Unveiling Fundamental Physics from the Cosmic First Light

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CIFAR | IDEAS EXCHANGE

Unveiling Fundamental Physics from the Cosmic First Light: from COMPLEXITY to SIMPLICITY to COMPLEXITY to SIMPLICITY, the Universe at Large

7^{+} numbers

3 densities: *ordinary* matter 4.4%

dark matter 26.8%

dark energy 68.8%

2 early-Universe inflation structure +1

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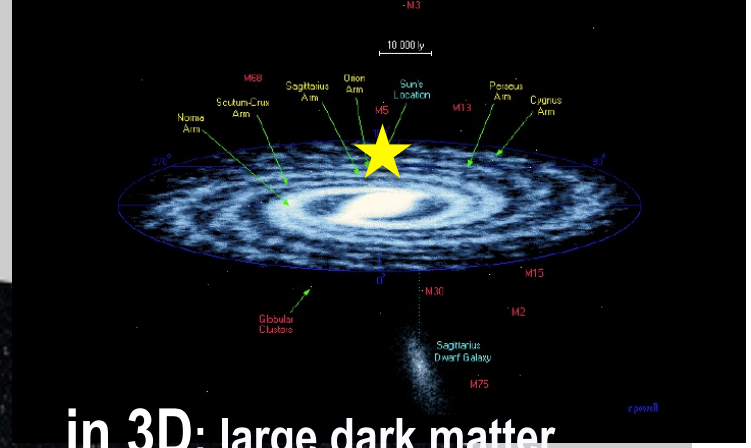
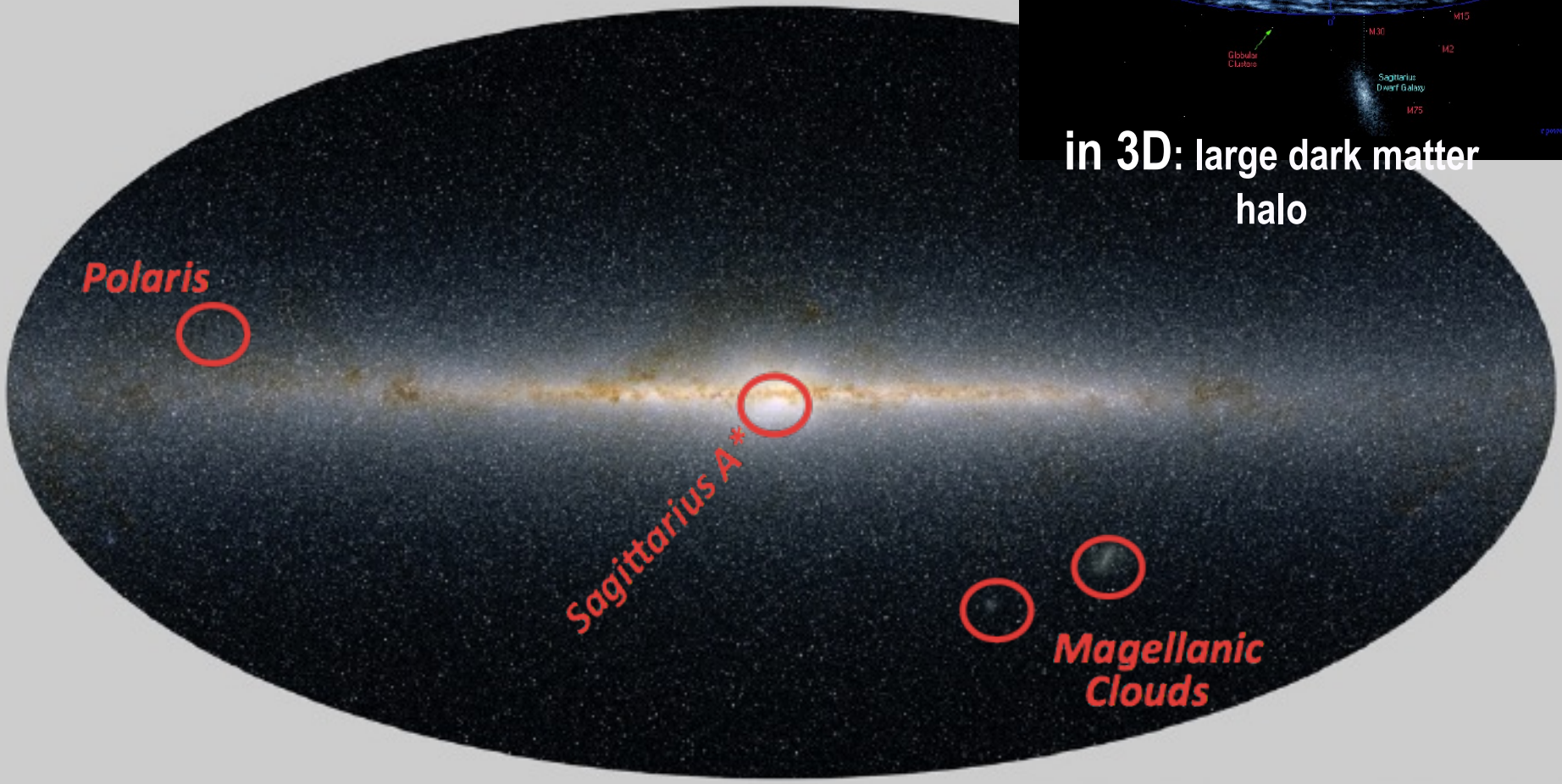
Milky Way in infra-red:

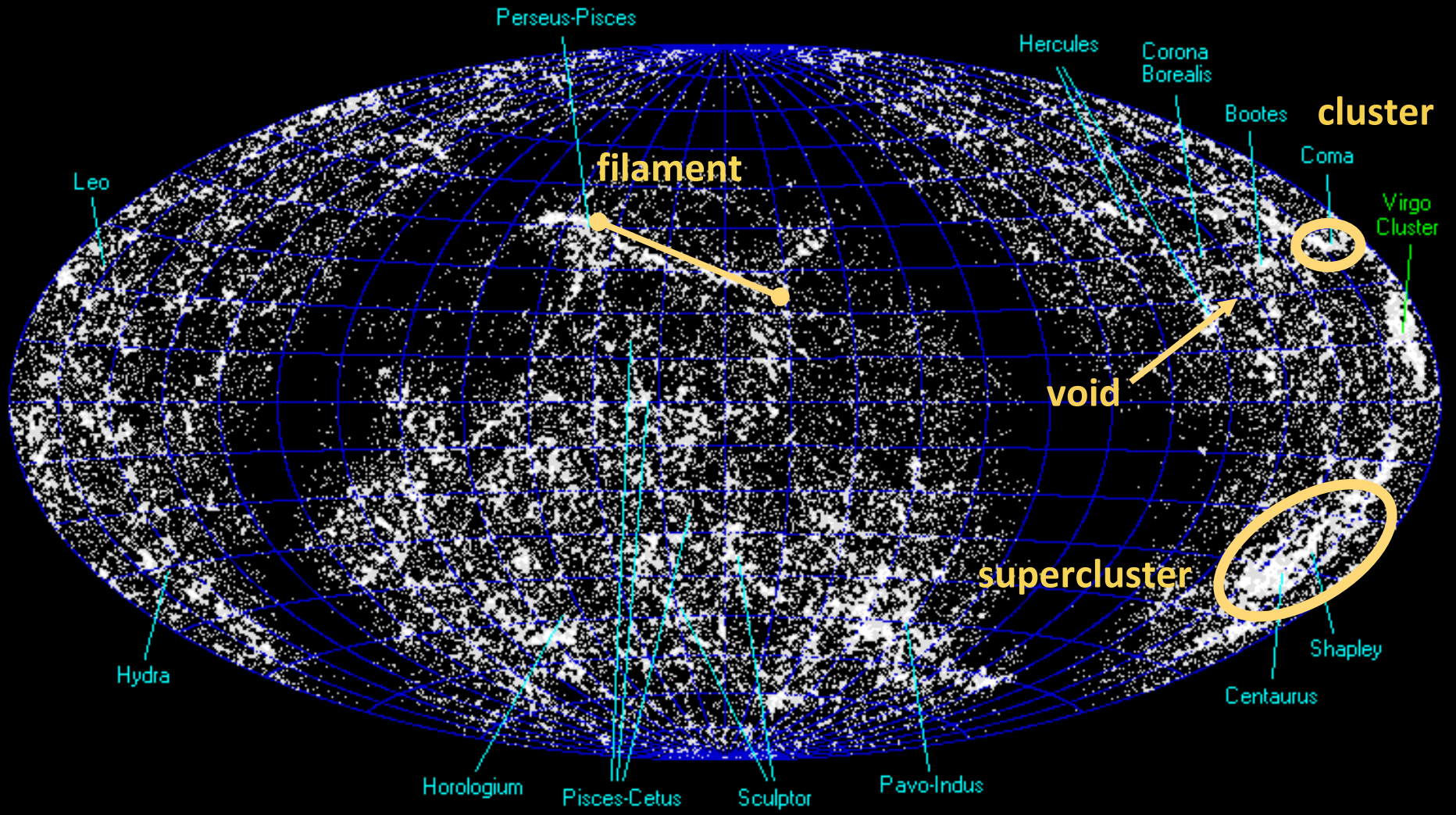
half a billion stars, a disk galaxy



in 3D: large dark matter halo



Cosmic Web of 60,000 nearby galaxies:
exhibits "local" **COMPLEXITY** **~1 billion *light yrs***



hard won observational emergence of the cosmic web of galaxies, clustered & interconnected

COMPLEXITY of here & now

the primordial light, released 13.8 billion years ago, 380,000 yrs after the “Big Bang”

7 veils

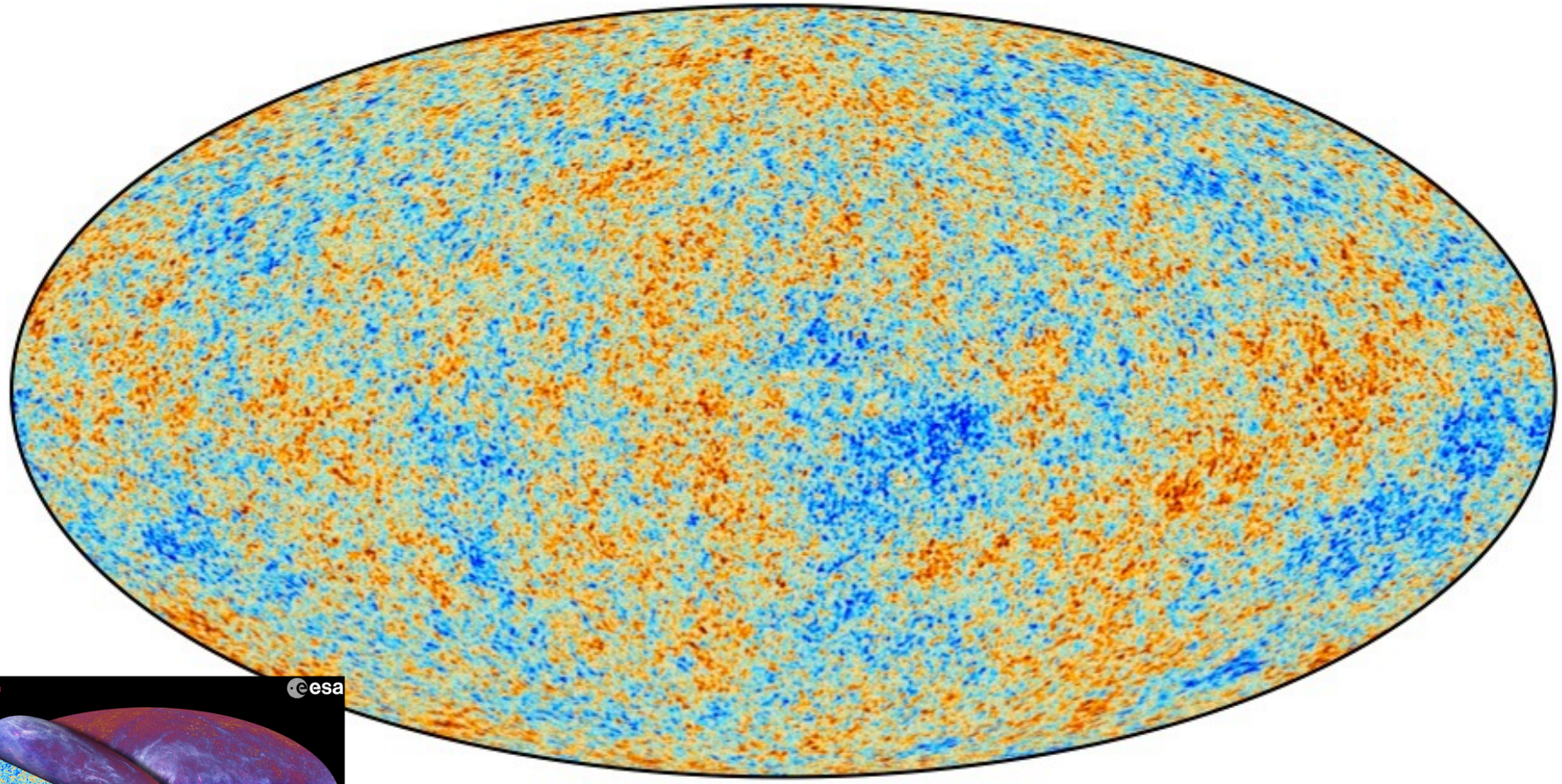
Milky Way 2013 in dust grain, radio-wave, carbon monoxide emissions; plus stellar, X-ray, gamma ray, cosmic ray emissions …

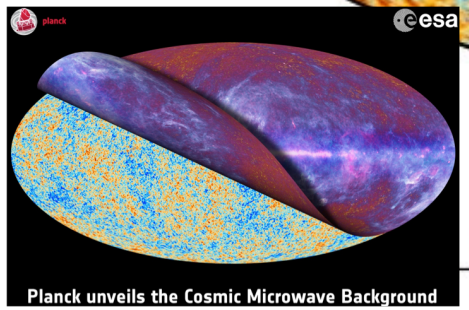
The Planck one-year all-sky survey

esa

Planck's primordial light unveiled
reveals primordial sound waves

=> the inharmonious *'music of the spheres'*
in 7^{+} numbers



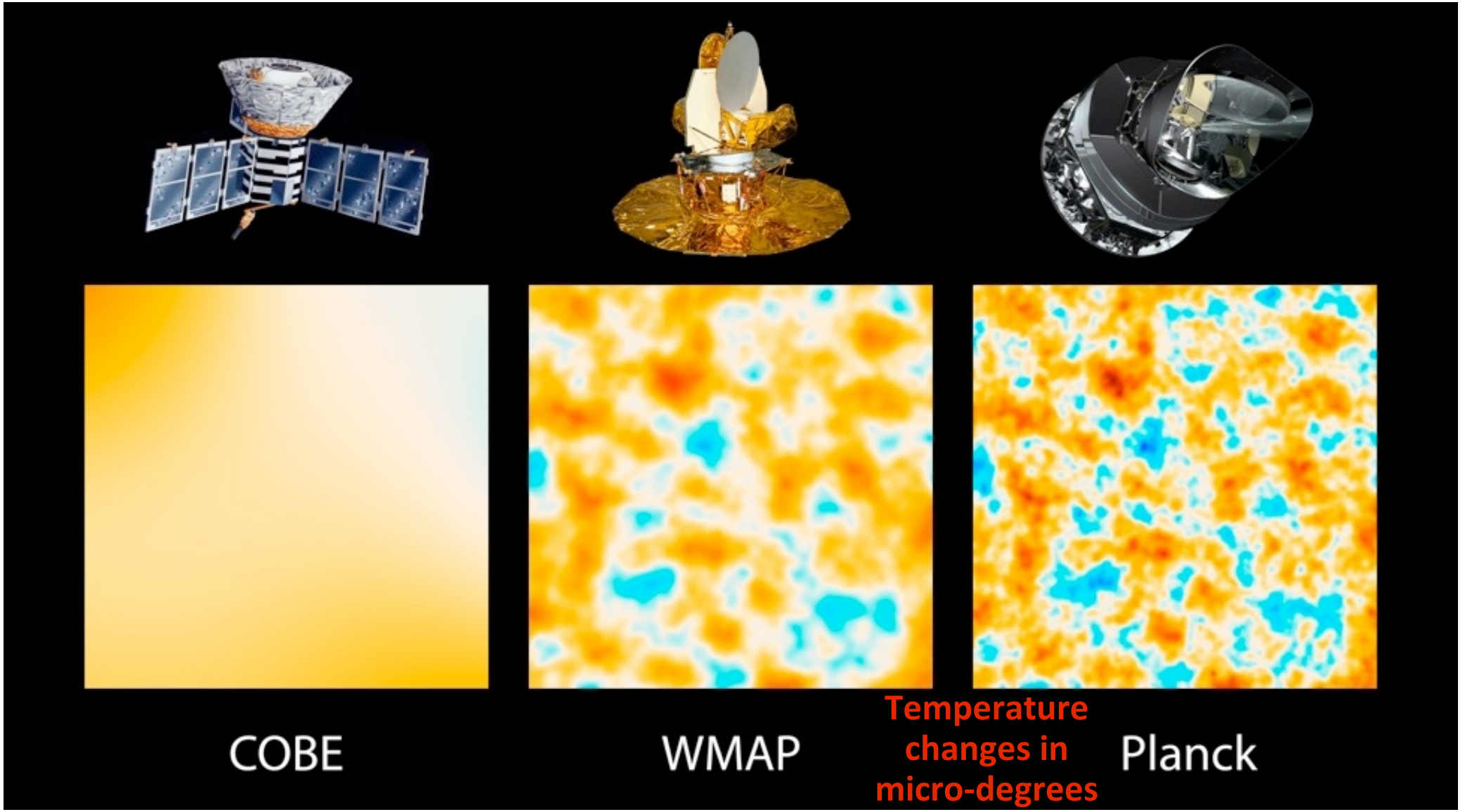


Comparison of CMB Space Experiments: Increasing Resolution

COBE 1989
launch

WMAP 2001
launch

Planck 2009
launch



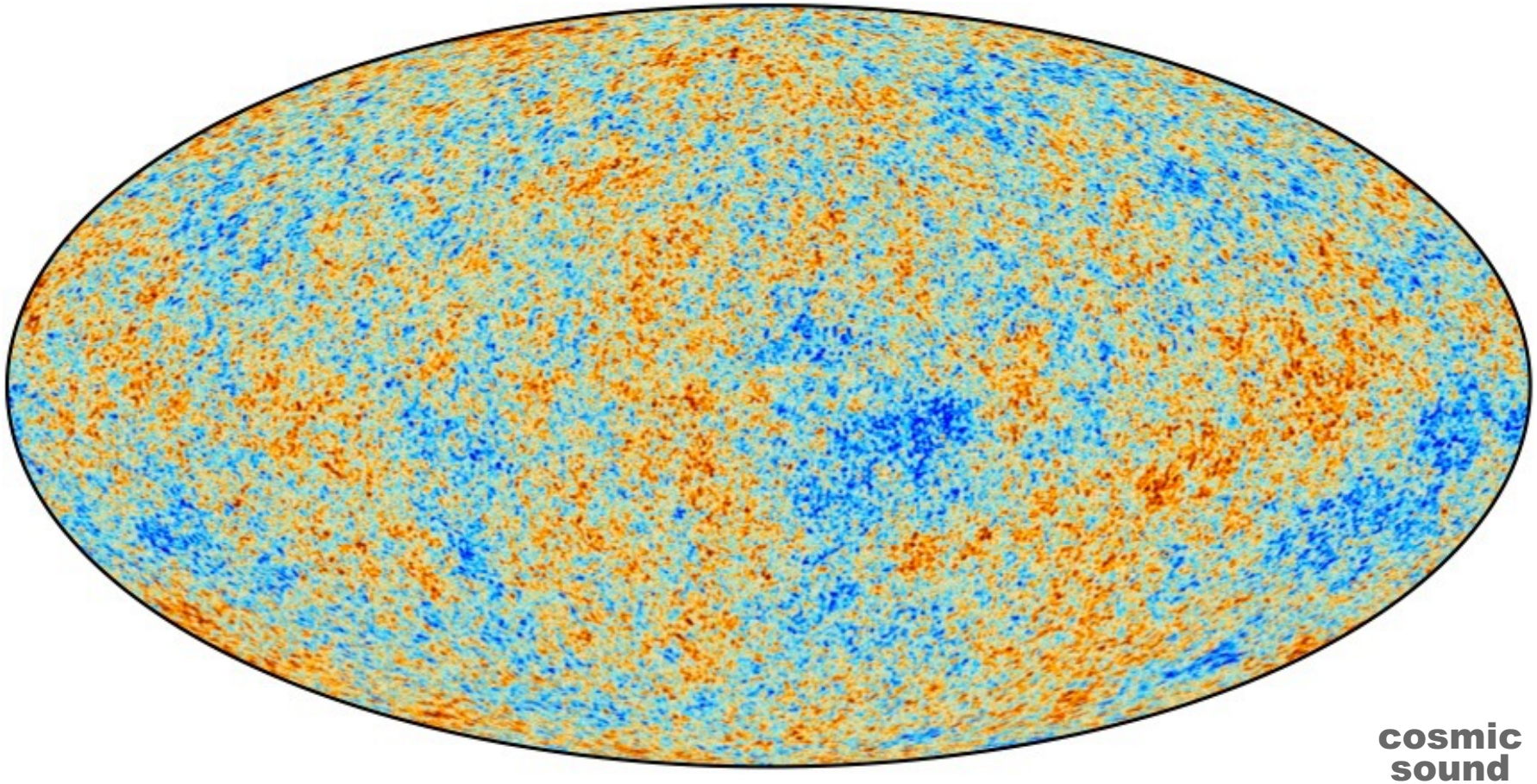
to even higher resolution with telescopes in Chile and the South Pole

Planck's primordial light unveiled

reveals **primordial sound waves**

=> the inharmonious *'music of the spheres'*

in 7^{+} numbers



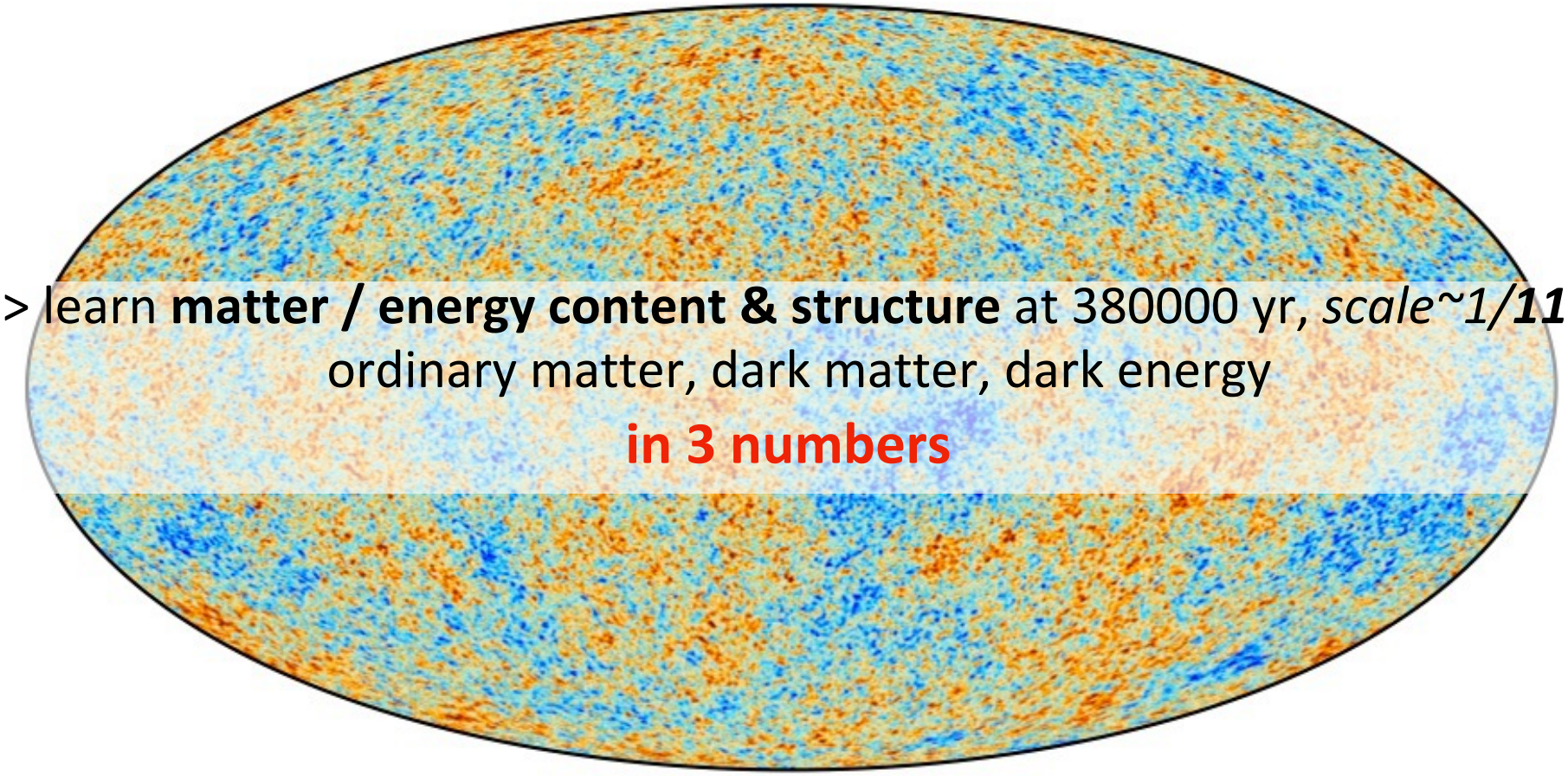
cosmic sound realization

Planck's primordial light unveiled

reveals **primordial sound waves**

=> the inharmonious *'music of the spheres'*

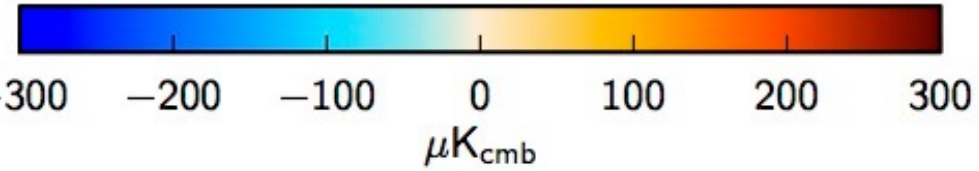
in 7^{+} numbers



=> learn **matter / energy content & structure** at 380000 yr, *scale~1/**1100***

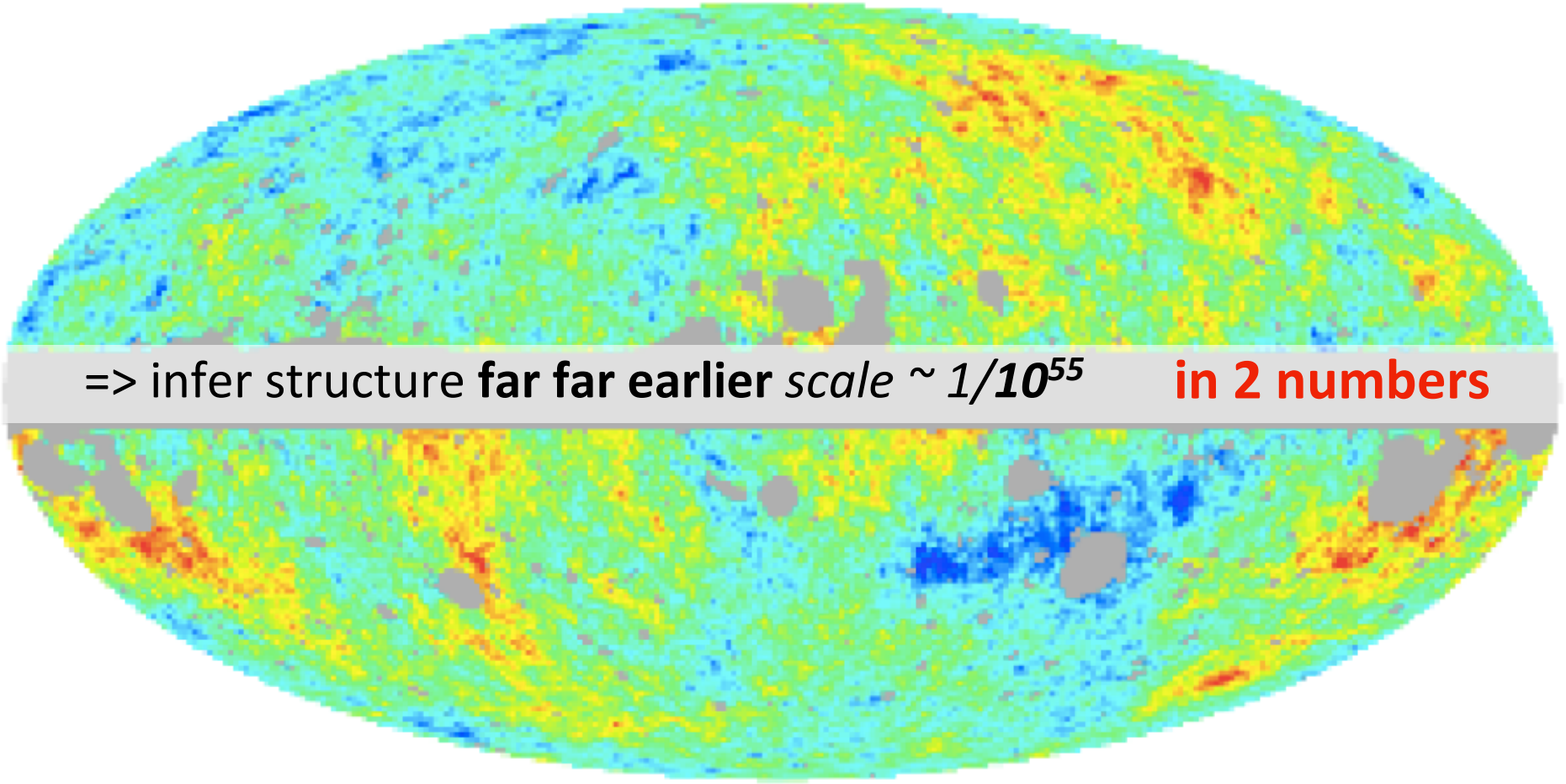
ordinary matter, dark matter, dark energy

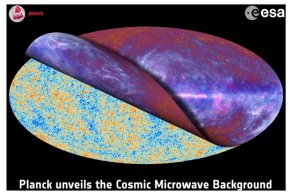
in 3 numbers



reveals **primordial sound** from far earlier times

=> the inharmonious early Universe *'music of the spheres'*

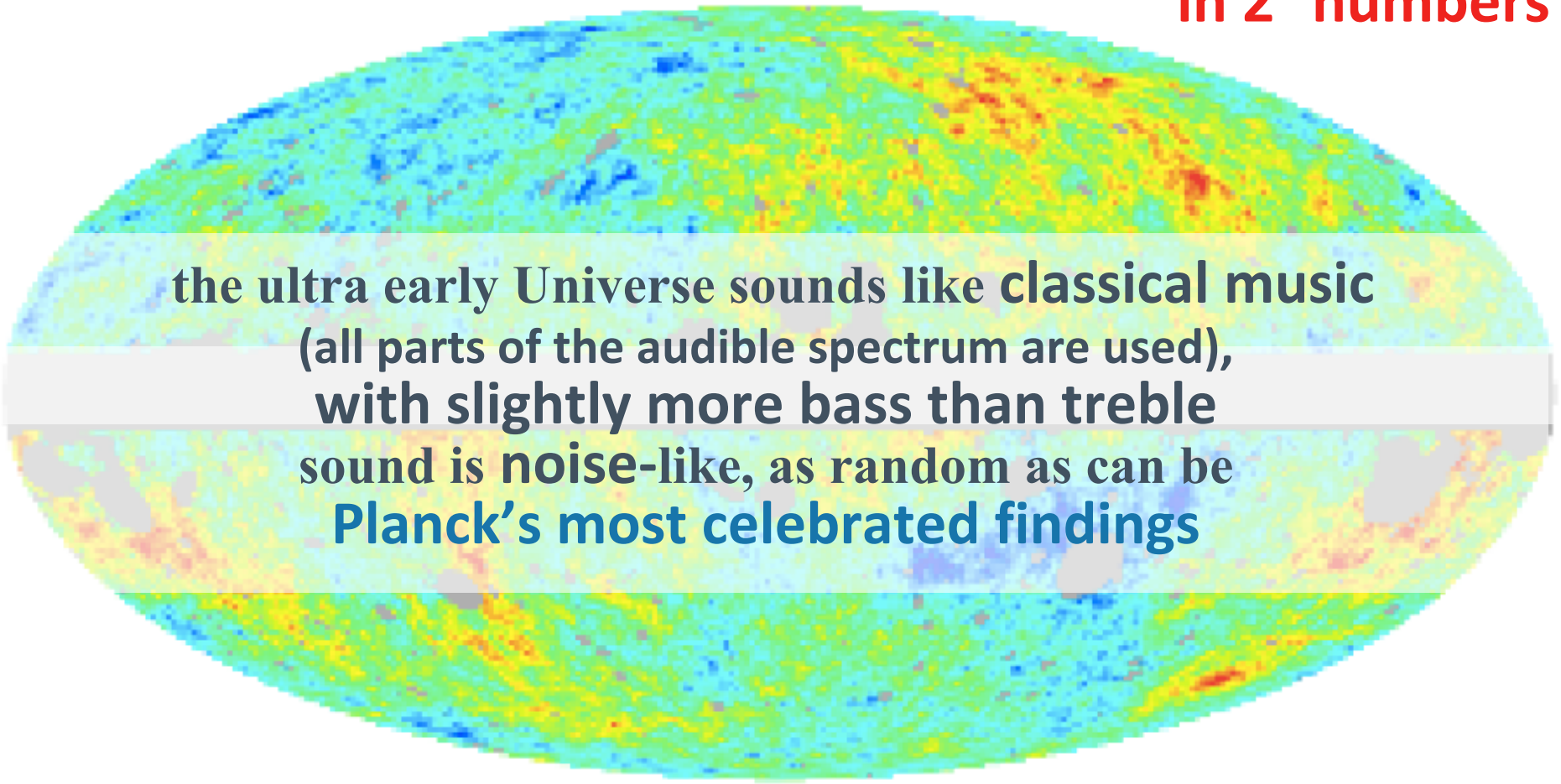


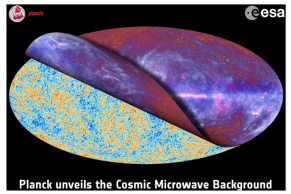


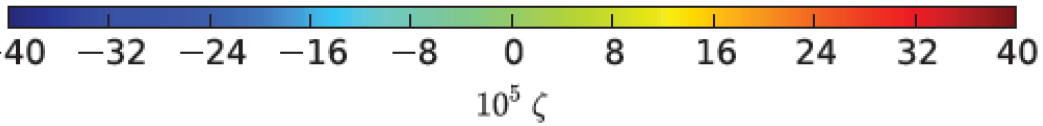
reveals **primordial sound** from far earlier times

=> the inharmonious early Universe *'music of the spheres'*

in 2^+ numbers







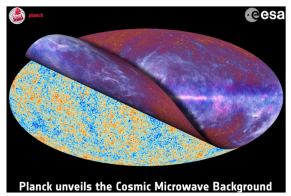
reveals **primordial sound** from far earlier times

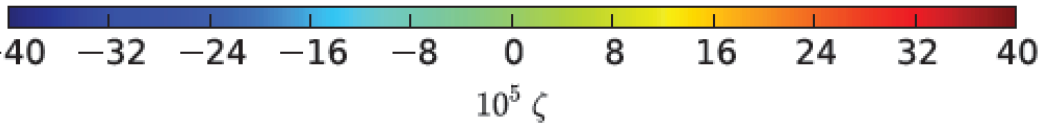
=> the inharmonious early Universe *'music of the spheres'*

=> infer structure **far far earlier** *scale ~ 1/10^{55}* **in 2 numbers**

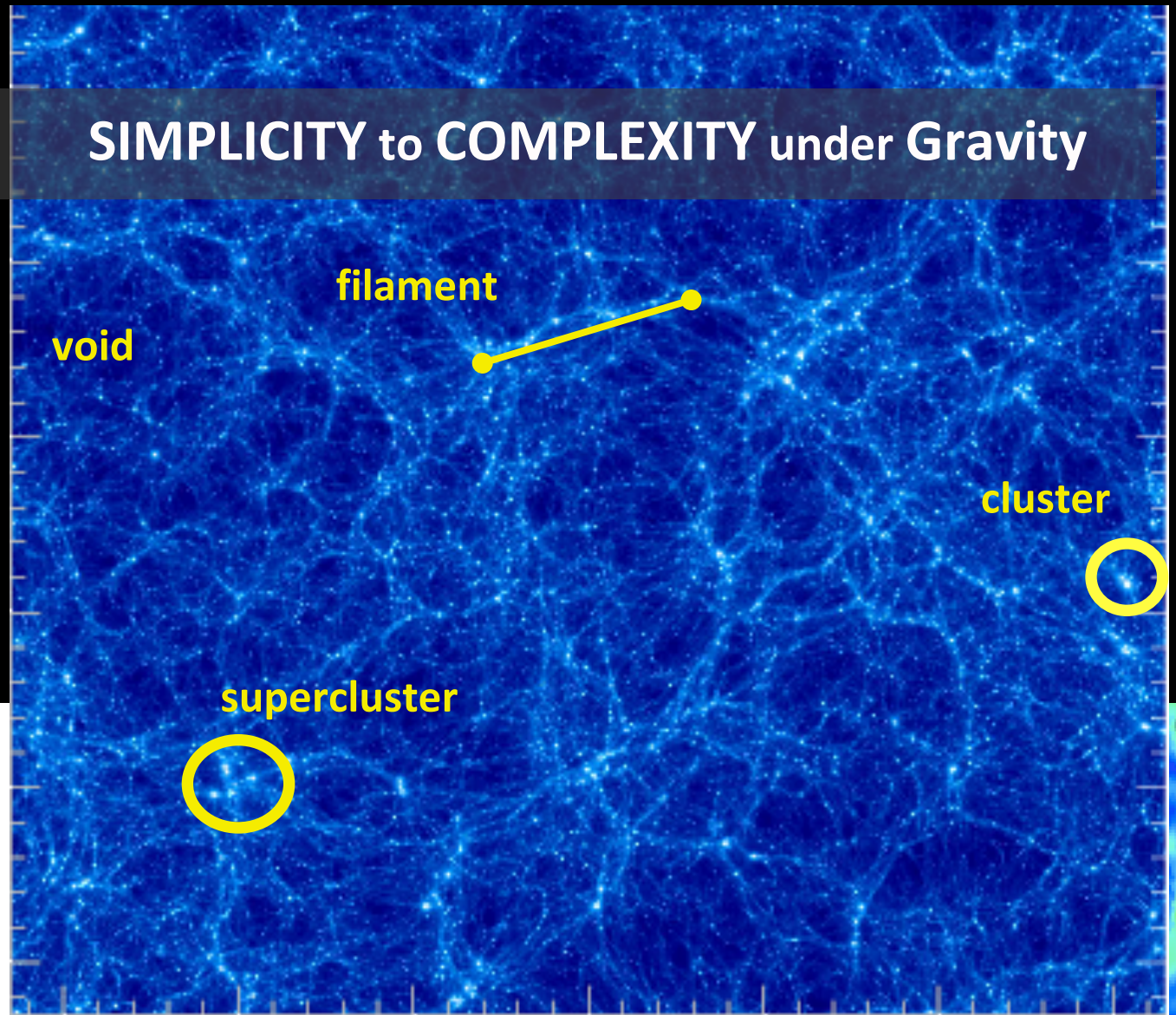
loudness, treble/bass

we search for a 3rd number, early Universe gravity waves





Simulation of the 7^{+} numbers
begets the Cosmic Web of clusters now & galaxies forming

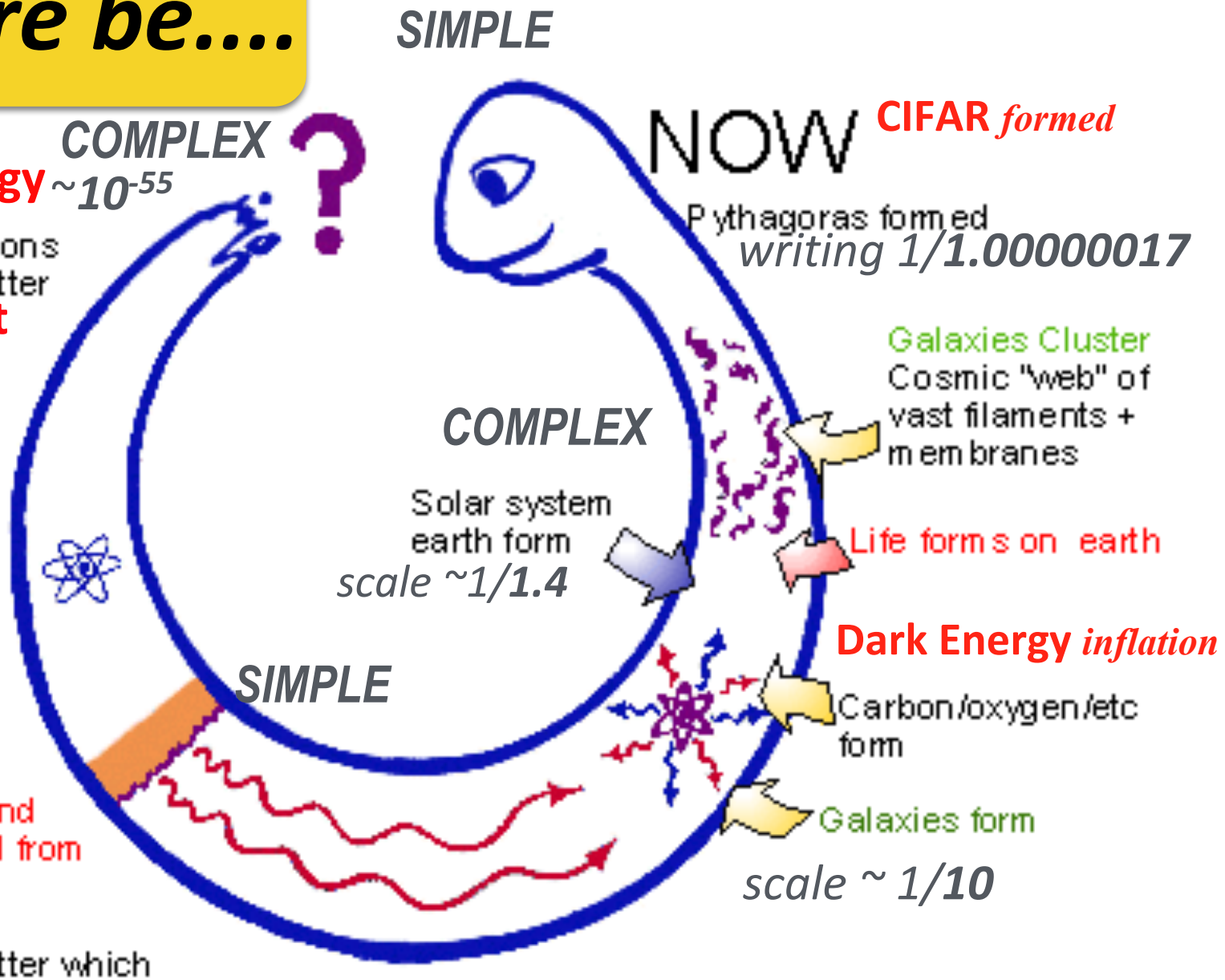


~ billion *light years*

state of the art simulation

+ ordinary matter
+ dark matter
+ dark energy

Let there be....



2 numbers +1

early **Dark Energy** ~10^{-55}

Inflation fluctuations form: quantum jitter

let there be **Heat**

scale ~ ***10^{-29}***

Dark Matter

Protons/Neutrons form light nuclei

Helium forms

let there be **Light**

Cosmic background radiation released from matter

carries imprint of fluctuations in matter which grow to generate galaxies etc.

*scale ~1/**1100*** **7+ numbers**