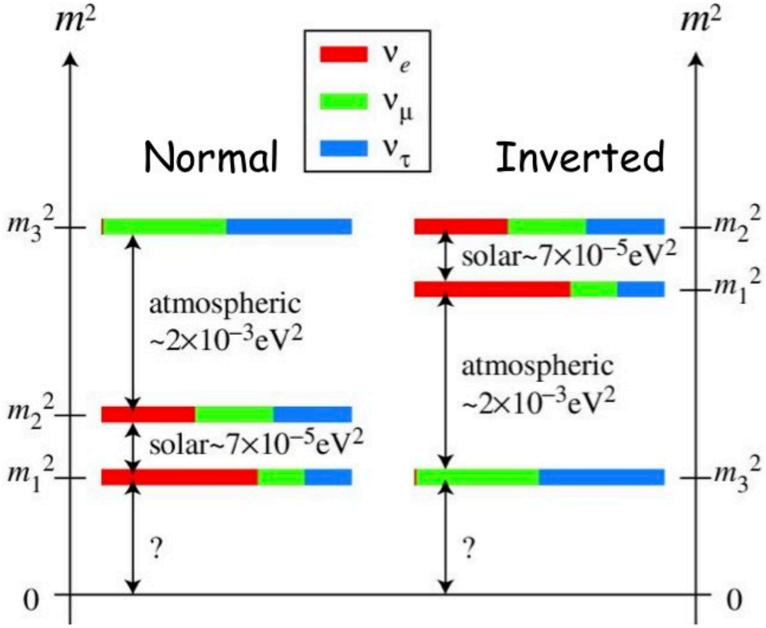


$$\frac{H^2(z)}{H_0^2} = \Omega_r(1+z)^4 + \Omega_m(1+z)^3 + \Omega_k(1+z)^2 + \Omega_\nu \frac{\rho_\nu(z)}{\rho_{\nu,0}} + \Omega_{DE}\frac{\rho_{DE}(z)}{\rho_{DE,0}}$$

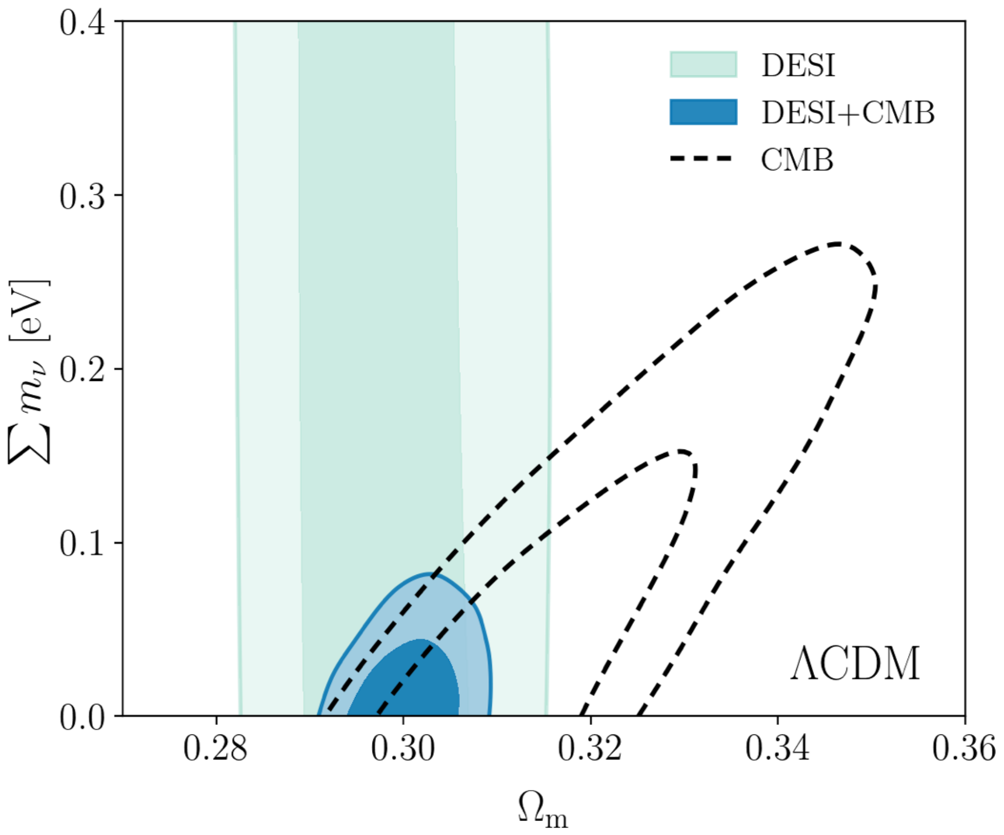
"Early" expansion history depends on the sum of neutrino masses

Constraints on the sum of neutrino masses in ΛCDM

In particle physics:
3 mass eigenstates and 3 flavor eigenstates
Solar neutrinos $m_2^2 - m_1^2$ ~ 7.5 10^{-5} eV^2
Atmospheric neutrinos $\left|m_3^2 - (m_1^2 + m_2^2)/2\right|$ ~ 2.4 10^{-3} eV^2



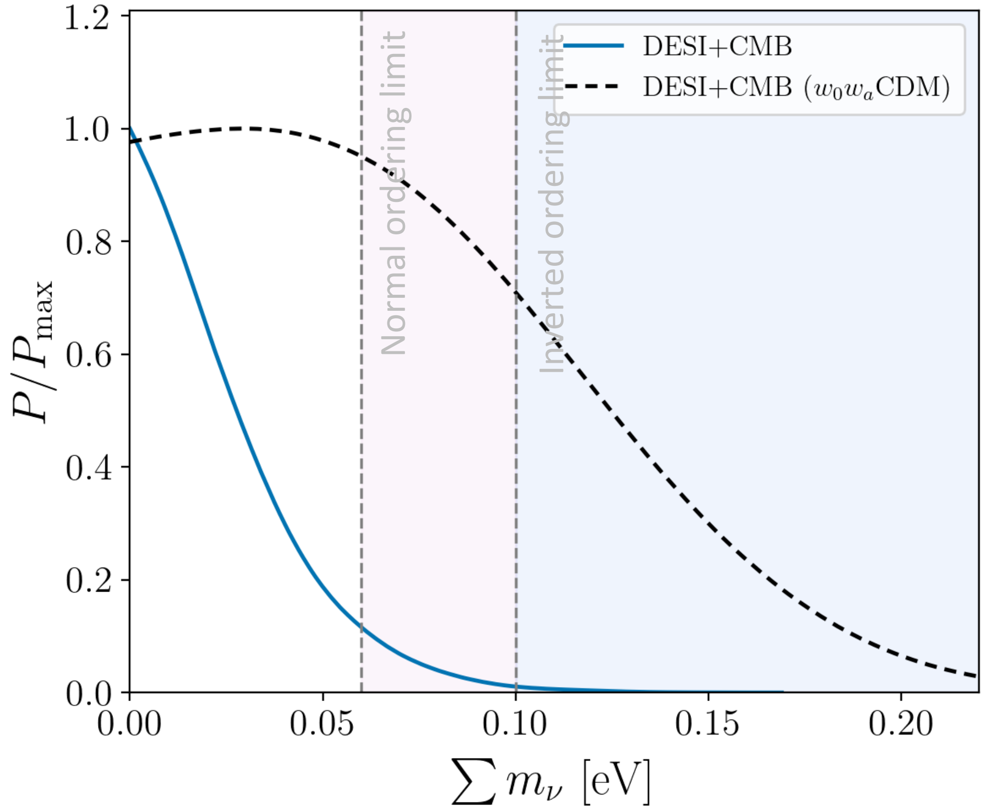
$\sum m_\nu$ > 0.06 eV $\sum m_\nu$ > 0.10 eV



- CMB data contraints are degenerate in the $\sum m_\nu$ vs Ω_m plane
- BAO data helps to break this degeneracy
- Lower Ω_m for BAO drives the constraint
- Quoted limits midly depend on ordering (DESI+CMB)

Constraints on neutrino mass in w_0w_aCDM

Why ? Alleviating the dependance in the assumed cosmological model



For DESI + CMB, the limit is :

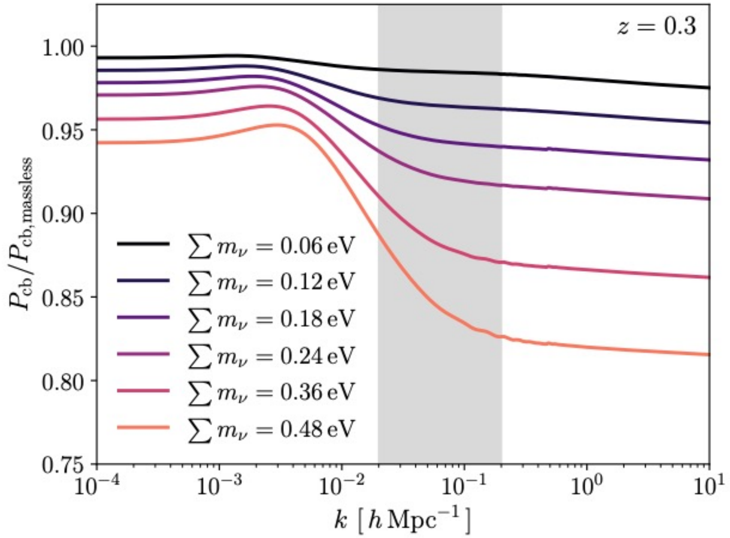
$$\sum m_\nu < 0.163\ eV\ (95\%, \mathrm{w_0w_aCDM})$$

For DESI + CMB + SN1a , the limits are :

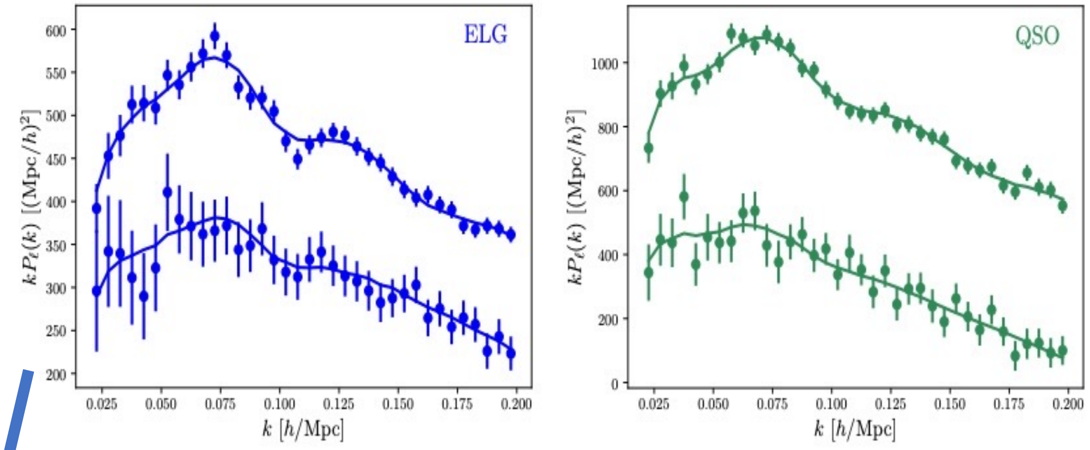
$$\sum m_\nu < 0.117 - 0.139\ eV\ (95\%, \mathrm{w_0w_aCDM})$$

Constraints on neutrino mass from Power spectrum

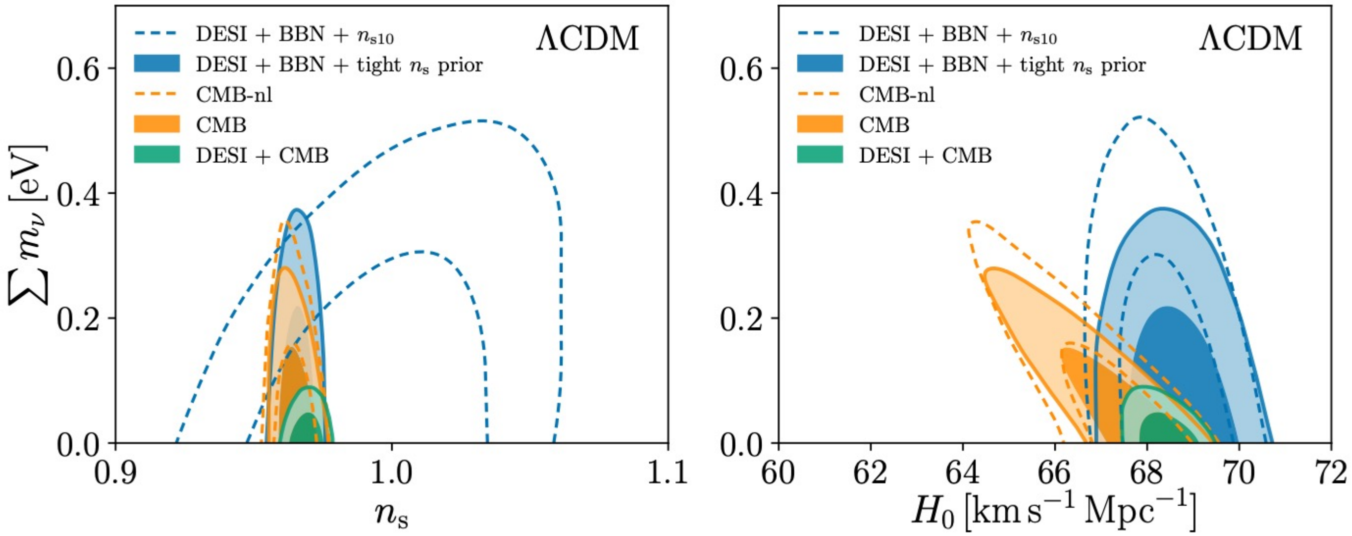
Damping of power at small scales
due to free-streaming of neutrinos



Full-shape power spectrum measurement

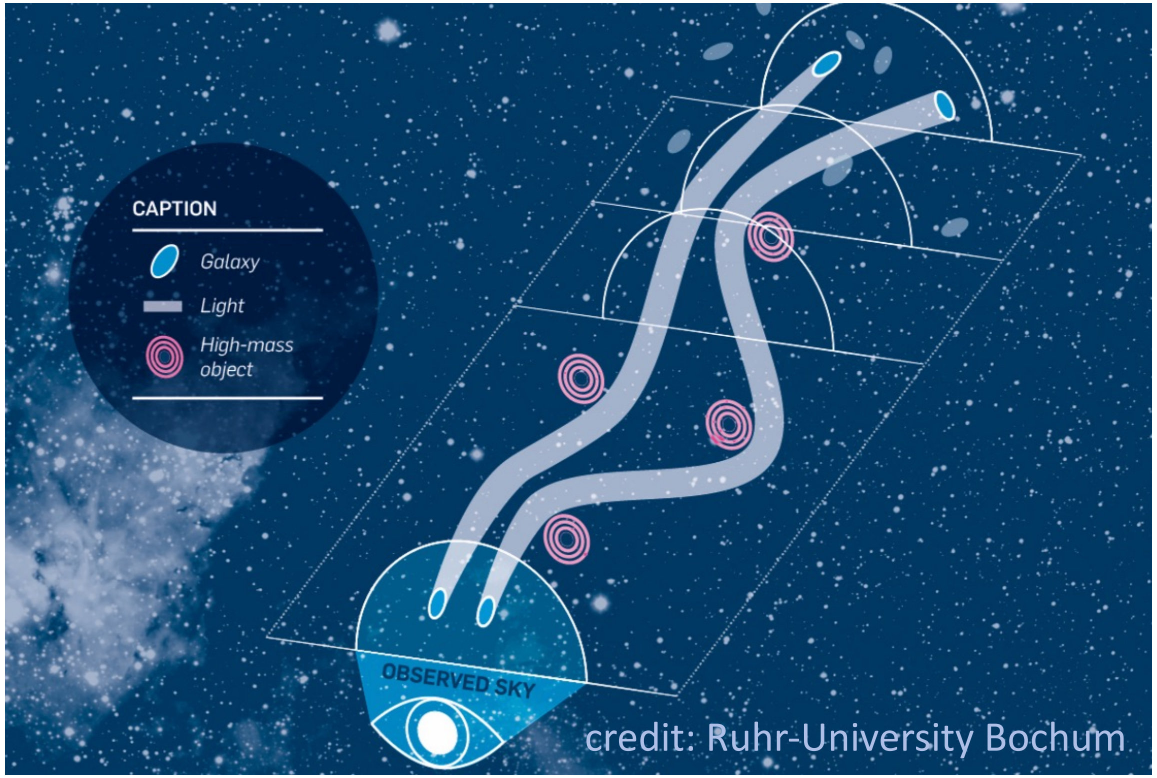


DESI +BBN + n_s constrain sum of neutrino mass

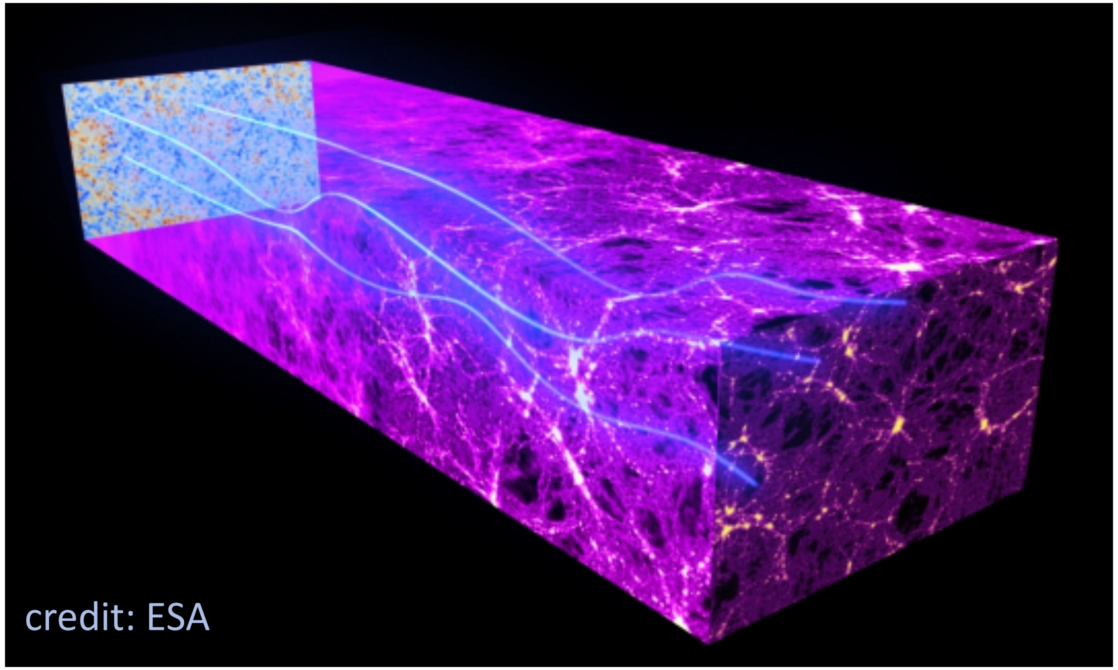


Lensing Observables

Galaxy-Galaxy lensing - weak shear : Propagation through similar structures imprints coherent distortions on galaxy shapes

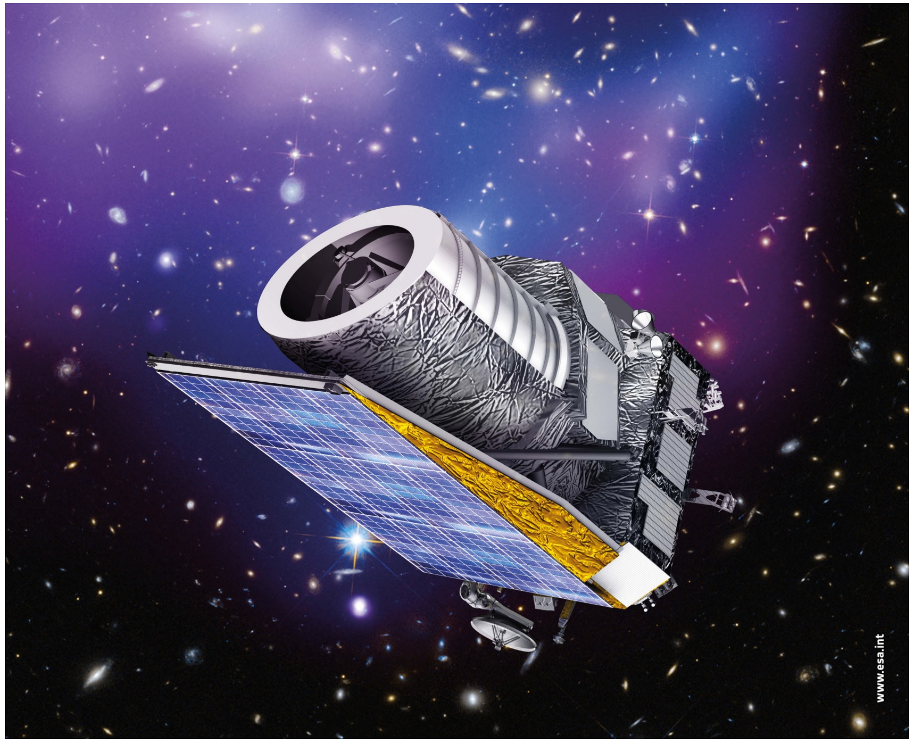


CMB-Galaxy lensing : deflection by the gravitational lensing effect of massive cosmic structures changing 'shapes' of hot and cold spots CMB structures

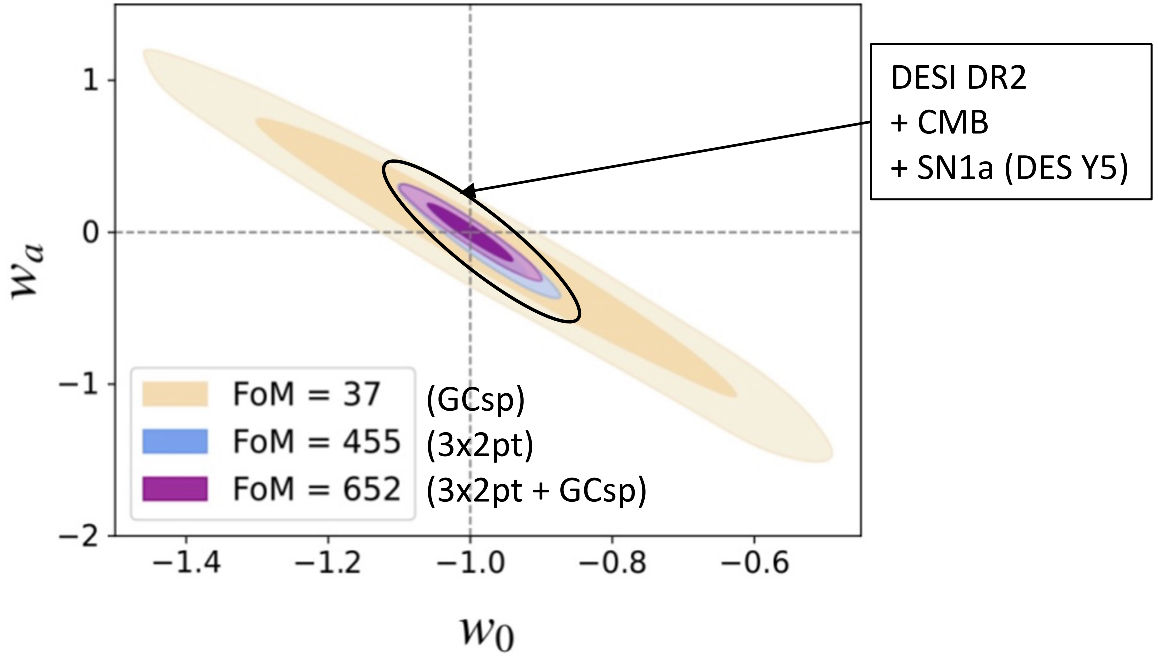


Upcoming results from Weak Lensing Surveys

EUCLID (inc. P2I):
- Spectroscopic and imaging instruments
- Mirroir 1.2 m, 0.55–2.0 µm
- Taking data ! Image quality fantastic



Weak Lensing:
constraints on Dark Energy
from the complete Euclid (Forecast, 2030+)

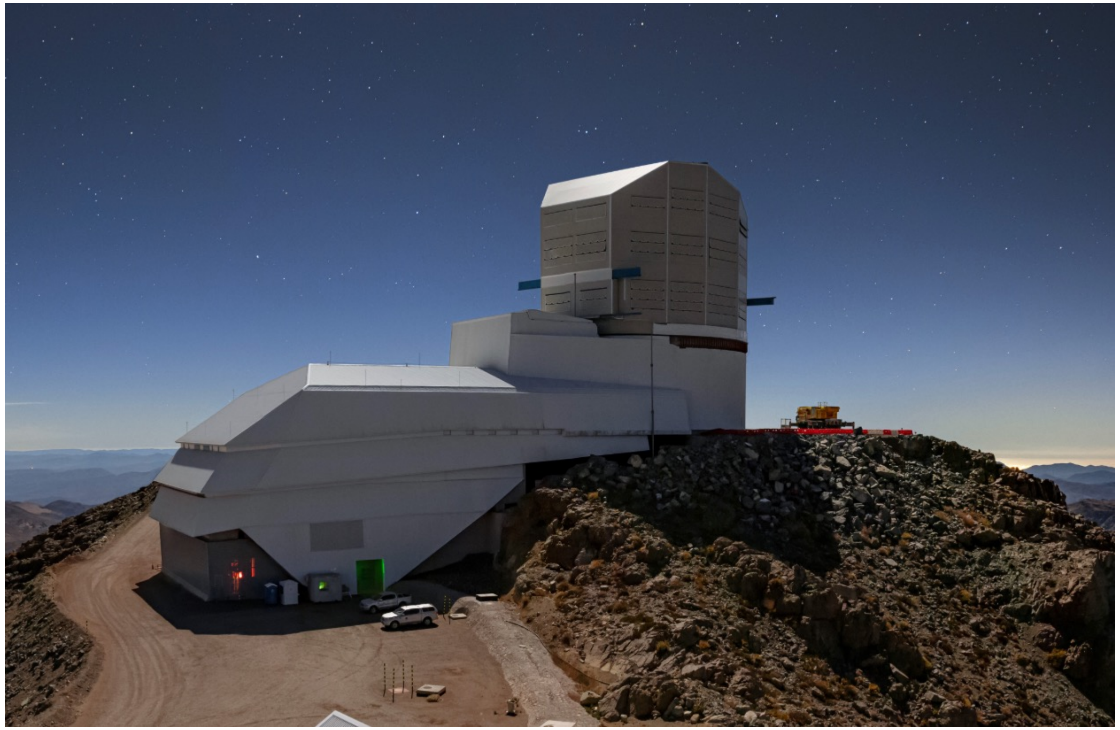


Euclid DR1 (2027) : similar as DESI DR2

Upcoming Weak Lensing Surveys

Vera Rubin - LSST (inc. P2I):
- Mirroir 8m, imaging du ciel complet tous les 3 jours
- Weak Lensing, Supernovae and more
- Taking SV data – Starts survey in 2026
- First data release in 2028

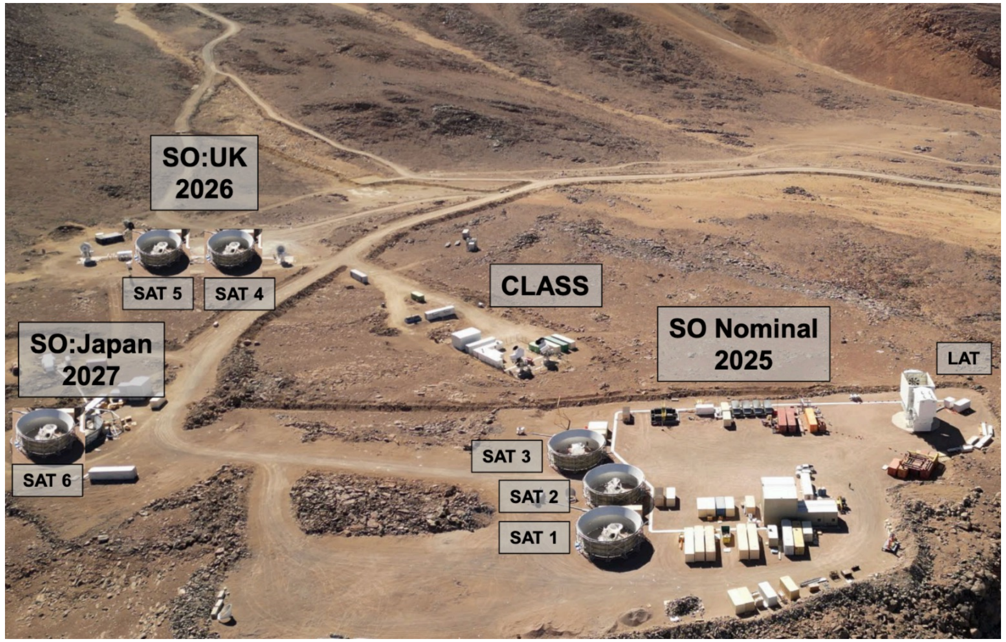
Nancy Grace Roman Telescope
- Launch end of 2026
- Mirroir 2.4 m, 0.48–2.30 µm, imaging

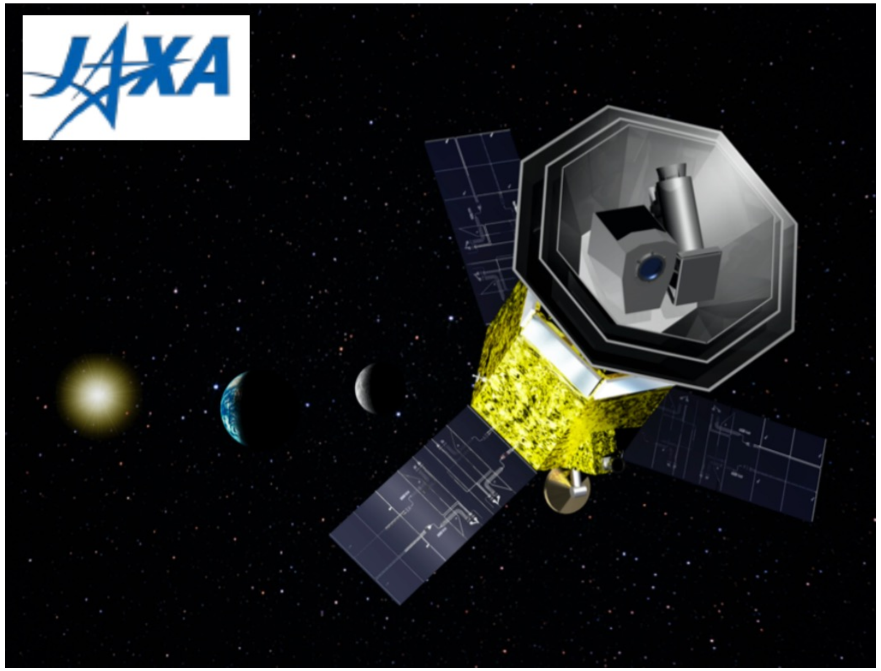


CMB upcoming experiments

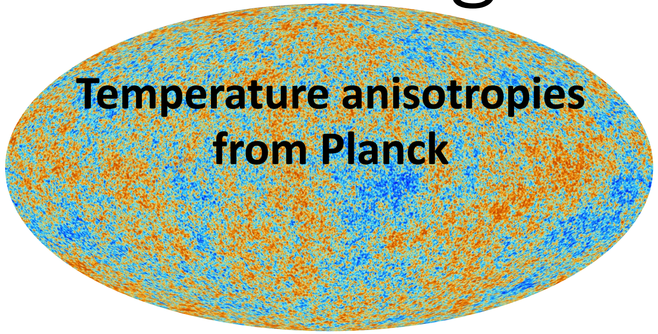
Simons observatory (US++, inc P2I):
- Taking data !
- Discussion for a French (inc. P2I) SAT : Kairos project

LiteBird (Japan++, inc. P2I):
- Rescoping the project, on sky in 2030s
- Important french contribution



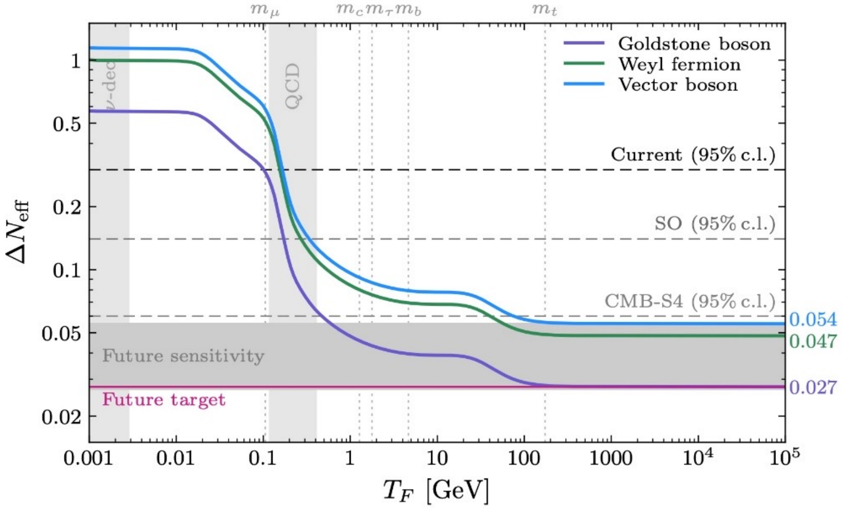


Cosmic Microwave Background
- Science goals -

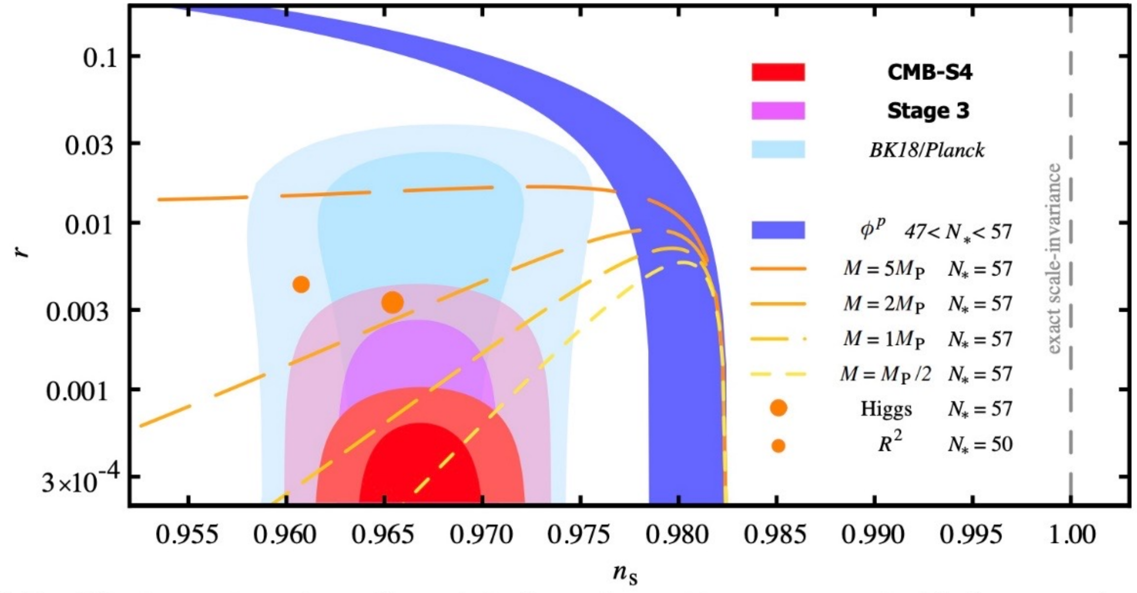


Tremendous science reach
- Primordial Universe
- Fundamental physics
- Matter in the Universe

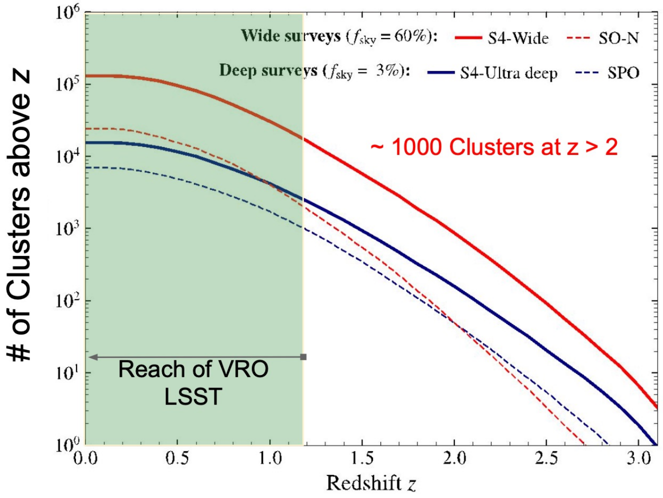
Search for light relics particle BSM
in combination with LSS constraints



- **Search for B-modes**, signature of primordial gravitational waves = > Constrain **inflation** scenarios



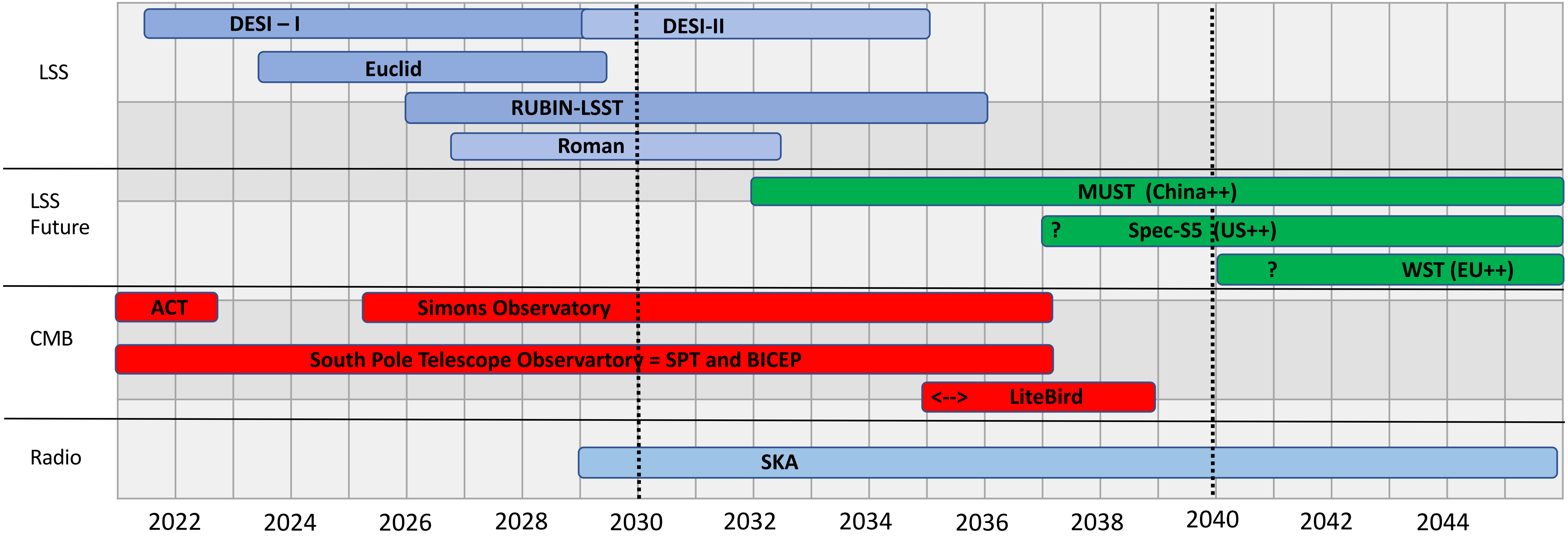
High redshift clusters



Synergy with the Athena X-ray mission
(beyond XMM+Euclid)

- **Cosmological science for the next decades:**
  - Expansion of the Universe
  - Establish the inflationary model
  - Standard model physics
  - Matter in the Universe

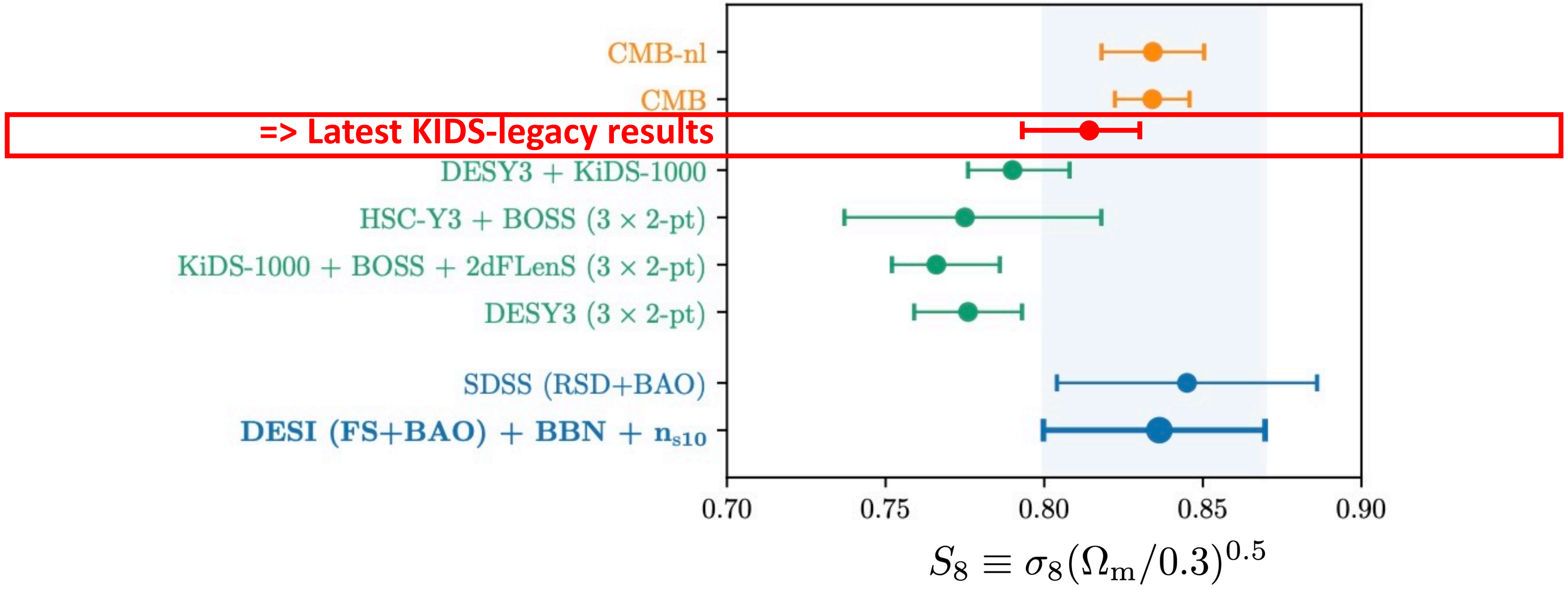
Timeline:



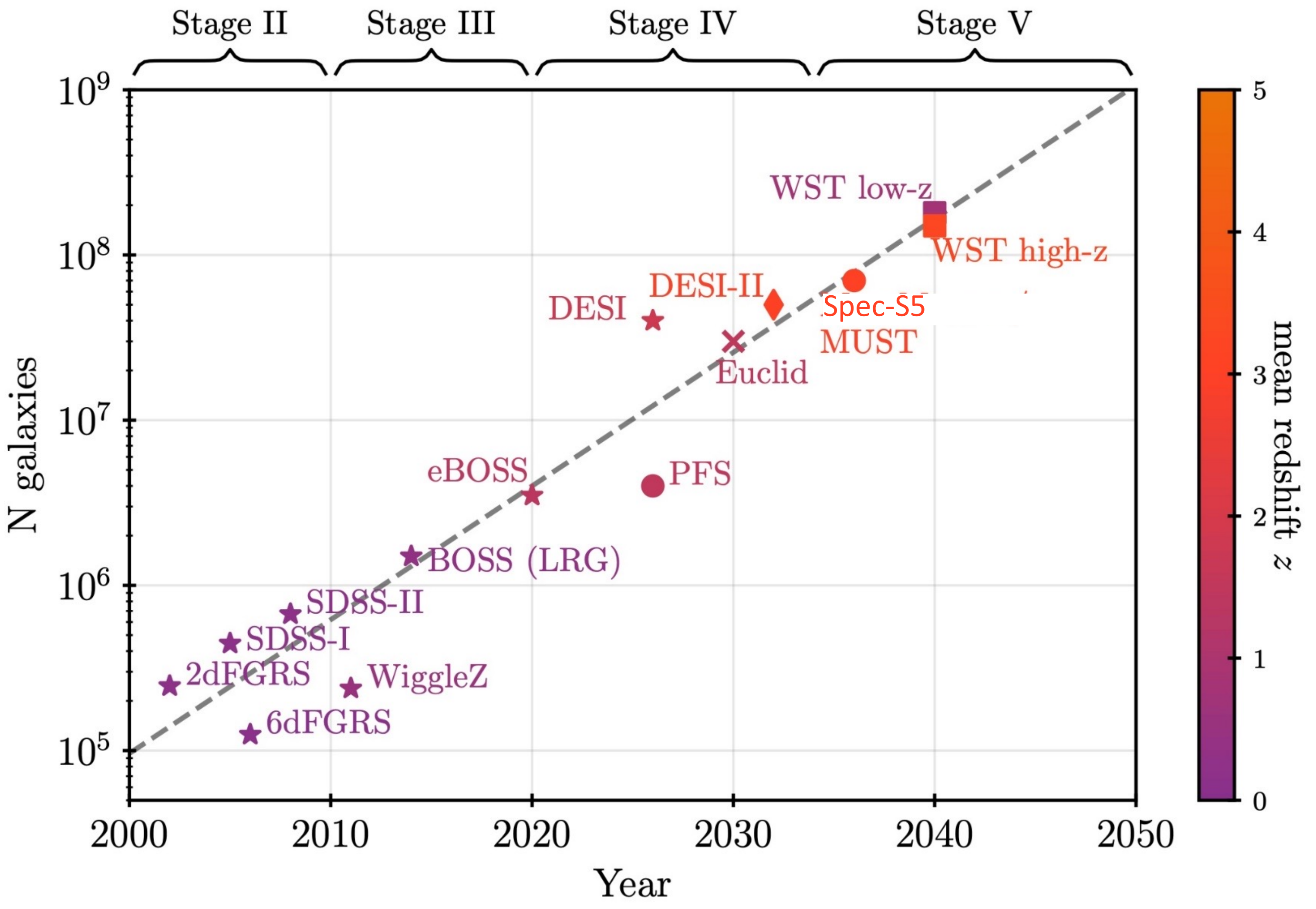
Conclusions

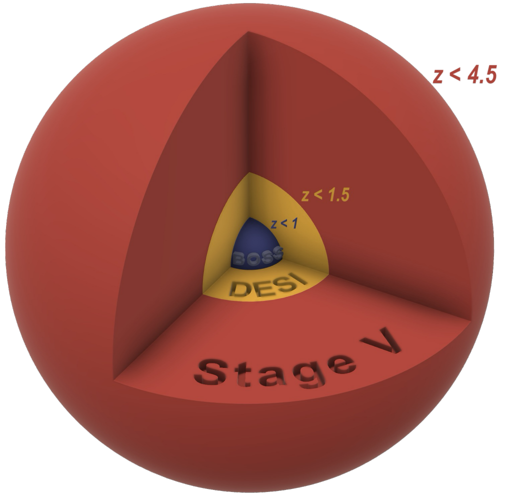
- Des progrès très importants en cosmologie cette année
  - LSS: DESI, CMB: ACT and SPT
- Des signes que le modèle ΛCDM n'est pas complet ?
  - Tension à ~ 3σ entre le CMB et les relevés de galaxies
  - Une énergie noire dynamique (surprenante) peut expliquer cette tension
  - Les SN1a confirment cette interprétation
- Les contraintes sur la somme des masses des neutrinos sont compétitives
- De nombreux résultats à venir :
  - Weak Lensing surveys
  - Fond diffus cosmologique
  - Supernovae Type 1a (Zwicky Transient Factory)
  - DESI DR3
  - Corrélations croisées entre les différentes sondes

Tension on growth is vanishing…



Future of Large Scale Spectroscopic Surveys





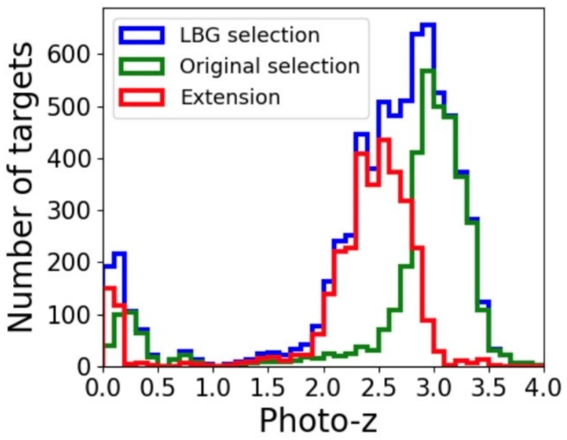
- **10-fold increase every decade**
- **Goals of future programs**
  - High-density low-redshift
  - High redshift
    - ➔ Largest Universe volume

LSS – 2029-2035 DESI-II

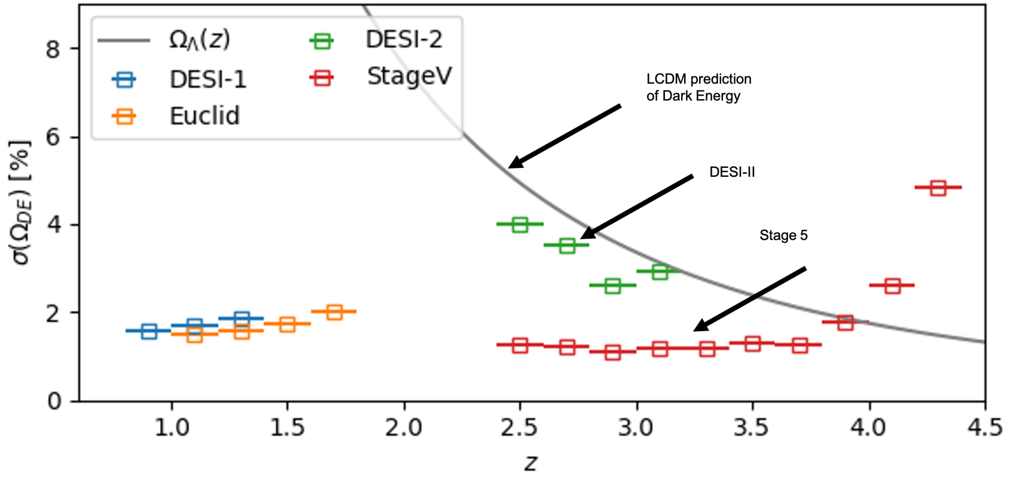
DESI-II (after a 2.5 extension of DESI)

- **a pathfinder for Stage-5 spectroscopic surveys**
- Modest hardware upgrades
- **Low-z program:**
  - ~20x density of DESI
  - Growth of structures
  - Modified gravity
  - Challenge for theoretical models
- **High-z program 2 < z < 3.5:**
  - New tracers : star forming galaxies (LAE, LBG)
  - Onset of Dark Energy
  - Non-gaussianities

DESI-2 high-z target selection



Onset of Dark Energy



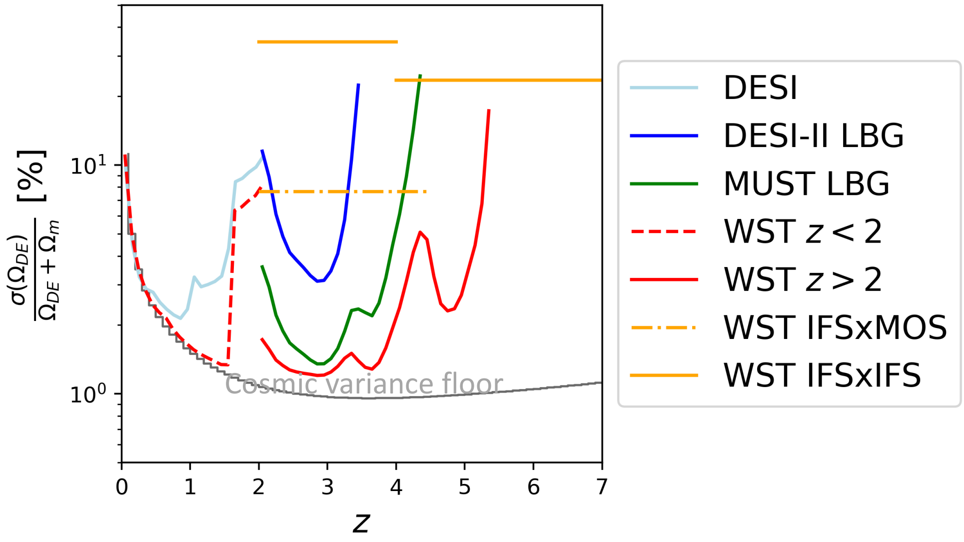
Constantin Payerne (Postdoc)
Henri Coquinot (Césure)
Maxime Devin-Pinson (Césure)

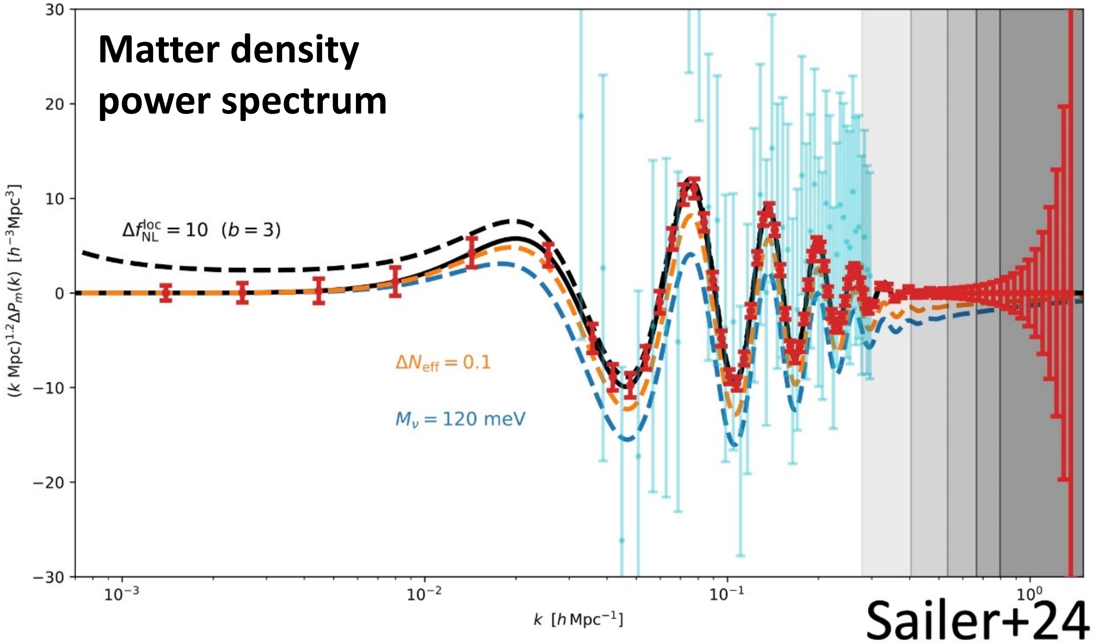
Leading role from cea irfu

LSS – “Stage 5” surveys (>2035)

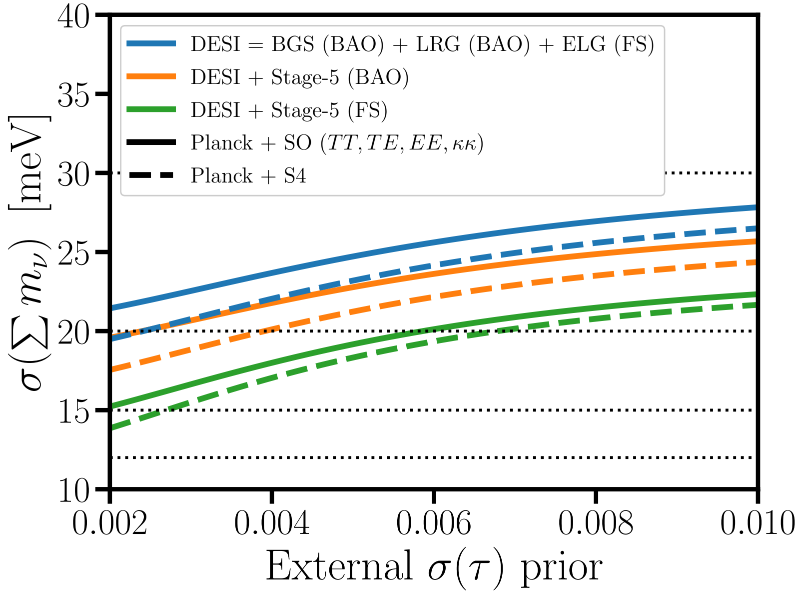
Key science goals

- “Saturate” cosmic variance up to z = 4
- σ(**DE**) < 2% → Rule out EDE models
- σ(**Σm$_\nu$**) < 15 meV → 4σ detection,
- non-gaussianities :
  - Distinguish single and multi-field **inflationary models**

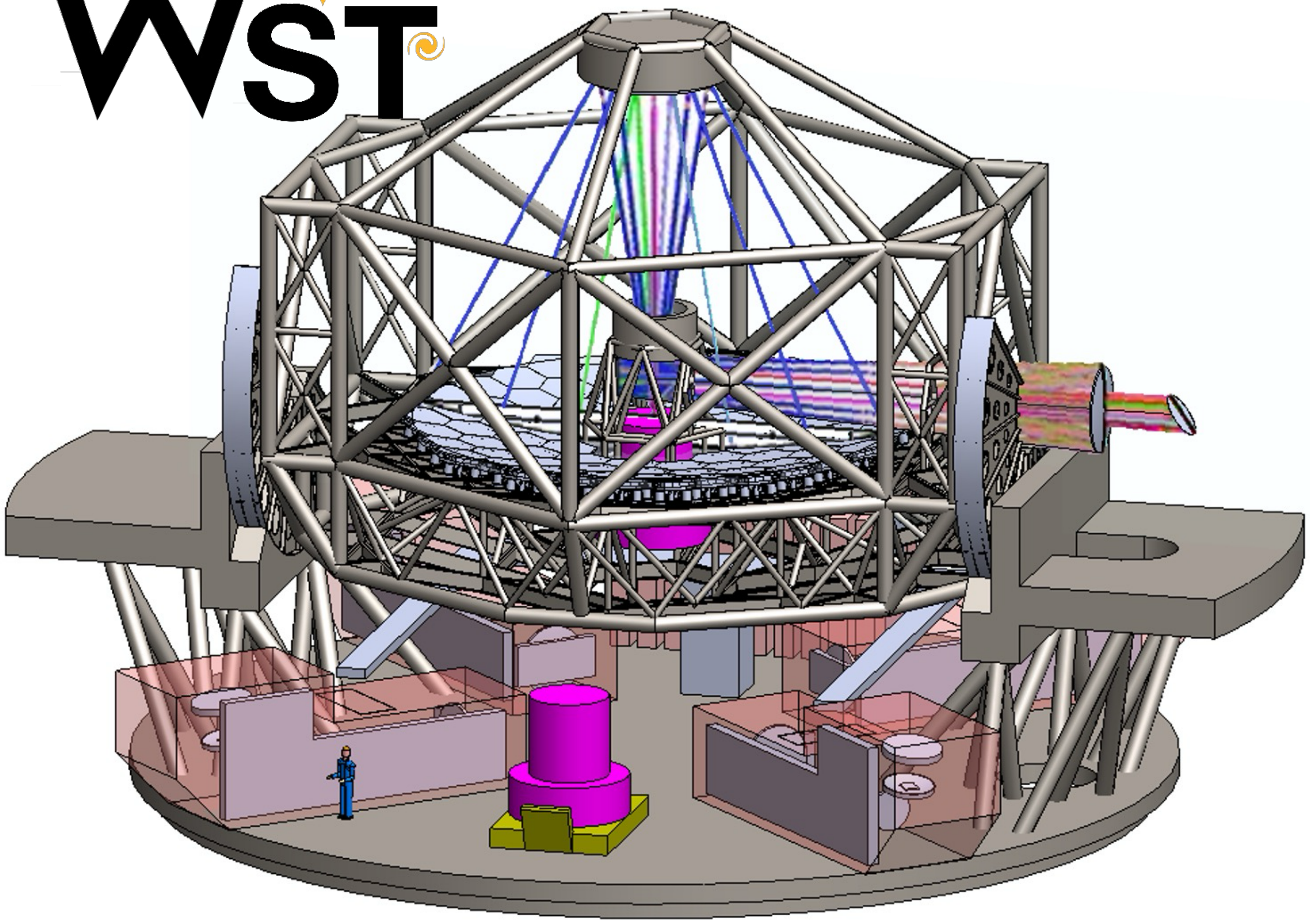




Sailer+24



The Wide-field Spectroscopic Telescope



The ultimate spectroscopic telescope :

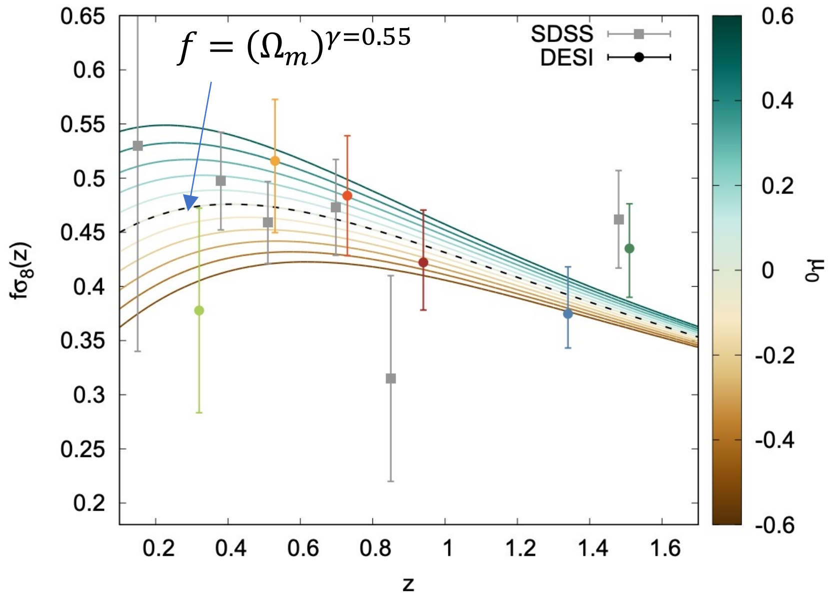
- 12m segmented Telescope – 3 deg^2 field of view
- Spectroscopic capability:
  - 20000-fiber Multi-Object Spectrograph
  - 9 $arcmin^2$ Integrated Field Spectrograph
- In Chile
- **Supported by ESO community**

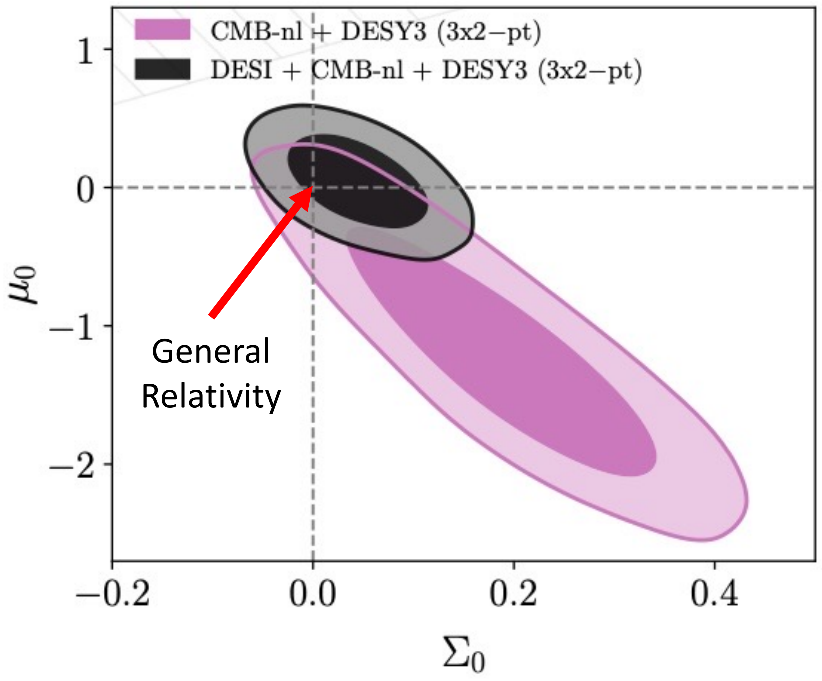
Timeline :

- Received EU funds for a 3-year concept study phase ("Horizon", -> Jan '28)
- ESO selection Q3 '28
- **ESO approval Q4 '28**
- First light 2040

DESI DR1 Full-Shape analysis – Test of GR

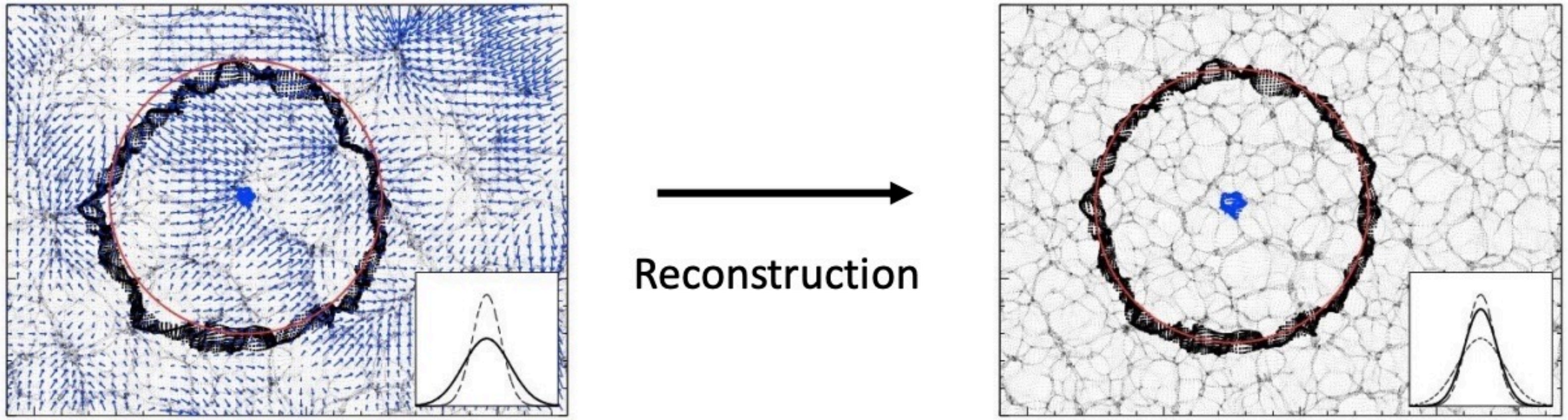
https://arxiv.org/pdf/2411.12022



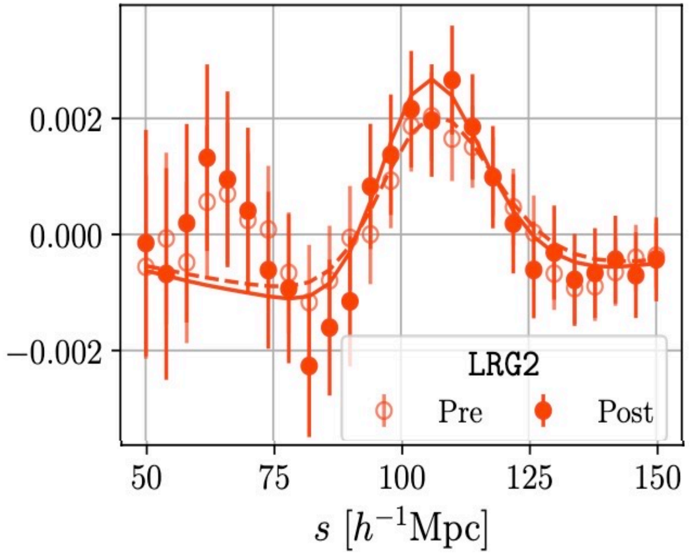


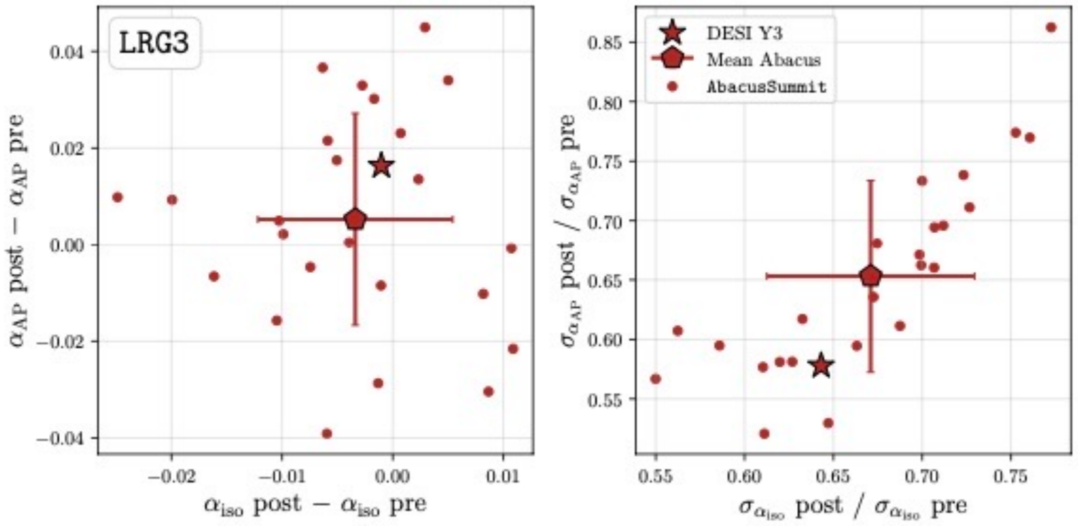
DESI DR2 Full-Shape results : Spring 2026

Density field reconstruction



- Galaxies move in the density field
- Displacement field determined from the tracer field in Zel'dovich approximation (1st order)





Improvement in precison :
10% to 40%
depending on tracer

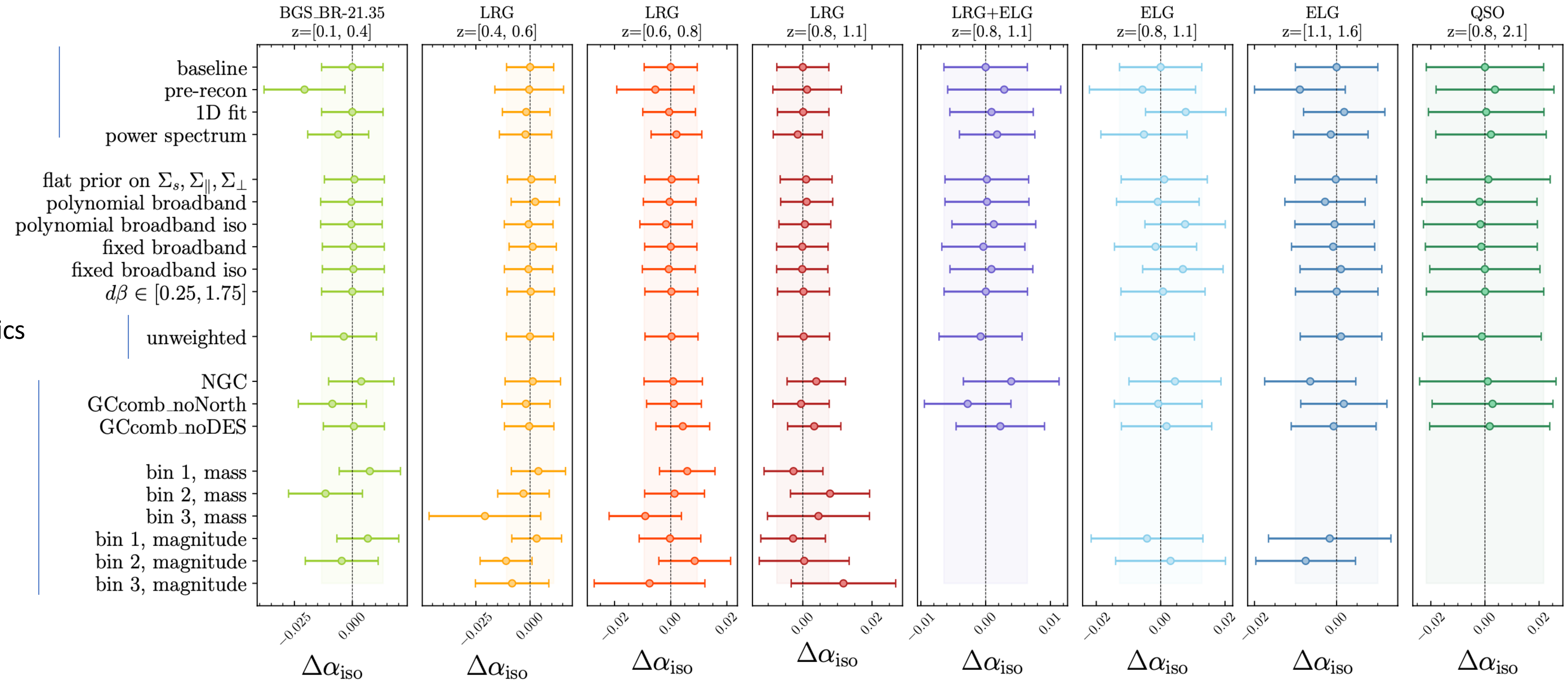
Systematics checks in BAO measurements

Data vector

BAO model

Imaging systematics

Data splits



Simulation (mocks) based systematics estimate :

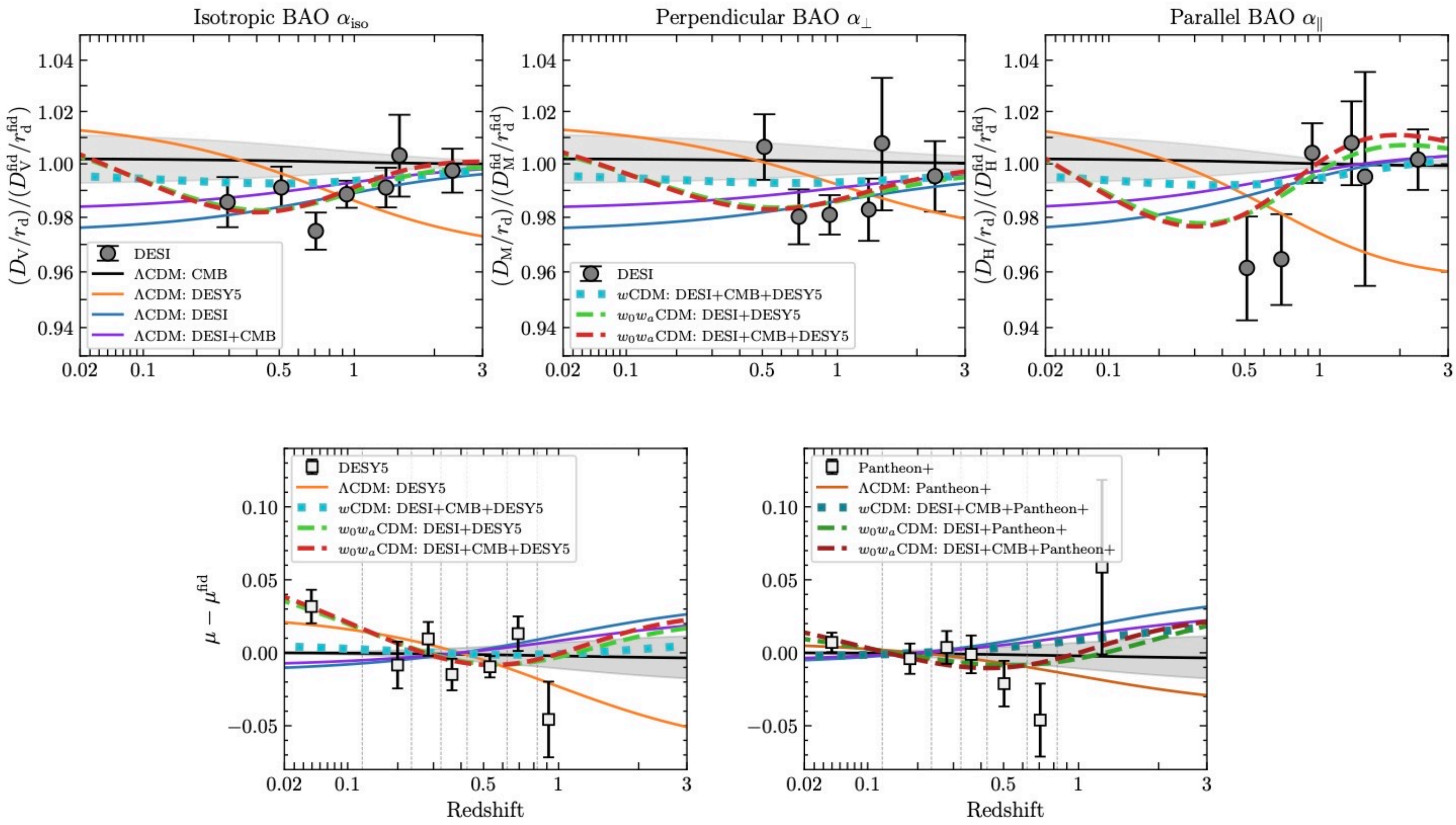
BAO model
Galaxy-halo connection
Choice of fiducial cosmology

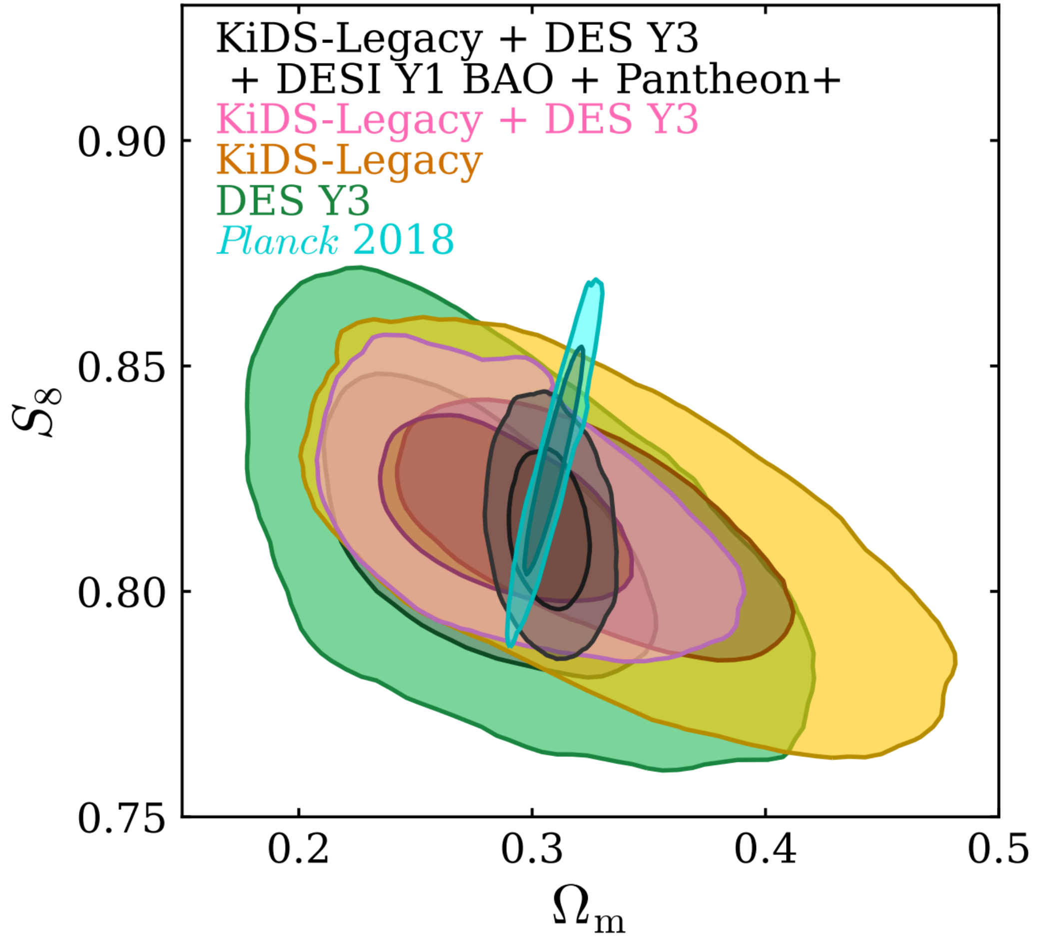
Total systematic errors :
0.2 % on α_{iso}, 0.3 % on α_{AP}
Limited by mock precison

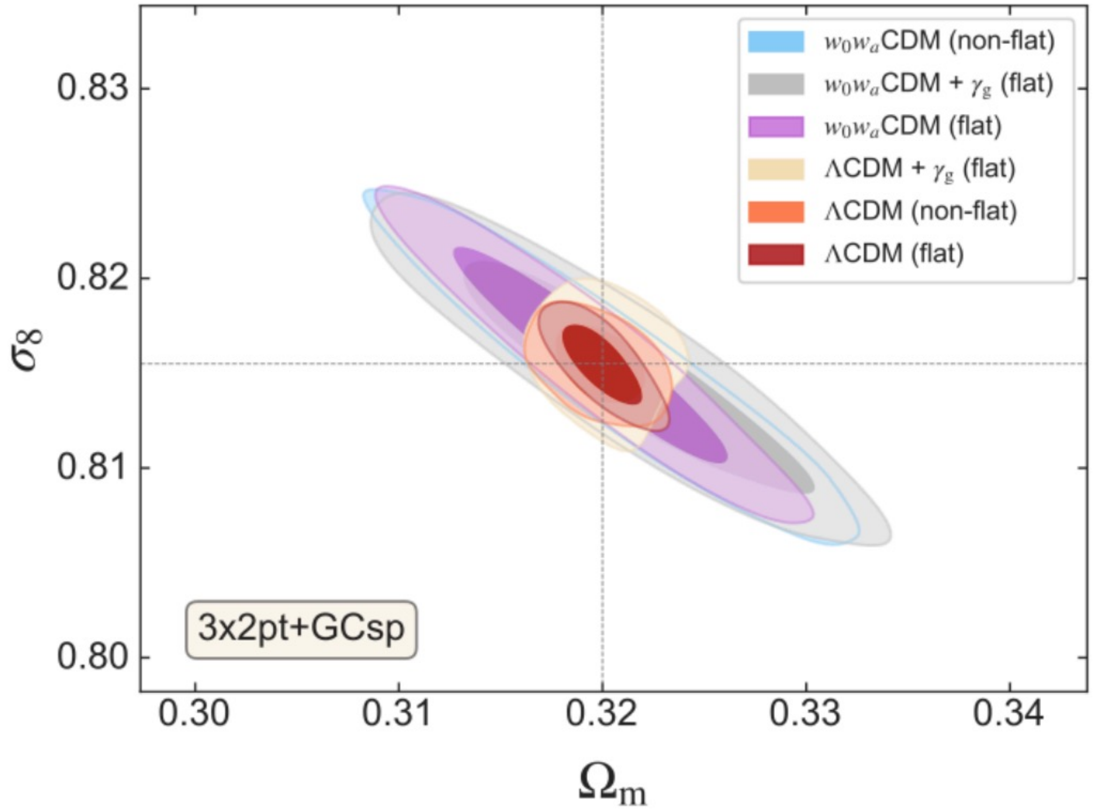
Antoine Rocher (PhD)
Mathilde Pinon (PhD)

Ly-alpha systematic errors : 0.3 % on α_{par}, 0.3 % on α_{perp} (non-linear evolution of the peak)

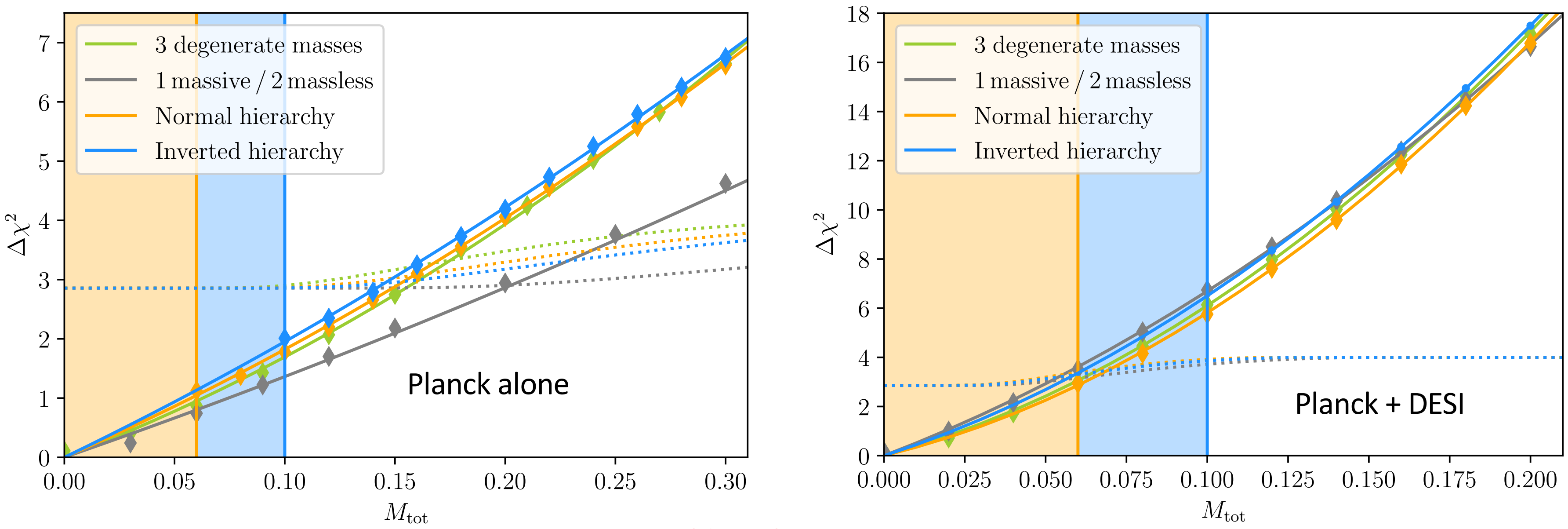
Fits of available data




KiDS-Legacy + DES Y3
+ DESI Y1 BAO + Pantheon+
KiDS-Legacy + DES Y3
KiDS-Legacy
DES Y3
Planck 2018
0.90
0.85
0.80
0.75
S_8
0.2
0.3
0.4
0.5
Ω_m


w_0w_aCDM (non-flat)
w_0w_aCDM + γ_g (flat)
w_0w_aCDM (flat)
ΛCDM + γ_g (flat)
ΛCDM (non-flat)
ΛCDM (flat)
3x2pt+GCsp
0.83
0.82
0.81
0.80
σ_8
0.30
0.31
0.32
0.33
0.34
Ω_m

Impact on neutrino mass fits



Laura Herold et al. arXiv:2412.03546

- ➢ Small difference for the 4 options
- ➢ Boltzmann solvers are faster with degenerated cases
- ➢ For fit in of Sm_n we use the (degenerate 3n) configuration.

- ➢ In near future, we should consider the NO/IO