

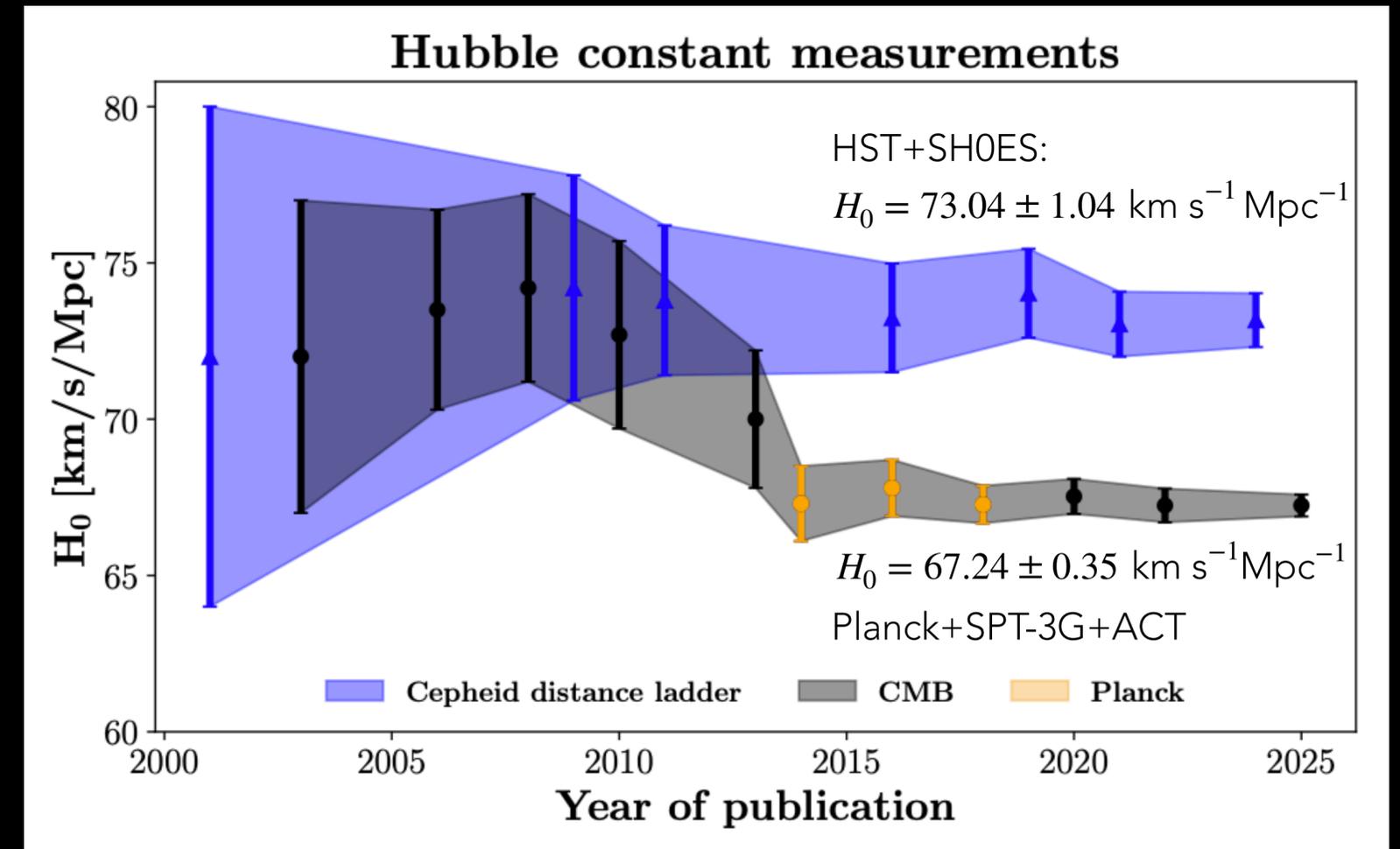
MASSIMO MENEGHETTI (INAF-OAS BOLOGNA)

THE COSMOLOGICAL MODEL, DARK MATTER AND DARK ENERGY

INSIGHTS ON COSMOLOGICAL TENSIONS FROM GALAXIES AND GALAXY CLUSTERS

H0 TENSION

- **What is the precise value of the Hubble constant?**
- **Directly measured** by fitting a cosmological model to distance (i.e. in the late universe)
- **Indirectly measured** from angular scales that characterize the early universe (sound horizon at recombination/drag epoch), assuming a cosmological model (from the acoustic peaks in the CMB power-spectrum or from BAO)
- The two methods disagree at $\sim 5\sigma$! Local ladder demands faster expansion today!



N. Schöneberg, Corfù 2025

$$\theta_{\star} = \frac{H_0 r_{\star}}{\int_0^{z_{\star}} 1/E(z) dz}$$

↘ Pre-recombination
↘ Late expansion

$$E(z) = \sqrt{\Omega_{m,0}(1+z)^3 + \Omega_{DE}(z) + \dots}$$

$w_0 - w_a$ TENSION

- **Is dark energy a cosmological constant?**
- Recently, DESI+CMB+SN combinations hint at $w(a)$ not equal to -1 ($>3\sigma$ evidence):

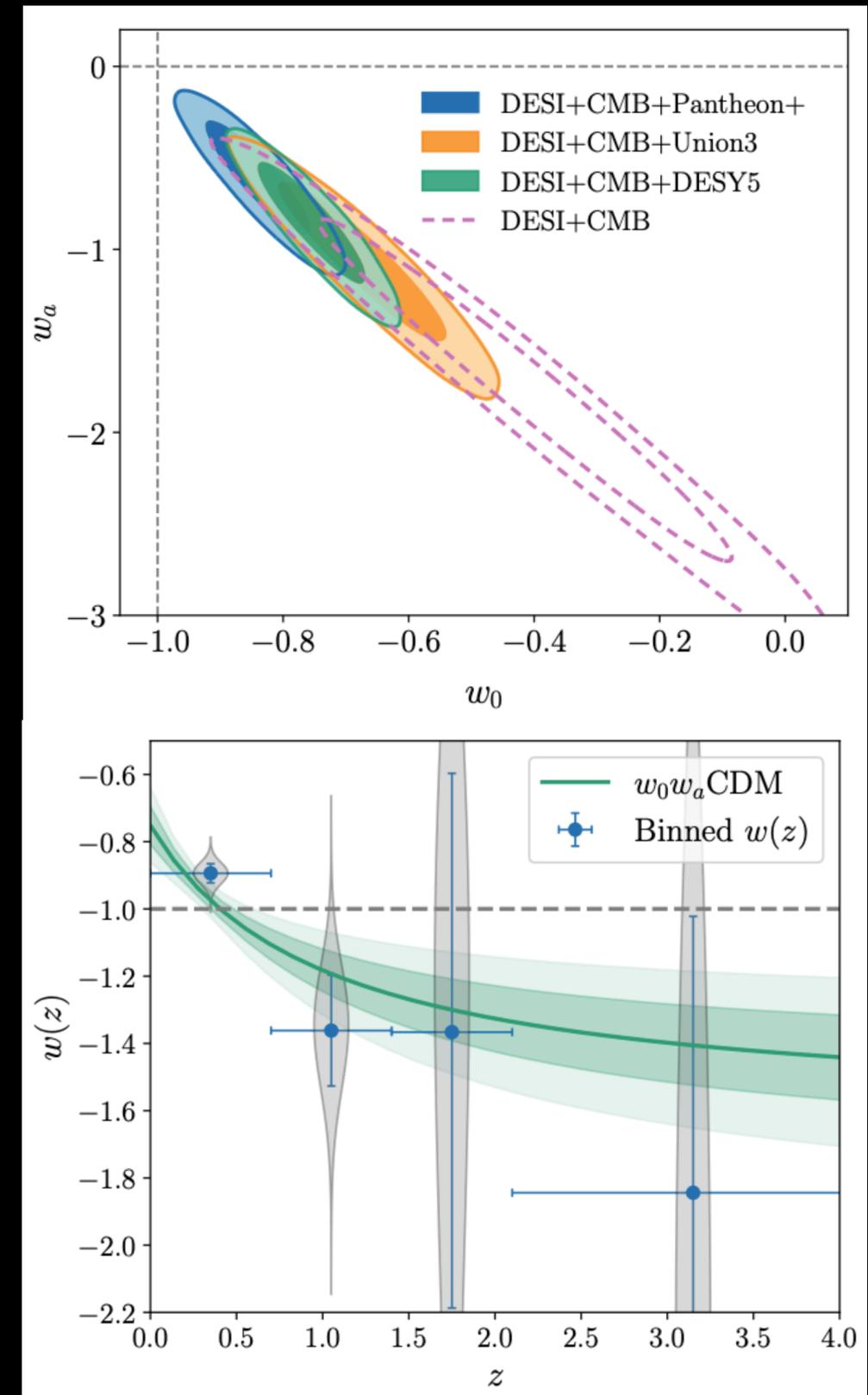
$$w(a) = w_0 + w_a(1 - a) \text{ (CPL)}$$

$$w_0 > -1, w_a < 0$$

This implies that DE is weaker than a cosmological constant at $z \lesssim 0.5$

- $H_0 = 67.51 \pm 0.59 \text{ km s}^{-1} \text{ Mpc}^{-1}$ ($w_0w_a\text{CDM}$, DESI+CMB+Pantheon+)
- Less freedom to solve the H_0 tension with late-time physics (e.g. phantom dark energy)!

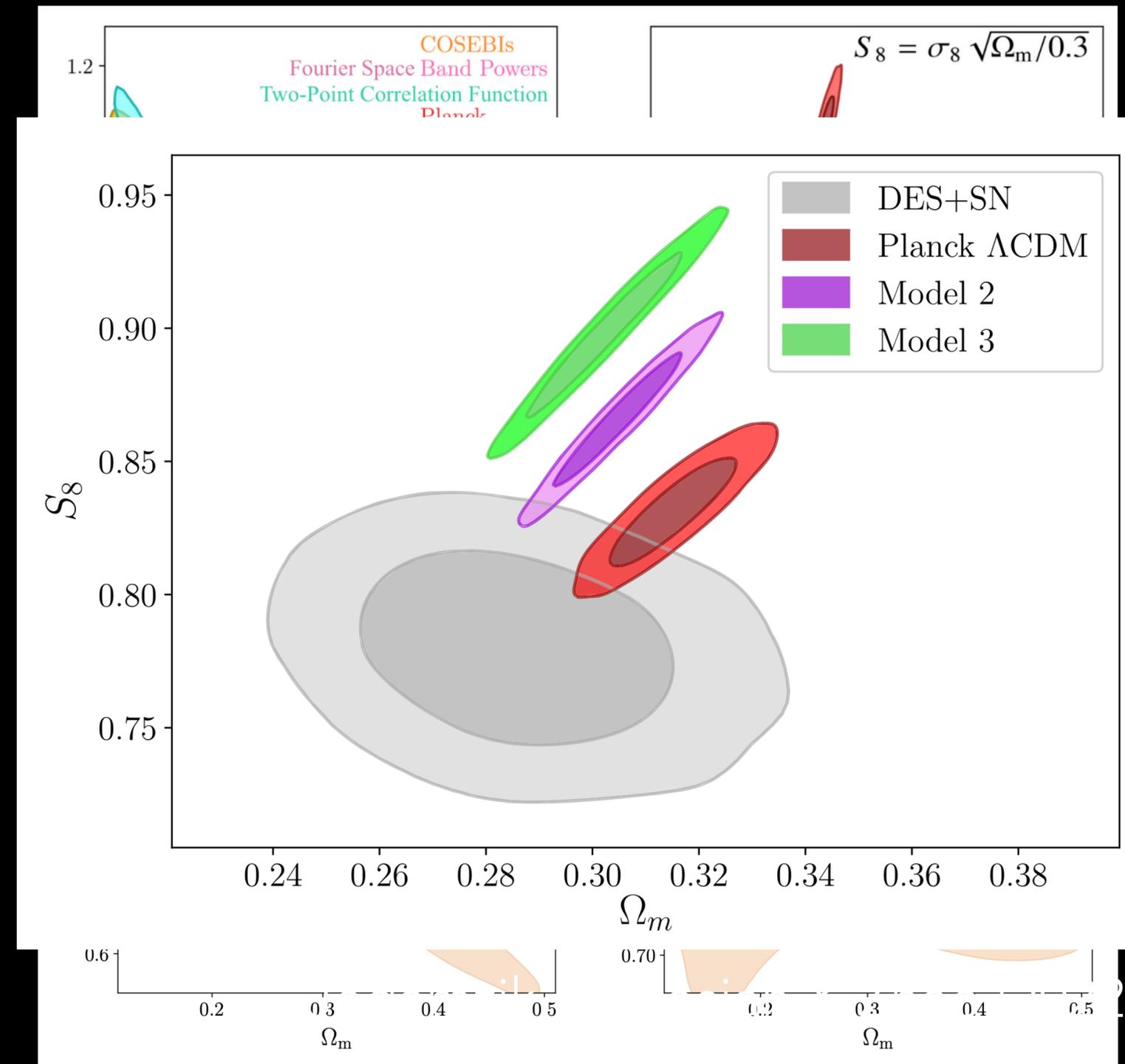
DESI DR2 BAO (DESI coll. 2025)



THE S8 TENSION

- **Does the clustering amplitude agree with LCDM predictions?**
- $S_8 = \sigma_8 \sqrt{\Omega_m / 0.3}$
- CMB observations support higher values of S8 compare to later-time probes of structure formation (cosmic shear from KiDS, DES, HSC)
- Milder tension (at $\sim 2\sigma$) compared to the previous tension on H0 and DE
- Could get worse when trying to solve the H0 tension with early-time physics!

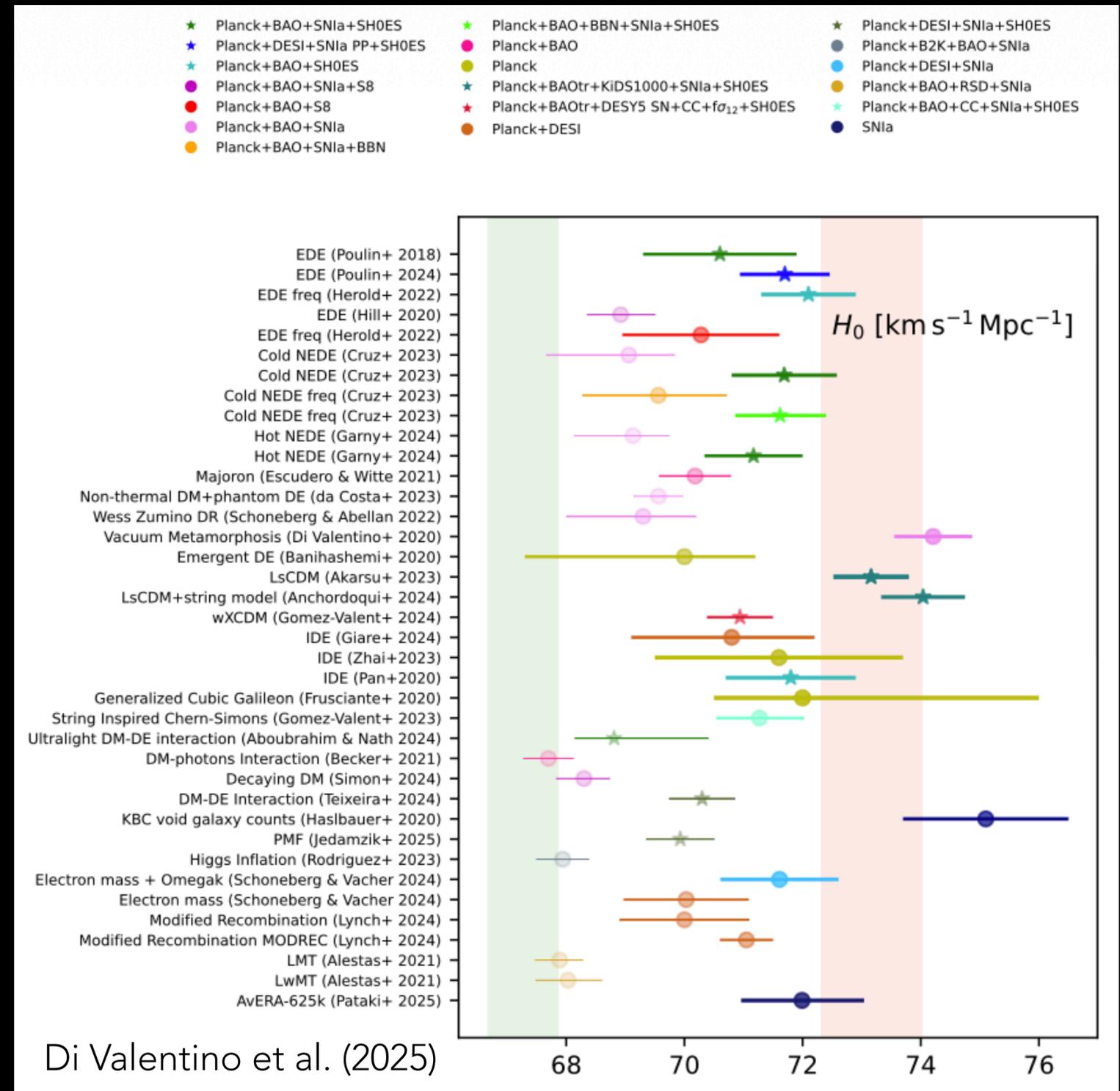
Asgari et al. (2020)



DESY3+KiDS1000 (2023)

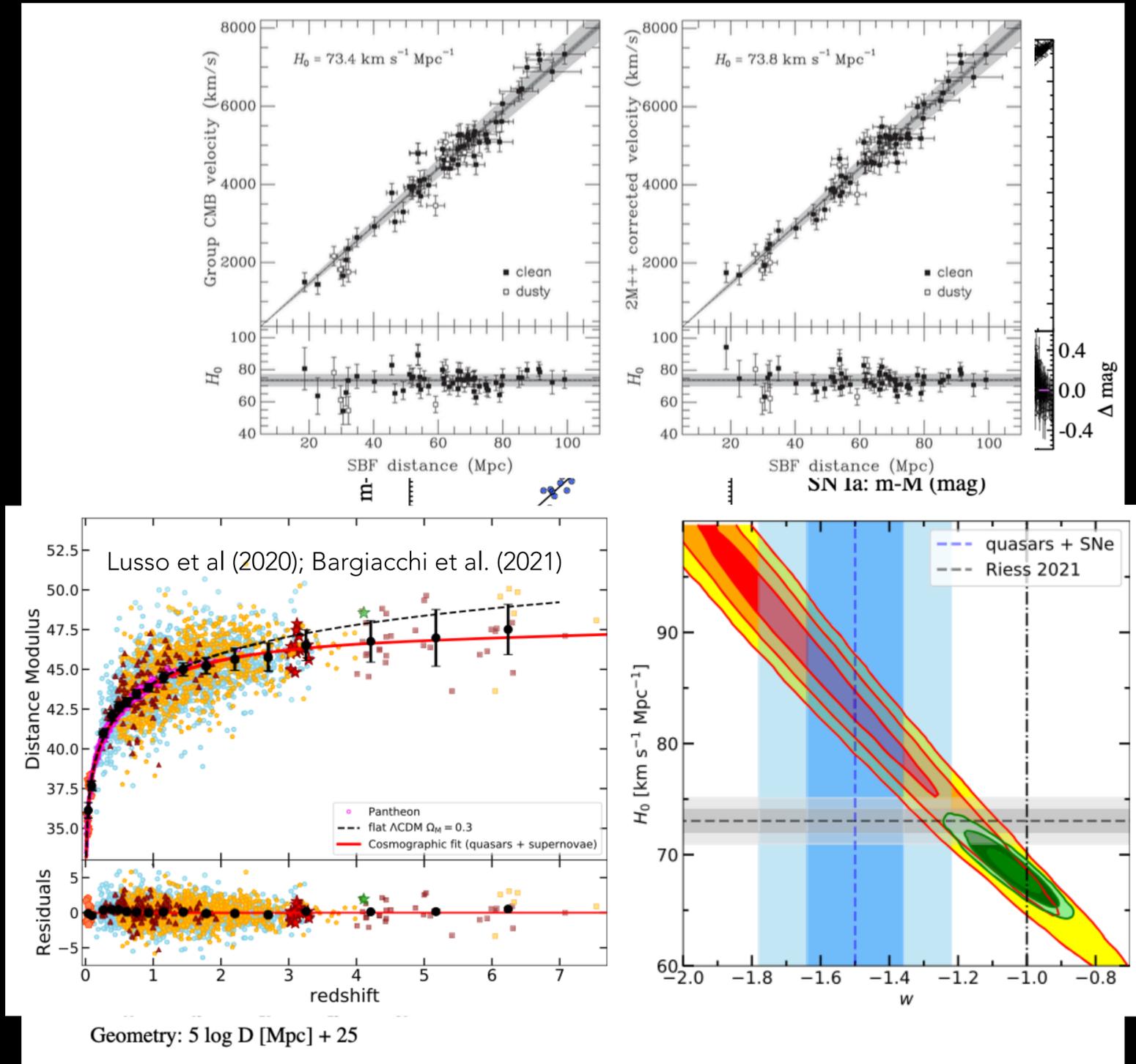
INVESTIGATING THE ISSUES: COSMIC EXPANSION

- These tensions may signal **unknown systematics** or **new physics beyond Λ CDM**
- **Theoretical work is ongoing.** For example: decaying DM, interacting DM-DE, early modified gravity, phantom dark energy, dark radiation (Viel et al.@Trieste, Finelli et al@Bologna, Menci@Rome)
- **Need to find a models that solve current tensions without creating new ones.**
- Using multiple independent probes of cosmic expansion is essential to cross-check assumptions, control systematics, disentangle solutions linked to early- vs late-time physics



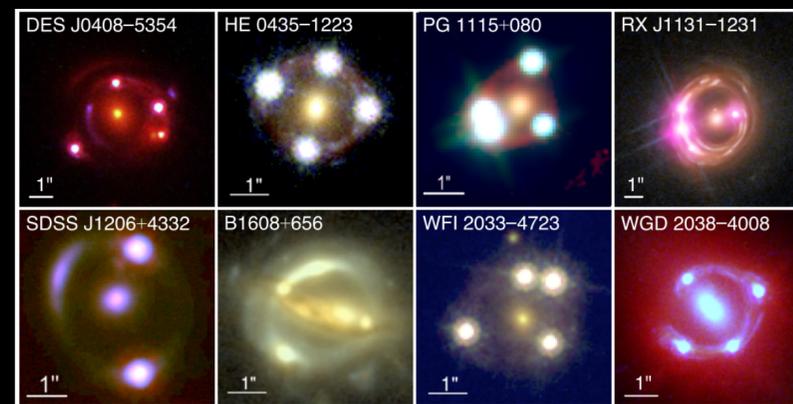
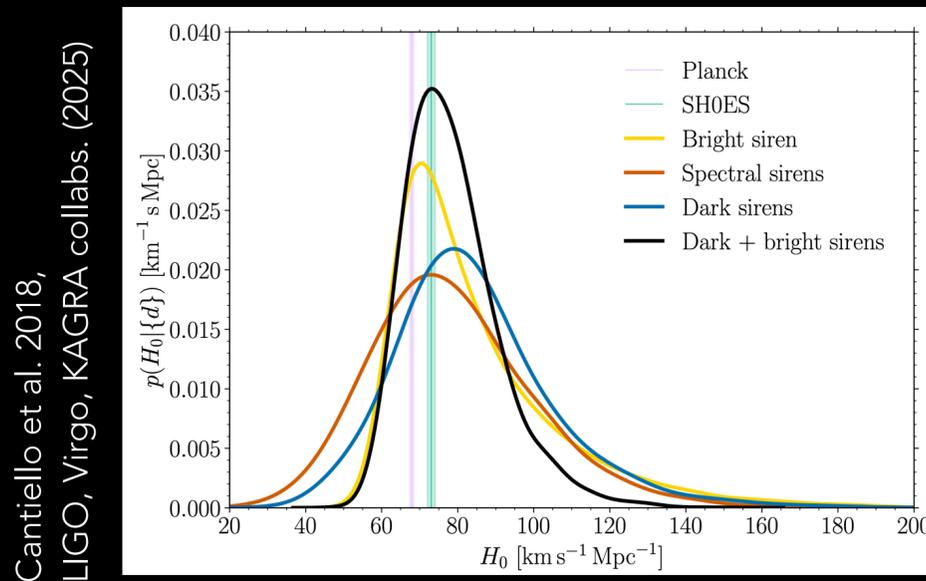
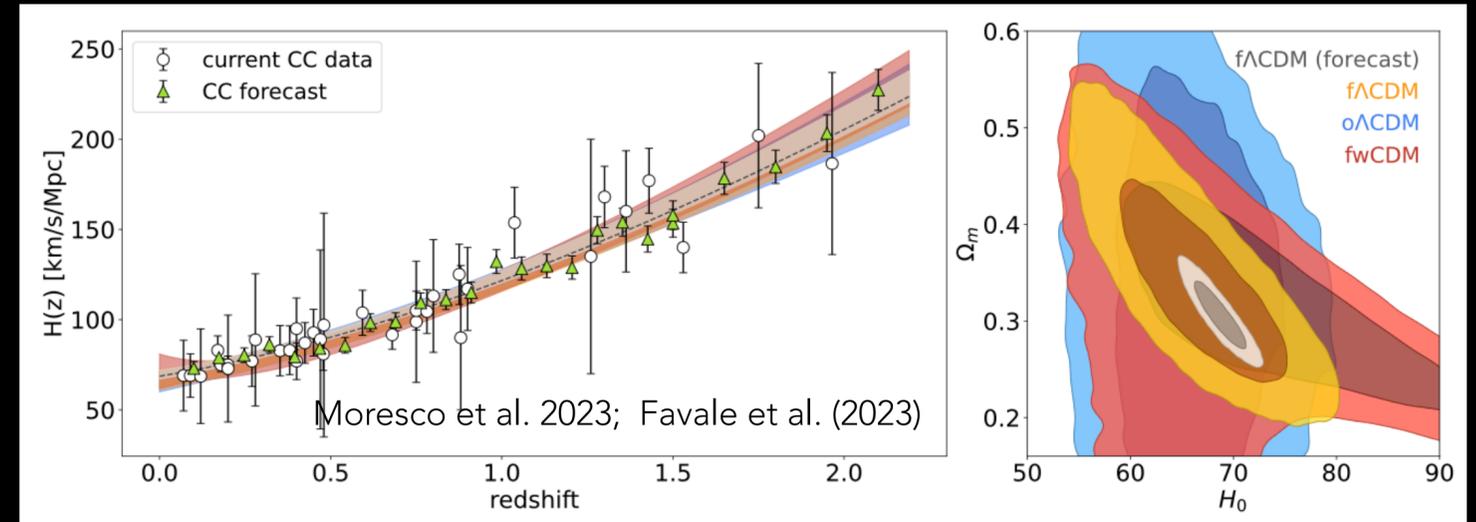
DIRECT PROBES OF COSMIC EXPANSION

- Naturally transversal science case within INAF (e.g., RSN2: local cosmology, calibration of distance indicators — Cepheids, MIRAS, TRGB, JAGB, SNIi; ⇒ **Ilaria Musella's talk at RSN2**; RSN4 — GWs, GRBs)
- Several galaxy based methods (e.g. Tully-Fischer relation, fundamental plane, ...)
- **Surface-brightness fluctuations**: using SB fluctuations in unresolved old stellar populations as distance indicator, also used to calibrate SNIa (Cantiello et al@Teramo)
- **Quasars**: based on L_{UV} - L_X relation (Risaliti-Lusso relation); extending the Hubble diagram to high redshift; $z \lesssim 7$ (Firenze)

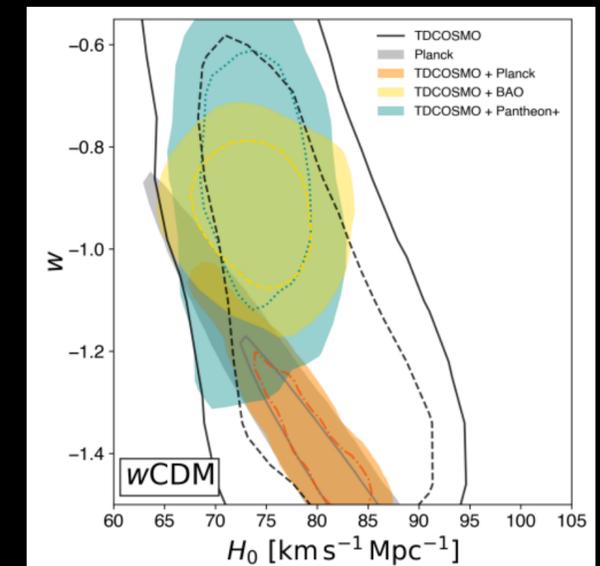


INDIRECT PROBES

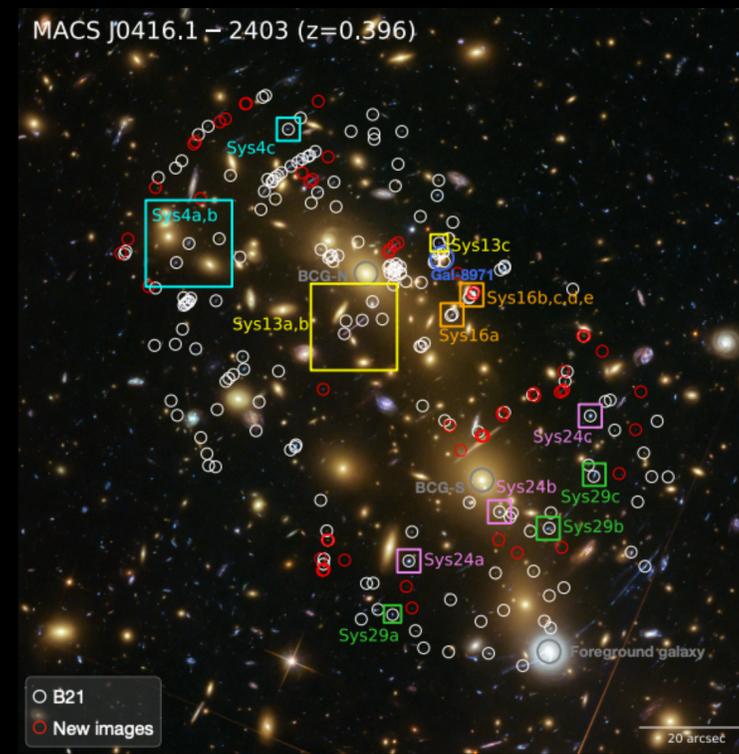
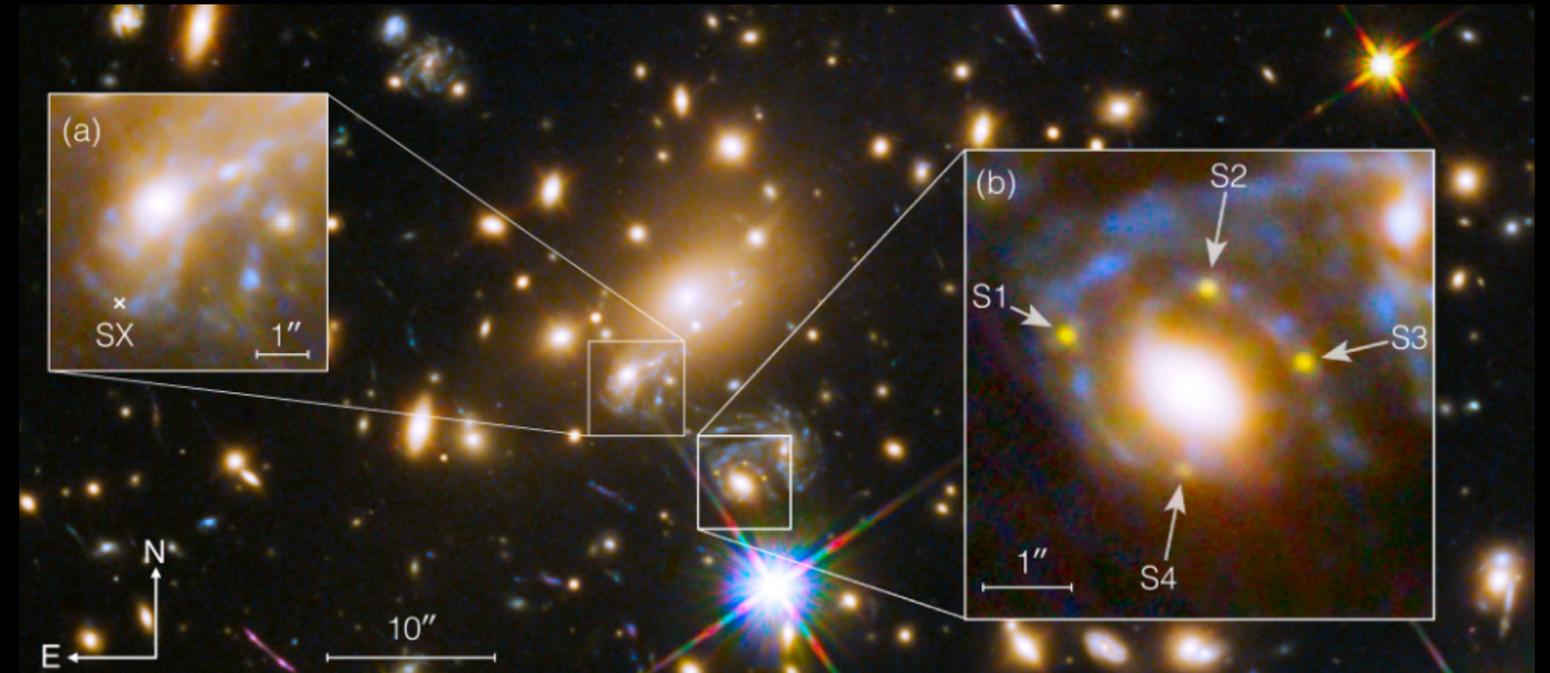
- **Modeling phenomena to infer H_0 or w :**
 - **Cosmic chronometers:** using differential ages of passively evolving galaxies. Dating stellar pops (Moresco, Cimatti, Pozzetti, et al@Bologna OAS+UniBO)
 - **Cosmic sirens:** modeling GW signals with EM counterparts (e.g. GW170817) or with galaxy catalogs (dark sirens) \rightarrow GRAWITA ($\gtrsim 100$ INAF members + associates)
 - **Time delay cosmography:** using time delays between multiple images of QSOs and SNs lensed by galaxies and **galaxy clusters** [Grillo, Annunziatella@Milano (IASF+UniMI), Rosati et al.@Ferrara, Bergamini, Meneghetti et al.@Bologna OAS, Angora, Mercurio et al.@Capodimonte]



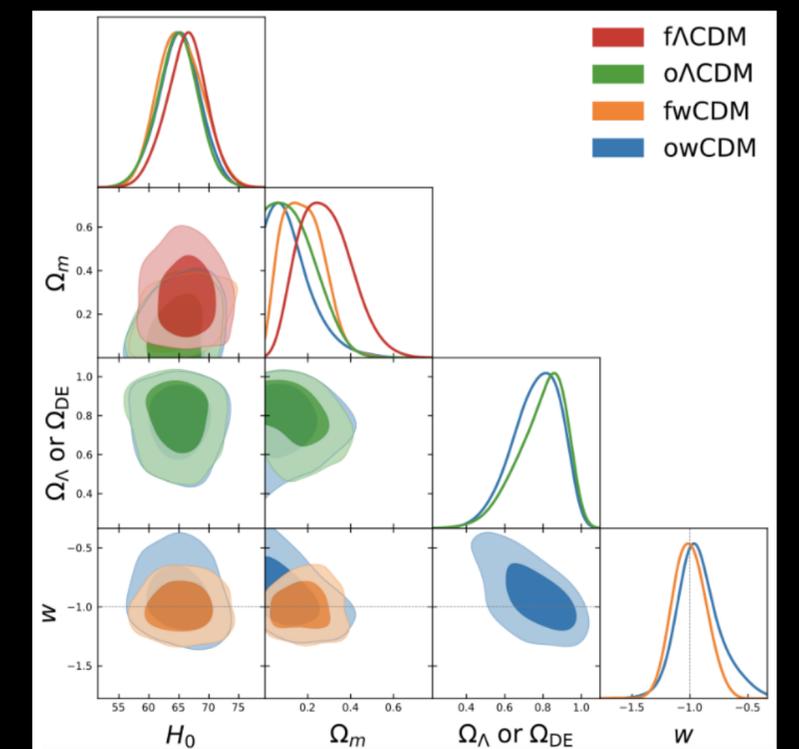
TDCOSMO: Birrer et al. (2025)



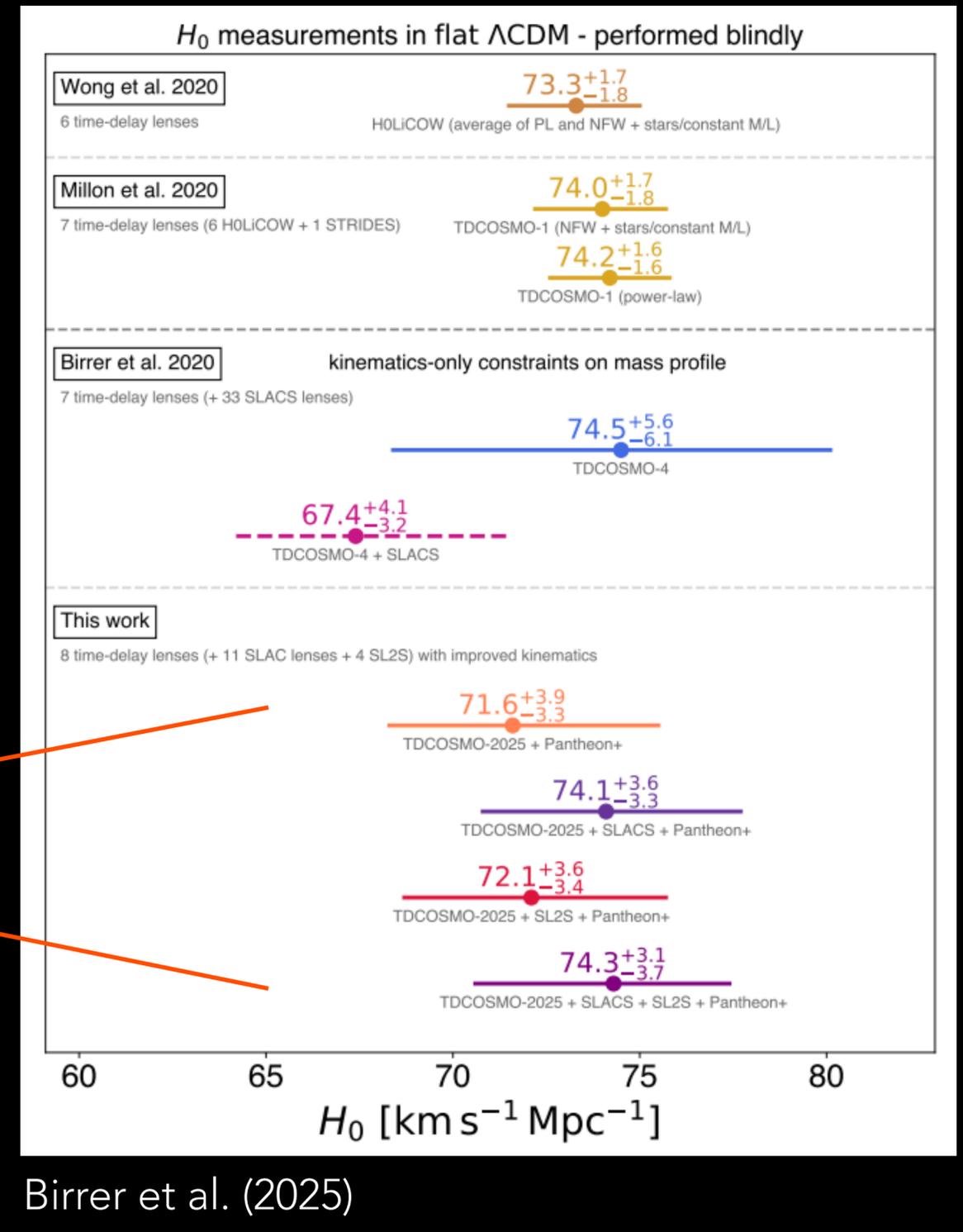
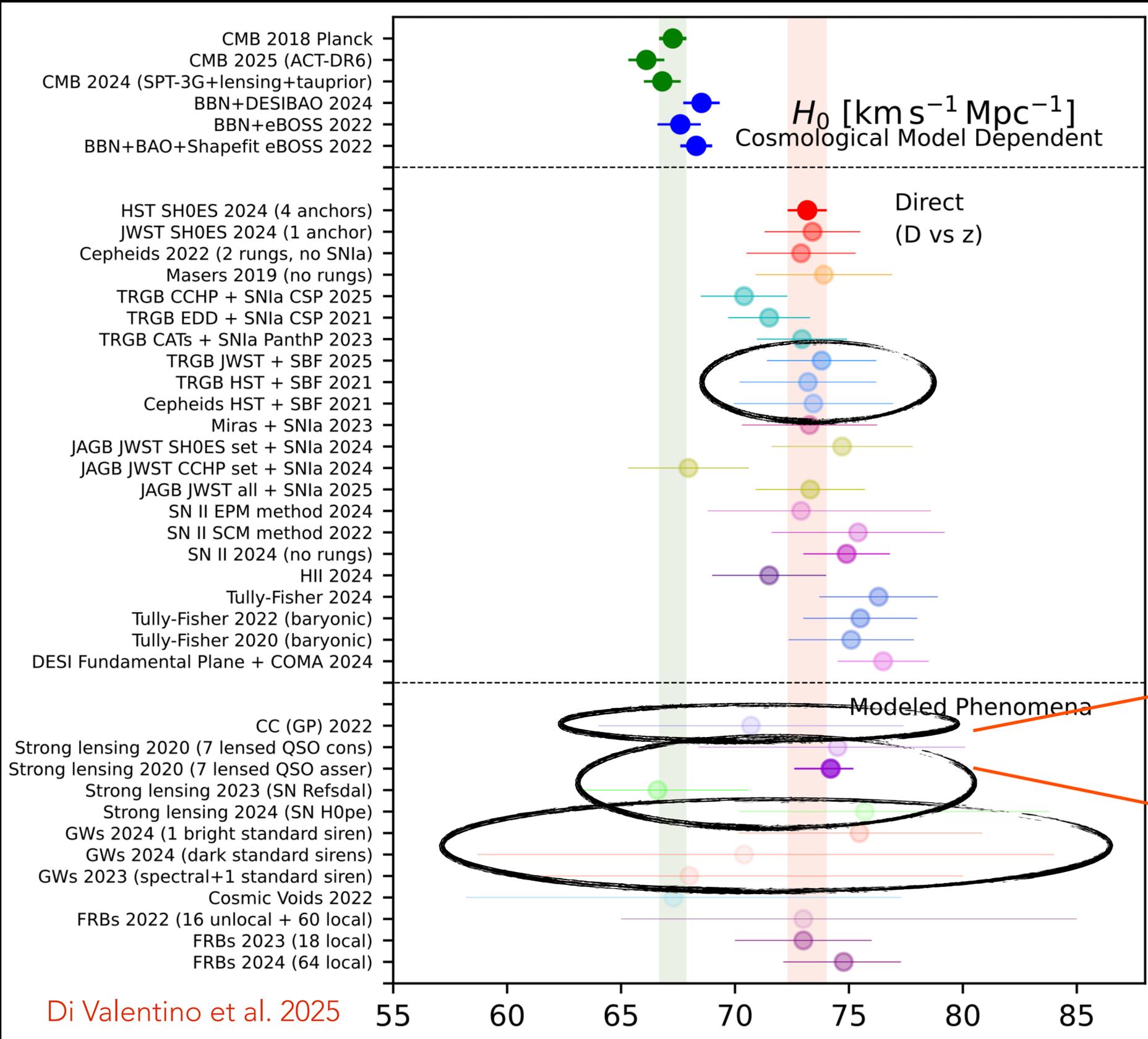
- Few SNe and QSOs (~ 10 , few with time monitoring) observed in galaxy clusters, but very interesting results.
- Examples: SN Refsdal in MACSJ1149 (observed in 2014, reappeared in 2015)
- **Strong lensing cosmography**: using distance ratios of lensed sources at different redshifts. Deep HST and JWST imaging + MUSE@VLT spectroscopy: up to 300 multiple images/cluster
- Increasing number of lensed SNaE and QSOs (JWST, Euclid, Rubin-LSST, ...)
- In-kind Rubin-LSST project (PI Grillo): VST monitoring of lensed QSOs in galaxies and clusters (4620 hrs over 7 years). Goal: ~ 30 new systems, $\sim 2\%$ TD precision, $\sim 1\%$ uncertainty on H_0 .



Bergamini et al. (2024)

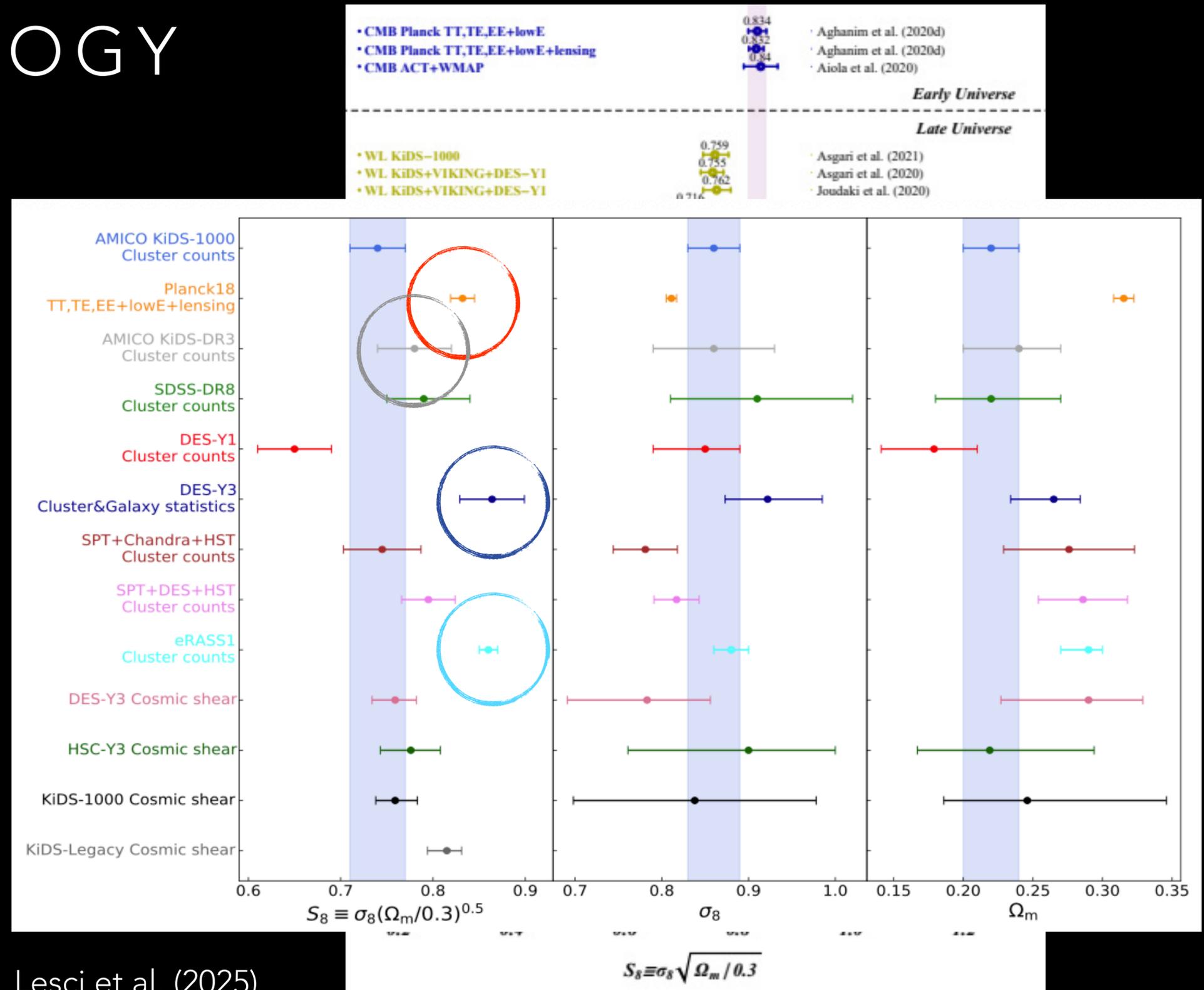


Grillo et al. (2024)



CLUSTER COSMOLOGY

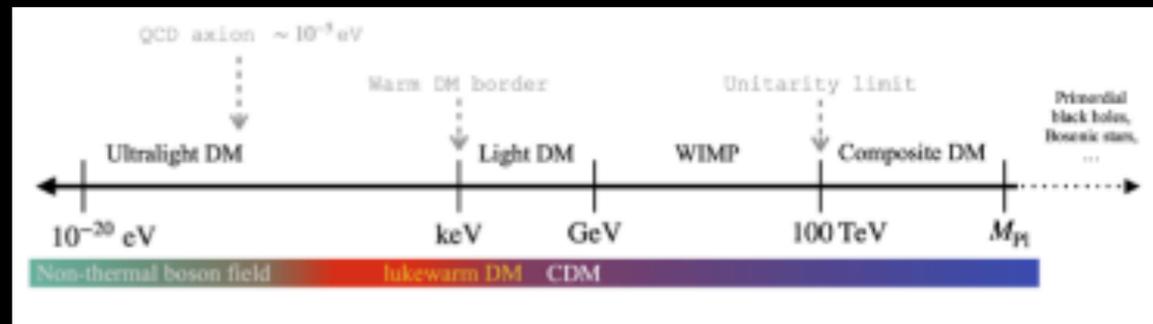
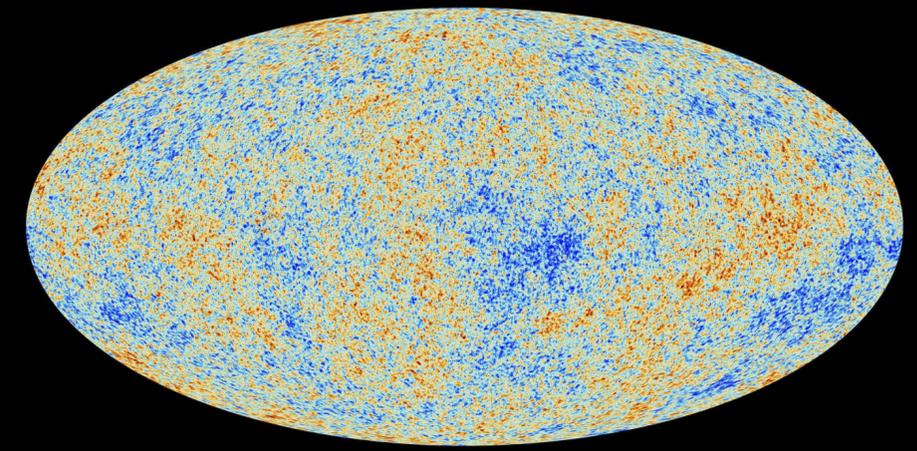
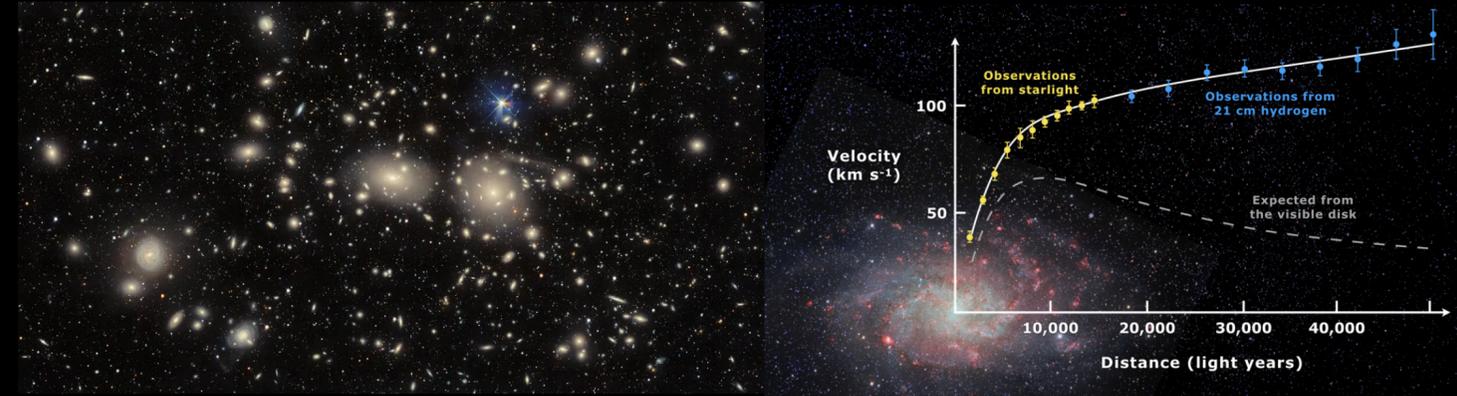
- Large cluster community (see talks by P. Tozzi and S. Molendi)
- Involvement in many cluster cosmology projects **SPT** (A. Saro, V. Strazzullo, ...), **eRosita** (Ghirardini, ...), **DES** (M. Costanzi, ...), **KiDS** (Lesci, Giocoli, Moscardini, Radovich, ...), **Euclid** (Giocoli, Sartoris, Munari, Moscardini, Sereno, and many more)
- Cluster counts, mass function and its evolution is a powerful probe of cosmology (including σ_8 , Ω_M , DE)
- Latest results from KiDS, DES (and also eRosita) support no S8 tension (e.g. Lesci et al. 2025, Ghirardini et al. 2024)
- Why? Better understood selection function, source contamination, mass calibration, etc.



Lesci et al. (2025)

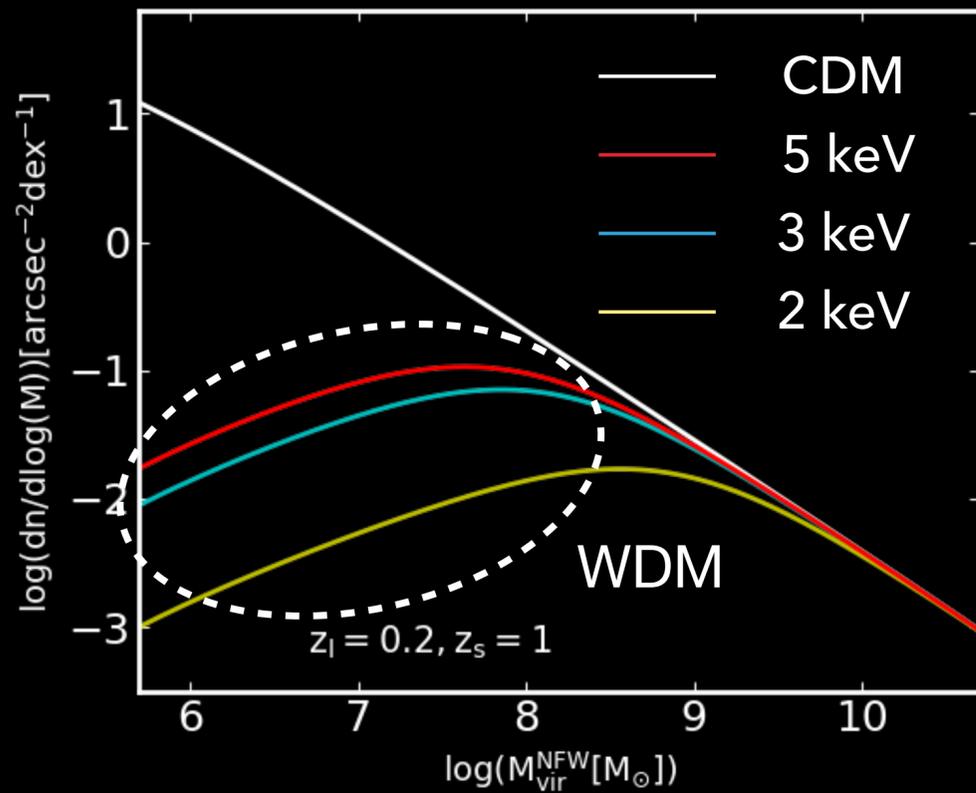
WHAT IS THE NATURE OF DARK MATTER?

- In the Cold Dark Matter (CDM) paradigm, DM consists of **massive** and **weakly interacting** (collision-less) particles
- Their velocities in the early universe were too low to erase **small-scale density fluctuations** on galactic and sub-galactic scales
- Particle candidate: **WIMP** (thermal relics)
- Consistent with observations of the universe on large scales, but...
- ...despite a host of particle physics experiments, no direct detection yet...

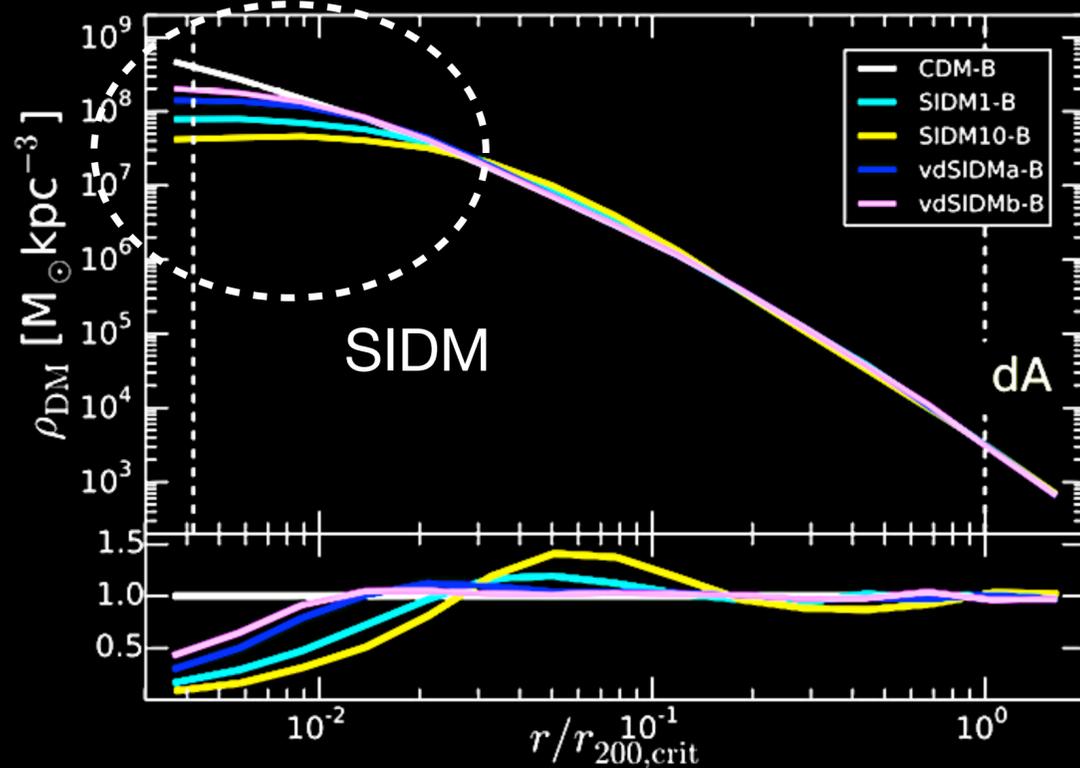


DOES CDM WORK ON SMALL SCALES?

→ in CDM: number density of haloes increasing with decreasing halo mass

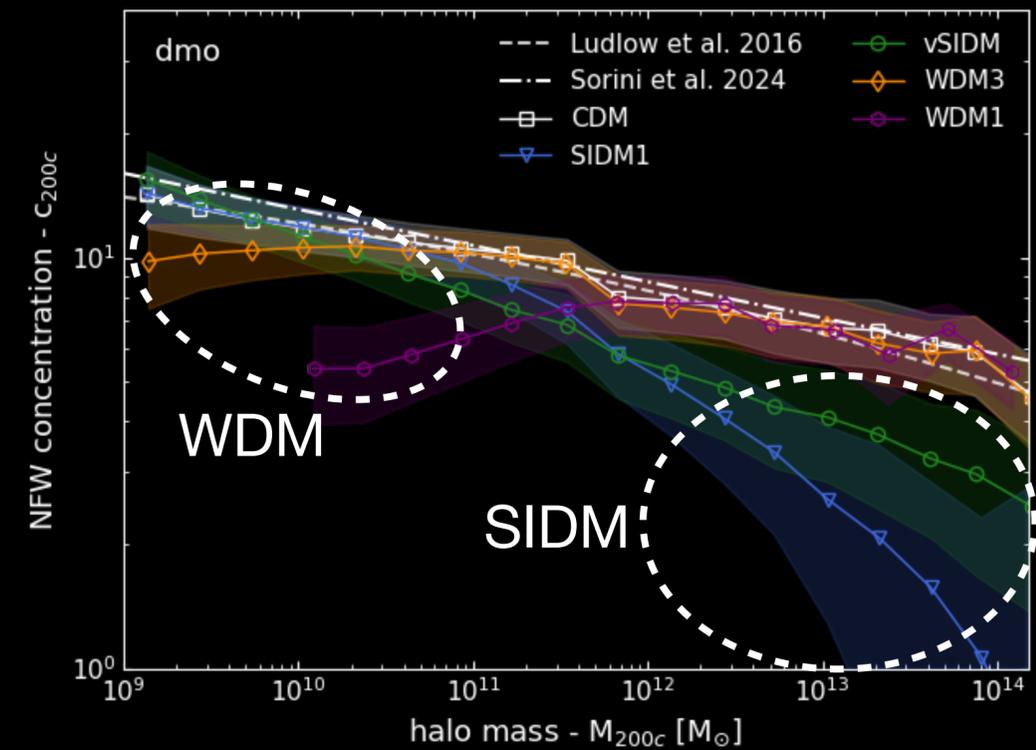


→ in CDM: structure of haloes well described by the NFW profile



(Vogelsberger et al. 2016)

→ CDM: low mass haloes are more concentrated

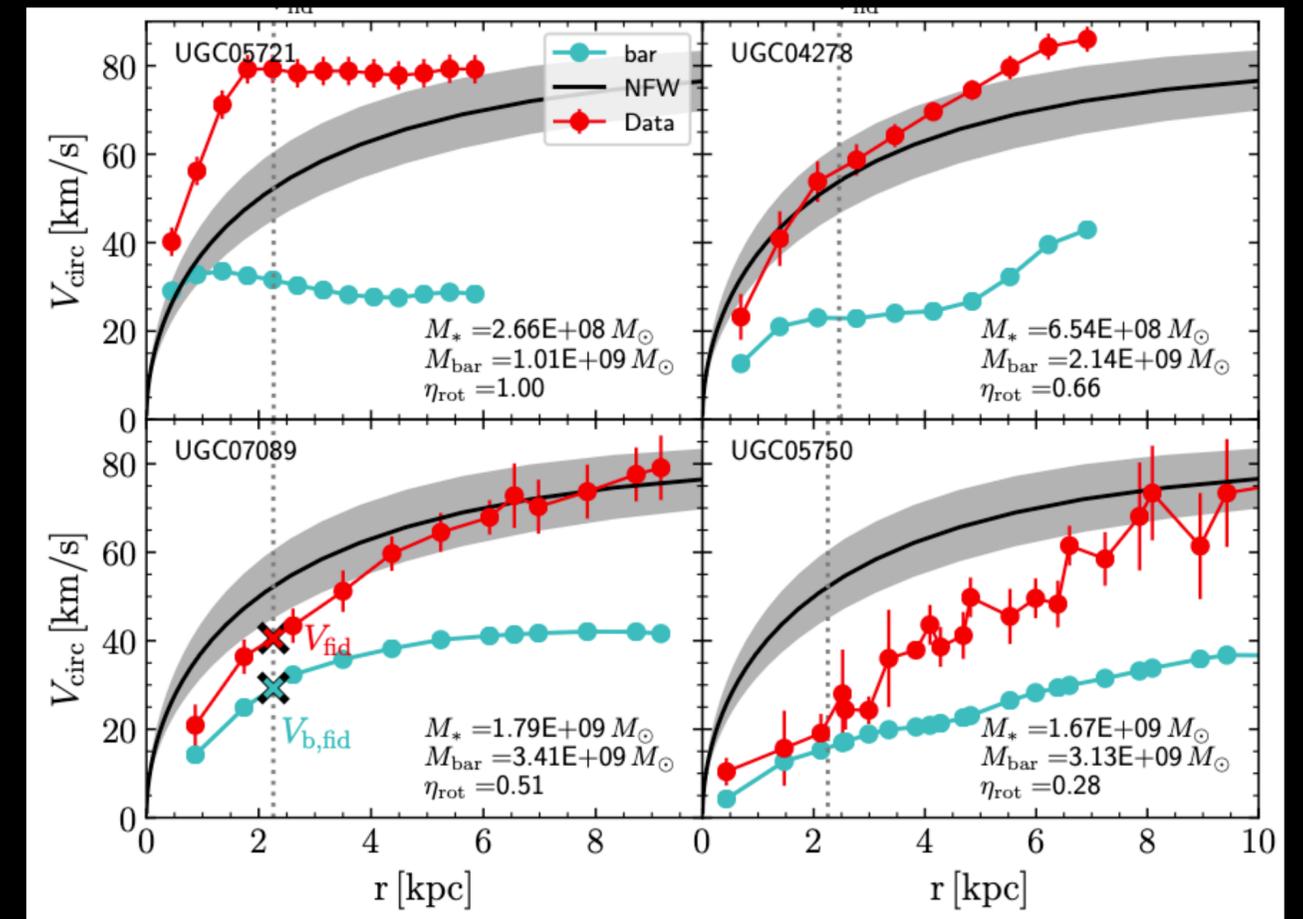


(Despali et al. 2025)

PROBES OF DARK MATTER

Santos-Santos et al. (2020)

- This topic is transversal to RSN2 (e.g. stellar streams, probing hierarchical structure formation in the MW, globular clusters as tracers of early DM subhalos, etc) and RSN4 (direct and indirect detection, gravitation) → [talk by C. Spingola at RSN4](#).
- How to measure the DM distributions in galaxies and clusters?
 - **Galaxy and clusters internal dynamics:** dwarf spheroidal galaxies (Tortora et al.@Capodimonte) , but also late type galaxies (e.g. GALDYN project, funded by MUR via FIS2 grant, PI: Lelli, to test DM vs modified gravity); Biviano et al.@Trieste
 - **X-ray, SZ modeling:** fitting temperature, surface brightness, pressure profiles of galaxy clusters assuming hydrostatic equilibrium (Ettori, Ghirardini, et al.@Bologna OAS, Gastaldello, Molendi et al.@Milano, Tozzi et al.@Arcetri)
 - **Gravitational lensing:** weak and strong lensing mass mapping in clusters; gravitational imaging, flux ratio anomalies (e.g., DARKER project, also funded by MUR via FIS2 grant; PI: Spingola)

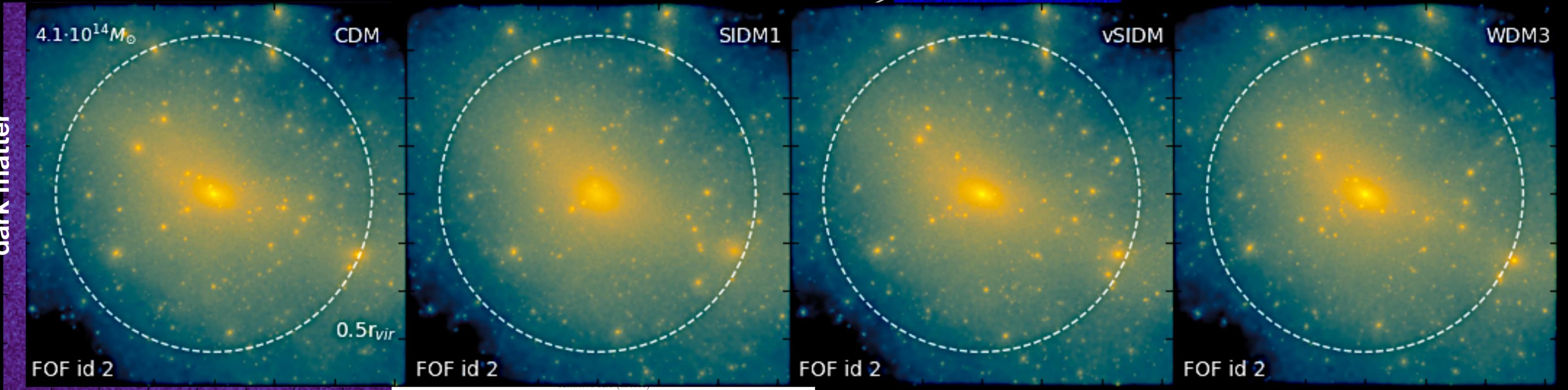


A diversity problem from rotation curves of dwarf spheroidal galaxies?

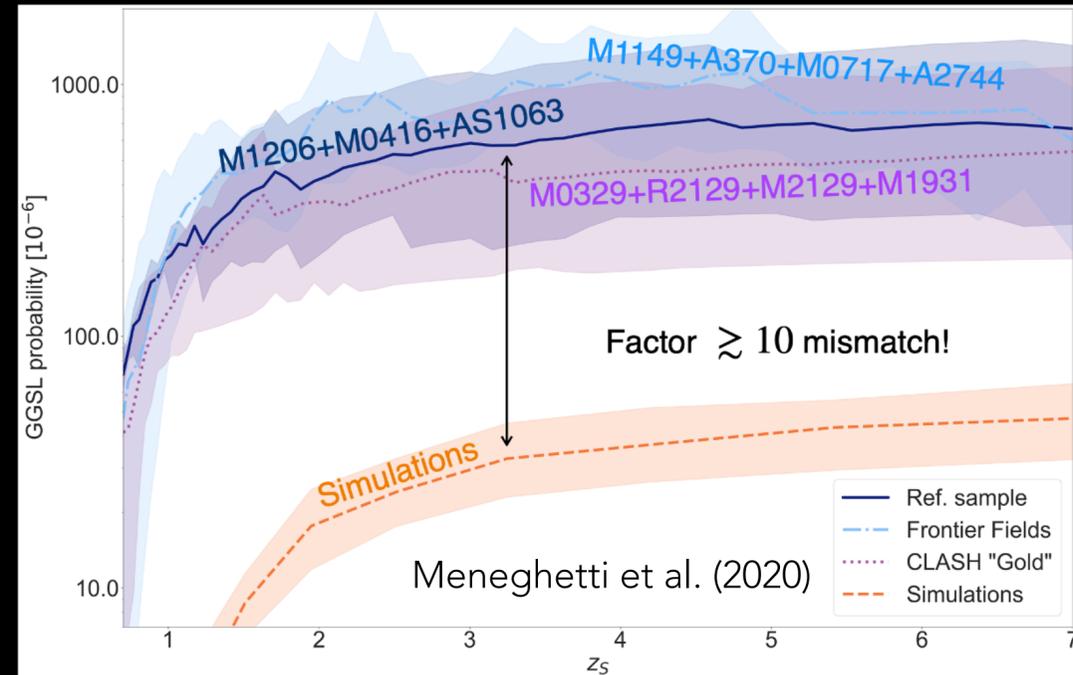
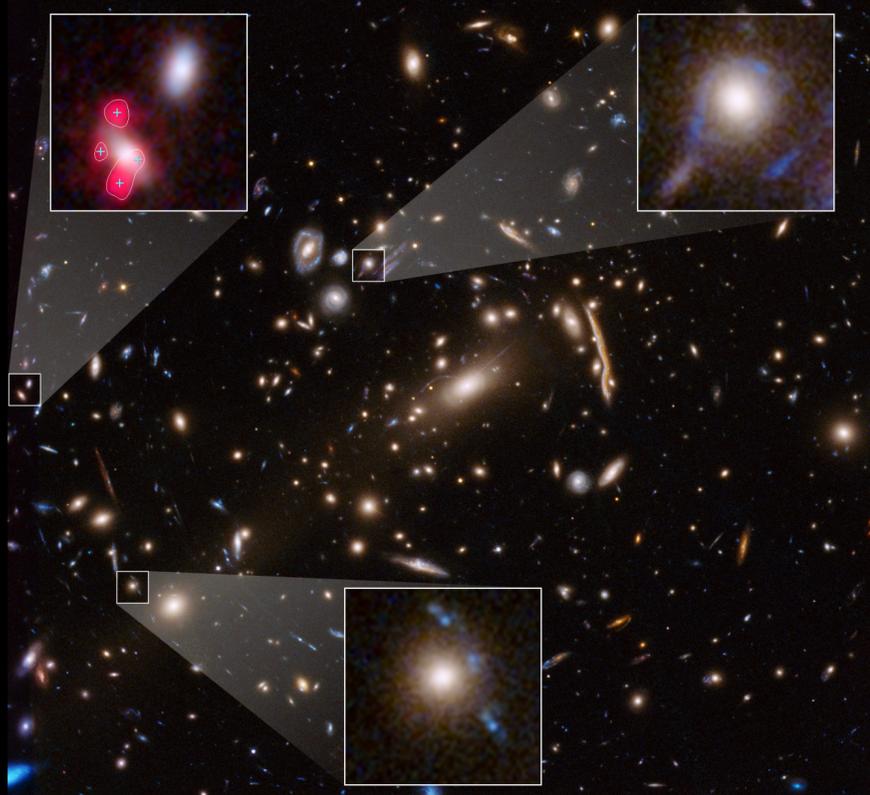
In LCDM, galaxies with similar "baryonic" (visible) properties should be embedded in similar dark matter halos, leading to similar internal dynamics.

Powell et al. (2025), Nat. Ast., McKean et al. (2025), Vegetti et al. (2026), Nat. Ast. With substantial contribution from C. Spingola & G. Despali

dark matter



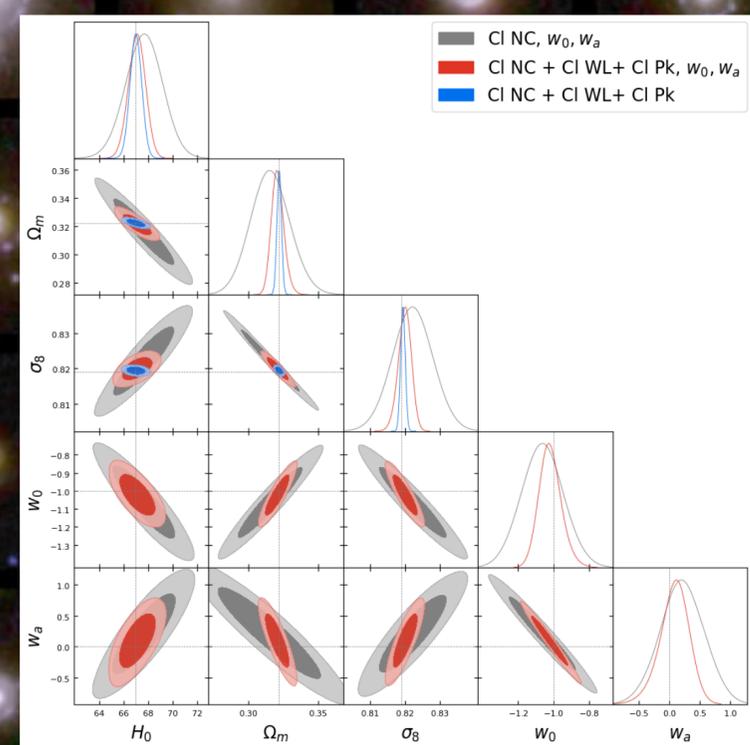
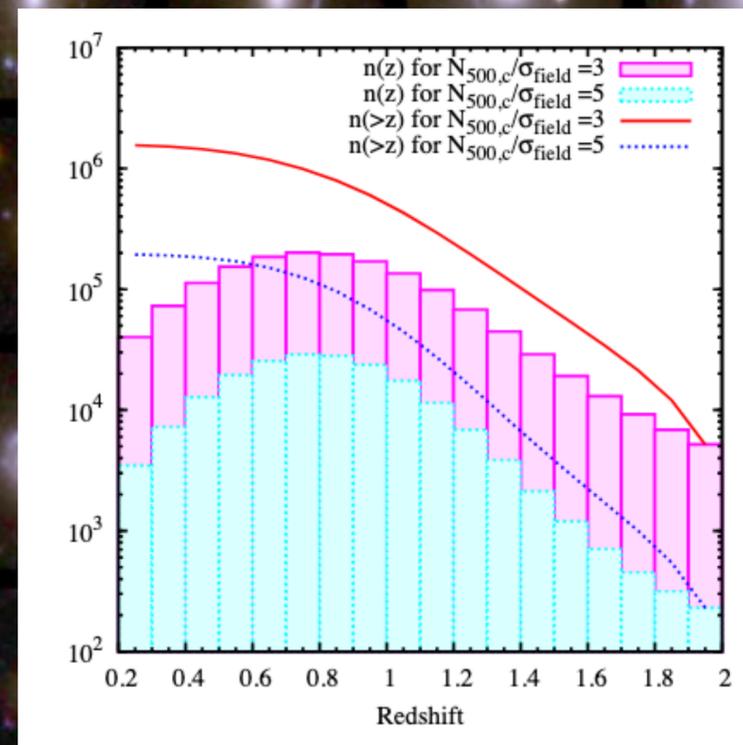
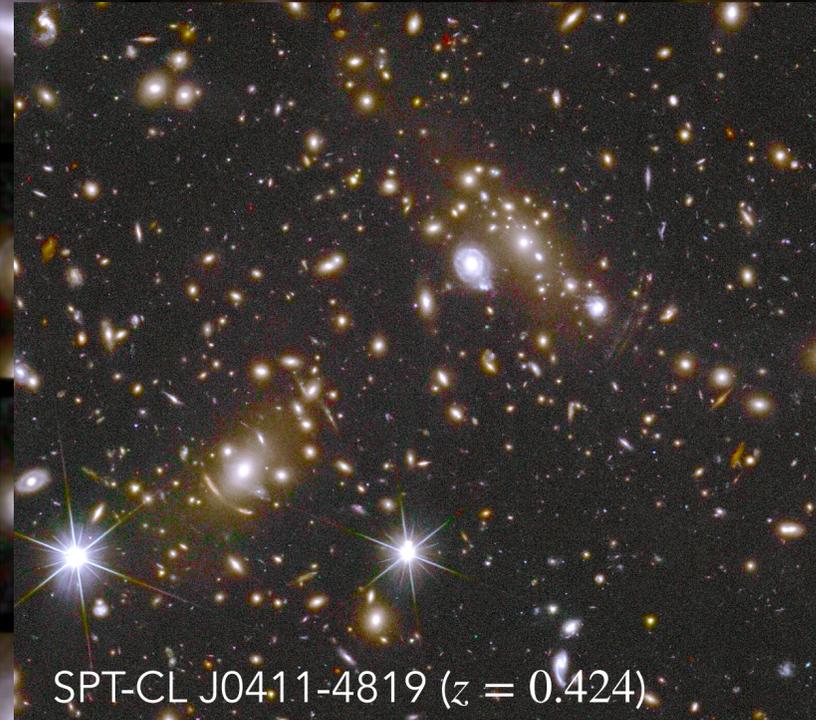
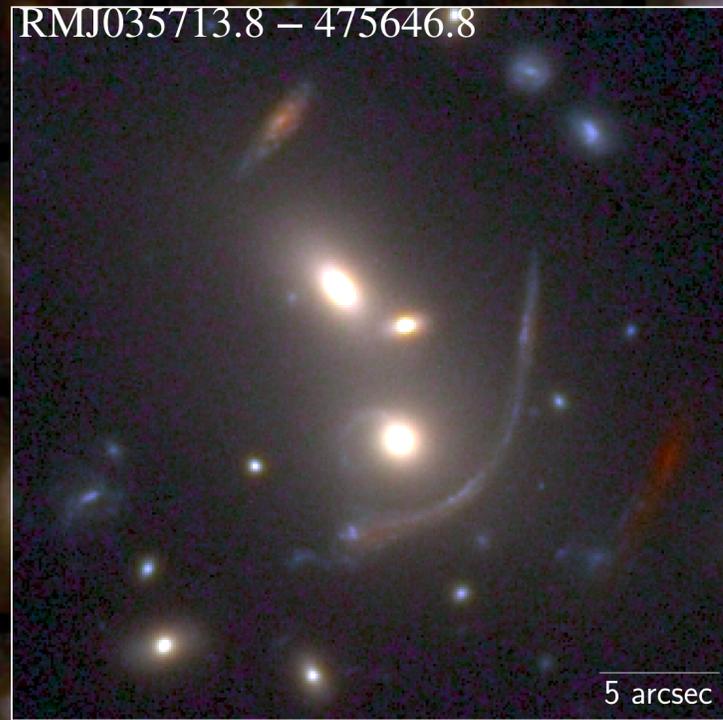
Dark halo perturbation? Ultra-compact dwarf? Globular cluster?



Hydro-sims by Trieste's group

Needed: **high-resolution cosmological hydro simulations**, also in **alternative DM models** (WDM, SIDM)! E.g. **AIDA-TNG** (Despali et al. 2025), **DIANOGA-SIDM** (Ragagnin et al. 2024)

WHAT NEXT?



An RSN1 opportunity:

- Galaxies and clusters are central to all major tensions
- We will have access to an impressive amount of data:
 - Euclid:** Among 241 members of RSN1, 118 are also members of the Euclid Consortium (total INAF Euclid members=298)
 - Rubin-LSST:** at least 5 in-kind contributions (Cantiello, Grillo, Rosati, Botticella, Saro,...)
 - In the future: E-ELT, SKA, Athena
- Challenges: follow-up observations? better understanding of systematics? Automatizing workflows? More simulations?
- Strong INAF positioning:
 - Leading roles in Euclid, Rubin, SKA
 - Expertise spanning theory, simulations, observations
- We can play a crucial role in assessing whether LCDM remains a consistent description of the universe or whether a paradigm shift is needed!**

VINCENZO F. CARDONE (INAF-OA ROMA)

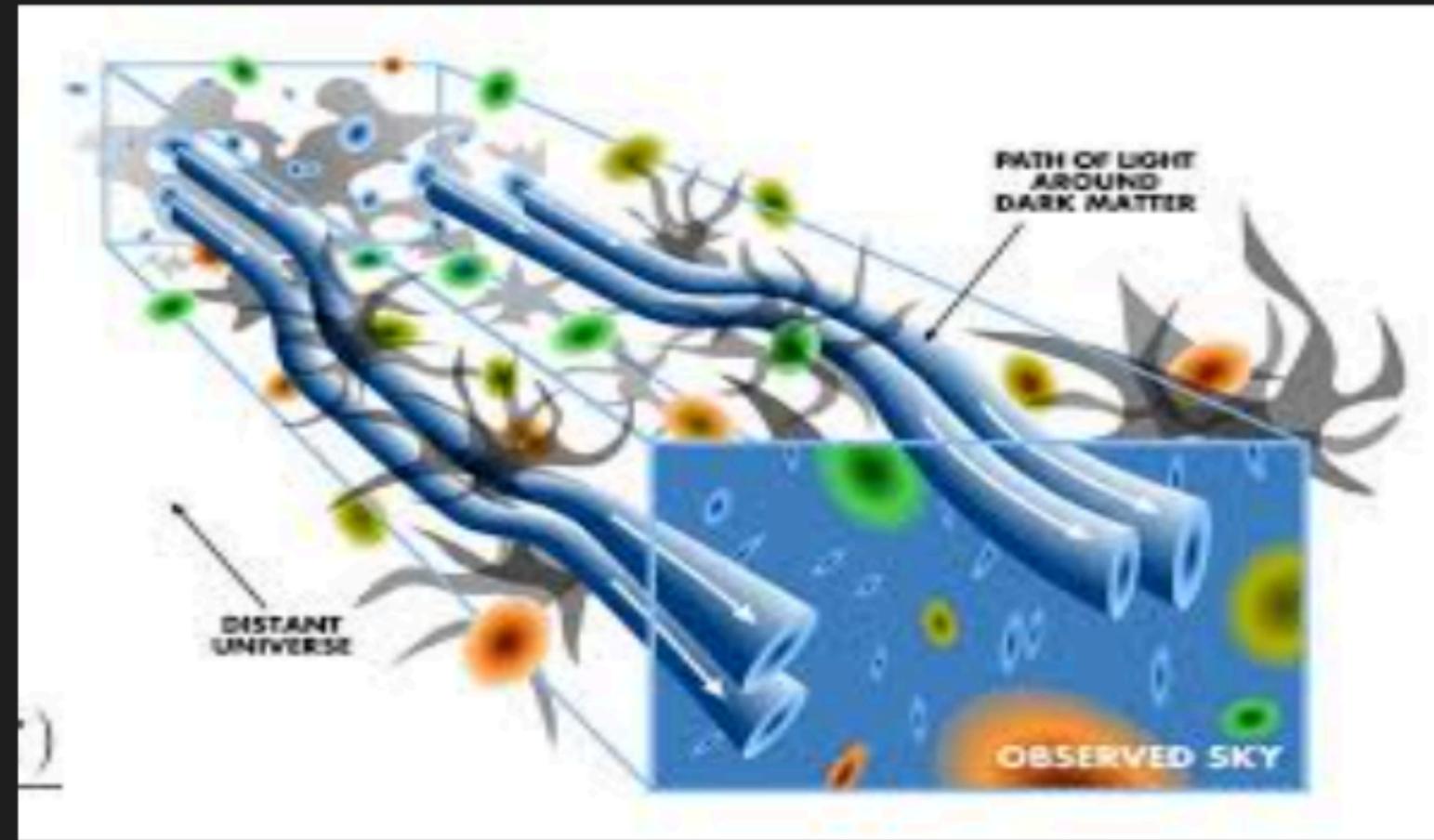
THE COSMOLOGICAL MODEL, DARK MATTER AND DARK ENERGY

DARK ENERGY OR MODIFIED GRAVITY?

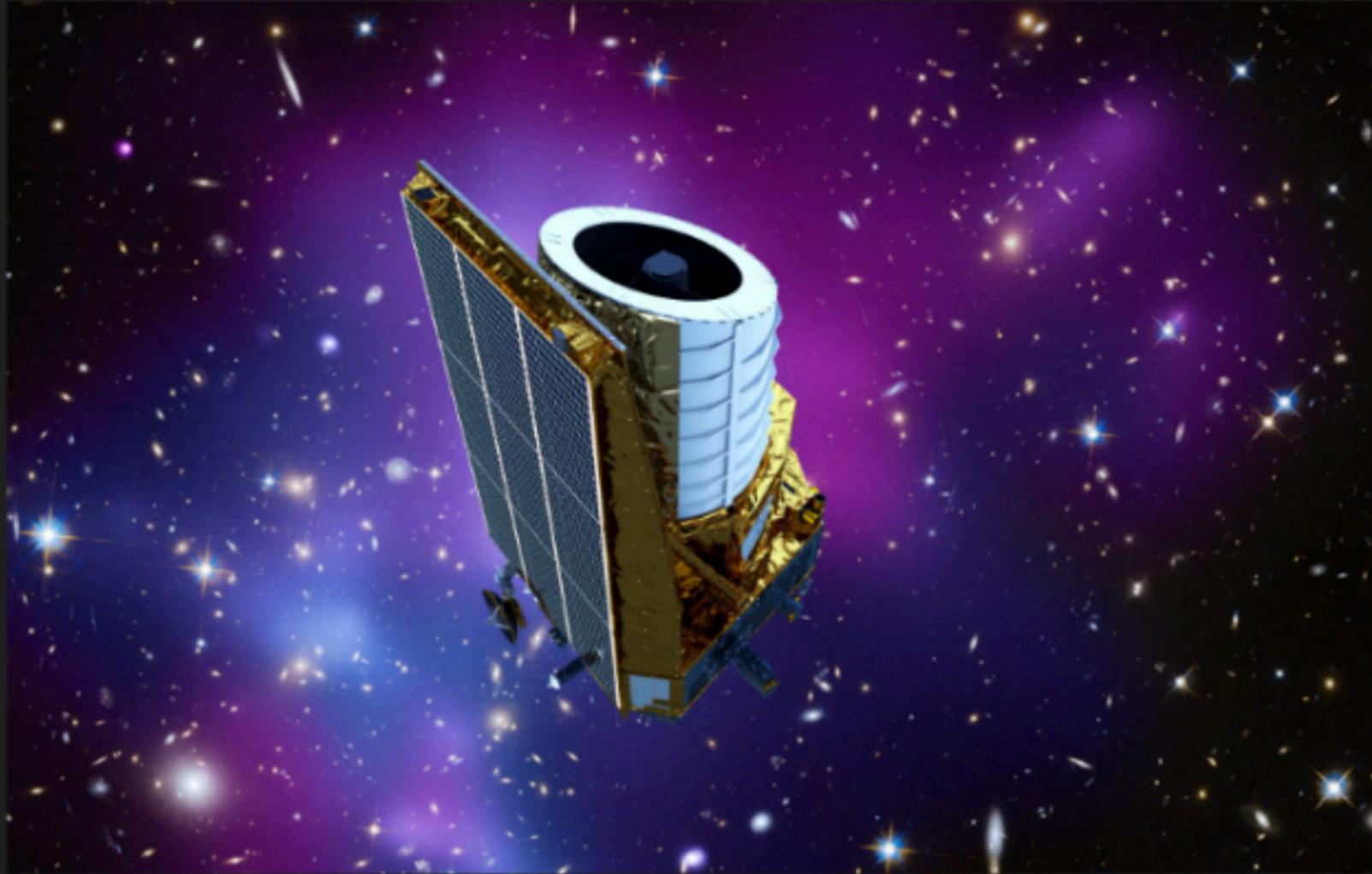
DIFFERENT SCALES FOR ONE QUESTION

Galaxy Surveys vs Dark Energy

- **Cosmic Shear**
 - shape measurement
 - light propagation
 - growth of structures
- **Galaxy clustering**
 - overdensity field
 - photometric
 - 2D clustering
 - galaxy bias
 - growth of structures
 - spectroscopic
 - 3D clustering
 - BAO



Looking into the Dark Universe: Euclid and LSST

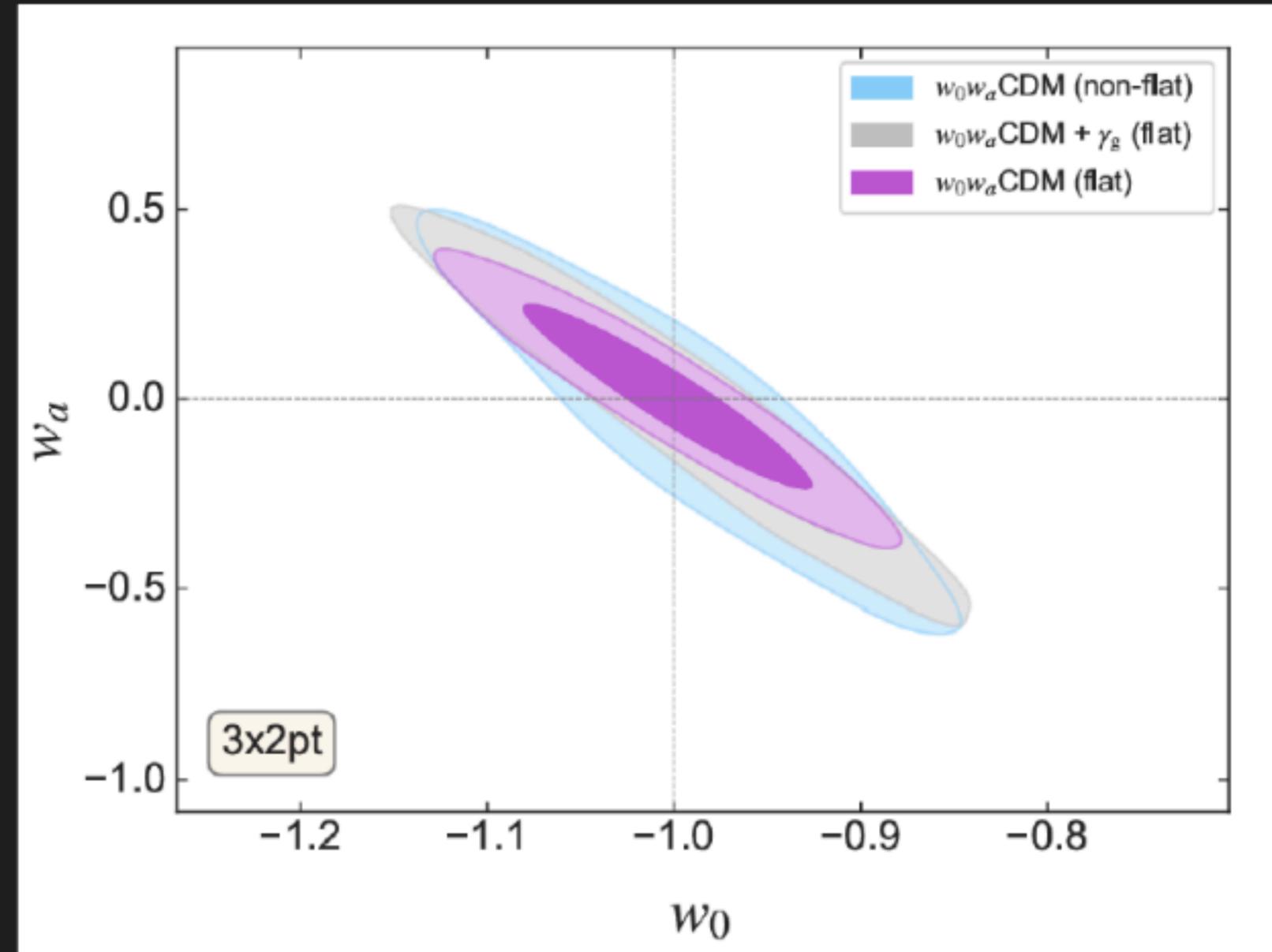
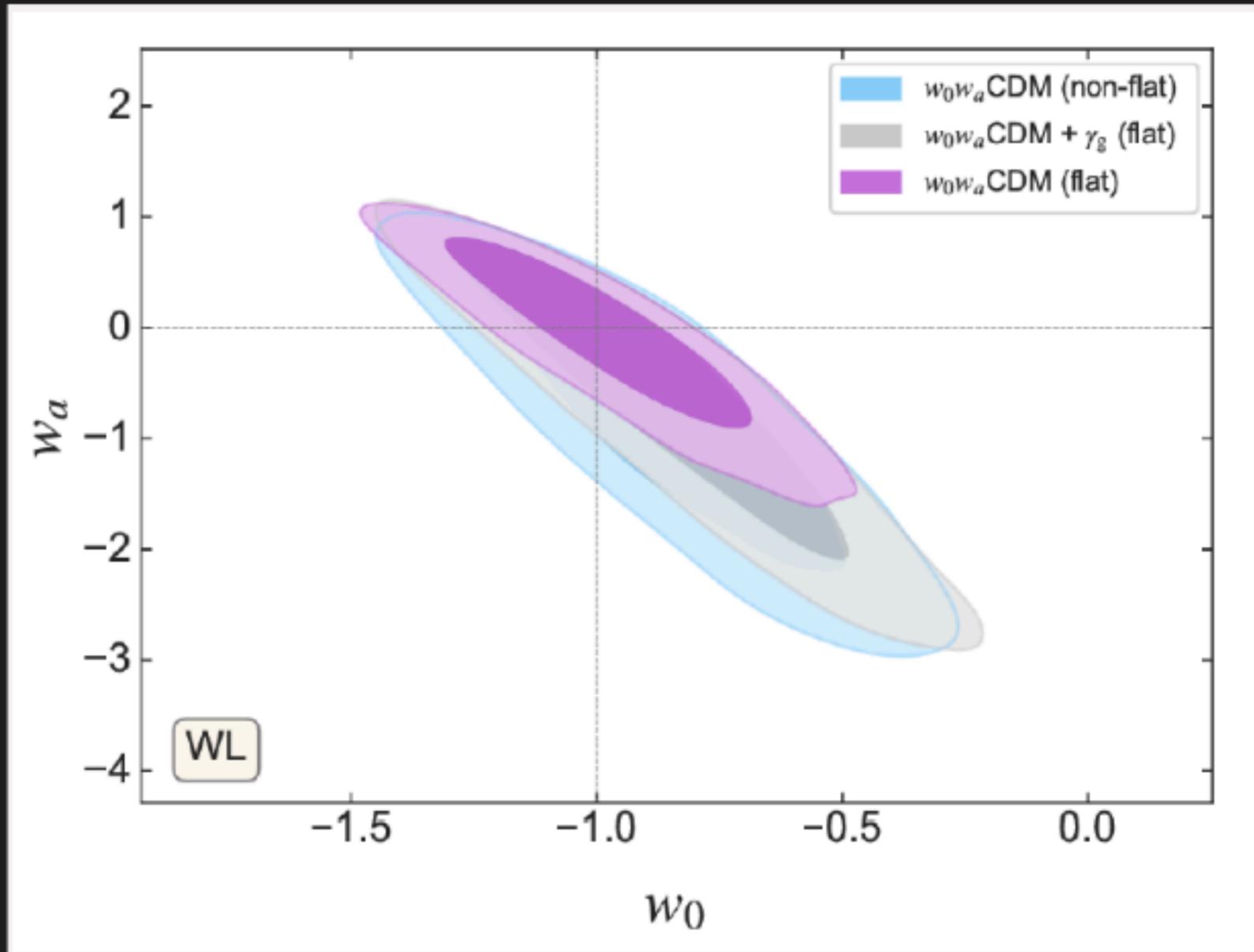


- space based survey
- photometry and spectroscopy
- cosmic shear and 2D photo clustering
- BAO and 3D power spectra



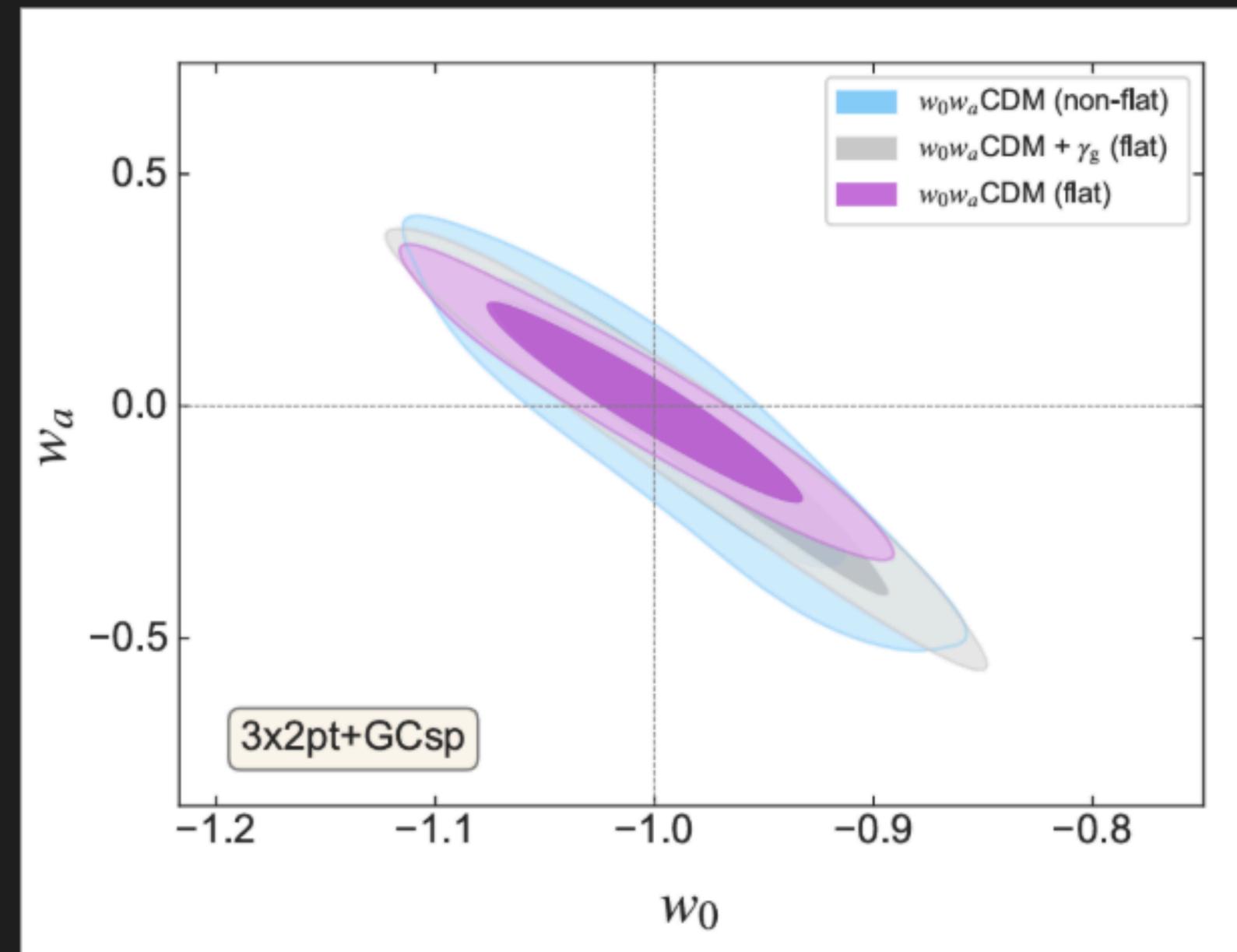
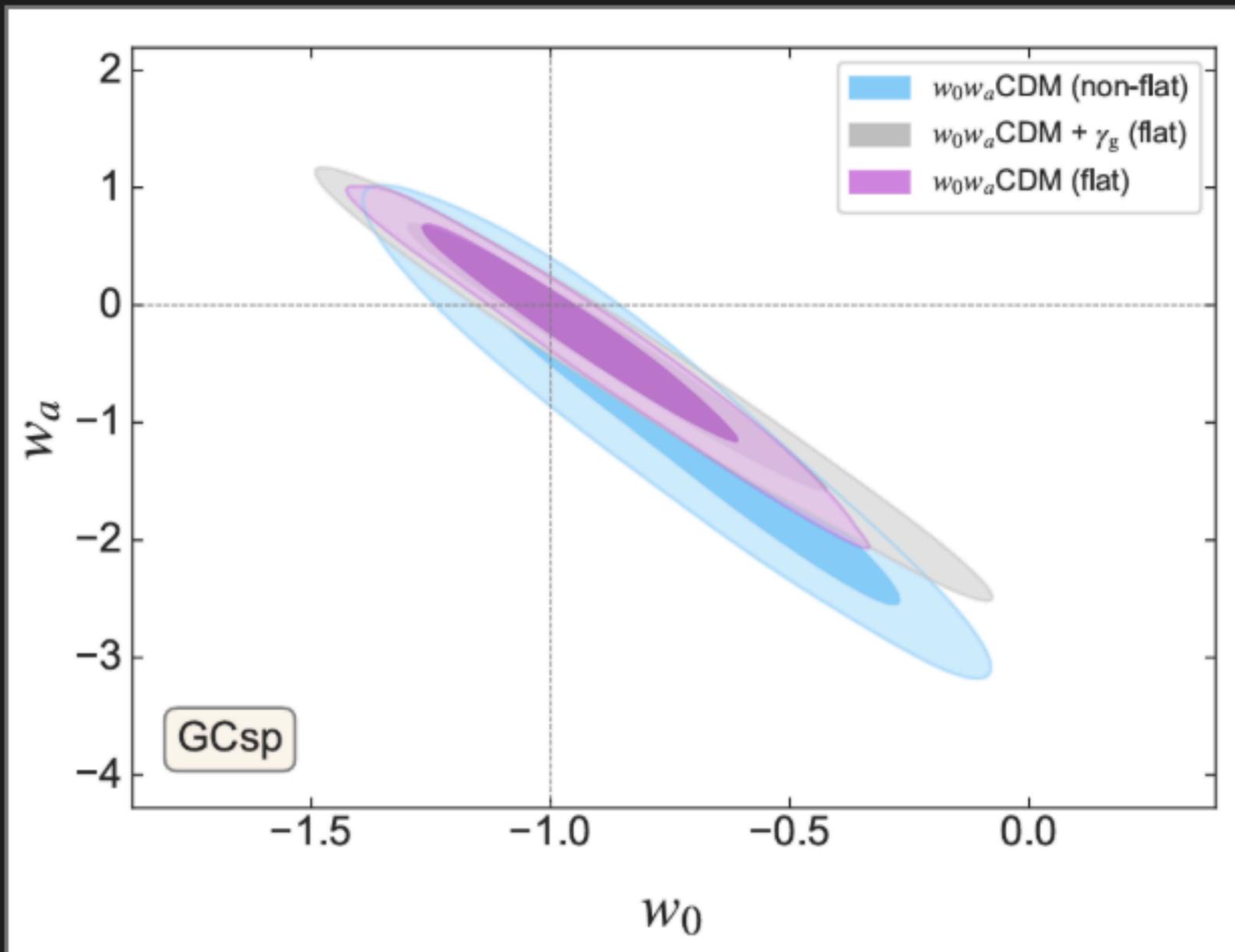
- ground based survey
- photometry and time domain
- cosmic shear and 2D photo clustering
- SNeIa and transients

Constraining Dark Energy with Euclid Photometry



- cosmic shear only vs 3x2pt (cosmic shear + photo clustering + galaxy galaxy lensing)
- *the total is more than the sum of the parts*

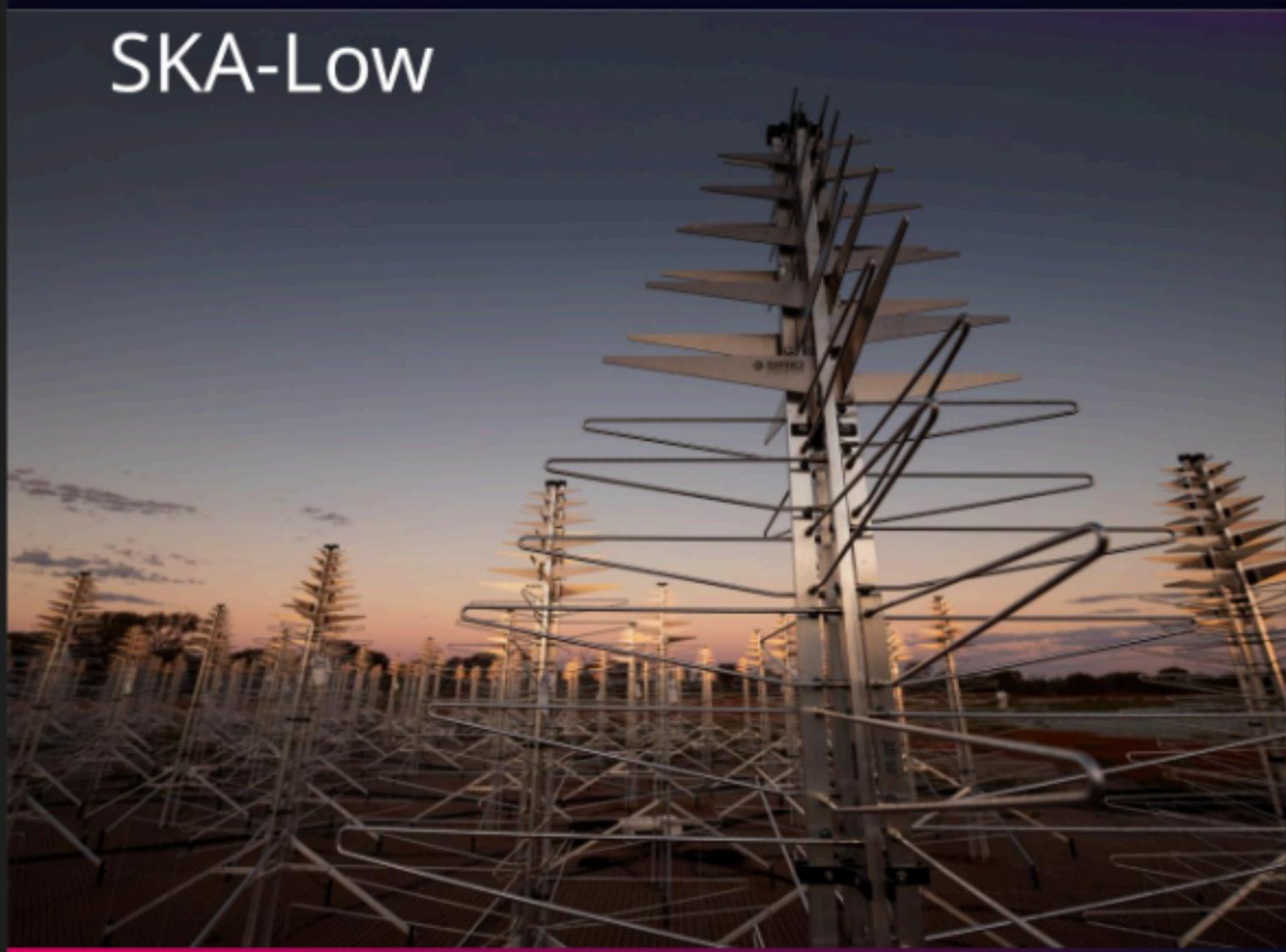
Constraining Dark Energy with Euclid Full Dataset



- 3D clustering only vs 3x2pt + GCsp (full set of Euclid main probes)
- *Figure of Merit: 21 for WL, 35 for GCsp, 380 for 3x2pt, 500 for 3x2pt + GCsp*

Cosmology Beyond the Optical: SKAO

SKA-Low



- 512 stations with 256 antennas each
- 2m tall over a central 1 km core
- spiral arms structure 74 km large
- 50 - 350 MHz

SKA-Mid

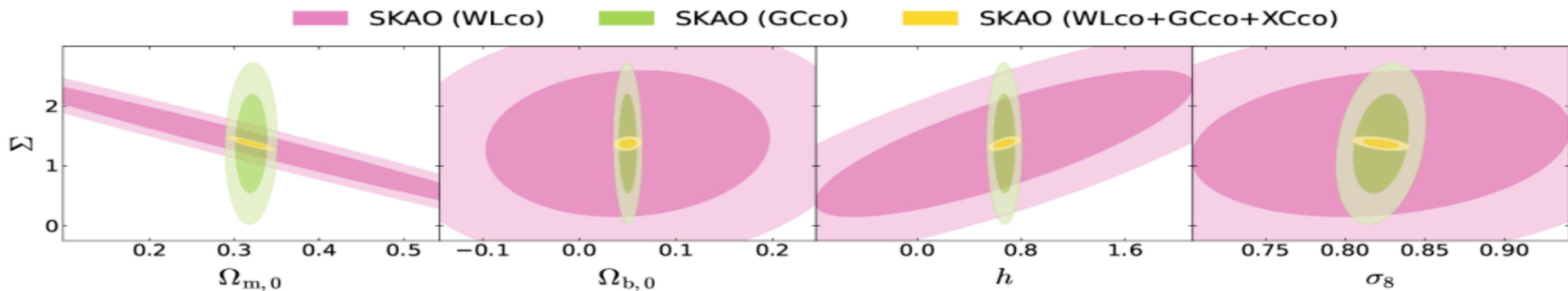
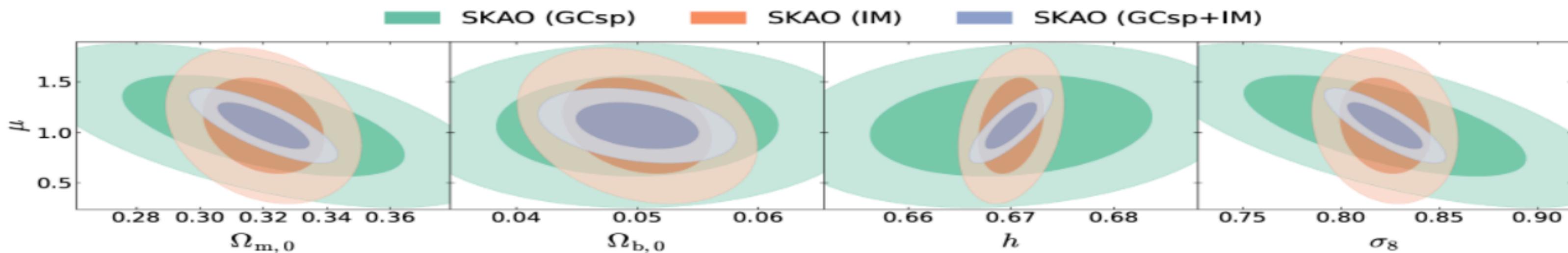


- 197 15m parabolic dishes
- 1 km core with MeerKat 13.5 m dishes
- spiral arms structure 150 km large
- 350 MHz - 15.4 GHz (goal 24 GHz)

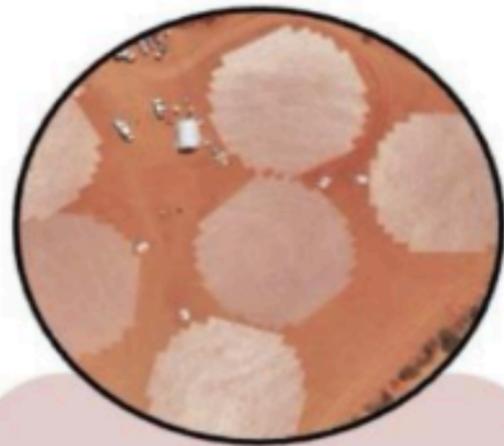
Cosmology in the Radio Domain: Surveys and Obs Probes

- HI line (spectroscopic - like)
- Radio continuum (photometric - like)
- HI intensity mapping

- 3D power spectrum and BAO
- 3x2pt at radio wavelengths
- constraining DE, MG and PNG

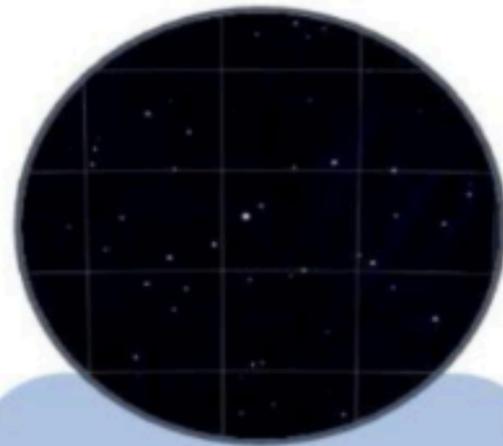


Evolution of SKAO operational modes



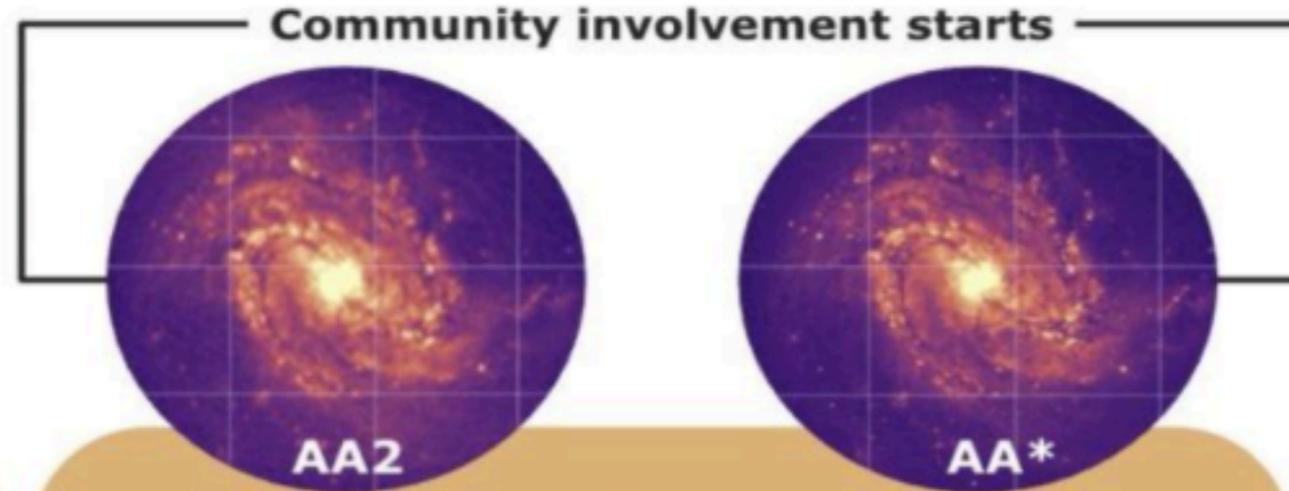
Construction

- Building antennas, dishes, roads etc!
- Followed by Assembly, Integration and Verification



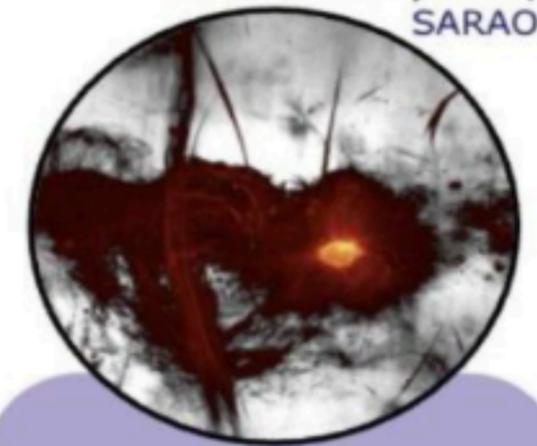
Commissioning

- SKAO activity
- Collaborative across system verification and science commissioning



Science Verification

- A full dress rehearsal of the end-to-end system for every mode of operation
- Once modes and pipelines are working, the community can submit target ideas
- Data will be publicly available for scrutiny
- Build trust and fostering an early science return



Cycle 0

- Shared-risk PI projects
- SRCNet resources ready for user
- proprietary periods

Credit: I. Heywood, SARAO



SKA-Low: Delivery of observing modes and ODPs to the astronomy community

AA2 2027	AA* 2029	Cycle 0 2030		Cycle 1 2031			Cycle 2 2032			Cycle 3 2033		
Science Verification (SV)	SV	SV	Shared risk	SV	Shared risk	Standard ops	SV	Shared risk	Standard ops	SV	Shared risk	Standard ops
Single subarray Both sidereal and non-sidereal tracking		4 subarrays Drift scanning capped at a few mins		16 subarrays Drift scanning capped at a few mins			Full drift scanning capabilities					
<p>Calibrated, averaged and gridded visibilities, image cubes</p> <p>Full BW (150MHz), FOV</p> <p>Single beam, single pointing</p> <p>40 channel max</p> <p>4h max observations</p>	<p>Full BW (300MHz)</p> <p>At least one substation arrangement, capped by data-rates</p> <p>Up to 16 station beams</p> <p>8 hour max observations, up to 16 images (either in time i.e. 30min, pointings or station beam s)</p>	<p>VLBI at least 2 beams</p> <p>50 PSS beams</p>	<p>Two substation arrangements, capped by data-rates</p> <p>Up to 24 station beams</p> <p>50h max integration</p> <p>Basic image-based mosaicing</p>	<p>PLDP generation tests</p> <p>Joint deconvolution</p>	<p>Source finding (& associated image cutouts)</p>	<p>Multiple pointings processed independently</p> <p>Greater than 2 substation arrangements, capped by data-rate</p> <p>50h max integration</p>	<p>Fast imaging</p> <p>Transient buffer triggered by fast imaging</p>	<p>Limited PLDP generation</p> <p>Joint deconvolution</p>	<p>Full substation capability</p>	<p>Autocorrelation processed data products</p>	<p>Fast imaging</p> <p>Transient buffer triggered by fast imaging</p>	<p>Full PLDP capabilities</p> <p>Joint deconvolution</p>
<p>Calibrated, averaged and gridded visibles, image cubes</p> <p>Early implementation of the continuum subtraction possible</p> <p>Single beam, single pointing</p> <p>Full FoV, 4k channel max, up to full BW</p> <p>4h max observations</p>	<p>At least one substation arrangement, capped by data rates</p> <p>Continuum subtraction</p> <p>Up to 8 station beams</p> <p>4 hour max observations, up to 8 images (either in time i.e. 30min, pointings or station beam s)</p>		<p>Two substation arrangements, capped by data-rates</p> <p>16k channel max</p> <p>Up to 24 station beams</p> <p>12h max integration</p> <p>Basic image-based mosaicing</p>	<p>Limited support for PLDP generation testing</p> <p>Limited joint deconvolution</p>	<p>Source finding (& associated image cutouts)</p> <p>64k channel max</p>	<p>Greater than 2 substation arrangements, capped by data-rate</p> <p>Multiple pointings processed independently</p> <p>Increased channels</p> <p>12h max integration</p>	<p>Improved PSS machine learning for improved triggering</p>	<p>Limited PLDP generation</p> <p>Joint deconvolution</p>	<p>Improved sources finding (and image cut outs)</p> <p>Full substation capabilities</p>	<p>Autocorrelation processed data products</p>	<p>Improved PSS machine learning for improved triggering</p>	<p>Full joint deconvolution capabilities</p> <p>Full PLDP capabilities</p>
<p>PST at least one beam, full processing</p>	<p>PST at least 2 beams, full processing</p> <p>VLBI at least one beam</p> <p>8 PSS beams fully processed</p>		<p>Two substation arrangements, capped by data-rates</p> <p>16k channel max</p> <p>Up to 24 station beams</p> <p>12h max integration</p> <p>Basic image-based mosaicing</p> <p>PST full 8 beam capacity</p>	<p>Transient buffer – triggered by PSS observations</p>	<p>PSS full basic capability</p> <p>VLBI full basic capability</p>	<p>Greater than 2 substation arrangements, capped by data-rate</p> <p>Multiple pointings processed independently</p> <p>Increased channels</p> <p>12h max integration</p> <p>PST full 8 beam capacity</p>		<p>Transient buffer – triggered by PSS observations</p>	<p>PSS full basic capability</p> <p>VLBI full basic capability</p>		<p>Transient buffer triggered by PSS obs</p>	

Telescope mode

Observatory Data Products (ODPs) and their capabilities

- Continuum
- Spectral
- Beamformed
- Transient

SKA-Mid: Delivery of observing modes and ODPs to the astronomy community

AA2 2029	AA* 2031	Cycle 0 2032		Cycle 1 2033			Cycle 2 2034			Cycle 3 2035		
Science Verification (SV)	SV	SV	Shared risk	SV	Shared risk	Standard ops	SV	Shared risk	Standard ops	SV	Shared risk	Standard ops
Single subarray Both sidereal and non-sidereal tracking		4 subarrays Drift scanning capped at a few mins		16 subarrays Drift scanning capped at a few mins			Full drift scanning capabilities Wide area scanning					
<p>Calibrated, averaged and gridded visibilities, image cubes (excluding SKA008)</p> <p>Full BW (800 MHz, FoV)</p> <p>Single pointing</p> <p>40 channel max</p> <p>4h max observations</p>	<p>Full BW (up to 5 GHz)</p> <p>8 hour max observations, up to 16 images (either in time i.e. 30min, or pointings)</p> <p>Zoom resolution (up to 0.21 kHz)</p> <p>Continuum subtraction</p> <p>4 hour max observations, up to 8 images (either in time i.e. 30min, or pointings)</p> <p>PSS 200 beams fully processed</p> <p>VLBI 4 beams</p> <p>PST 8 beams, full processing</p>	<p>Limited support for PLDP generation tests</p> <p>Limited joint deconvolution</p> <p>Limited support for PLDP generation tests</p> <p>Limited joint deconvolution</p> <p>Transient buffer - triggered by PSS observations</p>	<p>Multiple pointings processed independently (i.e. no joint deconvolution)</p> <p>Use of SKA008 possible for appropriate projects</p> <p>50h max integration</p> <p>16k channel max</p> <p>Multiple pointings processed independently (i.e. no joint deconvolution)</p> <p>Use of SKA008 possible for appropriate projects</p> <p>12h max integration</p> <p>PSS full basic capability</p> <p>VLBI full basic capability</p> <p>PST full 16 beam capability</p>	<p>Fast imaging</p> <p>Transient buffer triggered by fast imaging (limited by buffer latency, perhaps less than 10 seconds)</p> <p>Improved PSS machine learning for improved triggering</p>	<p>Source finding (& associated image cutouts)</p> <p>Limited PLDP generation</p> <p>Joint deconvolution</p> <p>Source finding (& associated image cutouts)</p> <p>64k channel max</p> <p>Joint deconvolution</p> <p>Limited PLDP generation</p> <p>Transient buffer - triggered by PSS observations</p>	<p>Multiple pointings processed independently (i.e. no joint deconvolution)</p> <p>Use of SKA008 possible for appropriate projects</p> <p>50h max integration</p> <p>16k channel max</p> <p>Multiple pointings processed independently</p> <p>Use of SKA008 possible for appropriate projects</p> <p>12h max integration</p> <p>PSS full basic capability</p> <p>VLBI full basic capability</p> <p>PST full 16 beam capability</p>	<p>Autocorrelation processed data products</p> <p>Autocorrelation processed data products</p>	<p>Fast imaging</p> <p>Transient buffer triggered by fast imaging (limited by buffer latency, perhaps less than 10 seconds)</p> <p>Improved PSS machine learning for improved triggering</p>	<p>Improved source finding (& associated image cutouts)</p> <p>Full PLDP generation</p> <p>Joint deconvolution</p> <p>Improved source finding (& associated image cutouts)</p> <p>64k channel max</p> <p>Joint deconvolution</p> <p>Full PLDP generation</p> <p>Transient buffer triggered by PSS observations</p>	<p>Autocorrelation processed data products</p> <p>Autocorrelation processed data products</p>	<p>Improved PSS machine learning for improved triggering</p> <p>Fast imaging</p> <p>Transient buffer triggered by fast imaging (limited by buffer latency, perhaps less than 10 seconds)</p>	
<p>Raw, calibrated, averaged and gridded visibilities, image cubes (excluding SKA008)</p> <p>Single pointing</p> <p>Full FoV, 4k channel max output, up to full BW</p> <p>Early continuum subtraction implementation</p> <p>4h max observations</p> <p>PST at least one beam, full processing</p> <p>8 PSS beams, fully processed</p> <p>1 VLBI beam</p>												

Telescope mode

Observatory Data Products (ODPs) and their capabilities

- Continuum
- Spectral
- Beamformed
- Transient

Towards the SKAO

[Courtesy of A. Bonaldi]

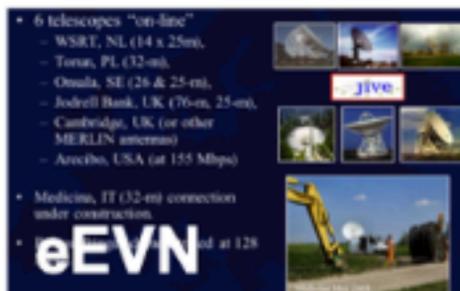
Precursors

Located at future SKA sites
(South Africa and Australia)



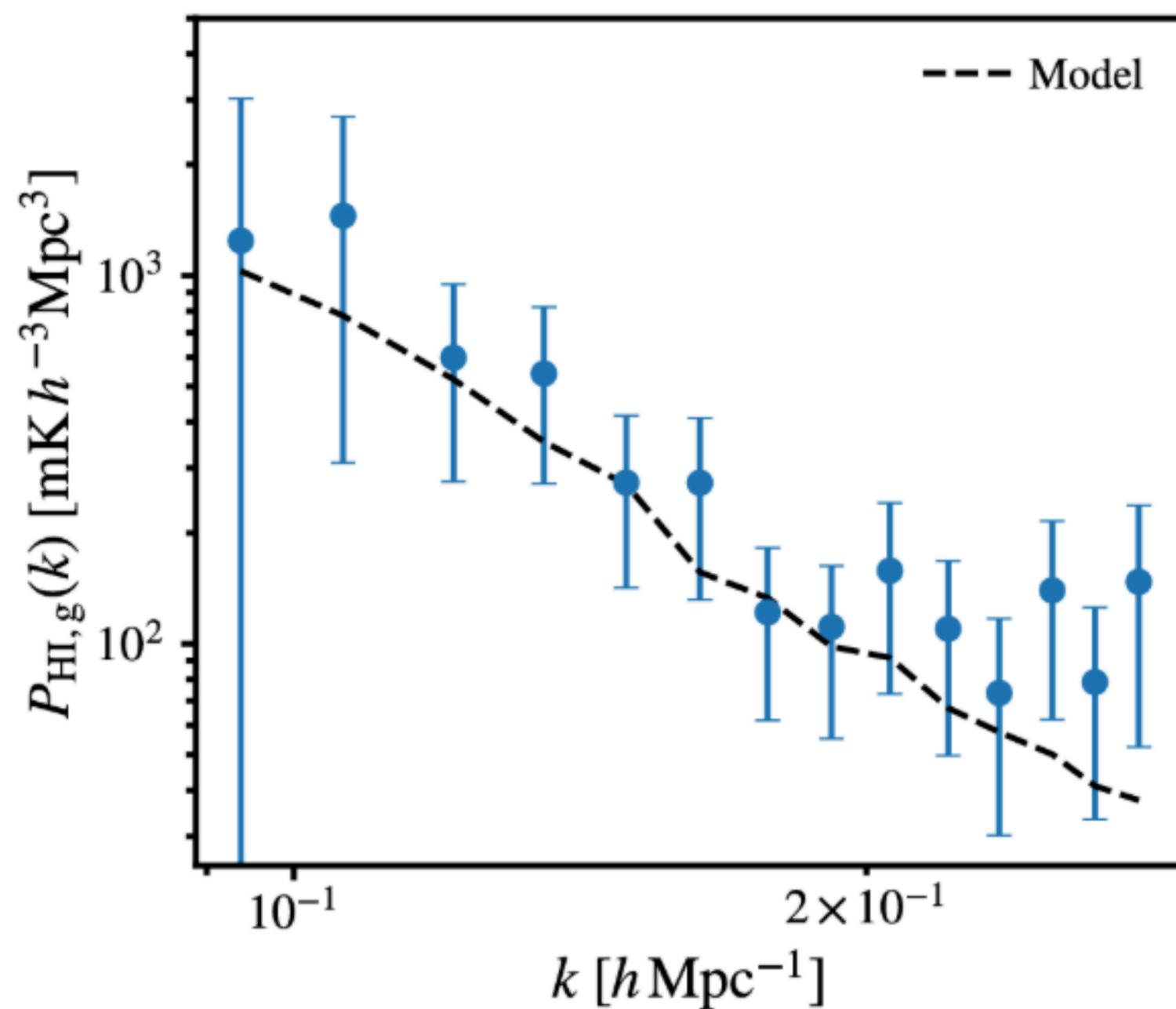
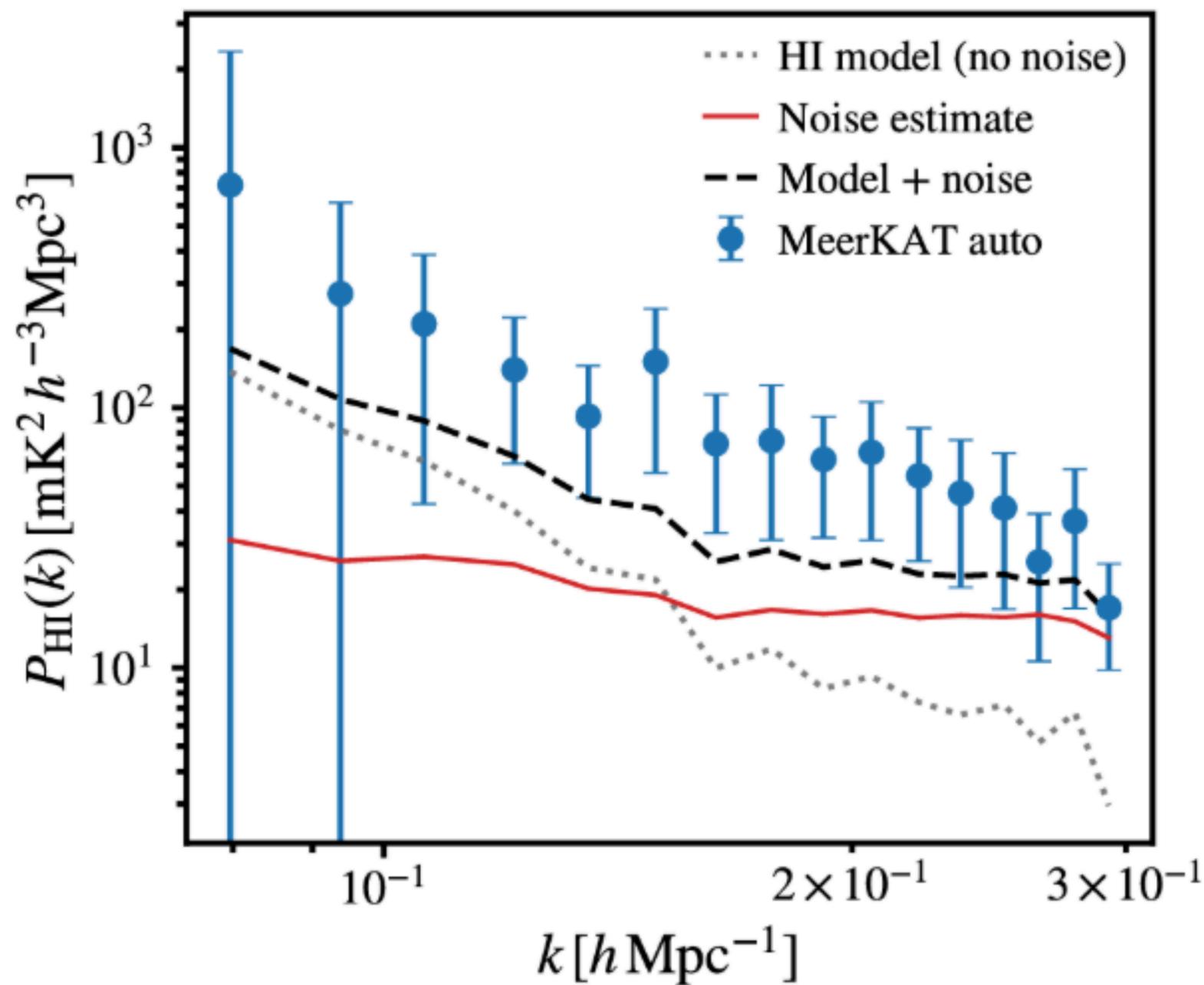
Pathfinders

Engaged in SKA related
technology and science
studies

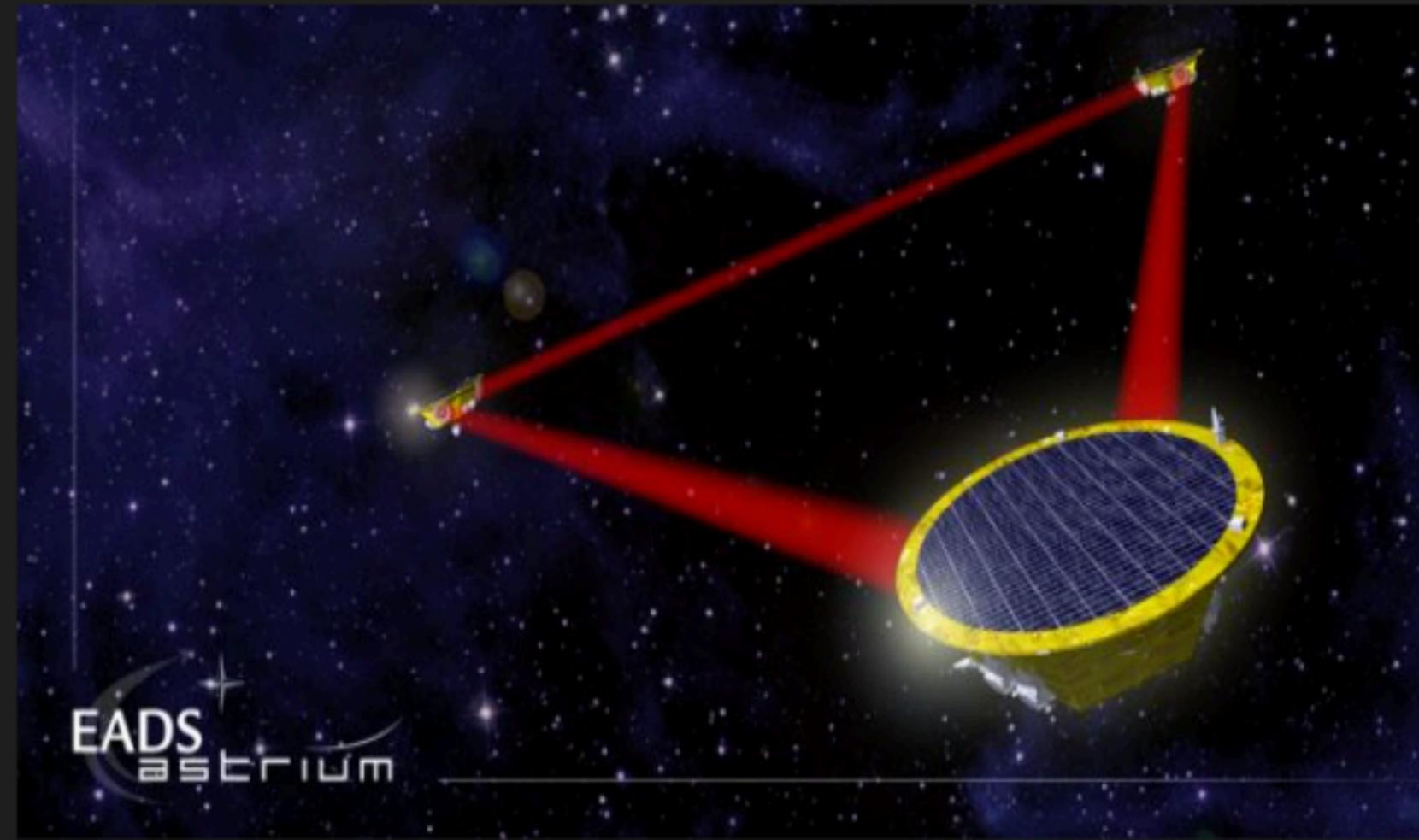
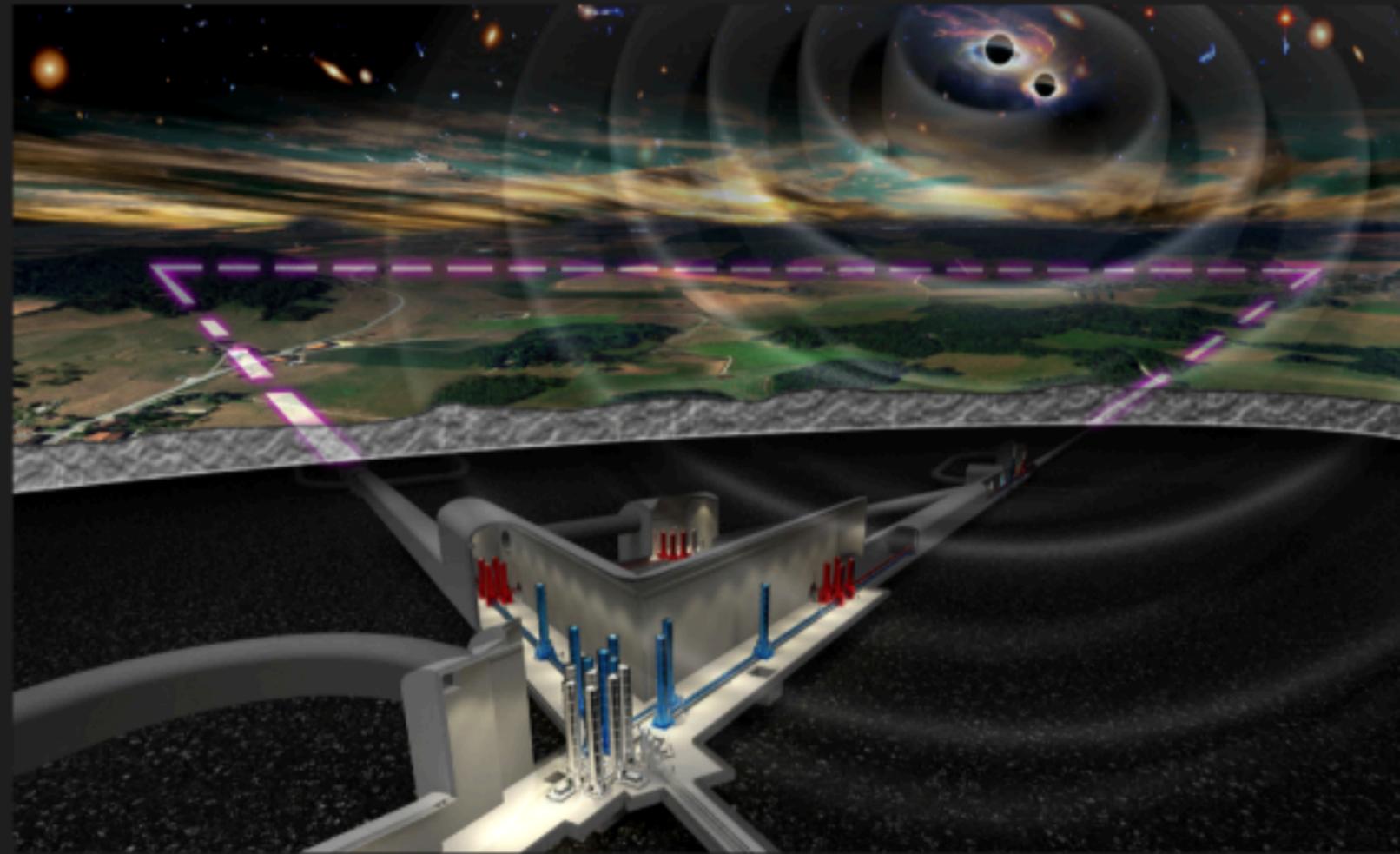


MeerKATCLASS

- 10000 sq deg at 580 - 1015 MHz (UHF)
- 500 sq deg at 856 - 1712 MHz (L)
- HI auto and cross spectra at $z = 0.44$



Cosmology in the Gravitational Waves Era



Einstein Telescope

- ground based interferometer
- planned for completion in 2035
- frequency range: 1 Hz - 10 kHz

LISA

- space based interferometer
- planned for launch in 2035
- frequency range: 0.1mHz - 1 Hz

Cosmology with Gravitational Waves

Stochastic GW Background

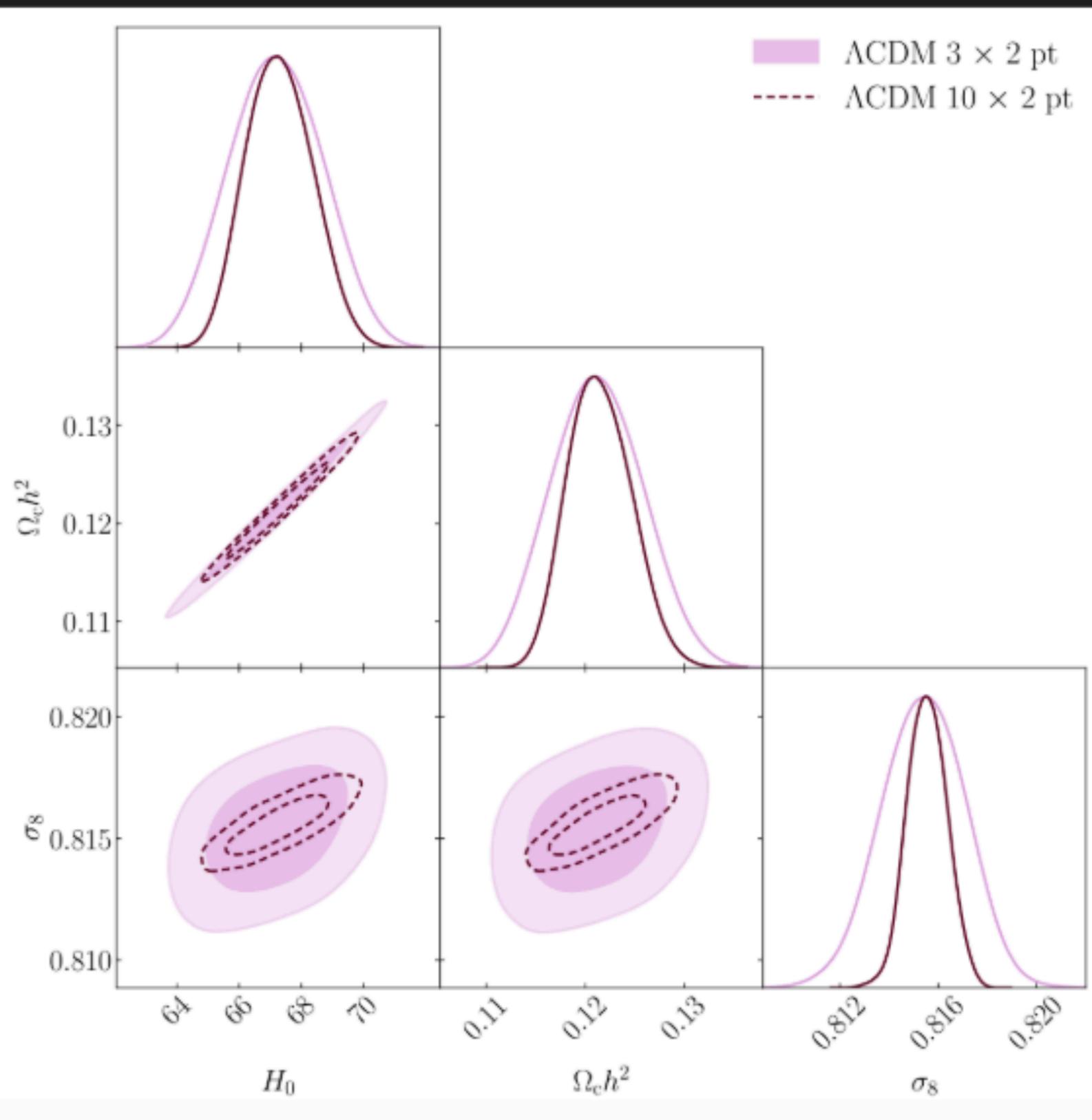
- anisotropy
- polarization

Early Universe

- inflation / domain walls
- primordial black holes

Late Universe and LSS

- GW propagation
- weak lensing of GW
- GW counts vs halo abundance
- cross correlation with other probes

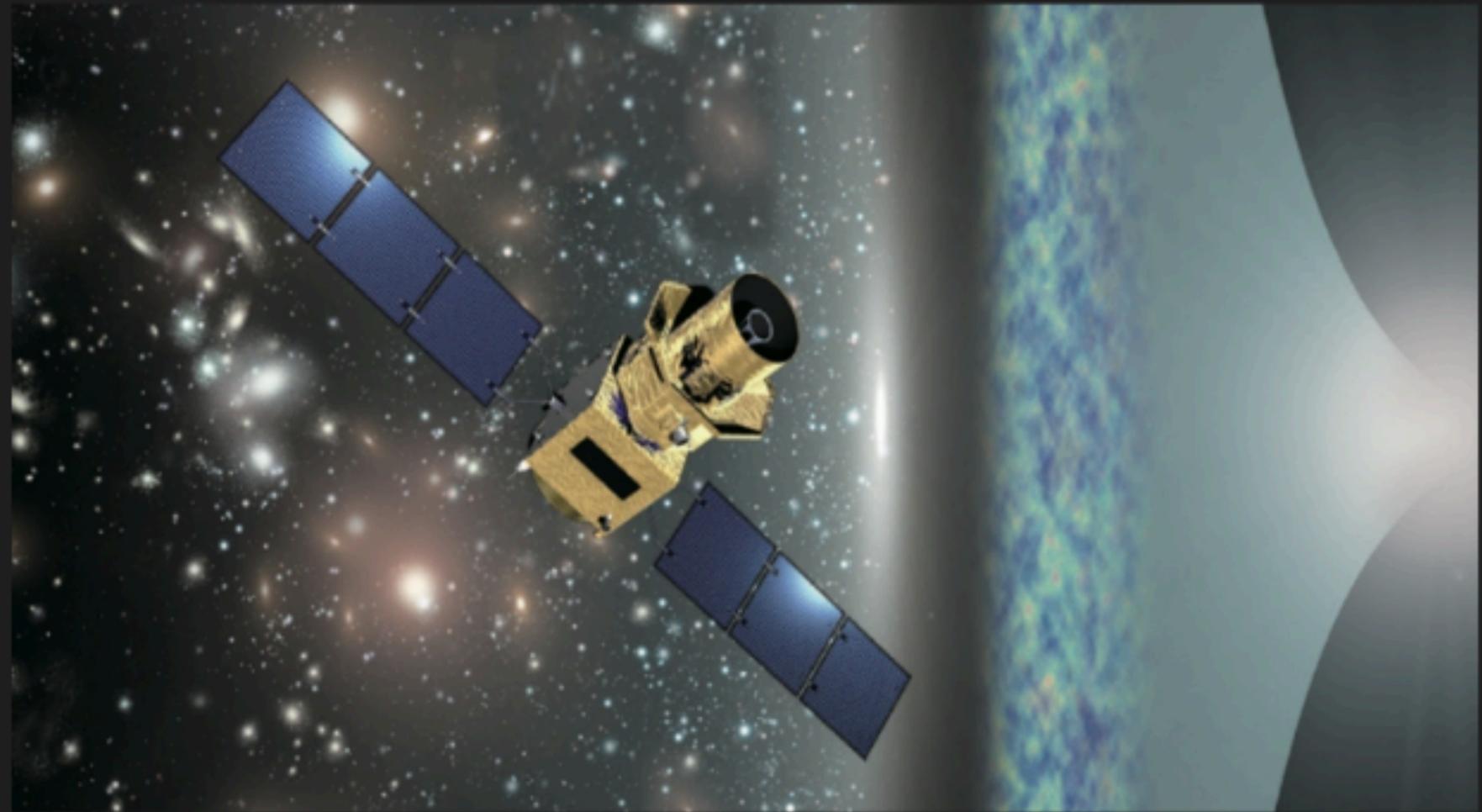


(Old School yet Evergreen) Cosmology: CMB



Simons Observatory

- now: 3x0.5mt SAT + 1x6mt LAT
- goal: 6x0.5mt SAT+ upgrade LAT
- in operation / commissioning



LiteBIRD

- 15 bands over the range 34 - 448 GHz
- $2.2 \mu\text{K}$ - arcmin with 0.5 deg res at 100 GHz
- planned for launch in 2032

1/f noise and
instrumental systematic effects

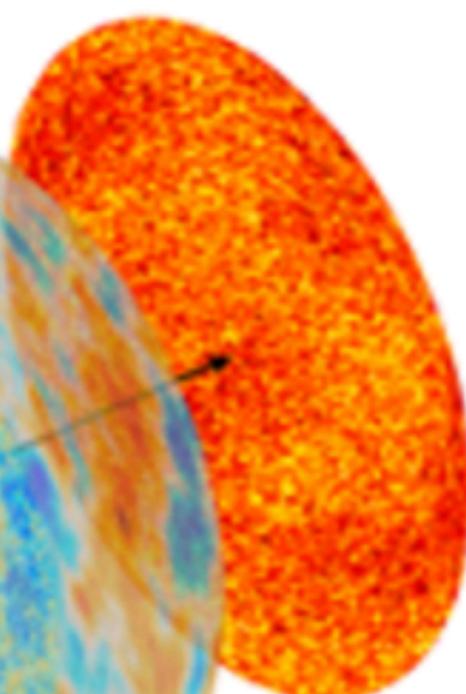
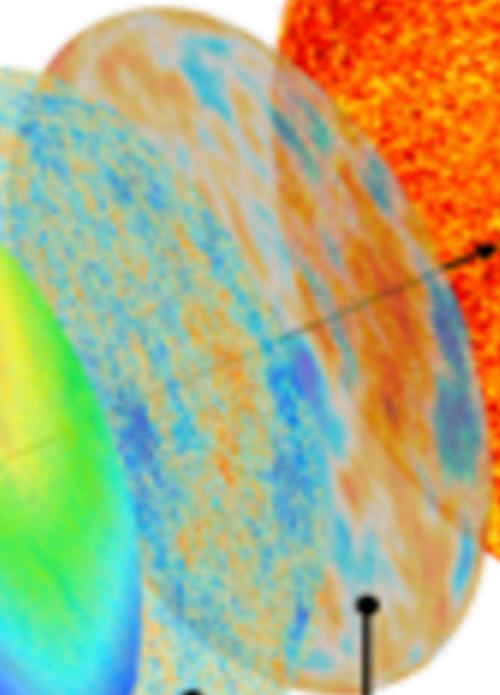
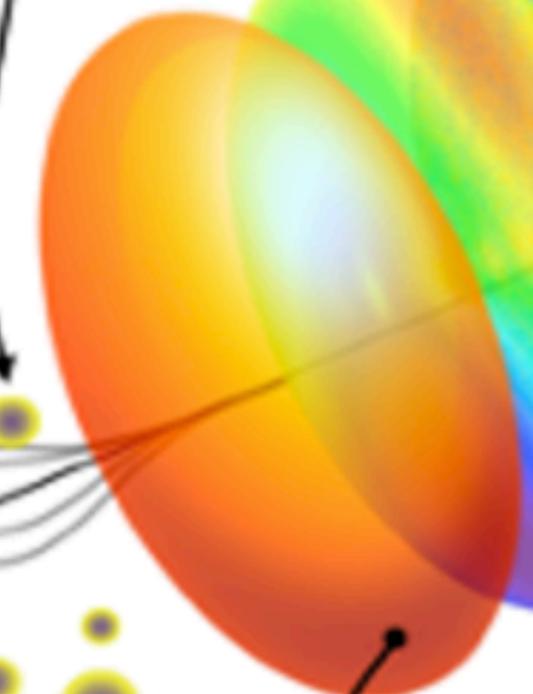
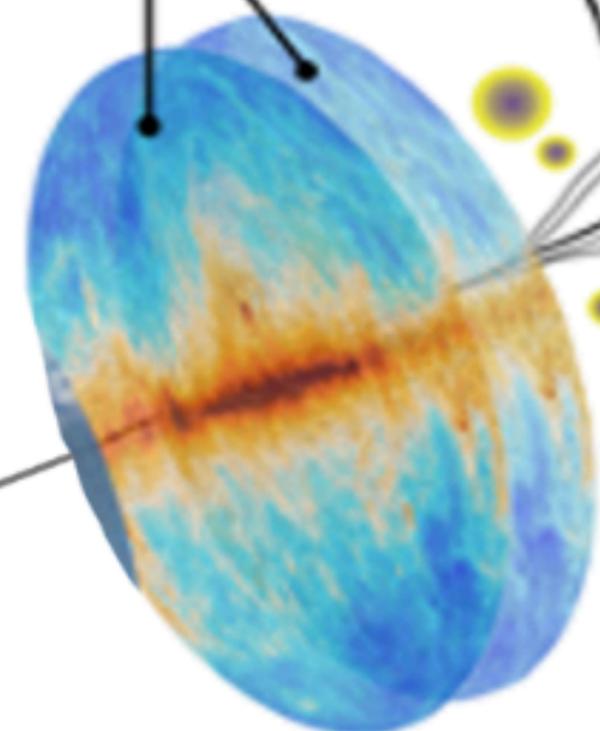
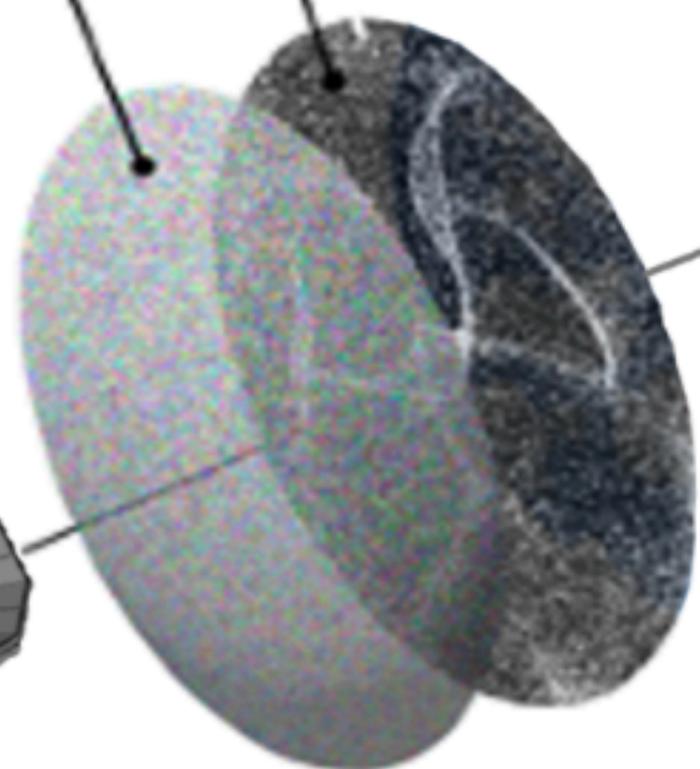
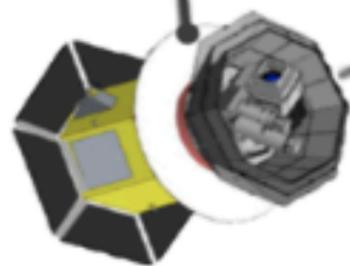
galactic and extra-galactic
foregrounds

white
instrumental
noise

gravitational
lensing

clusters

LiteBIRD



CMB
monopole
 $T = 2.7 \text{ K}$

CMB dipole
 $\Delta T/T \sim 10^{-3}$

CMB
intensity
anisotropies
 $\Delta T/T \sim 10^{-5}$

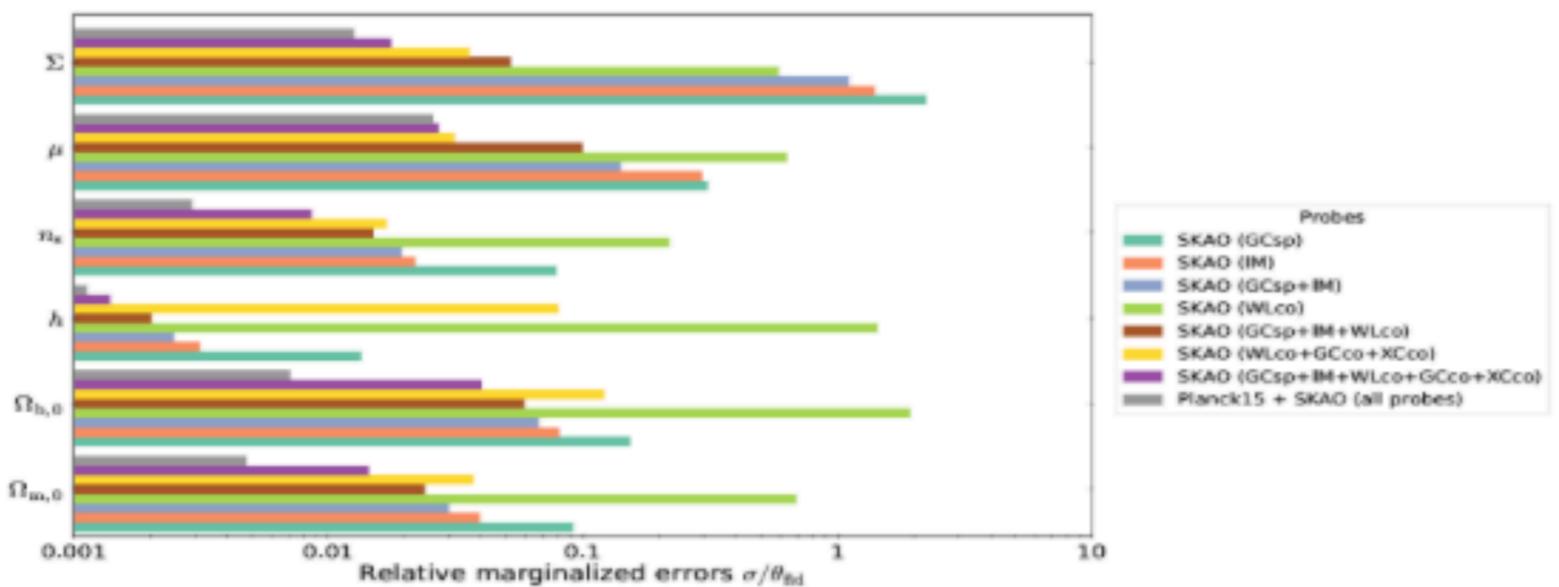
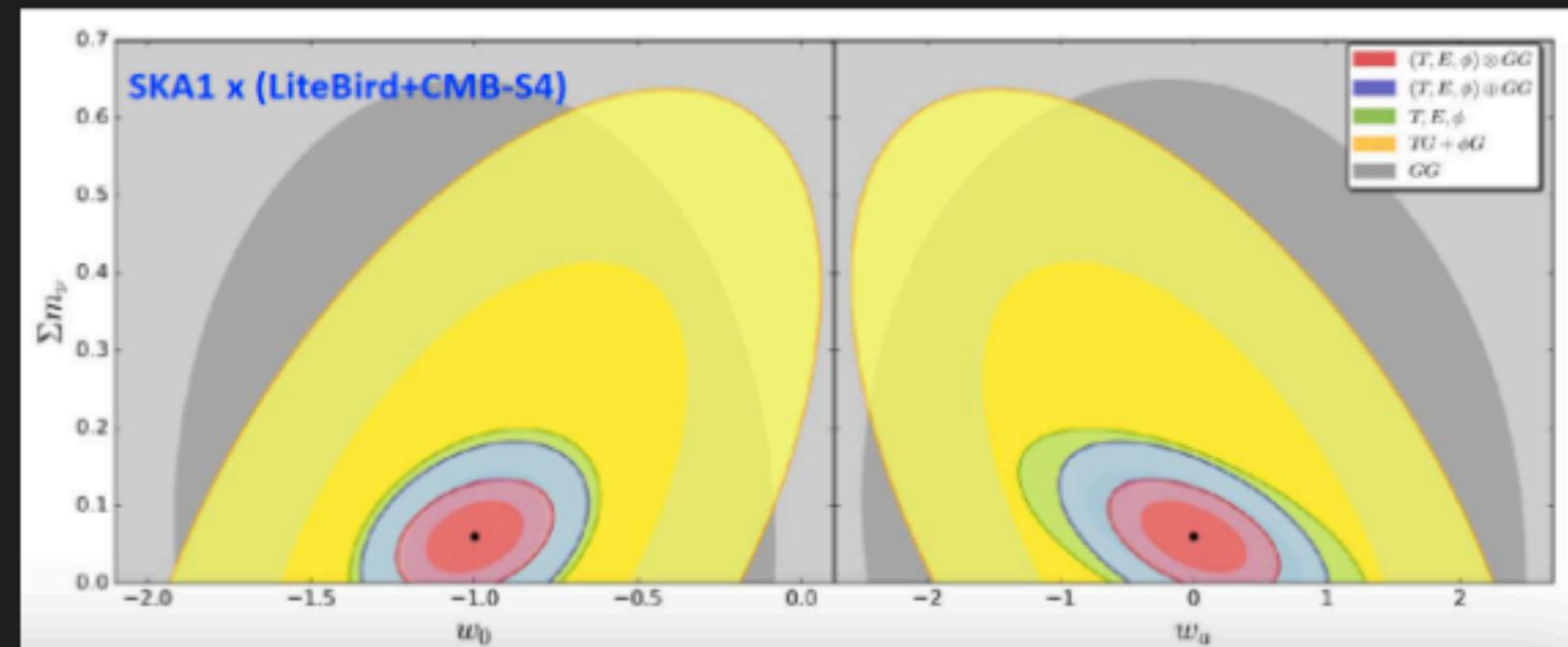
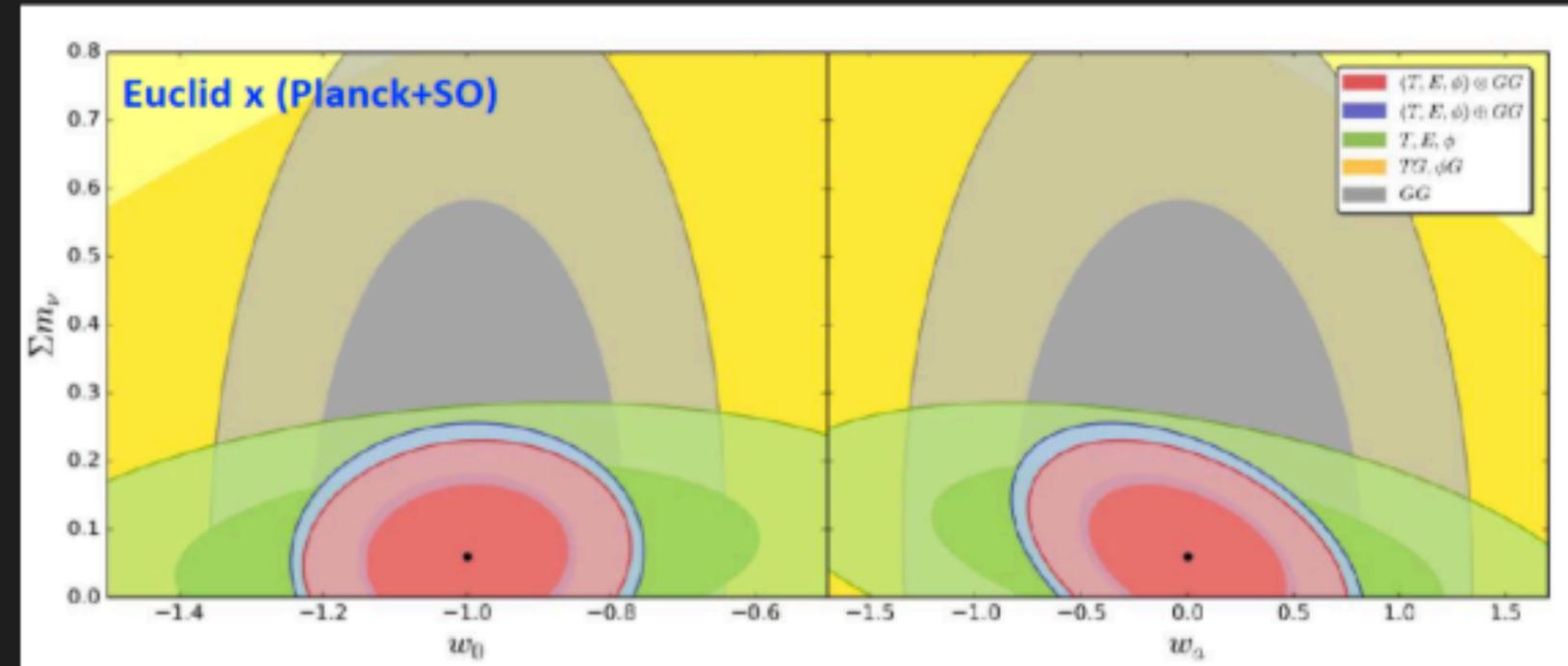
CMB E-modes
 $\Delta T/T \sim 10^{-6}$

CMB
B-modes
 $\Delta T/T \lesssim 10^{-7}$

With all due respect to Tolkien and its masterpiece

- *One ring to rule them all. One ring to find them. One ring to bring them all, and in the darkness bind them*

- *Many rings to rule it all. Many rings to find the one. Many rings to bright the dark, and in the light take it all.*



- Optical x Radio (Euclid x SKAO) or Old x New Astronomy (Euclid x GW) or CMB x LSS
- *Everything Everywhere All at Once*: cross correlation among all probes at all wavelengths

INAF and Cosmology in the Multiwavelength Era

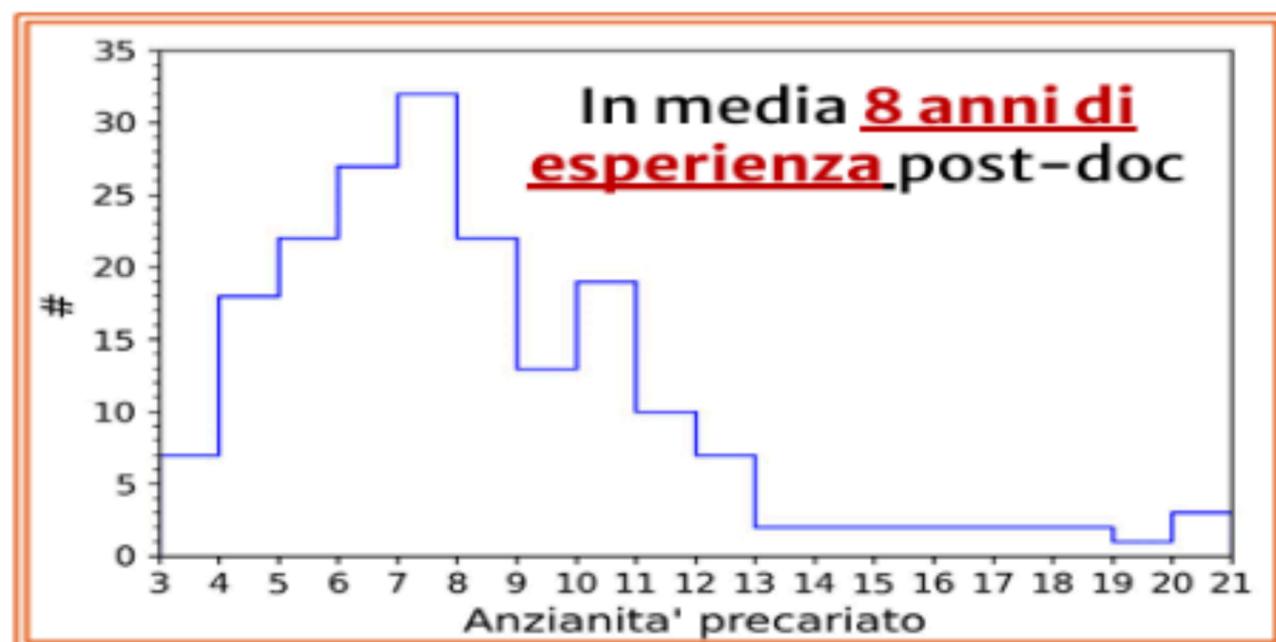
- massive involvement in all main ground and space based missions
- leading roles in Euclid, LSST, SKAO, LiteBIRD, Einstein Telescope
- strong synergies with universities and INFN
- good investment in computational facilities

In recent years, a large network of observatories has been deployed on remote places in the land, in the sea, underground and in space, to detect the signals coming from the "visible" Universe and even earlier, in the first moments beyond the "recombination wall" when nuclei and electrons formed neutral atoms and the Universe became transparent.

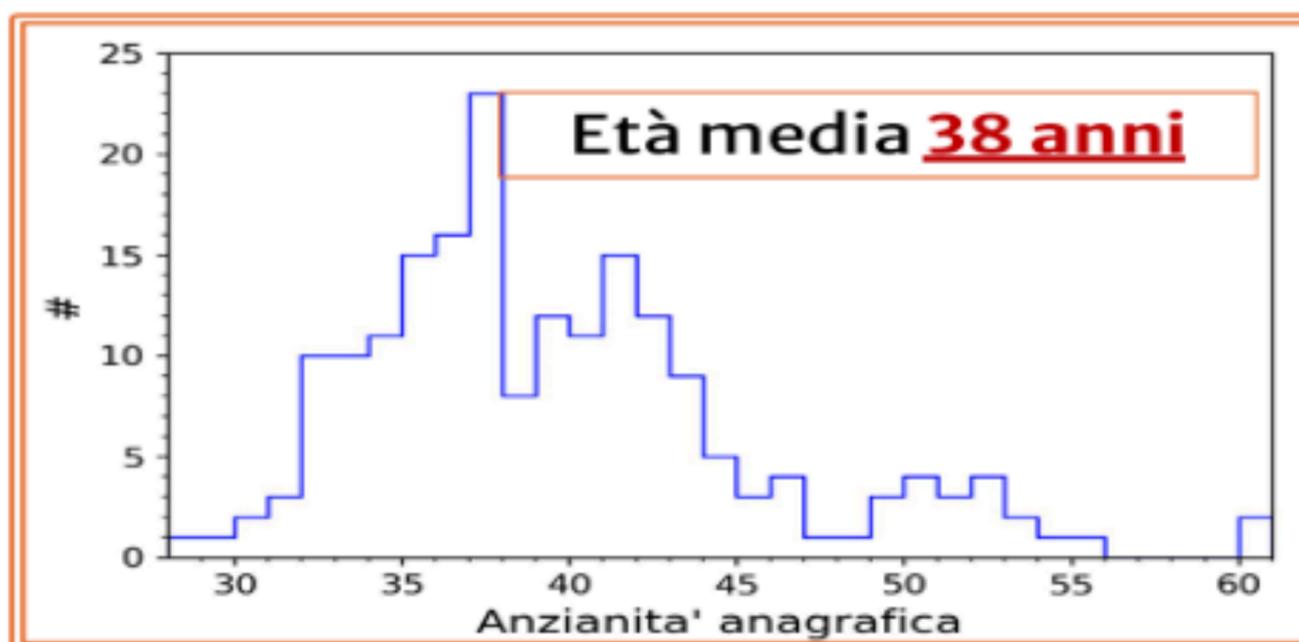
LISTENING TO NEW
COSMIC MESSENGERS

La situazione del personale precario in INAF è **INSOSTENIBILE!**

1.200 TI Vs **650** precari: più di 1 precario ogni 2 persone di ruolo



Plot di un campione rappresentativo dei precari INAF al 31/12/2024



Entro l'anno, l'attuale situazione determinerà l'esodo di > 100 lavoratori altamente qualificati

È **URGENTE** che INAF **RIVENDICHI** con fermezza, presso il MUR, finanziamenti svincolati dal turnover ed etichettati per le **STABILIZZAZIONI MADIA**: unica soluzione per questa emergenza



Per sostenerci, inquadra il QRcode e firma

