



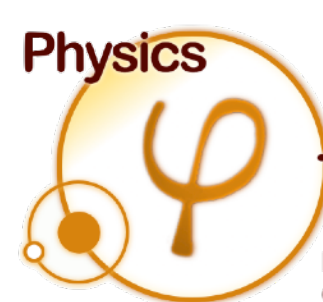
Cosmology

Stefano Camera

Dipartimento di Fisica
Università degli Studi di Torino



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Torino
Department
of Excellence



Istituto Nazionale di Fisica Nucleare
Sezione di Torino



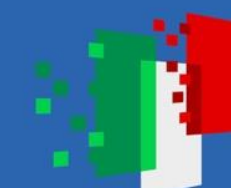
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and International Cooperation

Concordance cosmology



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- *Most* of the matter in the Universe appears to be *exotic* (*'cold' dark matter, CDM*)

Concordance cosmology



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- *Most* of the matter in the Universe appears to be *exotic* (*'cold' dark matter, CDM*)
- Two very *distant* (in time, scale, energy) yet remarkably *similar* stages of cosmic evolution

Concordance cosmology



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- *Inflation*:
 - A 'paradigm' with a large number of practical realisations—need to trim down
 - Imprints: *B-modes* (mainly CMB) and *primordial non-Gaussianity* (mainly LSS)

Concordance cosmology



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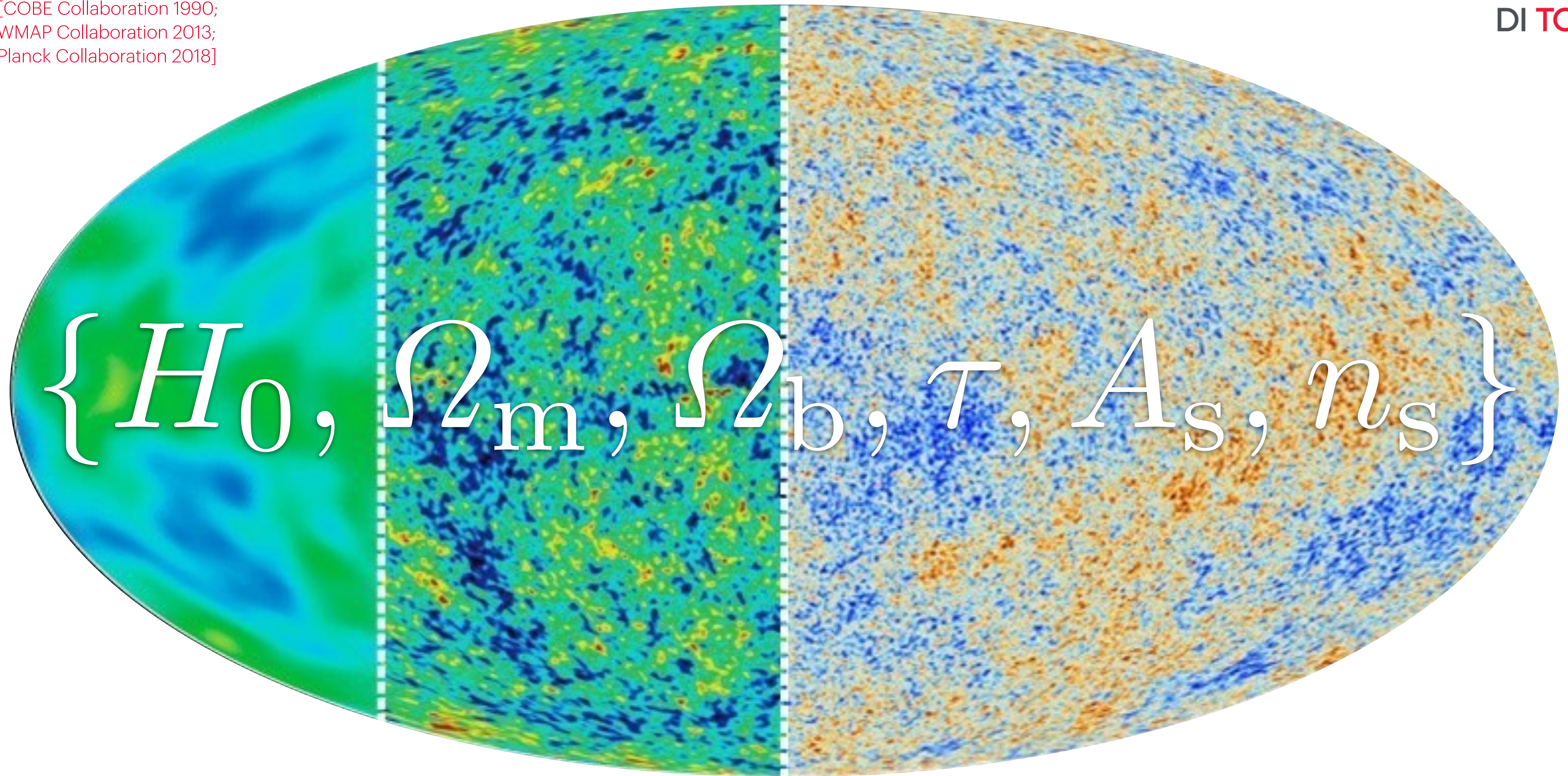
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 - Imprints: *B-modes* (mainly CMB) and *primordial non-Gaussianity* (mainly LSS)
- *Dark energy*:
 - Another mysterious scalar field or simply a seemingly fine-tuned Λ ?
 - Or, even, a symptom of an incorrect *gravity theory* on cosmological scales?

Cosmic microwave background

[COBE Collaboration 1990;
WMAP Collaboration 2013;
Planck Collaboration 2018]



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The cosmic large-scale structure

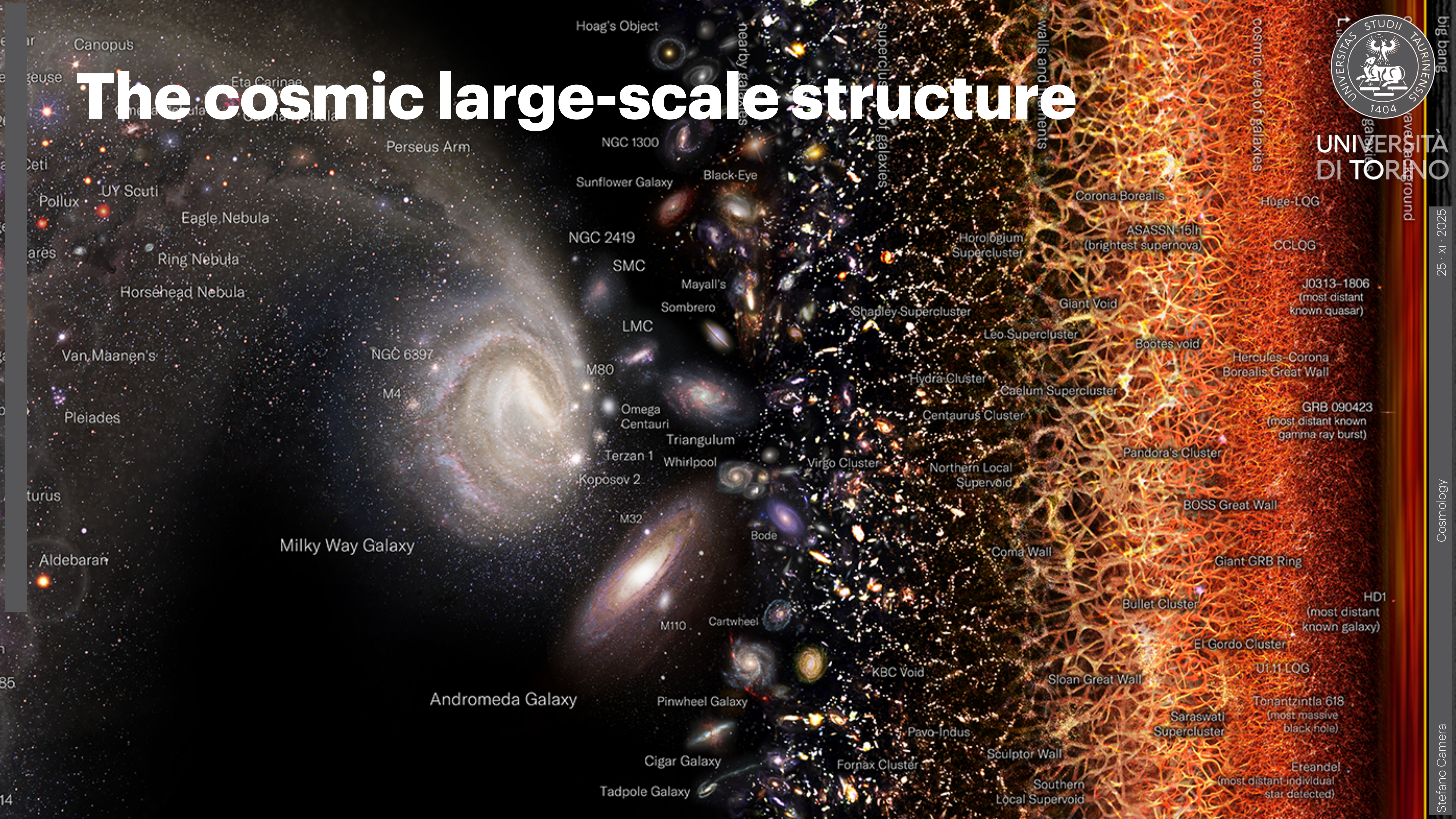


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25 · XI · 2025

Cosmology

Stefano Camera



Present and future data

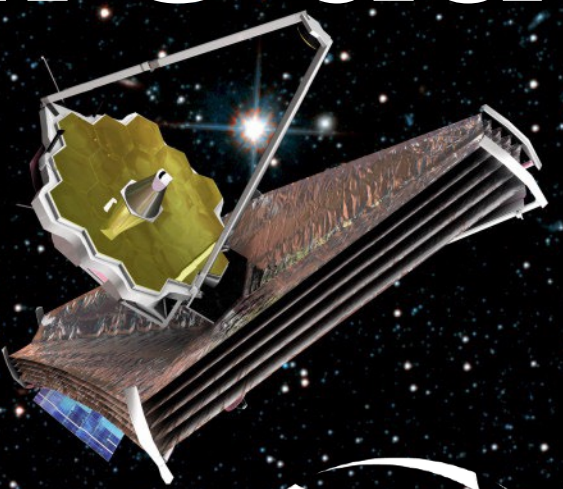
herschel

Unveiling the cool
and dusty Universe



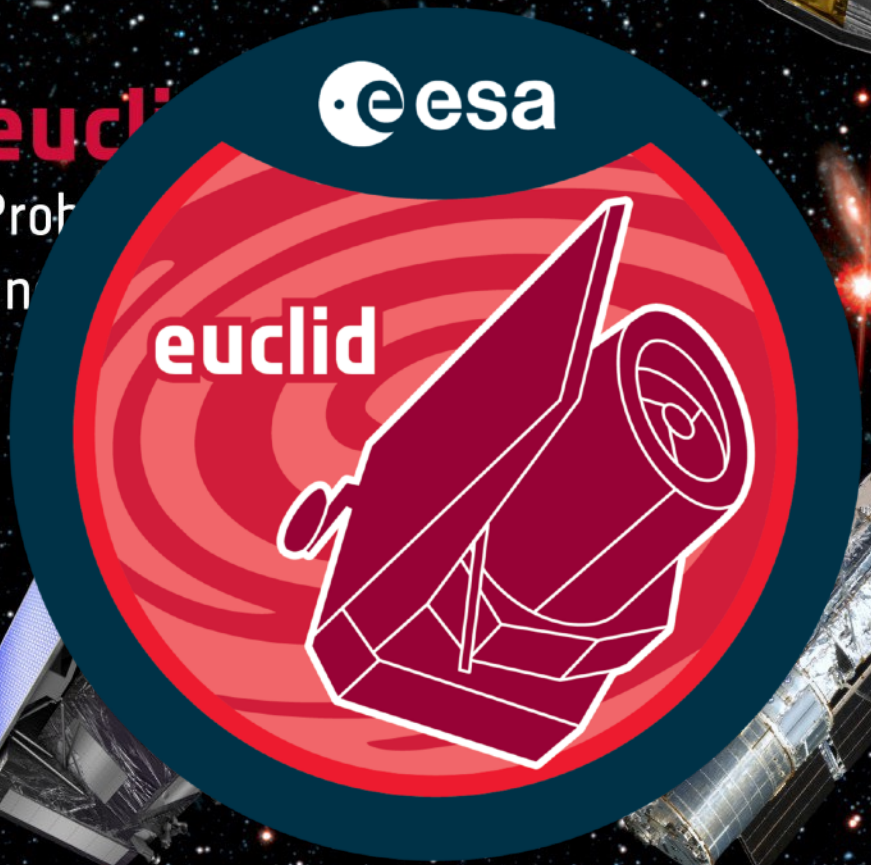
jwst

Observing the distant Universe



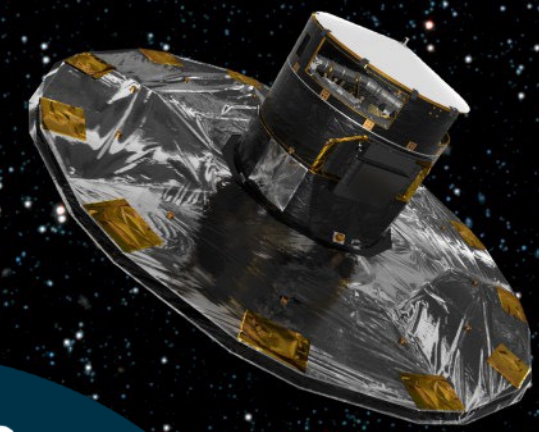
euclid

Probing the
dark Universe



gaia

Surveying a billion stars



hst

Expanding the frontiers
of the visible Universe



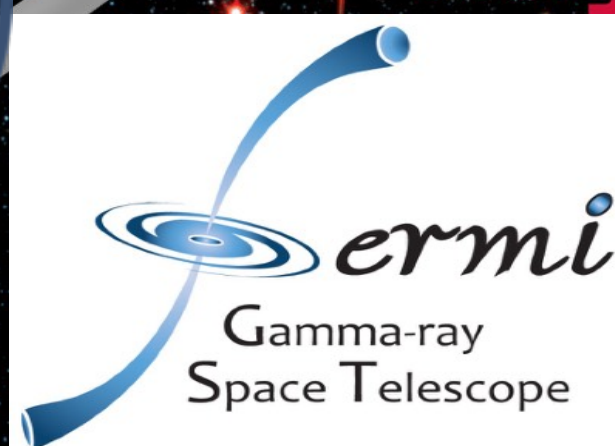
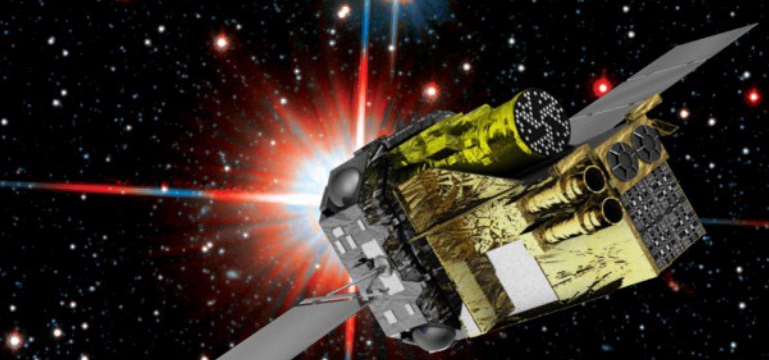
xmm-newton

Seeing deeply into the hot
and violent Universe



integral

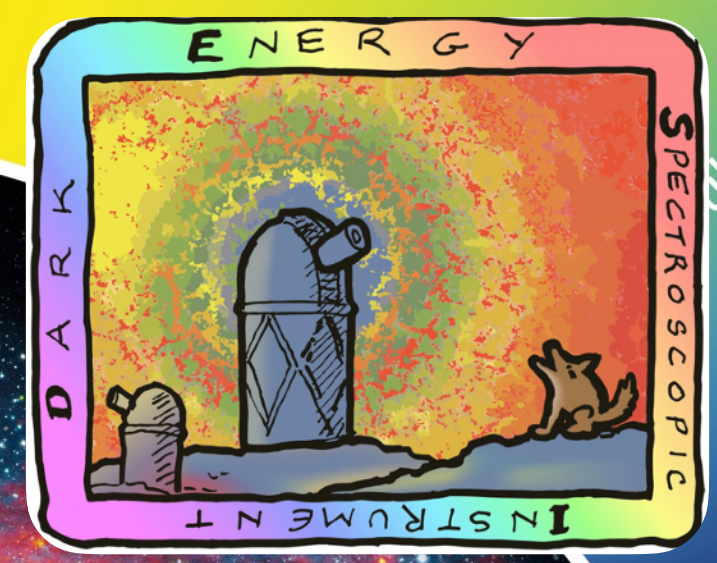
Peering into the extremes
of the Universe



eROSITA

x-rays

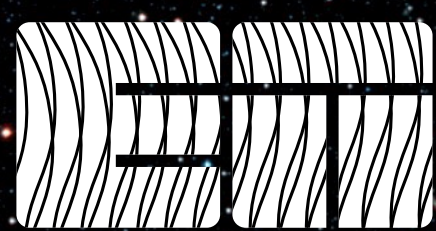
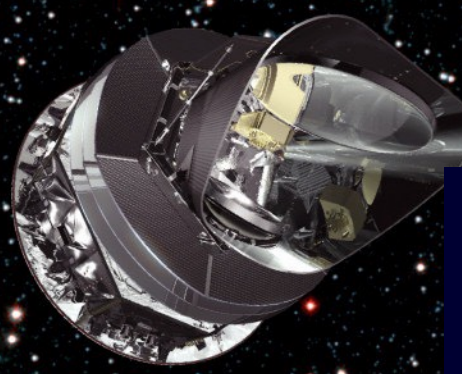
gamma rays



ultraviolet

planck

Looking back
at the dawn of time



EINSTEIN
TELESCOPE

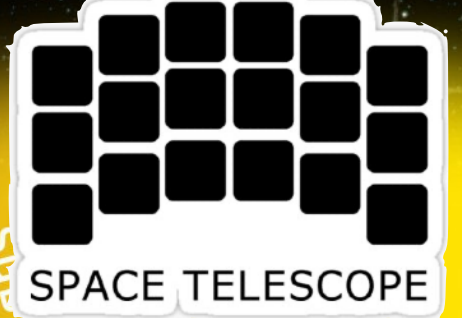


**lisa
pathfinder**

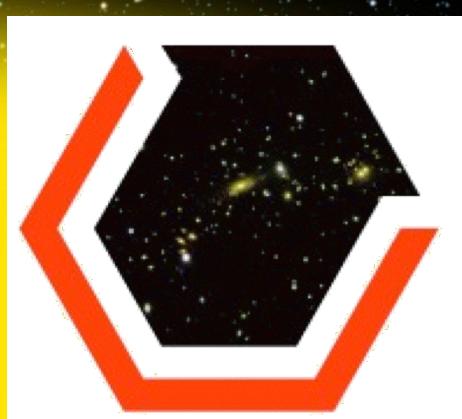
Testing the technology
for gravitational
wave detection



NANCY GRACE
ROMAN

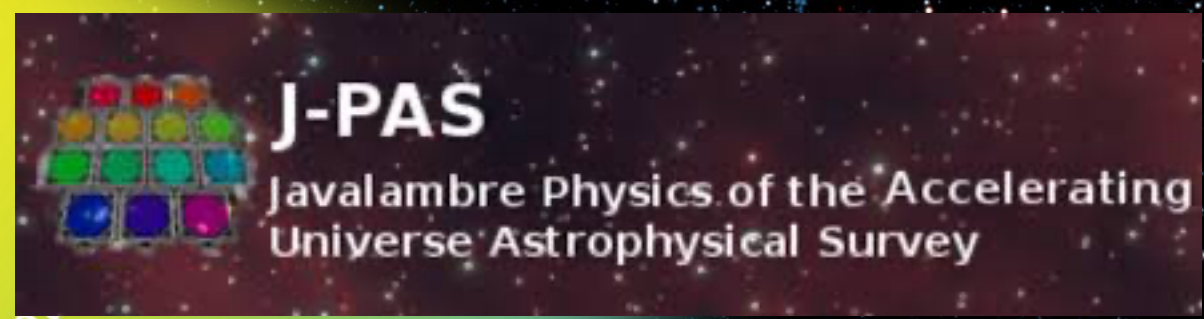


sub-millimetre



DARK ENERGY
SURVEY

KIDS
The Kilo-Degree Survey



J-PAS

Javalambre Physics of the Accelerating
Universe Astrophysical Survey



Cosmology at radio wavelengths



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- Surveys carried out at *radio* wavelengths:
 - *HI-line* galaxy surveys
 - *Continuum* galaxy surveys
 - *Radio* weak lensing surveys
 - *HI intensity mapping* surveys
- *Multi-wavelength* synergies

SKAO Cosmology

Publications of the Astronomical Society of Australia (2020), **37**, e007, 31 pages

doi:[10.1017/pasa.2019.51](https://doi.org/10.1017/pasa.2019.51)



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CAMBRIDGE
UNIVERSITY PRESS

[SKA Cosmology SWG $\supset$ SC 2020]

Research Paper

Cosmology with Phase 1 of the Square Kilometre Array Red Book 2018: Technical specifications and performance forecasts

Square Kilometre Array Cosmology Science Working Group: David J. Bacon¹, Richard A. Battye² , Philip Bull³, Stefano Camera^{2,4,5,6}, Pedro G. Ferreira⁷, Ian Harrison^{2,7}, David Parkinson⁸, Alkistis Pourtsidou³, Mário G. Santos^{9,10,11}, Laura Wolz¹², Filipe Abdalla^{13,14}, Yashar Akrami^{15,16}, David Alonso⁷, Sambatra Andrianomena^{9,10,17}, Mario Ballardini^{9,18}, José Luis Bernal^{19,20}, Daniele Bertacca^{21,22}, Carlos A. P. Bengaly⁹, Anna Bonaldi²³, Camille Bonvin²⁴, Michael L. Brown², Emma Chapman²⁵, Song Chen⁹, Xuele Chen²⁶, Steven Cunnington¹, Tamara M. Davis²⁷, Clive Dickinson², José Fonseca^{9,22}, Keith Grainge², Stuart Harper², Matt J. Jarvis^{7,9}, Roy Maartens^{1,9}, Natasha Maddox²⁸, Hamsa Padmanabhan²⁹, Jonathan R. Pritchard²⁵, Alwise Raccanelli¹⁹, Marzia Rivi^{13,18}, Sambit Roychowdhury², Martin Sahlén³⁰, Dominik J. Schwarz³¹, Thilo M. Siewert³¹, Matteo Viel³², Francisco Villaescusa-Navarro³³, Yidong Xu²⁶, Daisuke Yamauchi³⁴ and Joe Zuntz³⁵

Cosmology with the SKAO

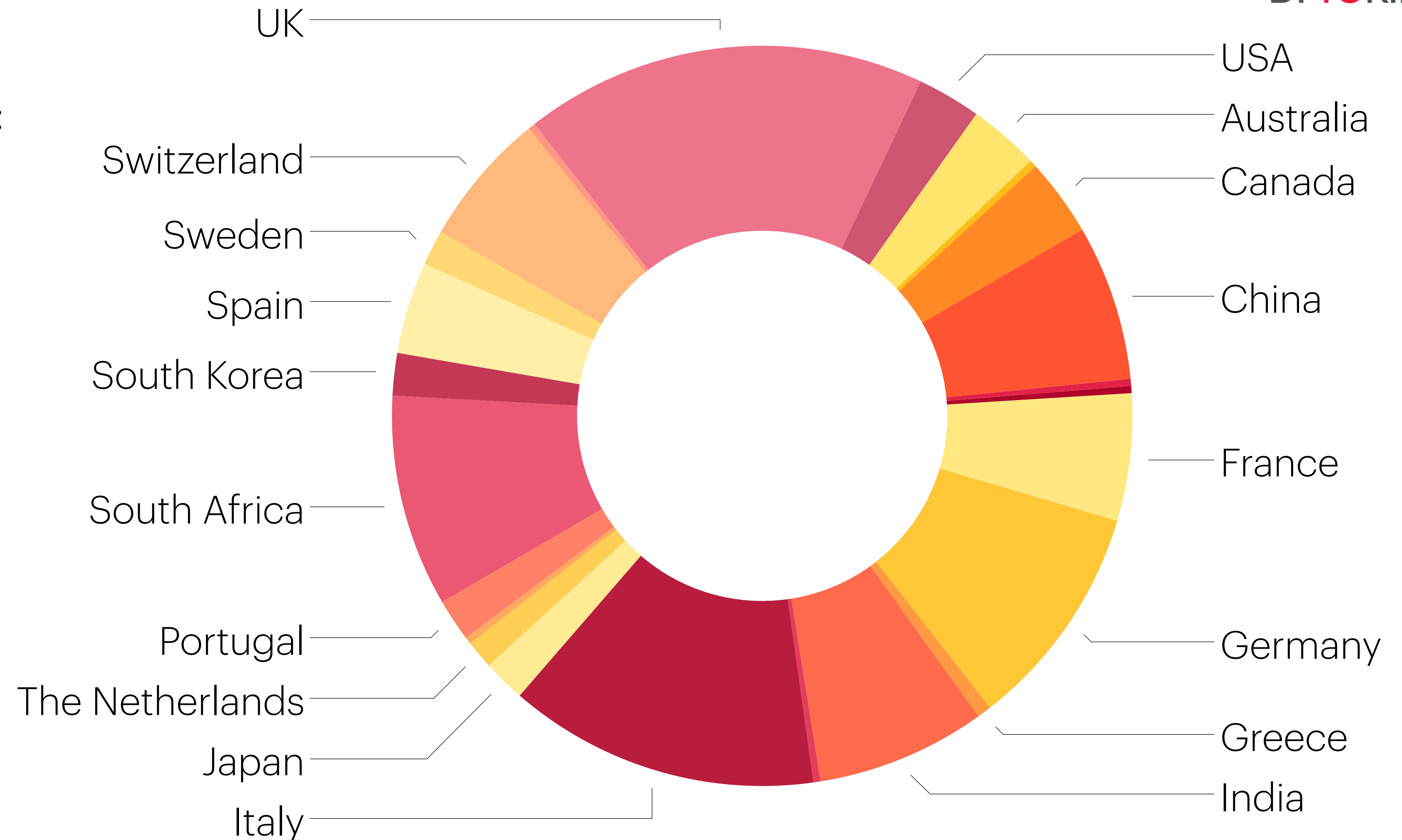


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- Current SWG chairs:

- *Ian Harrison*
(Cardiff, UK)

- *Marta Spinelli*
(Nice, France)



SKA Science Book 2025



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- 23 cosmology chapters
- 4 led/coordinated by Italian scientists

SKA Science Book 2025



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- *HI-line* galaxy surveys
- *Continuum* galaxy surveys
- *Radio* weak lensing surveys
- *HI intensity mapping* surveys
- *Multi-wavelength* synergies

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- *HI-line* galaxy surveys2
- *Continuum* galaxy surveys
- *Radio* weak lensing surveys
- *HI intensity mapping* surveys
- *Multi-wavelength* synergies

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- *HI-line* galaxy surveys2
- *Continuum* galaxy surveys2
- *Radio* weak lensing surveys
- *HI intensity mapping* surveys
- *Multi-wavelength* synergies

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- *HI-line* galaxy surveys2
- *Continuum* galaxy surveys2
- *Radio* weak lensing surveys3
- *HI intensity mapping* surveys
- *Multi-wavelength* synergies

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- *HI-line* galaxy surveys2
- *Continuum* galaxy surveys2
- *Radio* weak lensing surveys3
- *HI intensity mapping* surveys7
- *Multi-wavelength* synergies

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- *HI-line* galaxy surveys2
- *Continuum* galaxy surveys2
- *Radio* weak lensing surveys3
- *HI intensity mapping* surveys7
- *Multi-wavelength* synergies3

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• <i>HI-line</i> galaxy surveys	2
• <i>Continuum</i> galaxy surveys	2
• <i>Radio</i> weak lensing surveys	3
• <i>HI intensity mapping</i> surveys	7
• <i>Multi-wavelength</i> synergies	3
• <i>Fundamental</i> physics	2

Open for discussion



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- Capability deferral of *wide area scanning*
[*N.B.* Discussions started about *mitigation* via existing pipelines]
- SKA-Low *sensitivity* impacted by core station deferral
- AA4 is really looking *unlikely* now...
 - Anything relying on >50 km baselines *waits* until late-2030s?
- Concern about *turning off* MeerKAT before SKA is ready