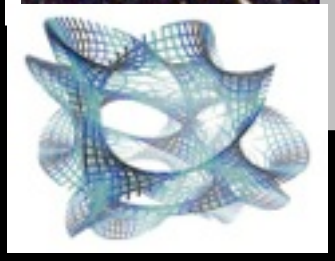
the BOUNDed flow of information
the BOUNDless thought



> "To me every hour of the light and dark is a miracle. Every cubic inch of space is a miracle."
> – Walt Whitman

In every **teaspoon** ~ *5 cubic cm*

. ***Ordinary Matter*** **0.7 amu nm^{-3} in air**

- ***cosmic*** *photon* ***radiation*** **412 cm^{-3}**
- *cosmic* ***neutrinos*** **~*cosmic* *photons***
- ***gravity waves*** **<< *cosmic* *photons***
- ***Dark Matter*** **~amu m^{-3} ~*5*xOrdinary**

compressed in MilkyWay ~0.1 amu cm^{-3} ; for LHC-type relics ~ 1 every 10 cm

- ***Dark Energy*** **~vacuum potential**

~ 3 amu m^{-3} ~ 2.3 *x* <matter-energy>

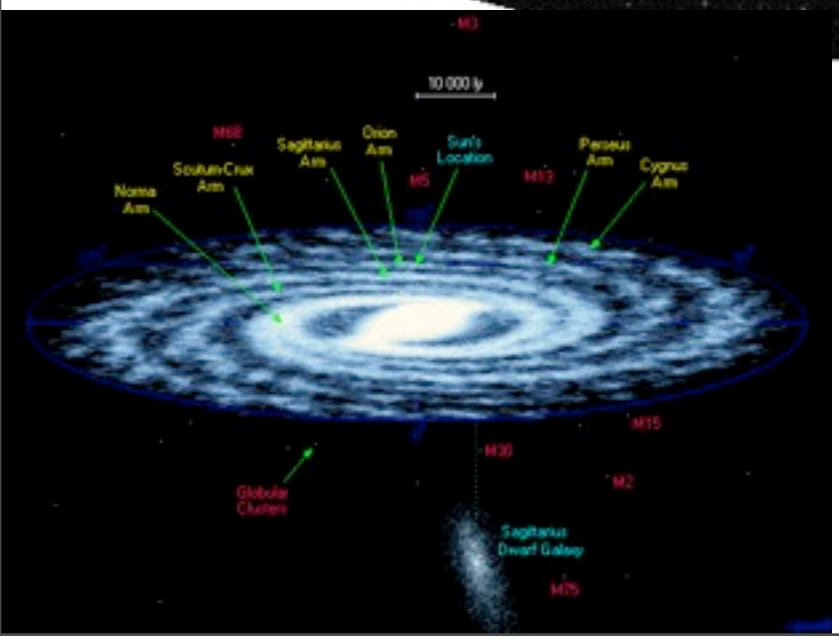
- ***vacuum fluctuations*** **virtual particles**

the origin of all the cosmic structure we see

- ***Higgs*** ***vacuum potential*** **origin of mass**
- ***extra dimensions*** **here, now? 6?**

www.cita.utoronto.ca/~bond/bondtalks/bond_TEDxUofT_13_05_18.pdf

Milky Way 1953-55 in stars: a disk galaxy



***large halo of* Dark Matter**

1970s/80s around galaxies;
1930s around clusters.

mass in* Dark Matter = 5.36 ±0.12 *X
mass in* Ordinary Matter *(stars+gas)
on average in the Universe

complexity of here & now

the primordial light,
released 13.8 billion years ago,
380000 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 ...

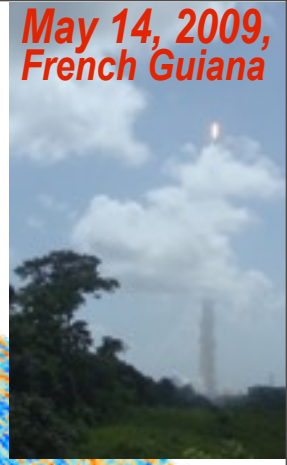
The Planck one-year all-sky survey

esa

the **primordial light unveiled,** released 13.8 billion years ago, 380000 years after the "Big Bang"

simplicity of there & then

7^{+} numbers

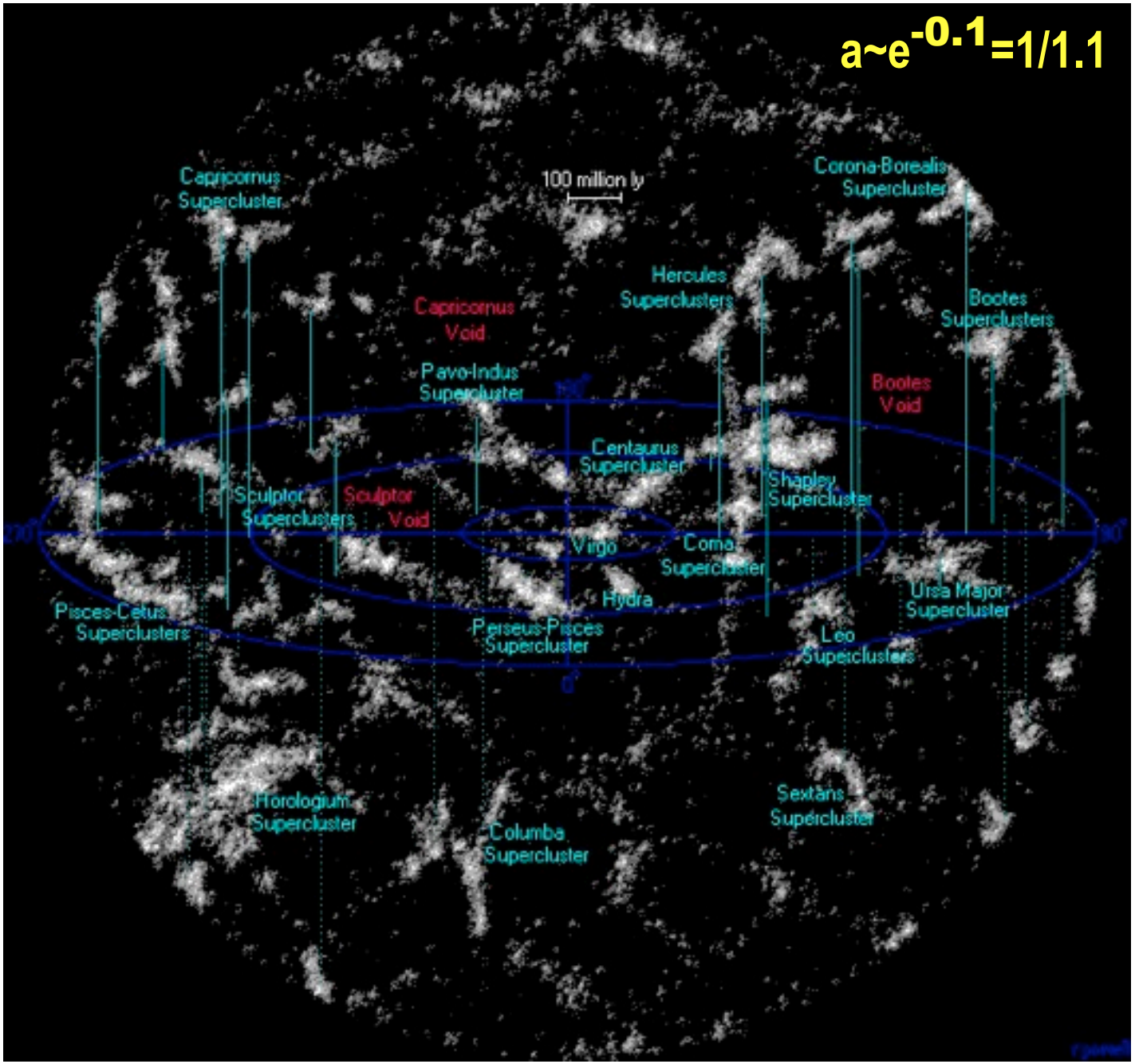


Temperature changes in micro-degrees

scale = $a \sim e^{0}$ = 1 now when we **observe** this **1st light**

scale = $a \sim e^{-7}$ ~1/1100 smaller when the **1st light** was released, billion X denser

cosmic web of nearby superclusters < 1000 million *light yrs*: *local complexity*



$a = e^{0} = 1$ now

we observe galaxies out to a time when the universe was

$a = e^{-2.3} = 1/10$

smaller in overall scale, *average density 1000X larger*

no galaxies formed when the universe was smaller than

$a = e^{-3} = 1/20$

Simulation of the 7^{+} number random mass fields begets the Cosmic Web of clusters now a~1 & galaxies "then" a~1/5

1300 Million light years

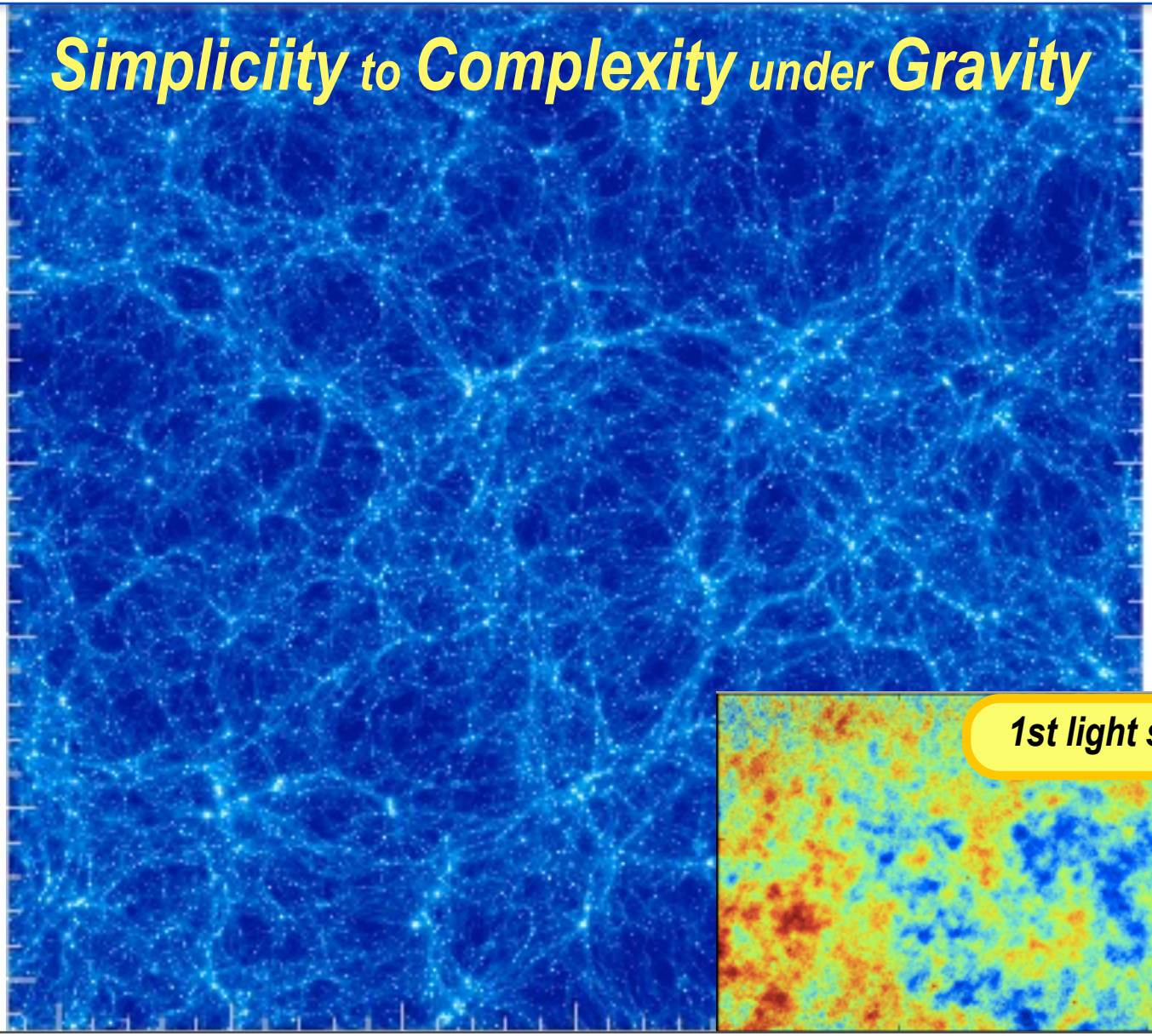
state of the art simulation of

gas density

& dark matter

& dark energy

512^3



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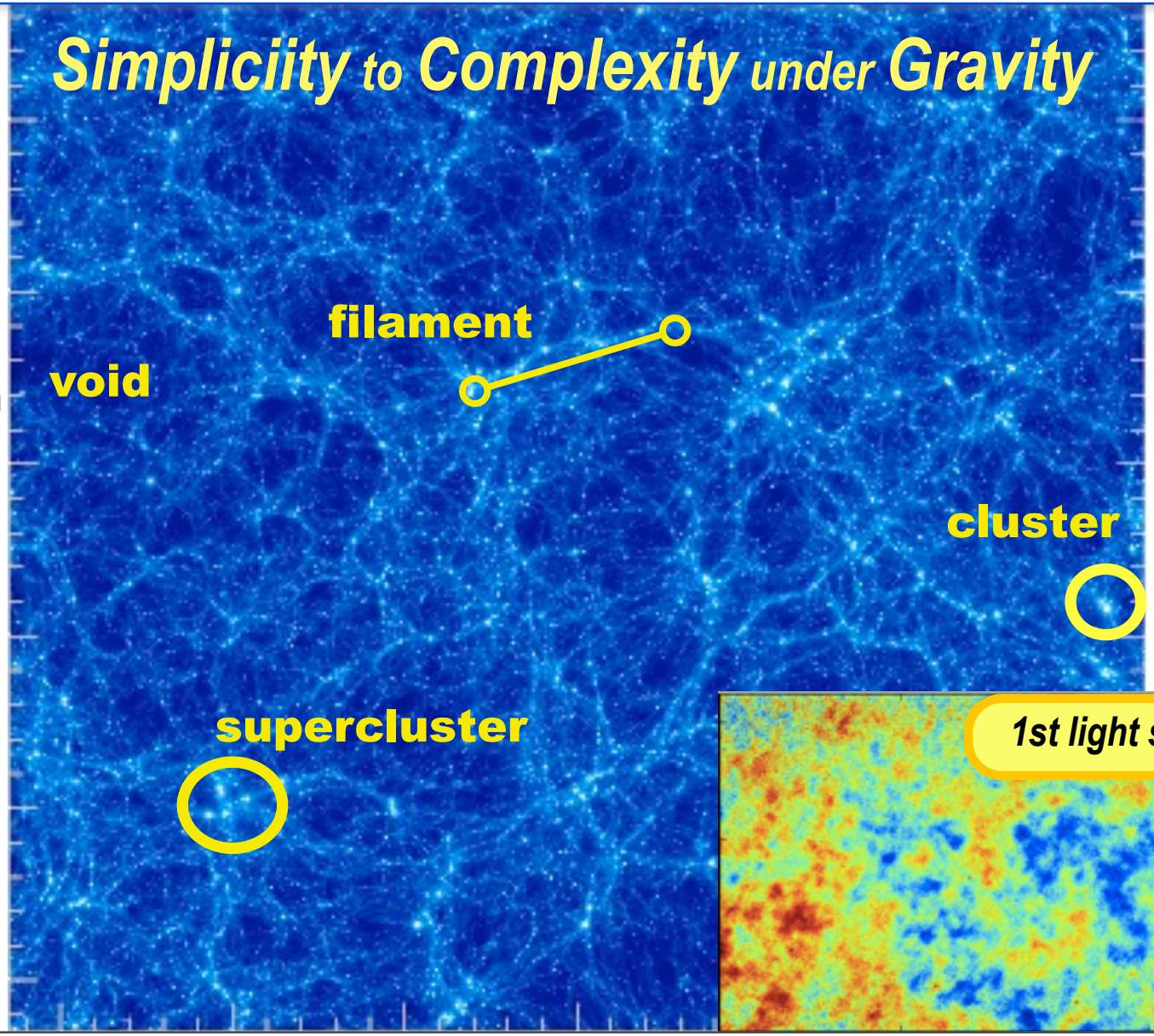

$a=e^{0}=1$ now

simulates gas from 1 to $a\sim e^{-0.1}\sim 1/1.1$

$a\sim e^{-7}\sim 1/1100$

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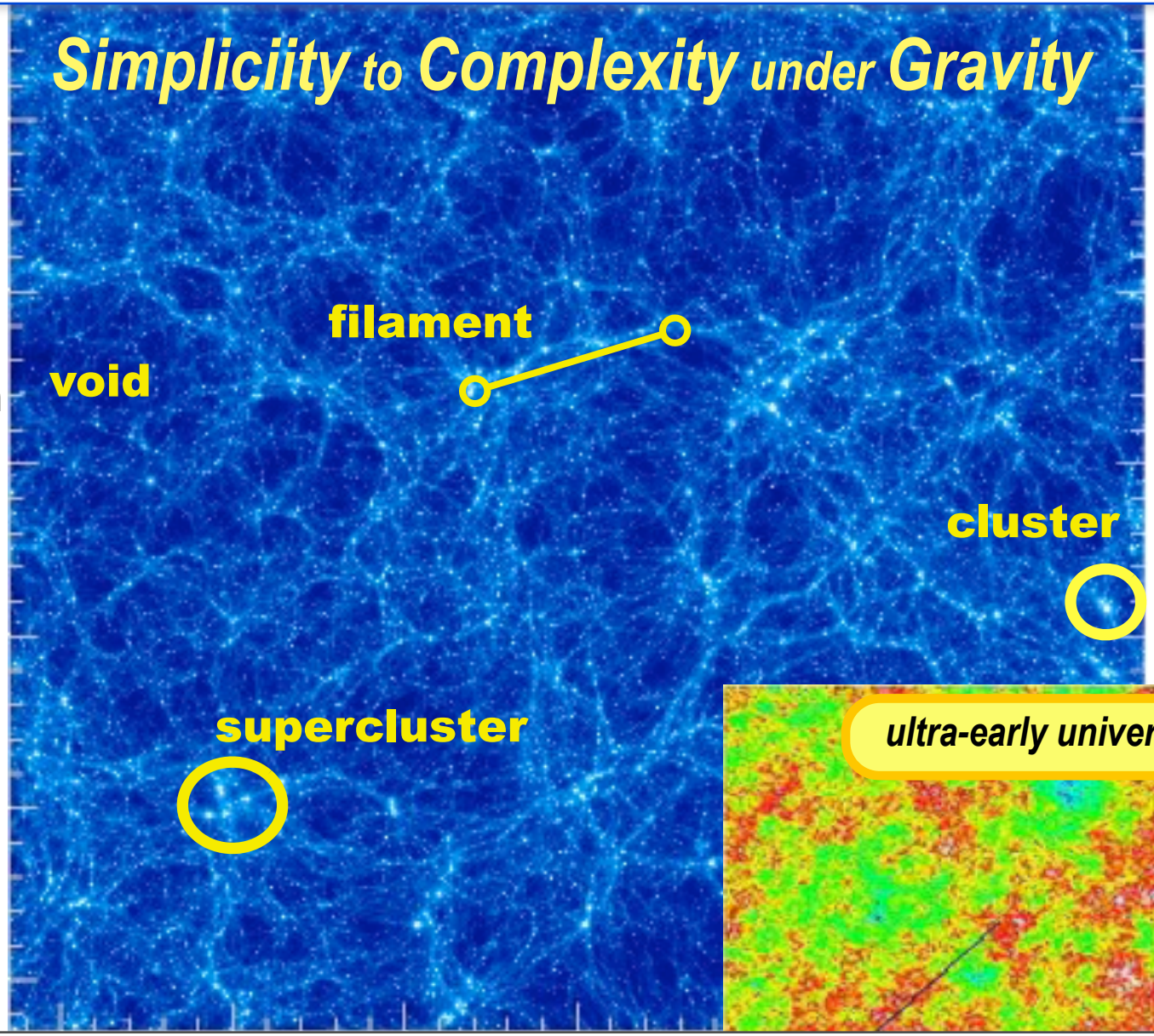

$a=e^{0}=1$ now

simulates gas from 1 to $a\sim e^{-0.1}\sim 1/1.1$

$a\sim e^{-67+60}$

$\sim 1/10^{30+25}$

the primordial light unveiled

March 21, 2013

Google Planck Satellite 2013 results: yields 926,000 links

Government of Canada / Gouvernement du Canada

Canadian Space Agency

Home > Audiences > Media > News releases > 201
> Canadian astronomers reveal surprising new portr

Canadian astronomers reveal surp

Planck space mission sheds light on t

Longueuil, Quebec, March 21, 2013 – Th
ever made of the most ancient light in the U
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Plancking at U of T: space

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PLANCK Light

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The New York Times

Space & Cosmos

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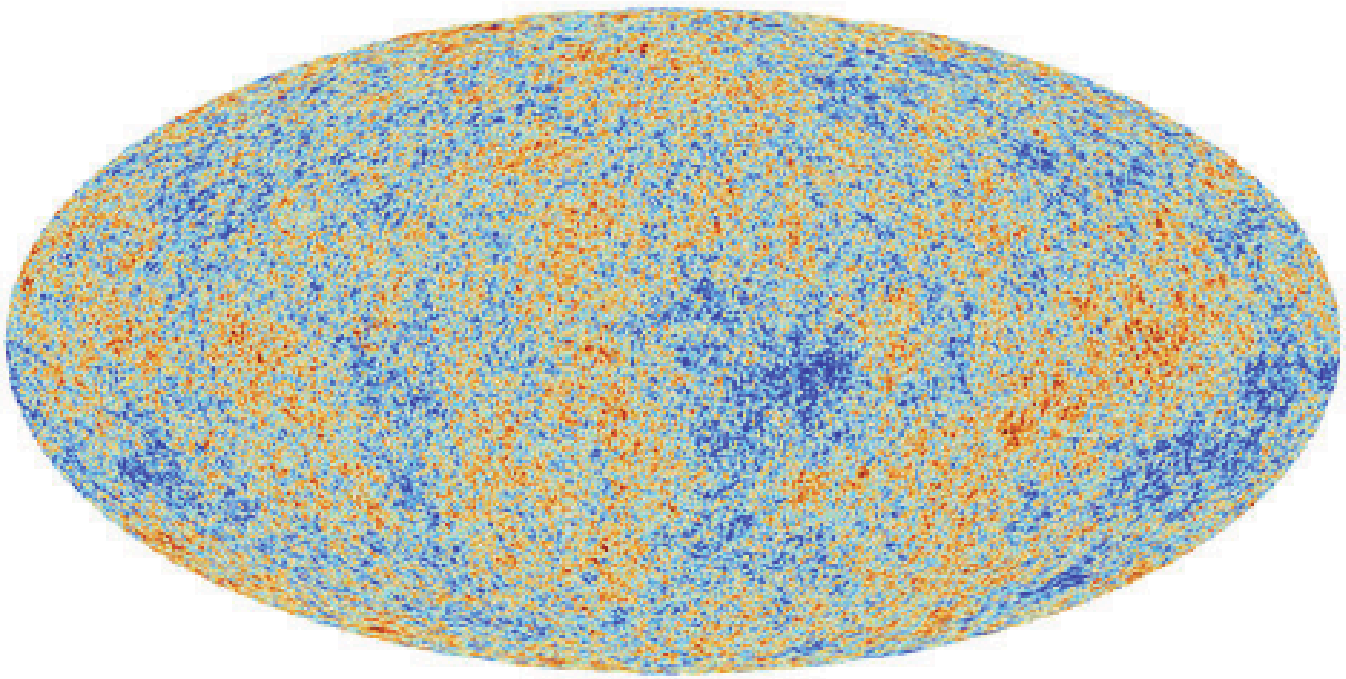
Universe as an Infant: Fatter Than Expected and Kind of Lumpy



European Space Agency; Planck Collaboration

A view of the cosmic microwave background collected by the European Space Agency's Planck satellite. The heat map of the cosmos was imprinted on the sky when the universe was just 380,000 years old.

By DENNIS OVERBYE
Published: March 21, 2013 | 345 Comments

Astronomers released the latest and most exquisite baby picture yet of the universe on Thursday, one that showed it to be 80 million to 100 million years older and a little fatter than previously thought.

FACEBOOK

TWITTER

SIMPLICITY

at $a \sim e^{-7} \sim 1/1100$ =>

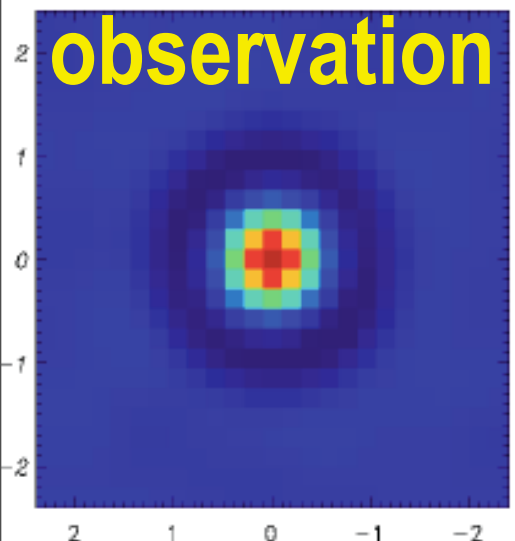
at $a \sim e^{-67+60} \sim 1/10^{30+25}$

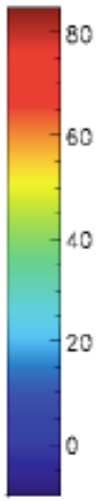
reveals ***primordial sound waves*** *in matter*

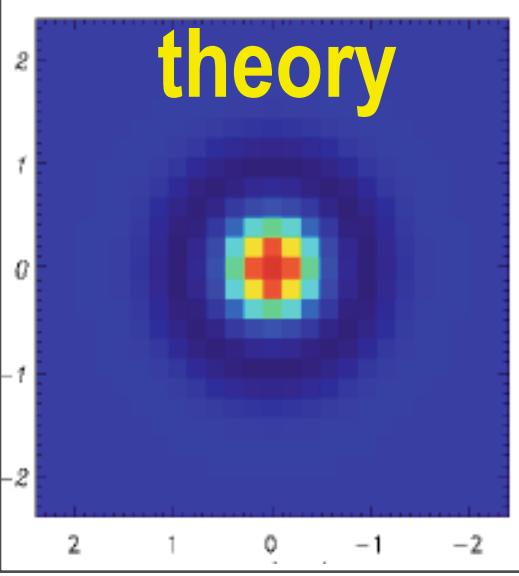
=> *learn* ***contents & structure*** *at 380000 yr,* $a \sim e^{-7}$

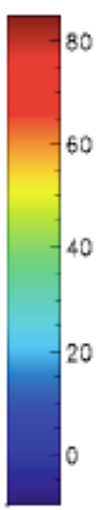
=> *infer the structure far far earlier* $a \sim e^{-67+60}$

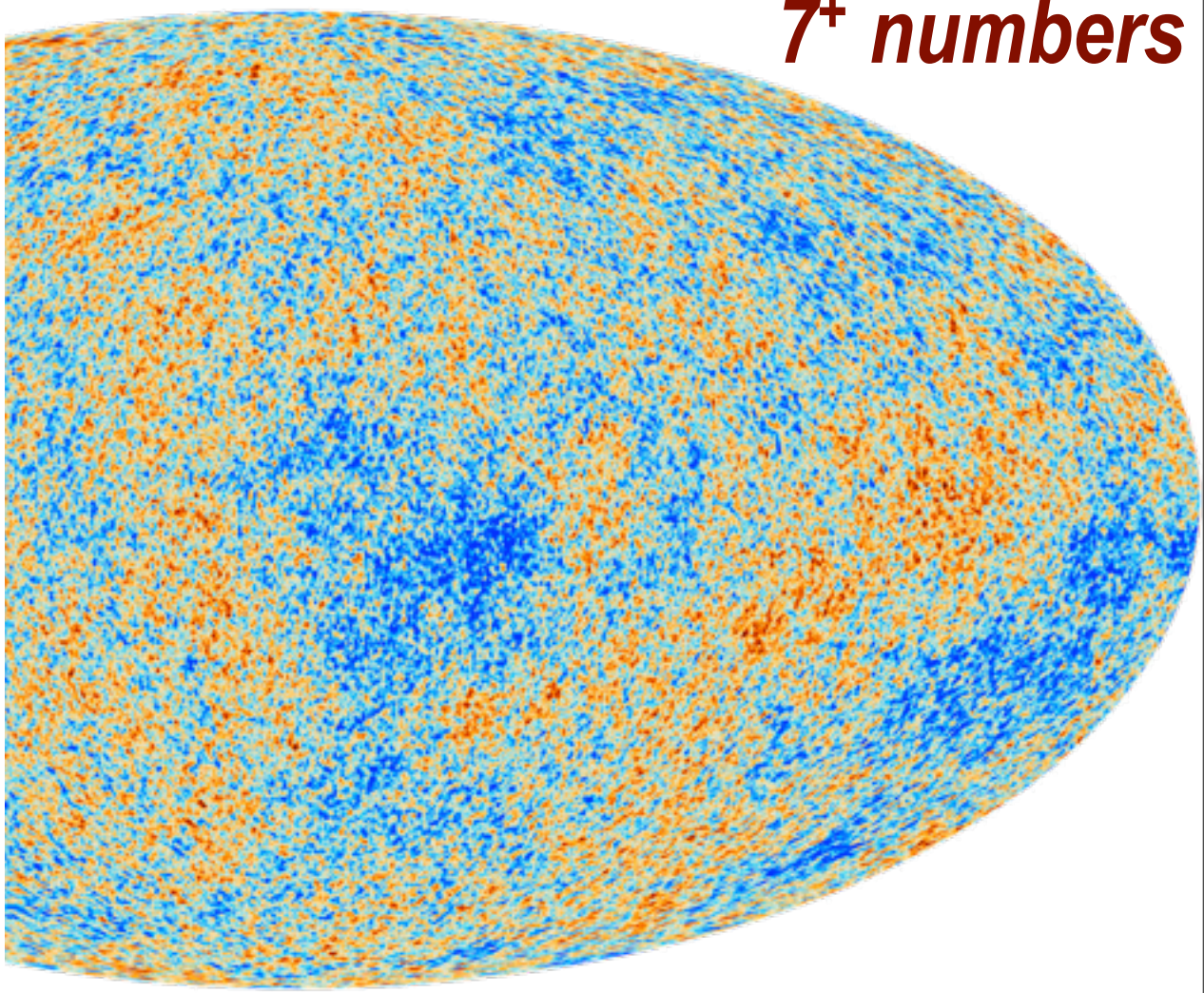
7+ numbers











SIMPLICITY

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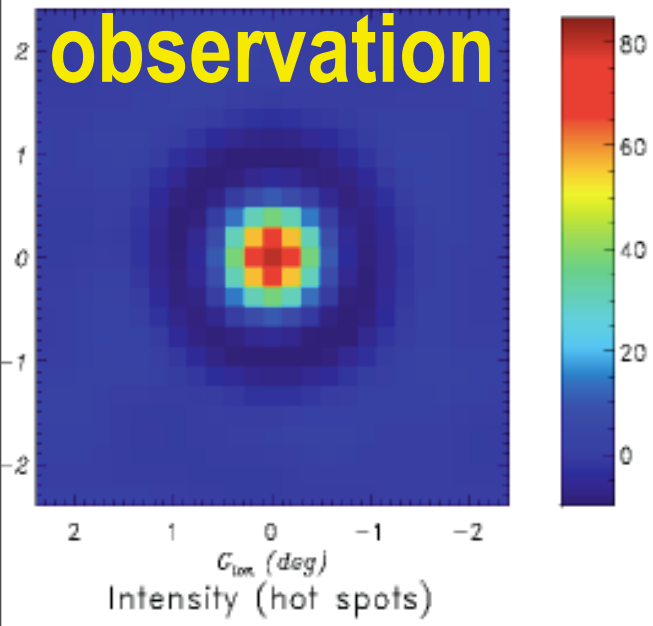

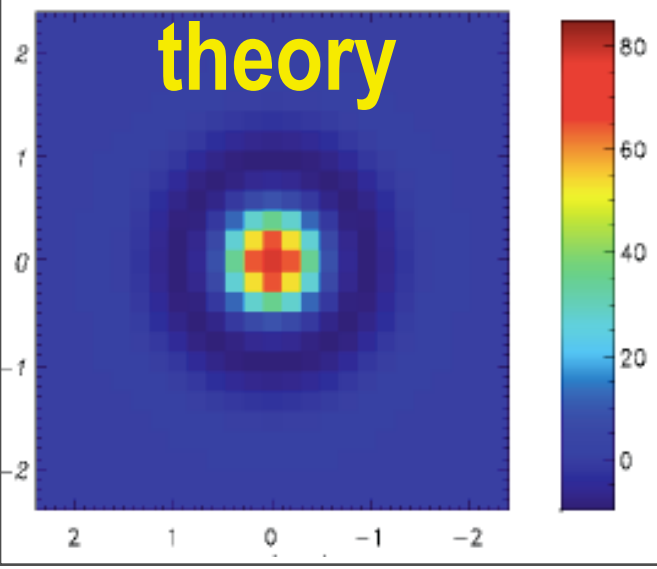

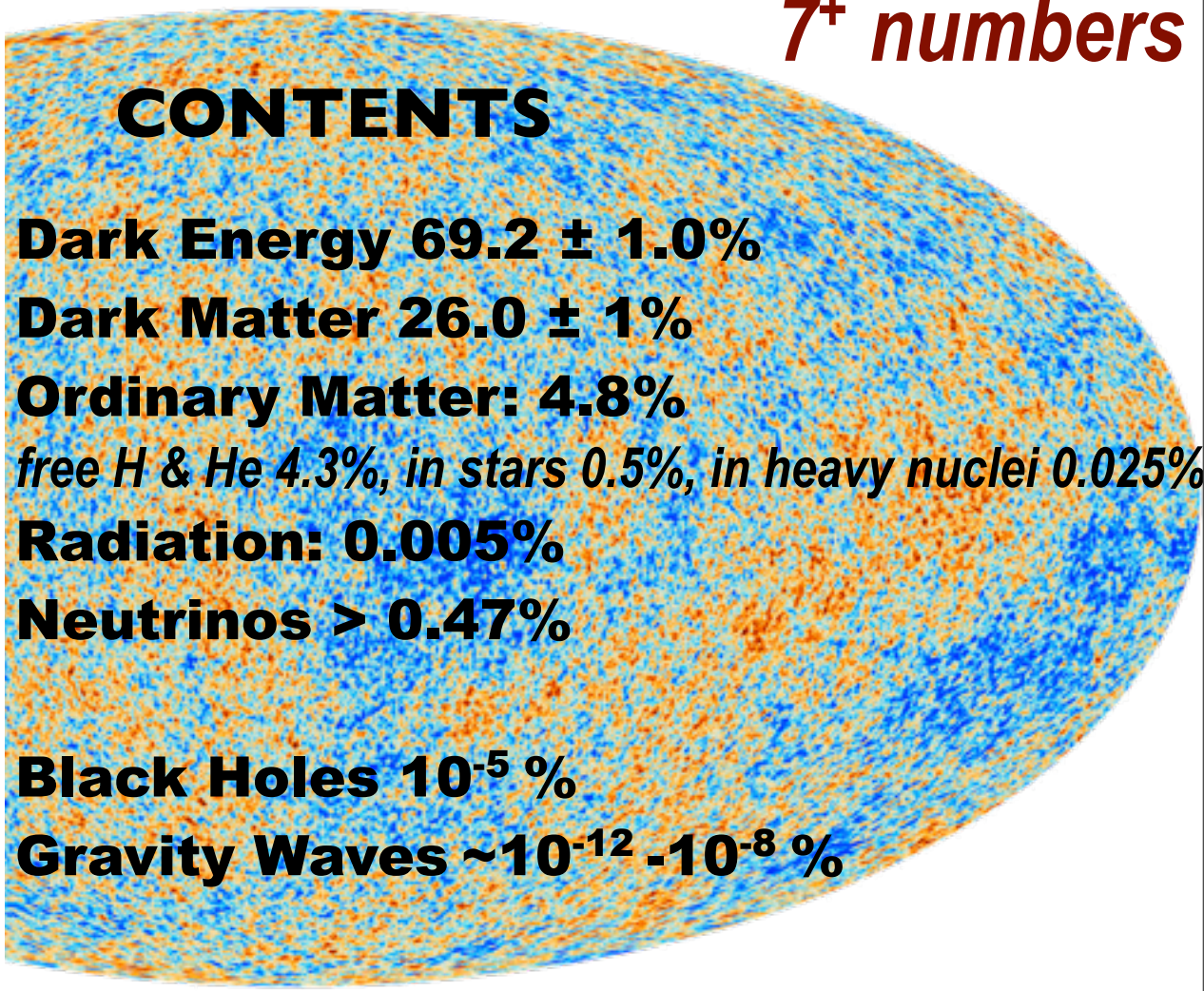

CONTENTS

Dark Energy 69.2 ± 1.0%

Dark Matter 26.0 ± 1%

Ordinary Matter: 4.8%

free H & He 4.3%, in stars 0.5%, in heavy nuclei 0.025%

Radiation: 0.005%

Neutrinos > 0.47%

Black Holes 10^{-5} %

Gravity Waves ~10^{-12} -10^{-8} %

SIMPLICITY

at $a \sim e^{-7} \sim 1/1100$ =>

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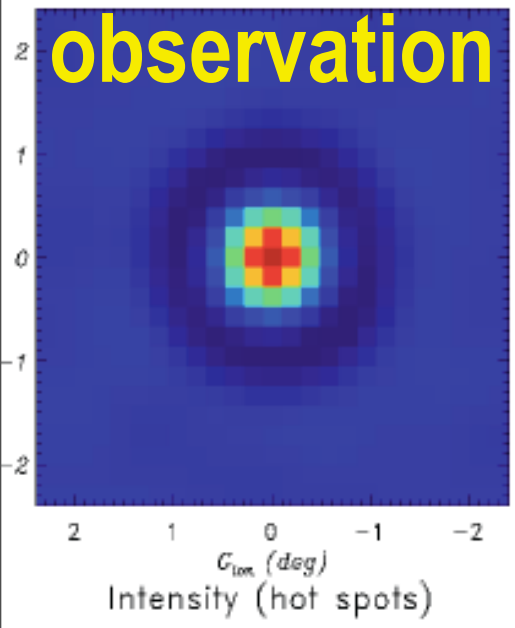

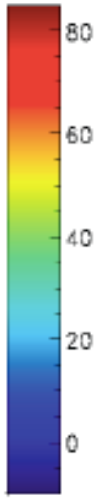

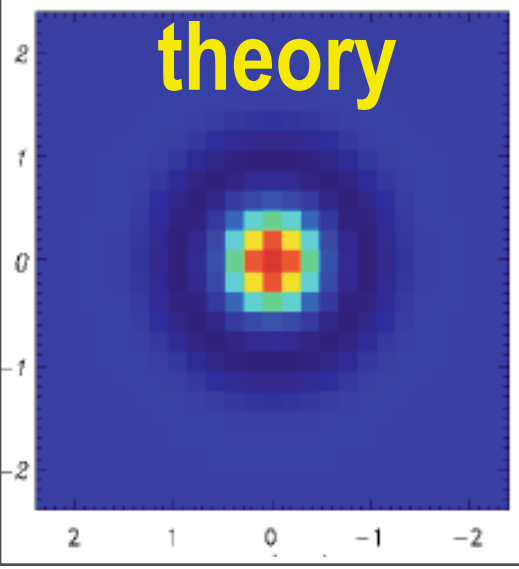

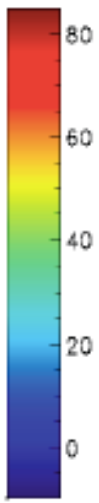

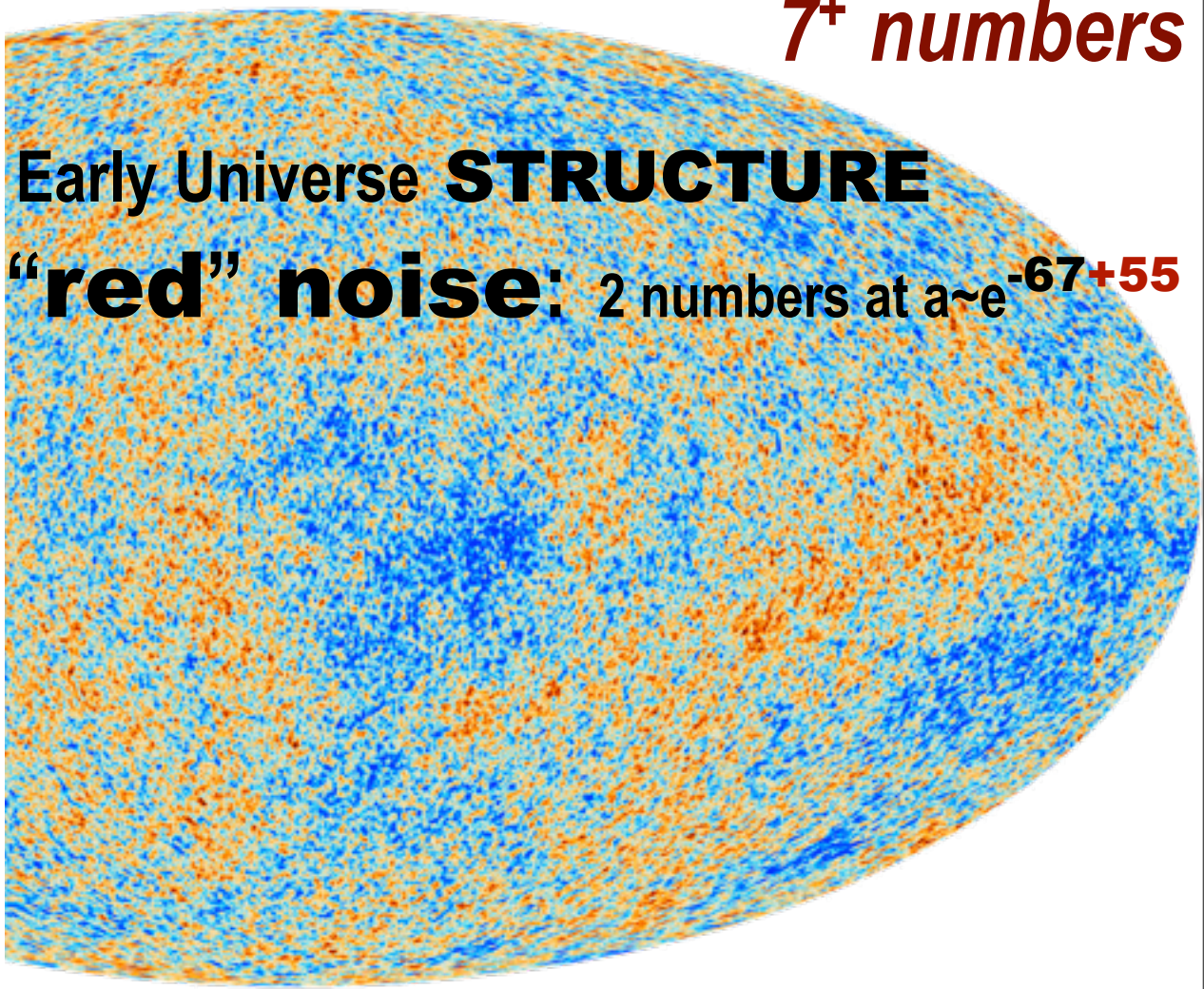

Early Universe **STRUCTURE**

"red" noise: 2 numbers at $a \sim e^{-67+55}$

SIMPLICITY

at a~e^{-7}~1/1100 =>

at a~e^{-67+60}~1/10^{30+25}

reveals ***primordial sound waves*** *in matter*

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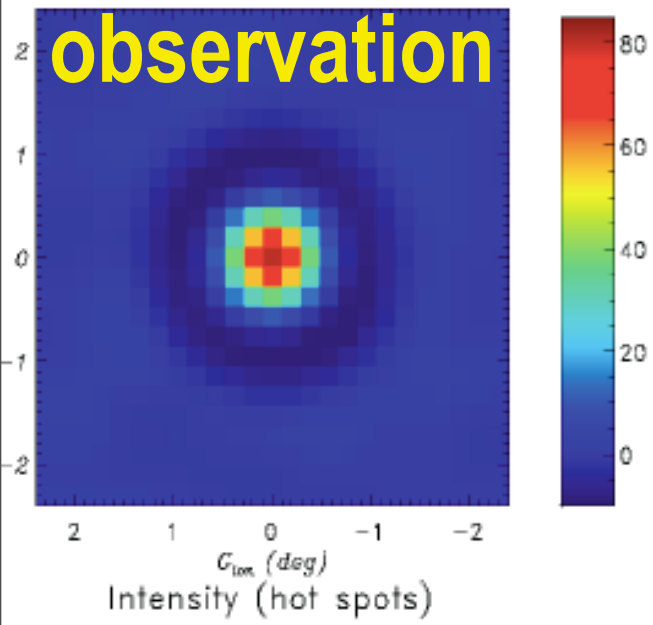
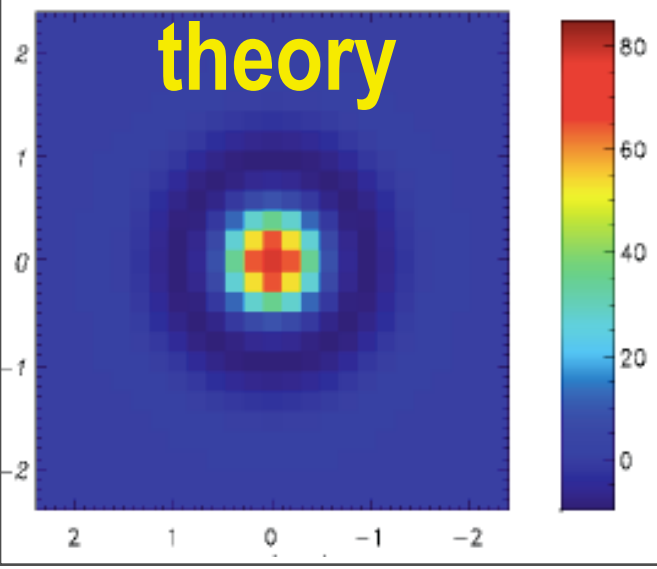
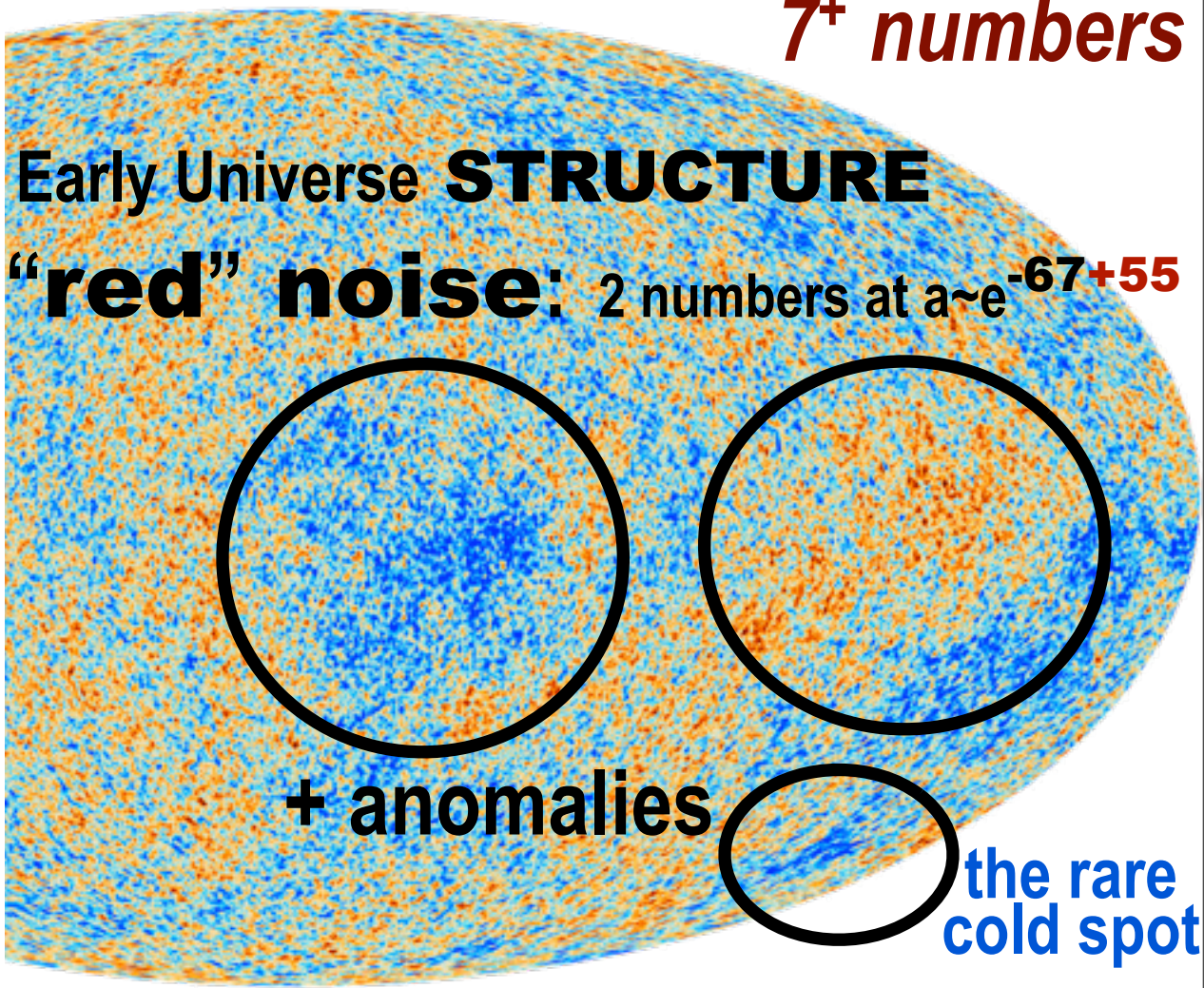


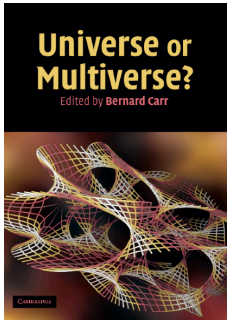




COMPLEXITY *at* a~e^{-67}?

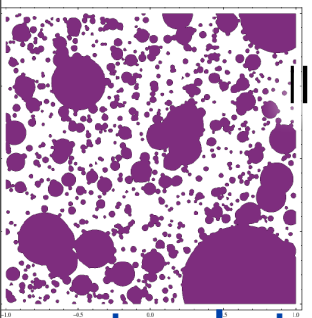
UltraUltraUltraLargeScaleStructure beyond our Horizon via *early* dark energy+quantum+gravity

Horizons: the ultimate-speed constraint on light & information



higher dimensions 6?

quantum tunnels

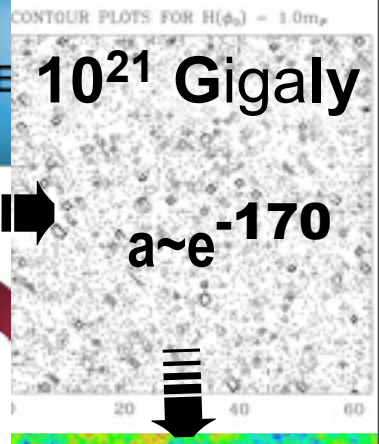


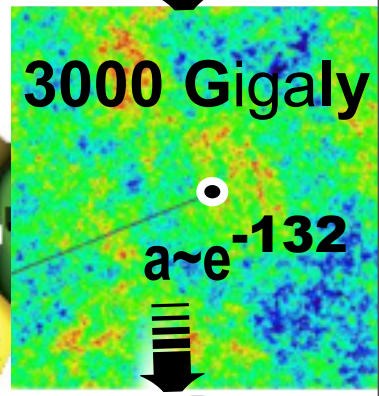
cosmic web simulation

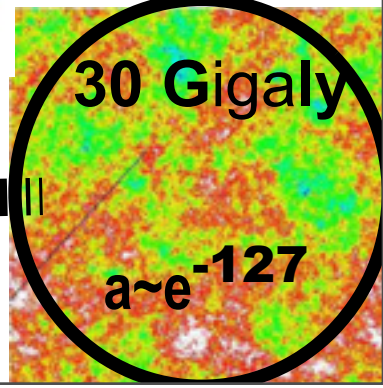
~1 Giga light yrs

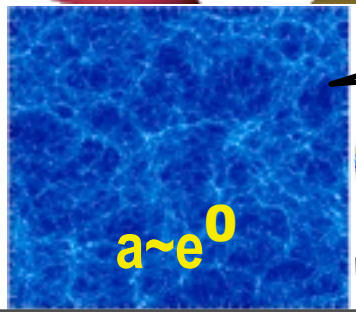
our current horizon

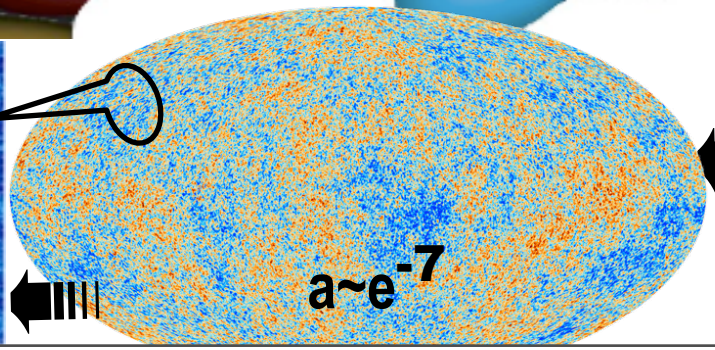
~50 Giga light yrs











We shall not cease from exploration
And the end of all our exploring
Will be to arrive where we started
And know the place for the first time

– T. S. Eliot

Let there be vacuum potential energy Dark Energy to $e^{-170?}$

Let there be the cosmic web

quantum jitter e^{-127} to e^{-67}

Let there be Heat: matter & radiation forms $a \sim e^{-67}$

Let there be Dark Matter, light nuclei $a \sim e^{-21}$ to e^{-35}

Let there be Light: 1st light released, 1st atoms $a \sim e^{-7}$

Let there be 1st stars $a \sim e^{-3}$

1st heavy nuclei (O, C, Fe,..)

galaxies form $e^{-1.2}$ to $e^{-2.2}$

Let there be earth $a \sim e^{-0.34}$

1st writing $a \sim e^{-0.0000004}$

Let there be here & now $a \sim e^{0}$

Let there be Dark Energy to e^{+++}

we think most of the Volume of the Universe has not Banged

Our Big Bang

We shall not cease from exploration
And the end of all our exploring
Will be to arrive where we started
And know the place for the first time

– T. S. Eliot

will our patch re-Bang? No Maybe

Let there be vacuum potential energy Dark Energy to $e^{-170?}$

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end