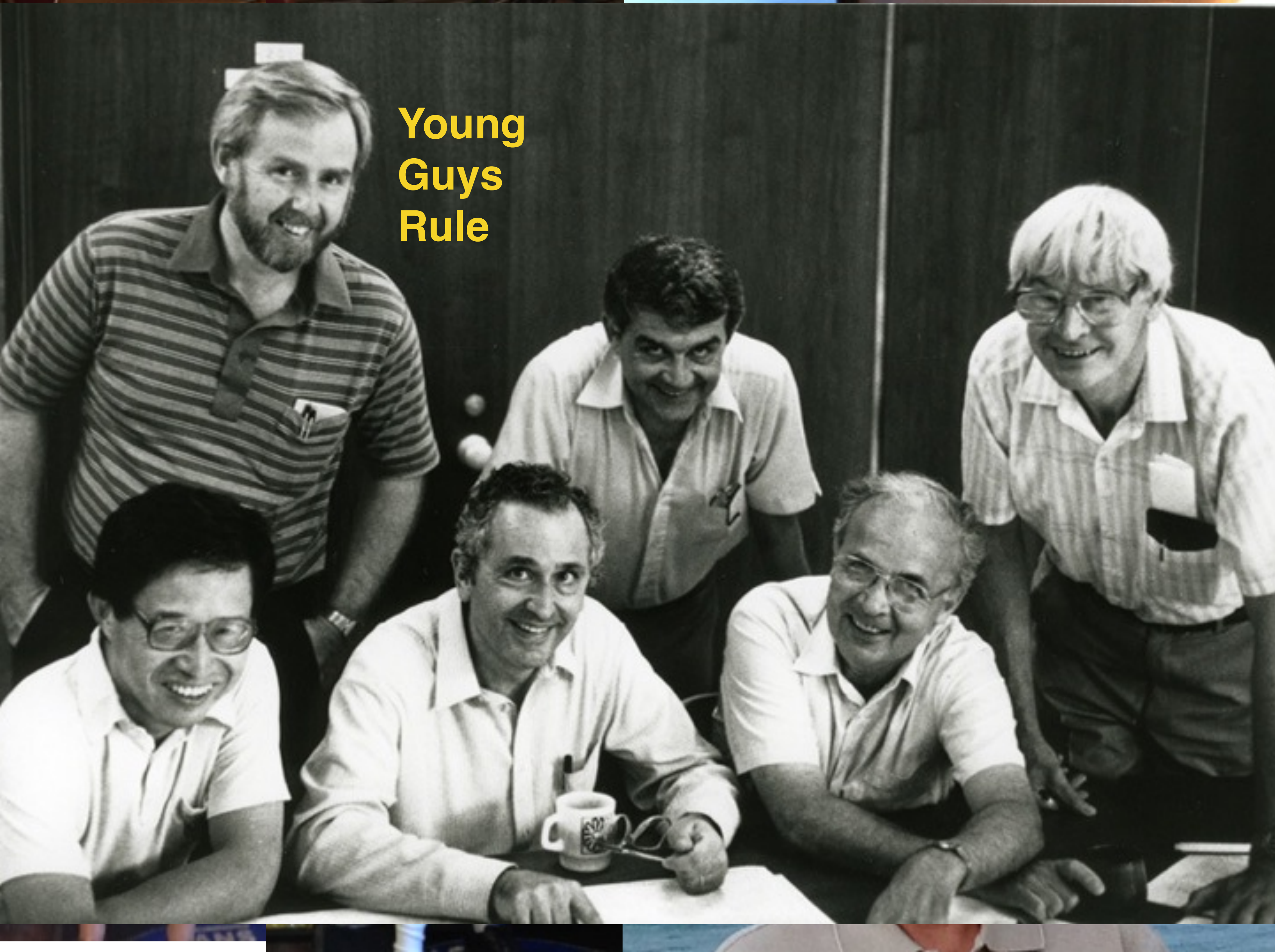
Young
Guys
Rule


OLD
GUYS
RULE


OLD
GUYS
RULE
DUKE

OLD
GUYS
RULE

CIFAR: Art is a Cosmologist & Gravitator

Art is forever young

Cosmic Photons, Phonons & Neutrinos in the Universe at Large

CIFAR CANADIAN INSTITUTE FOR ADVANCED RESEARCH

Dick Bond

CITA ICAT Canadian Institute for Theoretical Astrophysics L'institut Canadien d'astrophysique théorique

"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 of air ~5 cubic cm

Ordinary Matter ~amu /nm^3 4.8% O_2 N ; H,He

THE DARK

Dark Matter

~amu /m^3 26.0 ± 1% compressed in MilkyWay ~0.3 amu /cm^3 ;
for LHC@CERN-type relics ~ 1 every 10 cm

Dark Energy

~ vacuum potential density ~ 3 amu /m^3 69.2 ± 1.0%
inflaton-phonon condensate

THE LIGHT

cosmic radiation

the 1st light of the universe 412 **photons**/cm^3 0.005%
cosmic **neutrinos** ~ cosmic **photons** Energy fraction > 0.47% ~ stars
cosmic **gravity waves** << cosmic photons

THE VACUUM

Higgs@CERN vacuum origin of mass
vacuum fluctuations in **phonons** origin of all cosmic structure we see
the vacuum is under **gravitational strain**, differentially accelerating

Cosmic Photons, Phonons & Neutrinos in the Universe at Large

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Dark Energy

~ vacuum potential density ~ 3 amu /m^3 69.2 ± 1.0%
inflaton-phonon condensate

THE LIGHT

$S_{U,\gamma+\nu} \sim 10^{88.6}$

cf. $S_{th,cl} \sim 10^{76}$ *cf.* $S_{G,DE} \sim 10^{121.9}$

cosmic radiation

the 1st light of the universe 412 **photons**/cm^3 0.005% 5.2 bits/γ

cosmic **neutrinos** ~ cosmic **photons** Energy fraction > 0.47% ~ stars

cosmic **gravity waves** << cosmic photons

5.0 bits/ν (N_{eff}/3.046)

THE VACUUM

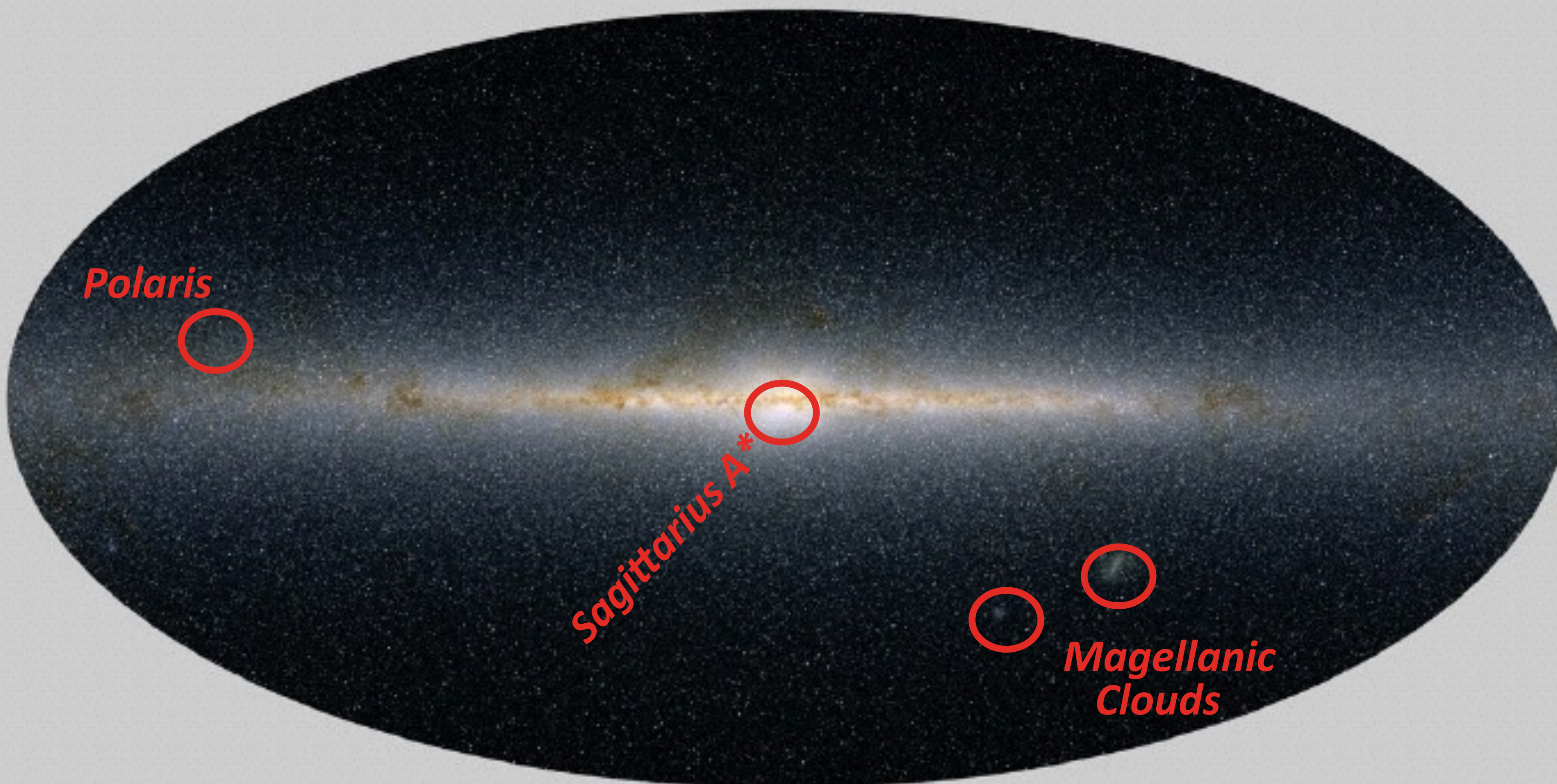
Higgs@CERN vacuum origin of mass

vacuum fluctuations in **phonons** origin of all cosmic structure we see

the vacuum is under **gravitational strain**, differentially accelerating

Milky Way in infra-red:

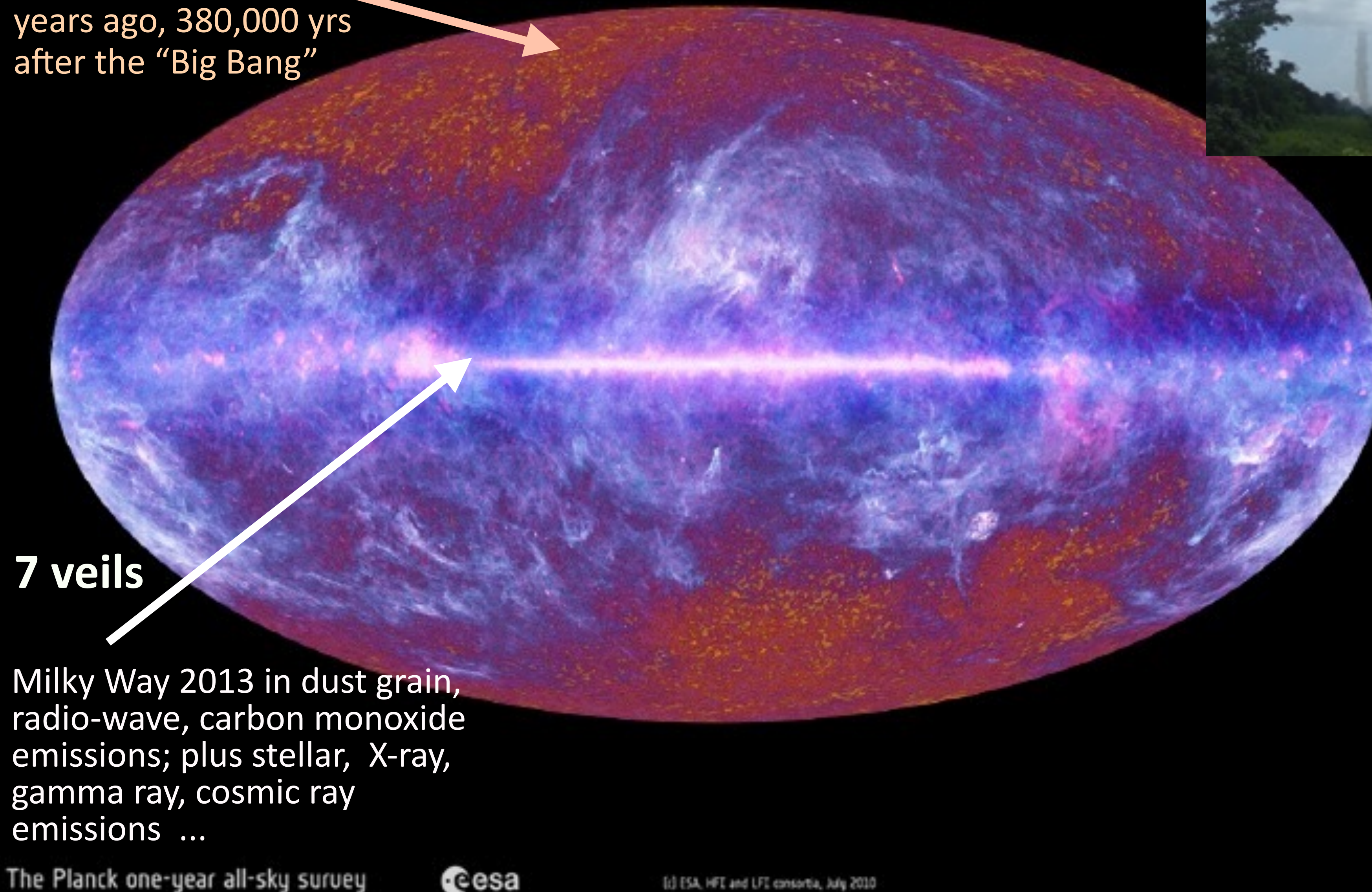
half a billion stars, a disk galaxy



Two Micron All Sky Survey Image Mosaic: Infrared Processing and Analysis Center/Caltech & University of Massachusetts

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 ...

Bond since 1993, Canada since 2001, 1st CSA pre-launch contract 2002-09, post-launch 2010-11, 2011-15

Planck+Herschel Launch May14 09 French Guiana

1.5m telescope,

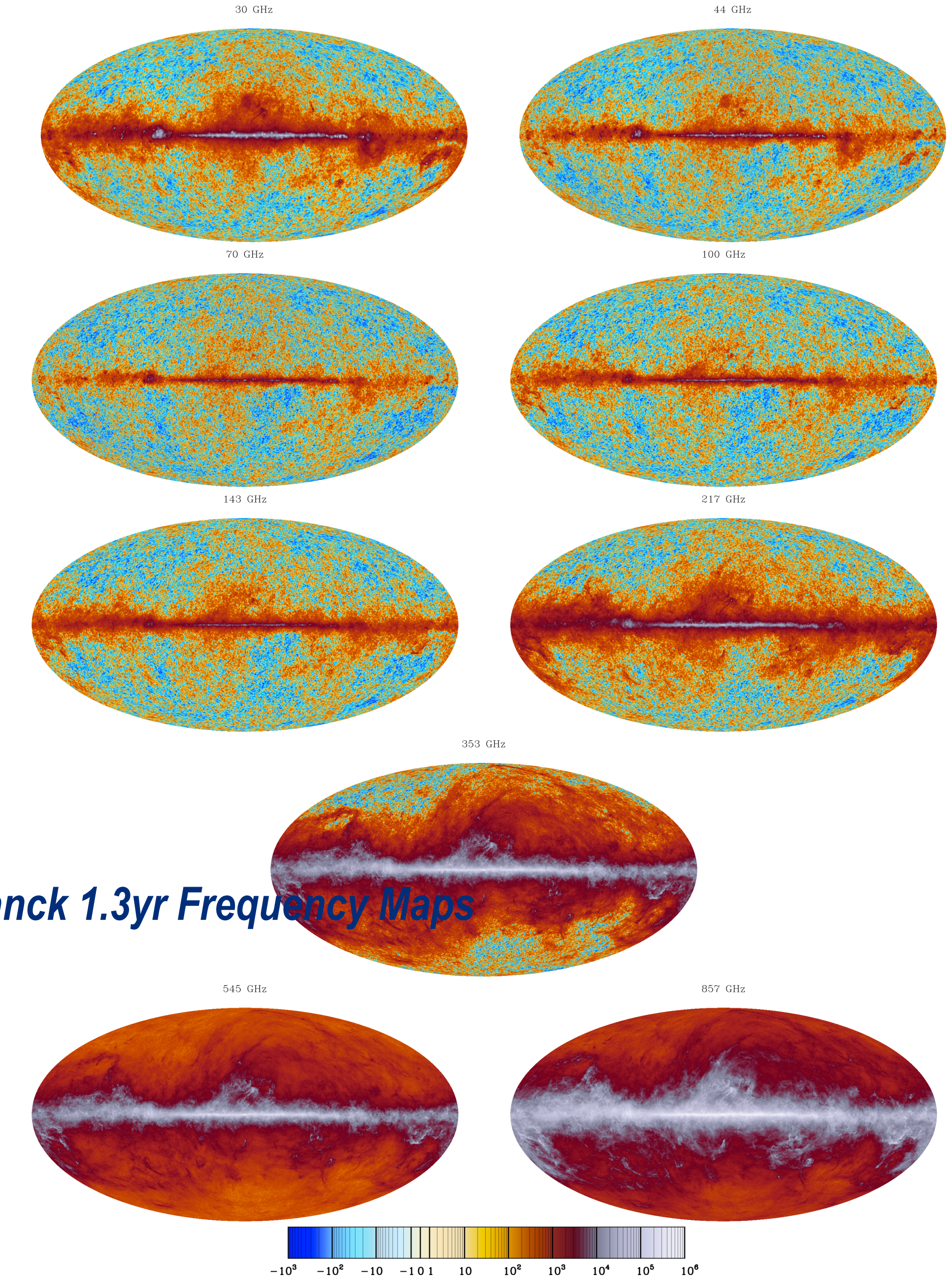
HFI bolometers @6freq <100mK,

LFI HEMTs@3freq,

some bolometers & all HEMTS are polarization sensitive

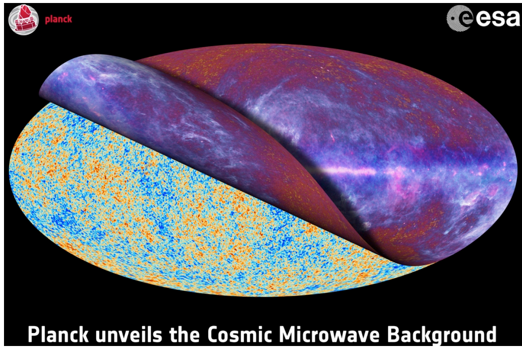
- **Left earth at ~10 km/s, 1.5 million km in 45 days, cooling on the way (20K, 4K, 1.6K, 0.1K 4 stage). @L2 on July 2 09; Survey started on Aug 13 09**
- **spun@1 rpm, 40-50 minutes on the same circle, covered all-sky in ~6 month**
- **kicked out of L2 Oct13**
- **5 HFI all-sky surveys (to Jan 2012) 29 months**
- **8 LFI surveys 48 months**
- **Oct14 T,Q,U all-data, refined final set late 2015**

Planck 1.3yr Frequency Maps Mar13



Planck 1.3yr Frequency Maps

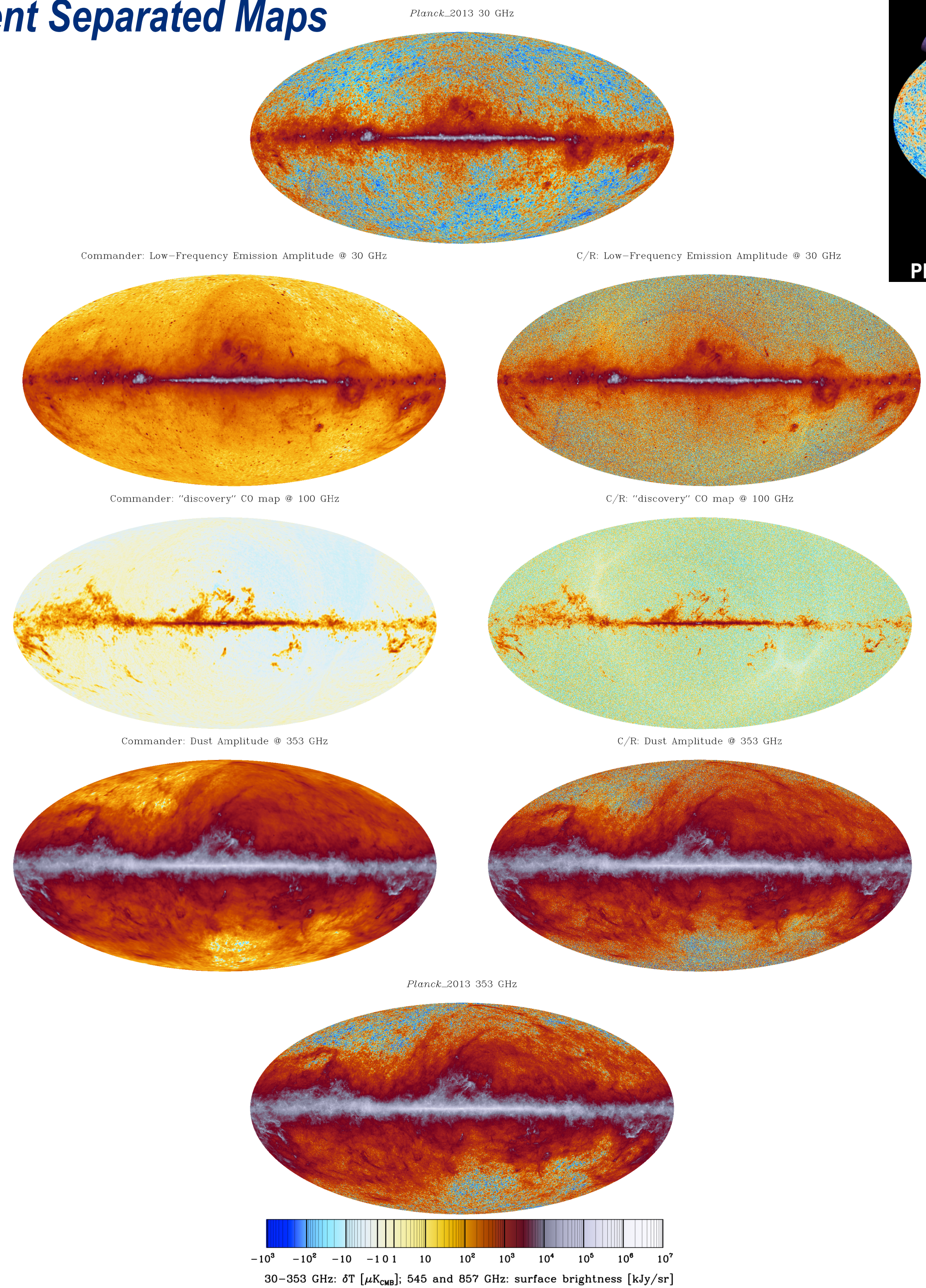
Some Planck Component Separated Maps



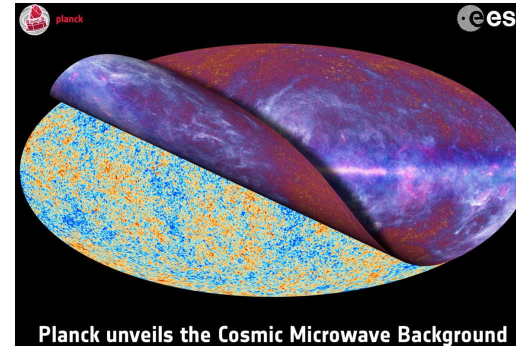
LF Synchrotron + bremsstrahlung

Galactic Carbon Monoxide

HF Thermal Dust Emission



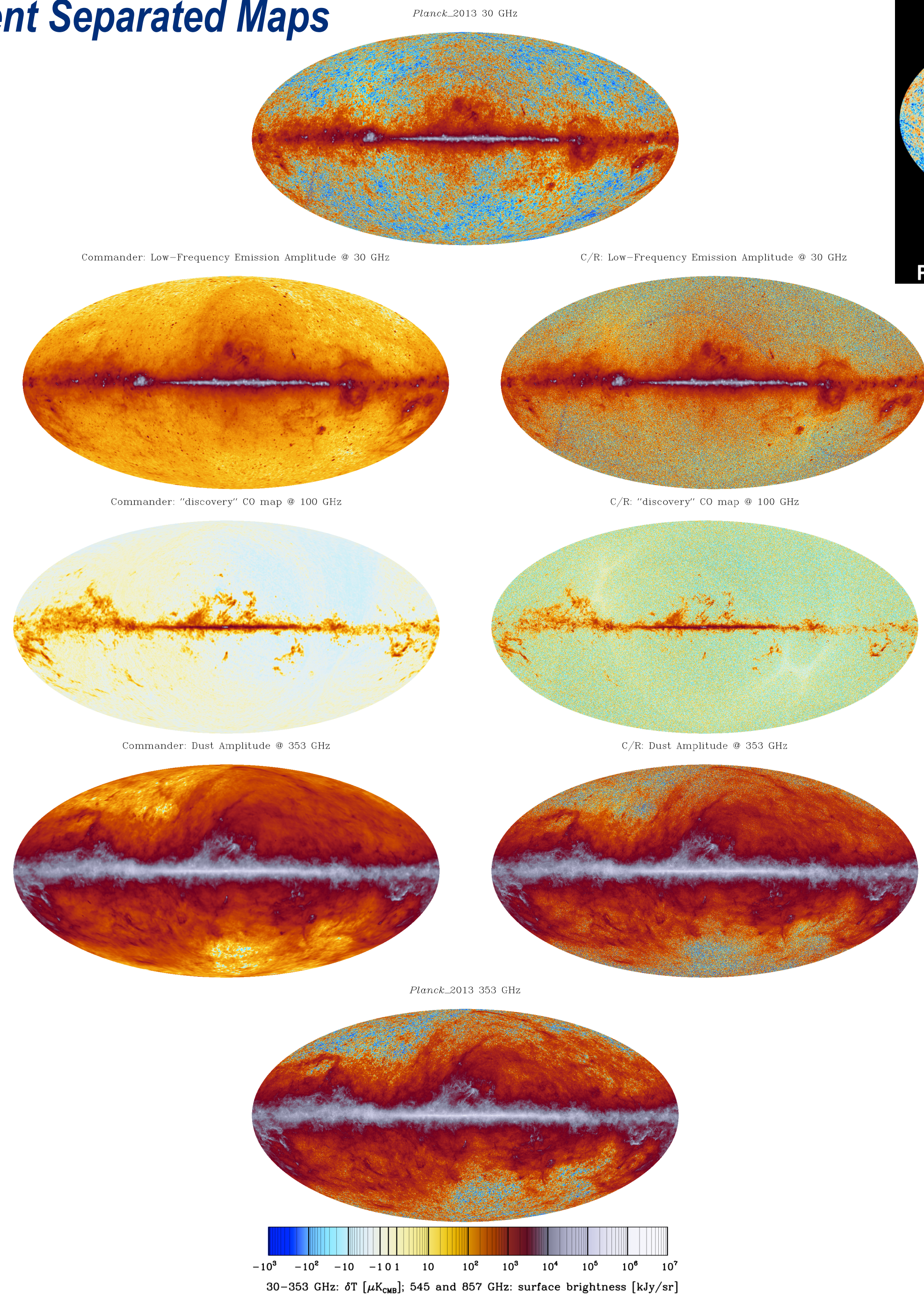
Some Planck Component Separated Maps



LF Synchrotron + bremsstrahlung

Galactic Carbon Monoxide

HF Thermal Dust Emission



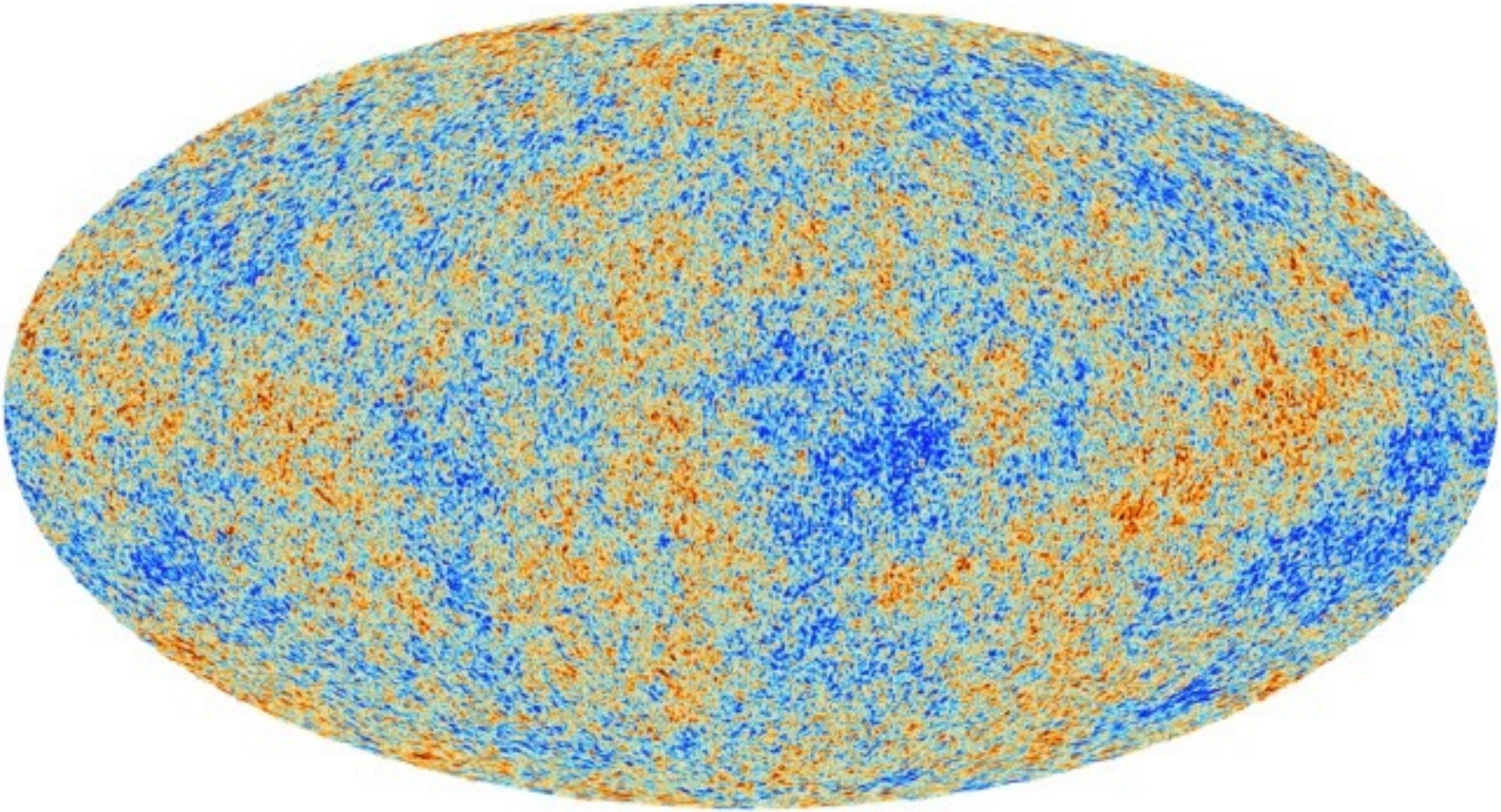
Galactic Dust Polarization Papers

4 in May 2014 on dust polarization, finishing 1 more in series on power spectra, including high Galactic Latitude, possible relevance to BICEP2 claim of T/S detection

Planck's primordial light unveiled, March 21, 2013

reveals the SIMPLICITY of primordial cosmic structure

7^+ numbers, 3 densities, 2+1 early-Universe inflation



Temperature changes
in micro-degrees

Google “Planck Satellite 2013 results” yields ~ 1 million links

Google “gravity waves from inflation 2014” yields ~ 0.3 million links”

THE GLOBE AND MAIL

SPACE

New glimpses of ancient light fuel cosmic debate

Government of Canada Gouvernement du Canada

Canada

Canadian Space Agency

Home > Audiences > Media > News releases > 2013

> Canadian astronomers reveal surprising new portrait of the Early Universe

Canadian astronomers reveal surprising new portrait of the Early Universe

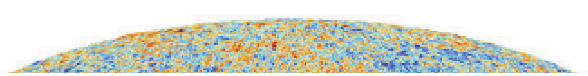
The New York Times

Space & Cosmos

WORLD | U.S. | N.Y. / REGION | BUSINESS | TECHNOLOGY | SCIENCE | HEALTH | SPORTS | OPINION

ENVIRONMENT SPACE & COSMOS

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



L'enfance de l'Univers dévoilée

LE MONDE | 21.03.2013 à 11h27 • Mis à jour le 21.03.2013 à 13h44

UNIVERSITY OF TORONTO

U of T News

Home

Plancking at U of T: space

CIFAR

CANADIAN INSTITUTE FOR ADVANCED RESEARCH

CIFAR cosmologists contribute to new portrait of the Early Universe

CITA–ICAT

NEWS ARCHIVE

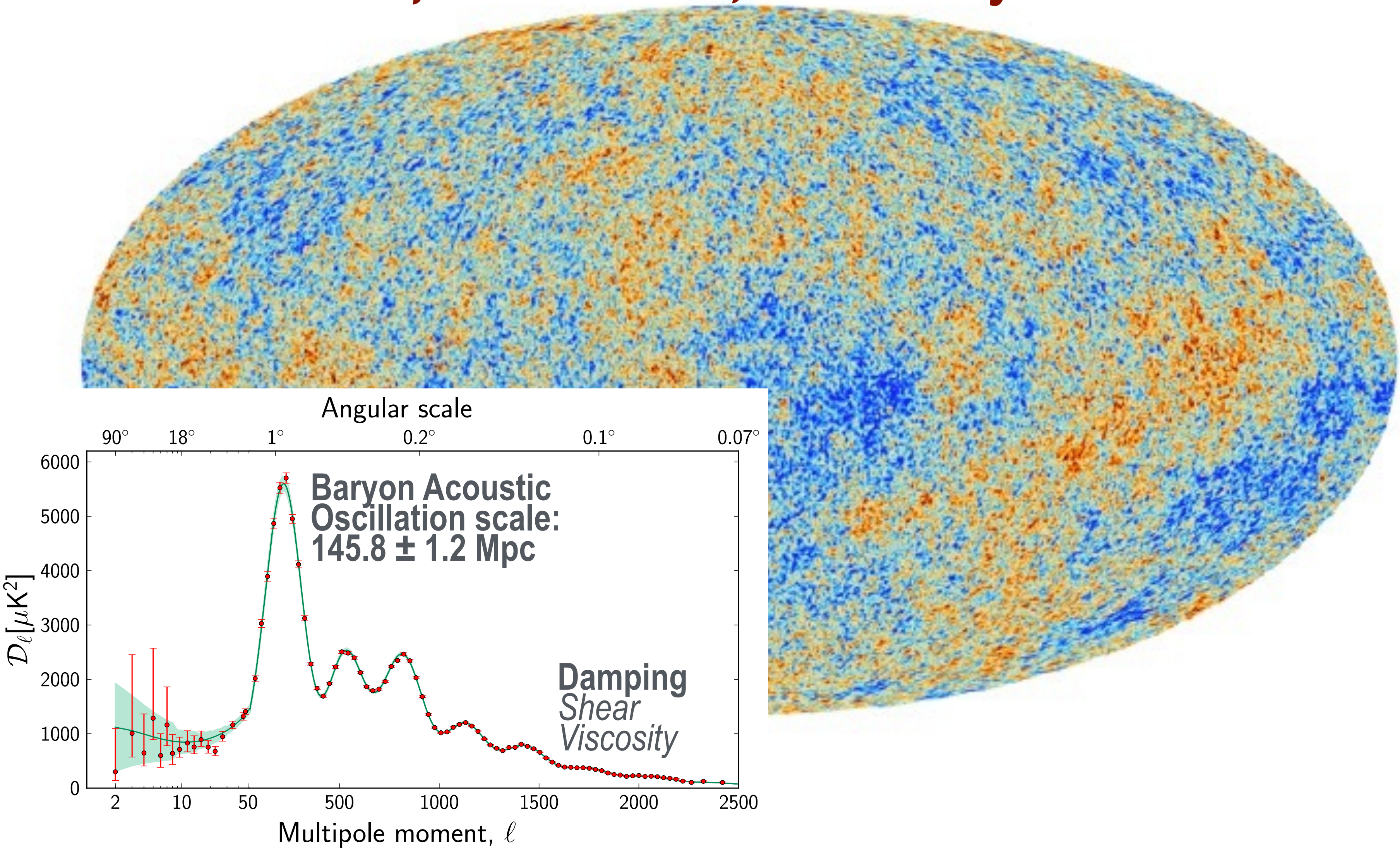
PLANCK Light

gravity waves from inflation

http://www.nytimes.com *Space Ripples Reveal Big Bang’s Smoking Gun* *By DENNIS OVERBYE MARCH 17, 2014* reveals **primordial sound waves**

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

7⁺ numbers, 3 densities, 2+1 early-Universe inflation



reveals primordial sound waves

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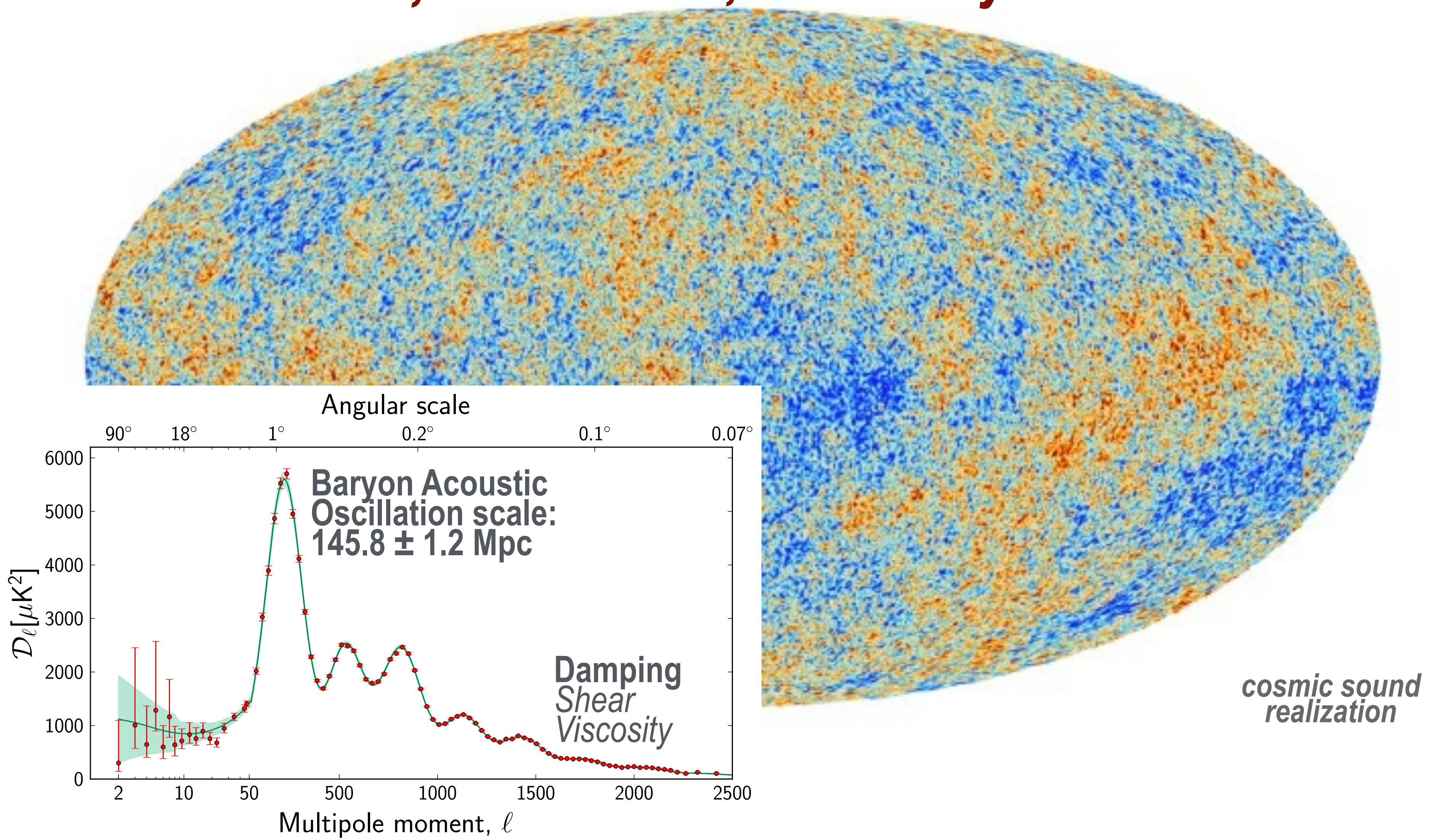
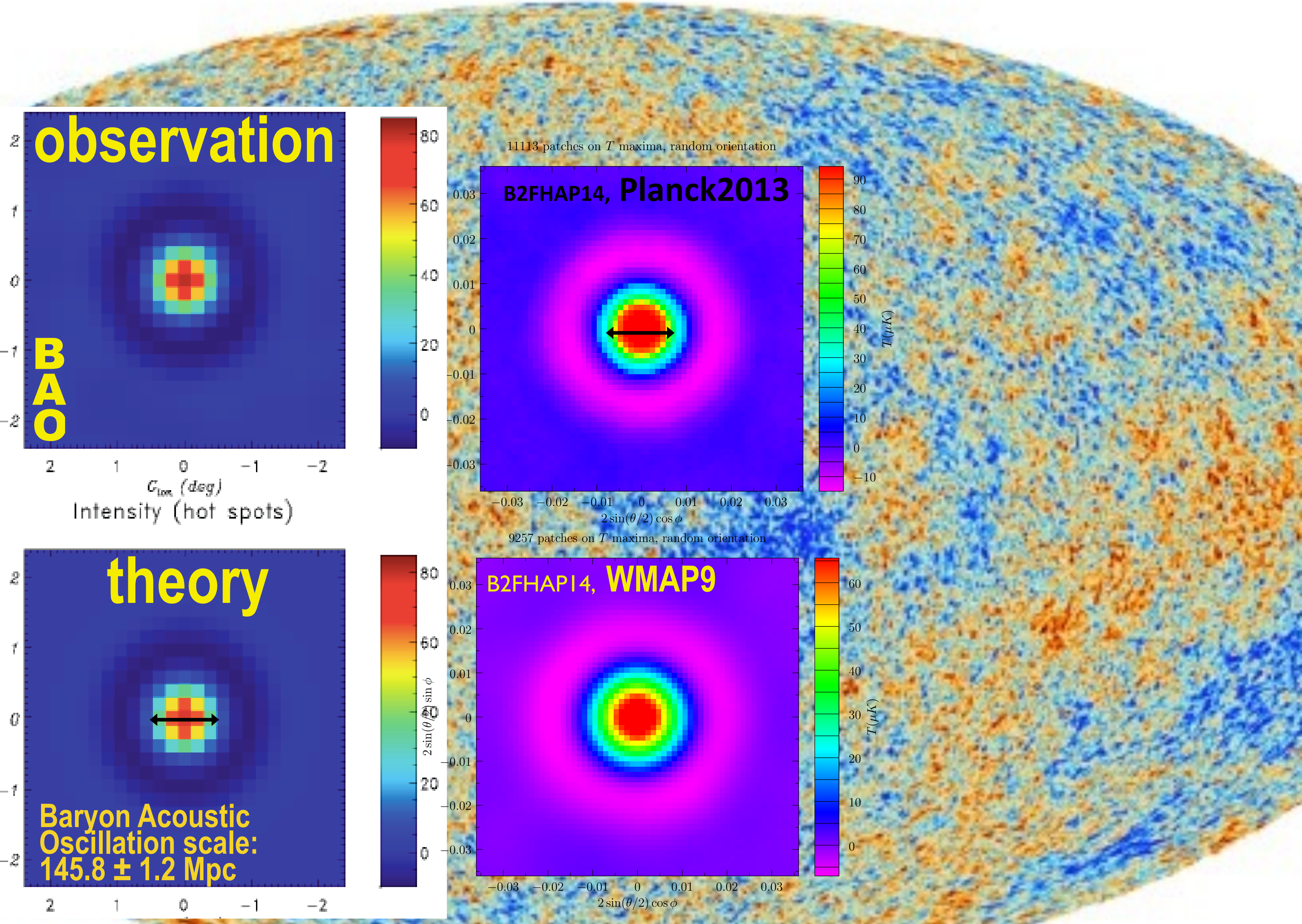
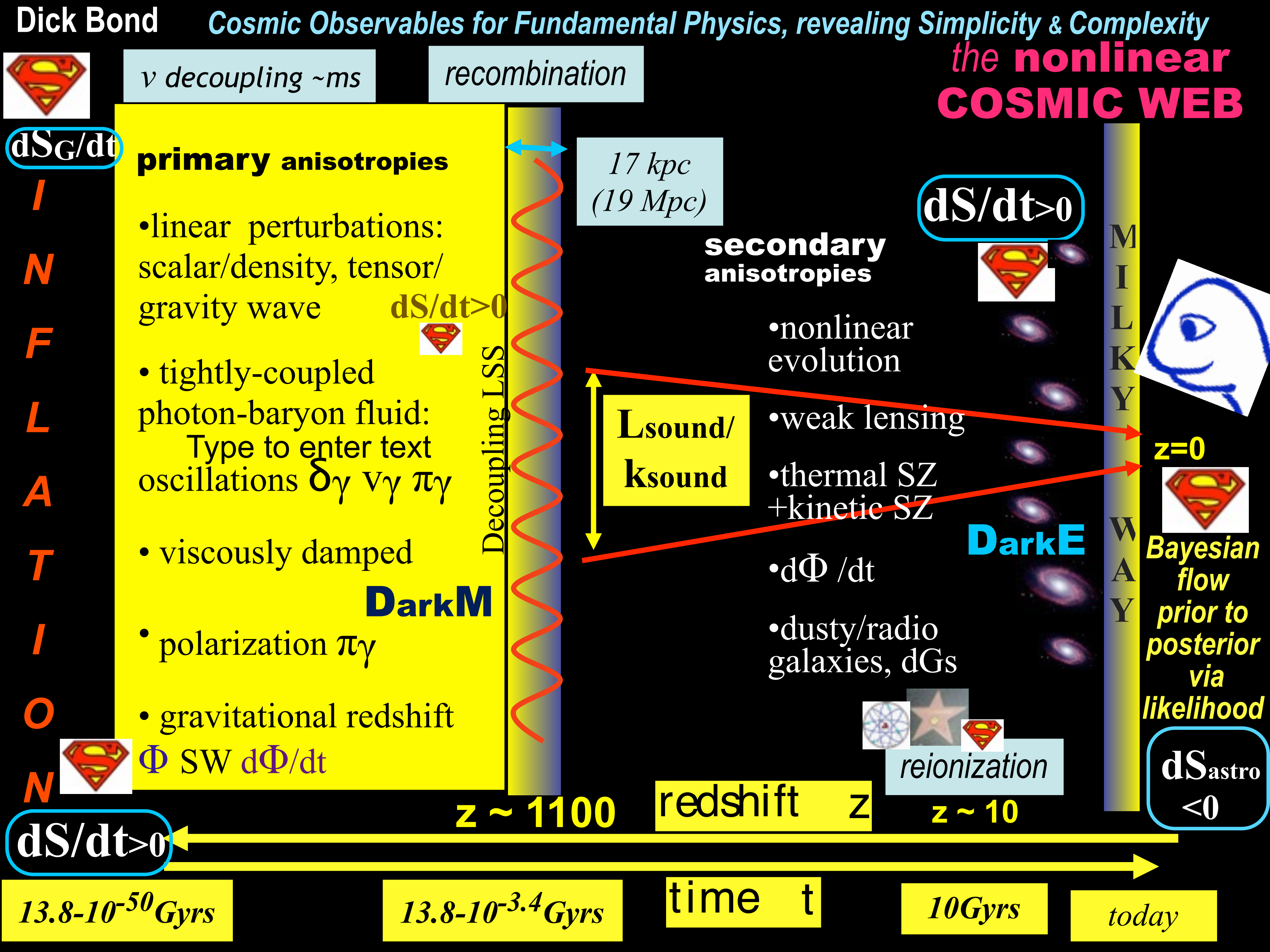


Planck13+ reveals **primordial sound waves BAO in matter** *at* **a~e^{-7}**~1/1100





Dick Bond
Cosmic Observables for Fundamental Physics, revealing Simplicity & Complexity
the nonlinear COSMIC WEB
ν decoupling ~ms
recombination
dS_G/dt
INFLATION
primary anisotropies
•linear perturbations: scalar/density, tensor/ gravity wave
dS/dt>0
• tightly-coupled photon-baryon fluid: oscillations δγ vγ πγ
Type to enter text
• viscously damped
DarkM
• polarization πγ
• gravitational redshift
Φ SW dΦ/dt
Decoupling LSS
17 kpc (19 Mpc)
dS/dt>0
secondary anisotropies
•nonlinear evolution
•weak lensing
•thermal SZ +kinetic SZ
•dΦ /dt
•dusty/radio galaxies, dGs
Lsound/ ksound
DarkE
MILKY WAY
z=0
Bayesian flow prior to posterior via likelihood
dSastro <0
reionization
z ~ 1100
redshift z
z ~ 10
dS/dt>0
time t
13.8-10^-50 Gyrs
13.8-10^-3.4 Gyrs
10Gyrs
today

Dick Bond *Cosmic Observables for Fundamental Physics, revealing Simplicity & Complexity*

the **nonlinear COSMIC WEB**

ν decoupling ~ms

recombination

dS_G/dt

I N F L A T I O N

o67

primary anisotropies

•linear perturbations: scalar/density, tensor/ gravity wave dS/dt>0

• tightly-coupled photon-baryon fluid: oscillations $\delta\gamma$ $v\gamma$ $\pi\gamma$

Type to enter text

• viscously damped

DarkM

• polarization $\pi\gamma$

• gravitational redshift

Φ SW $d\Phi/dt$

Decoupling LSS

17 kpc (19 Mpc)

Lsound/ ksound

BAO

7

secondary anisotropies

•nonlinear evolution

•weak lensing

•thermal SZ +kinetic SZ

•$d\Phi$ /dt

•dusty/radio galaxies, dGs

3

2⇓1

CMB

LENS

SN Ia

LENS

H0

BAO (z)

cls

ISW

DarkE

MILKY WAY

0

z=0

Bayesian flow prior to posterior via likelihood

dS_{astro} <0

z ~ 1100

redshift z

z ~ 10

dS/dt>0

time t

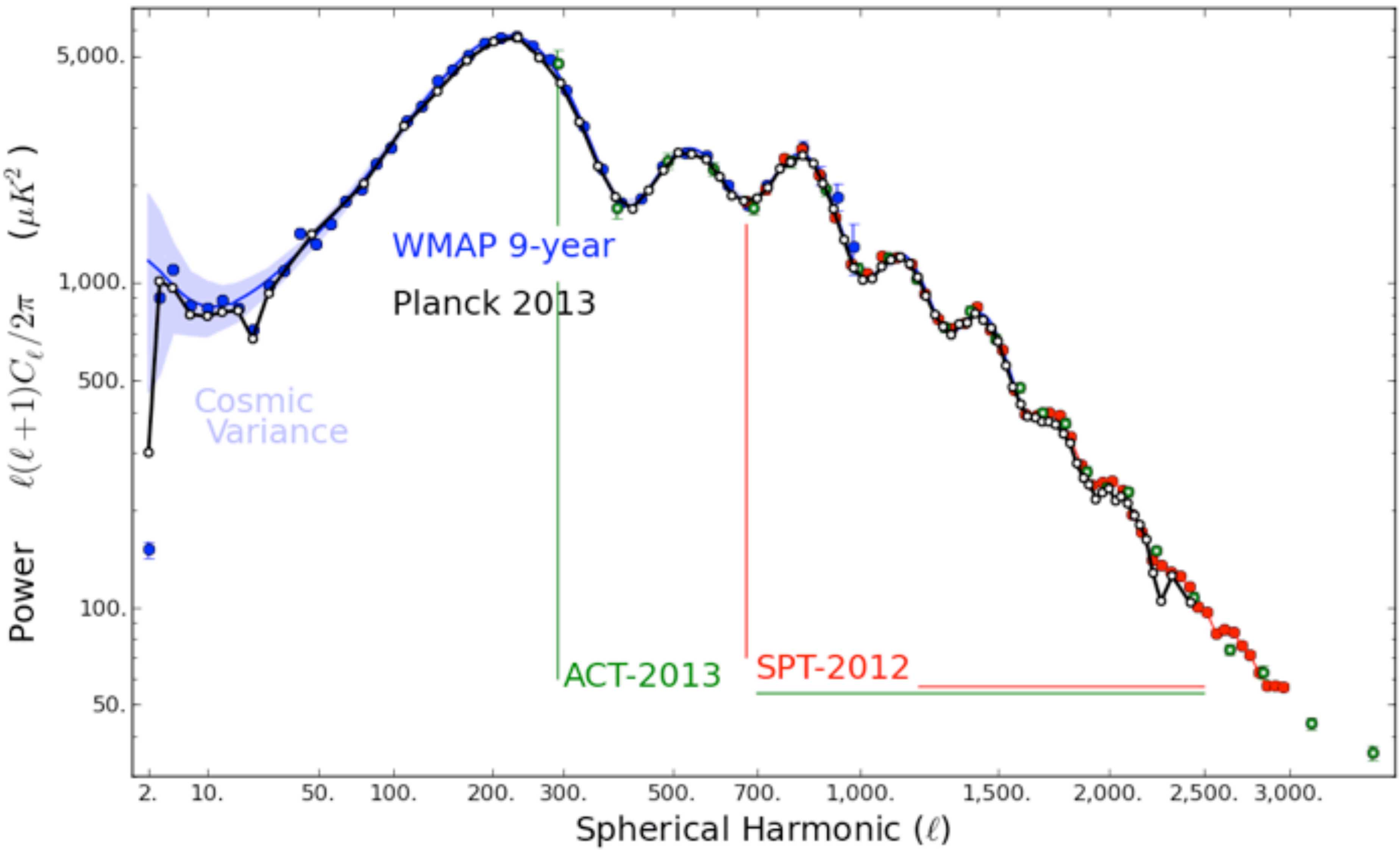
$13.8\text{-}10^{-50}$Gyrs

$13.8\text{-}10^{-3.4}$Gyrs

10Gyrs

today

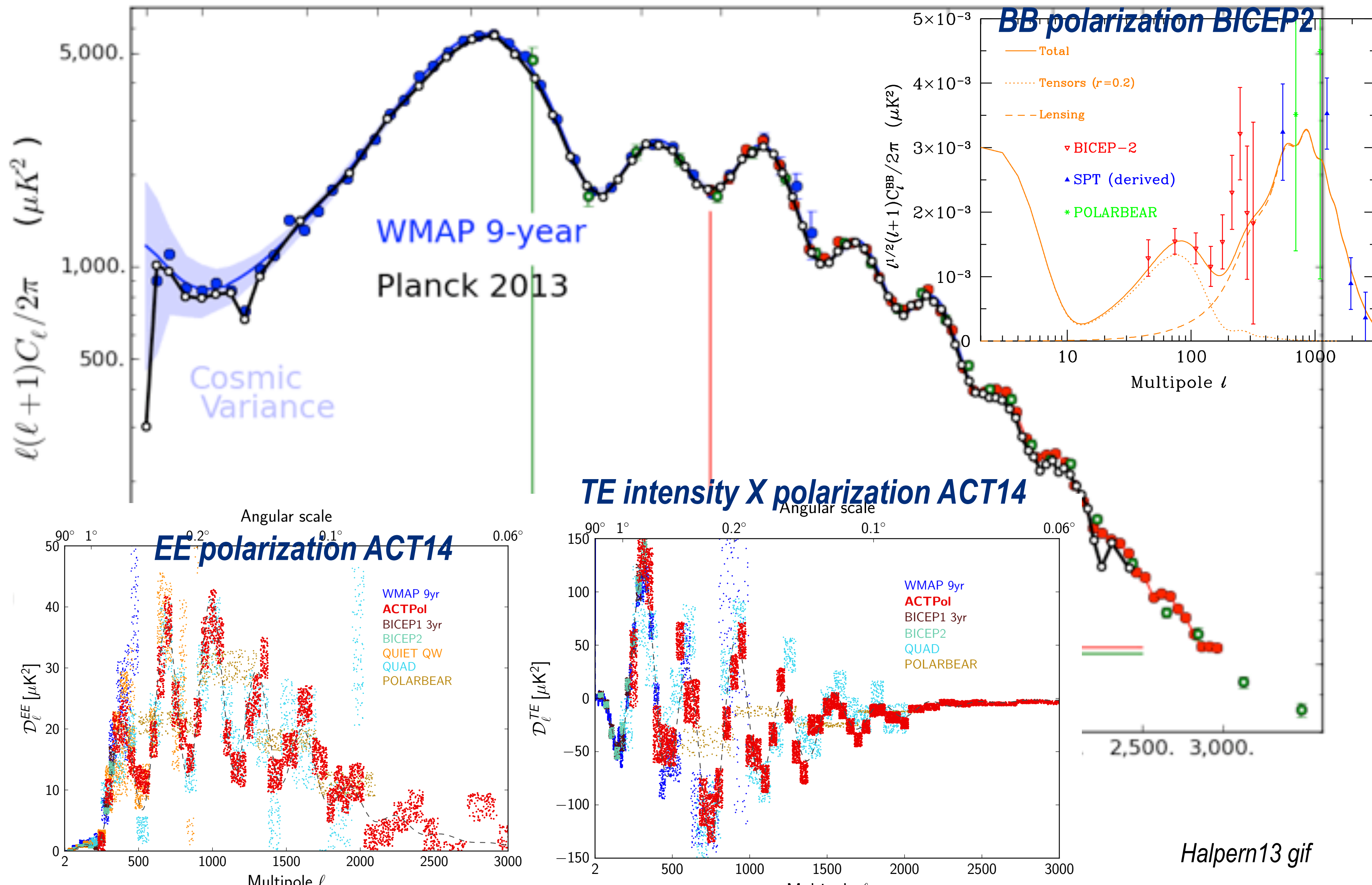
harmonic analysis of the *'music of the spheres'* *=> inharmonious, coloured noise in the CMB*



WMAP9 +ACT + SPT cf. Planck2013 = Planck1.3yr

Halpern13 gif

harmonic analysis of the *'music of the spheres'*
=> inharmonious, coloured noise in the CMB



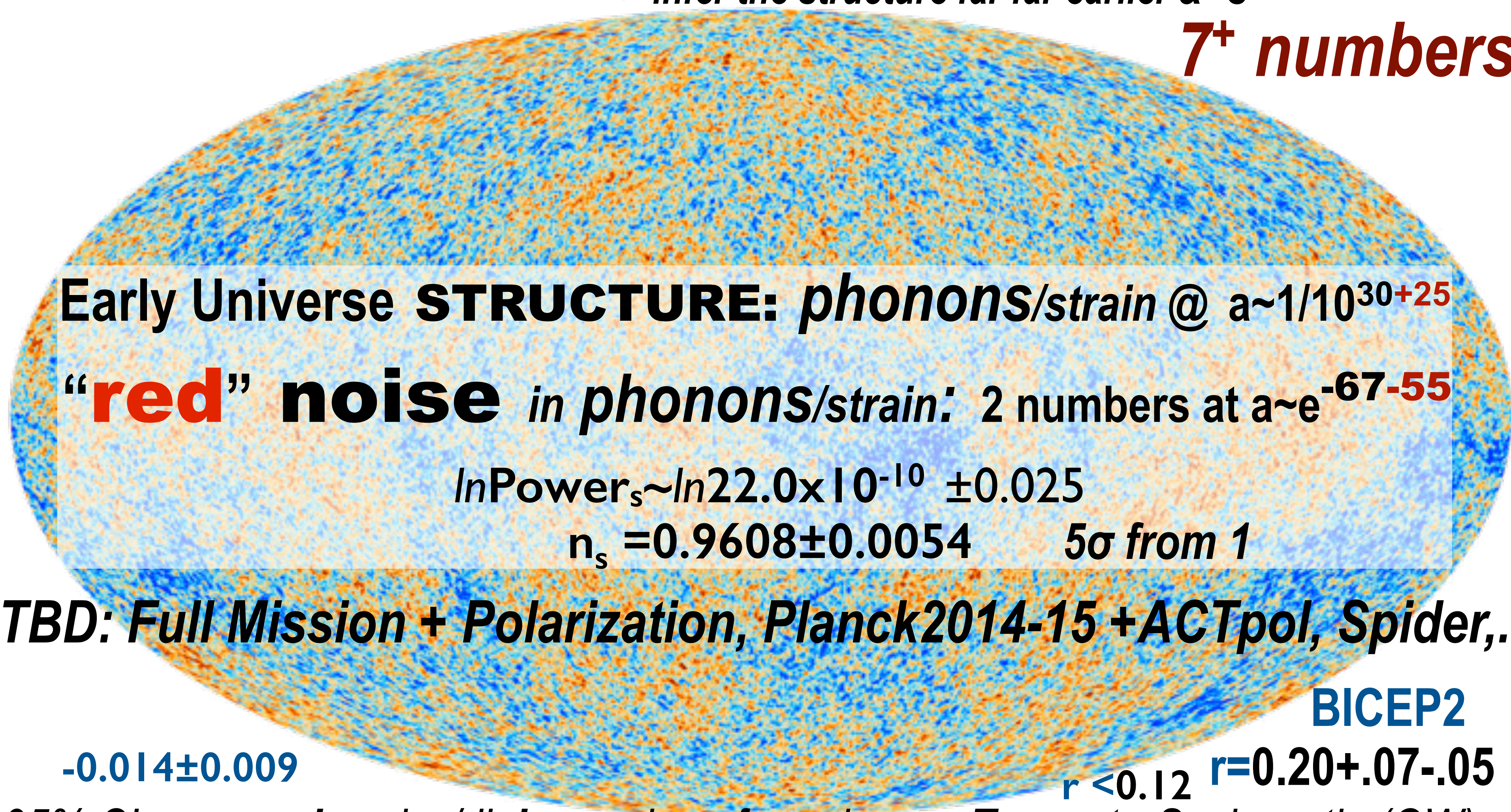
SIMPLICITY

at $a\sim e^{-7}\sim 1/1100$ =>
at $a\sim e^{-67-60}\sim 1/10^{30+25}$

Planck2013 CMB map

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



Early Universe STRUCTURE: ***phonons****/strain* @ $a\sim 1/10^{30+25}$

"red" noise *in* ***phonons****/strain:* 2 numbers at $a\sim e^{-67-55}$

$\ln \mathrm{Power}_s \sim \ln 22.0\times 10^{-10}$ ±0.025

n_s =0.9608±0.0054 *5σ from 1*

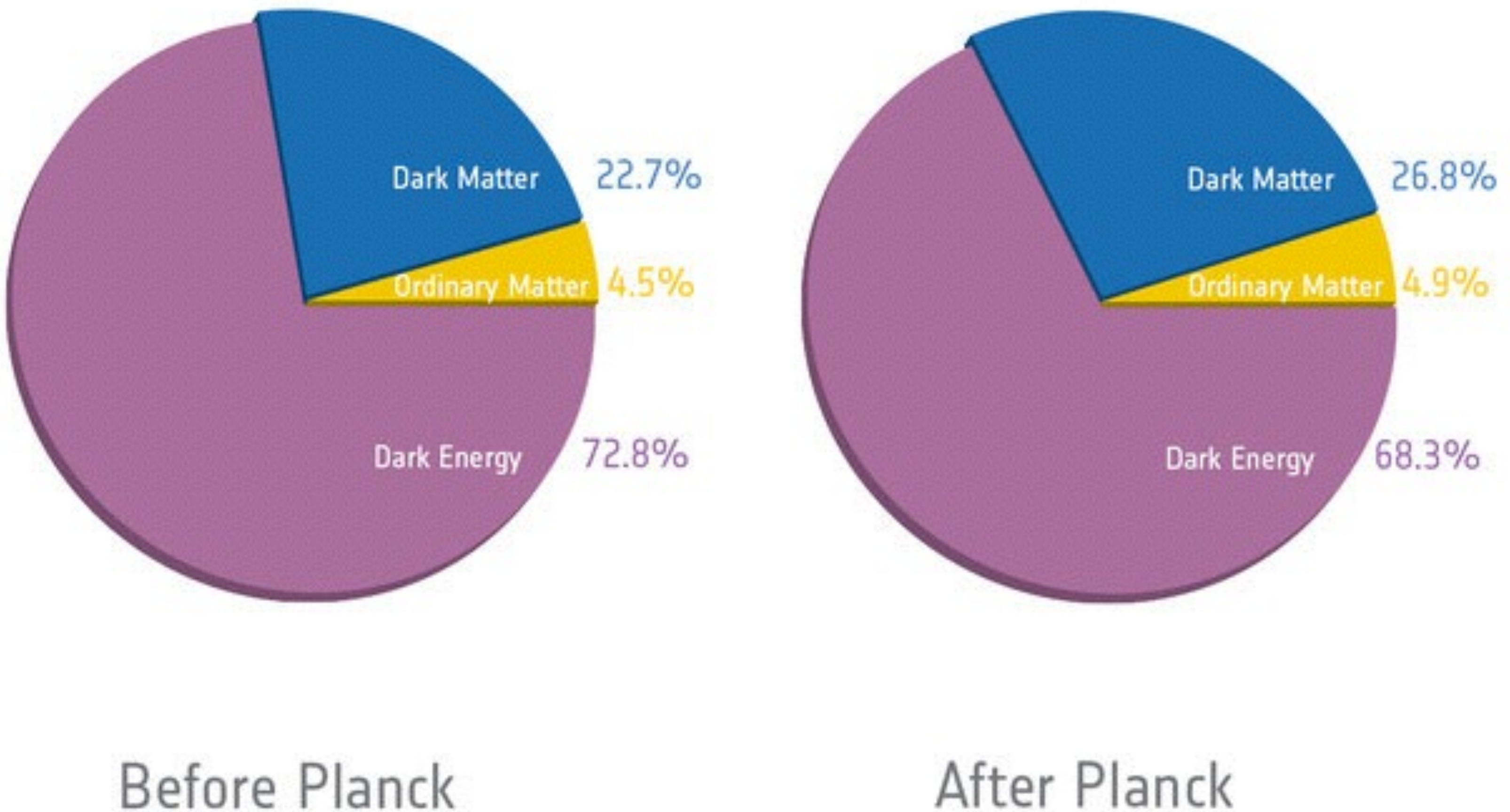
TBD: Full Mission + Polarization, Planck2014-15 +ACTpol, Spider,..

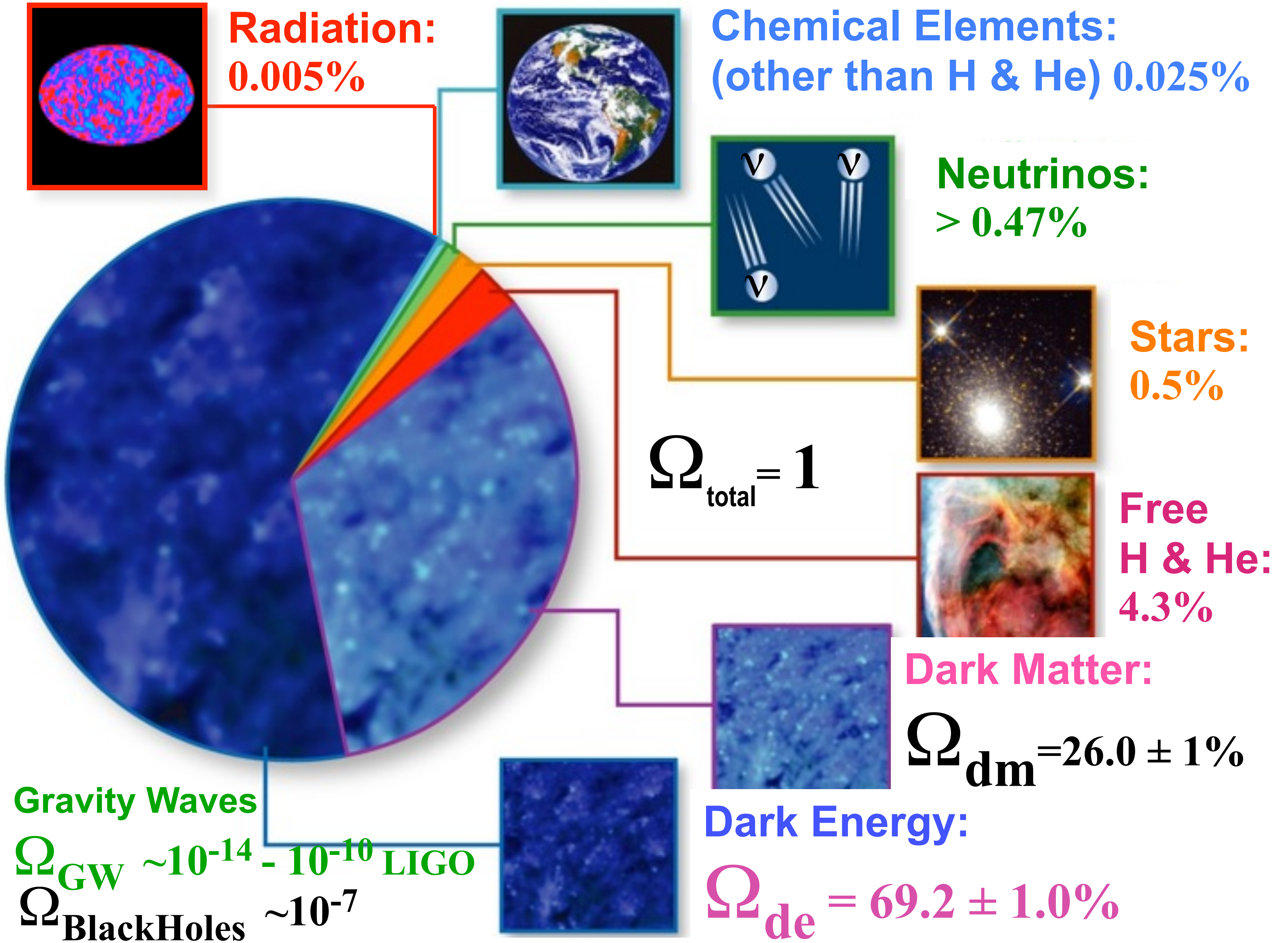
BICEP2

-0.014±0.009 r <0.12 r=0.20+.07-.05

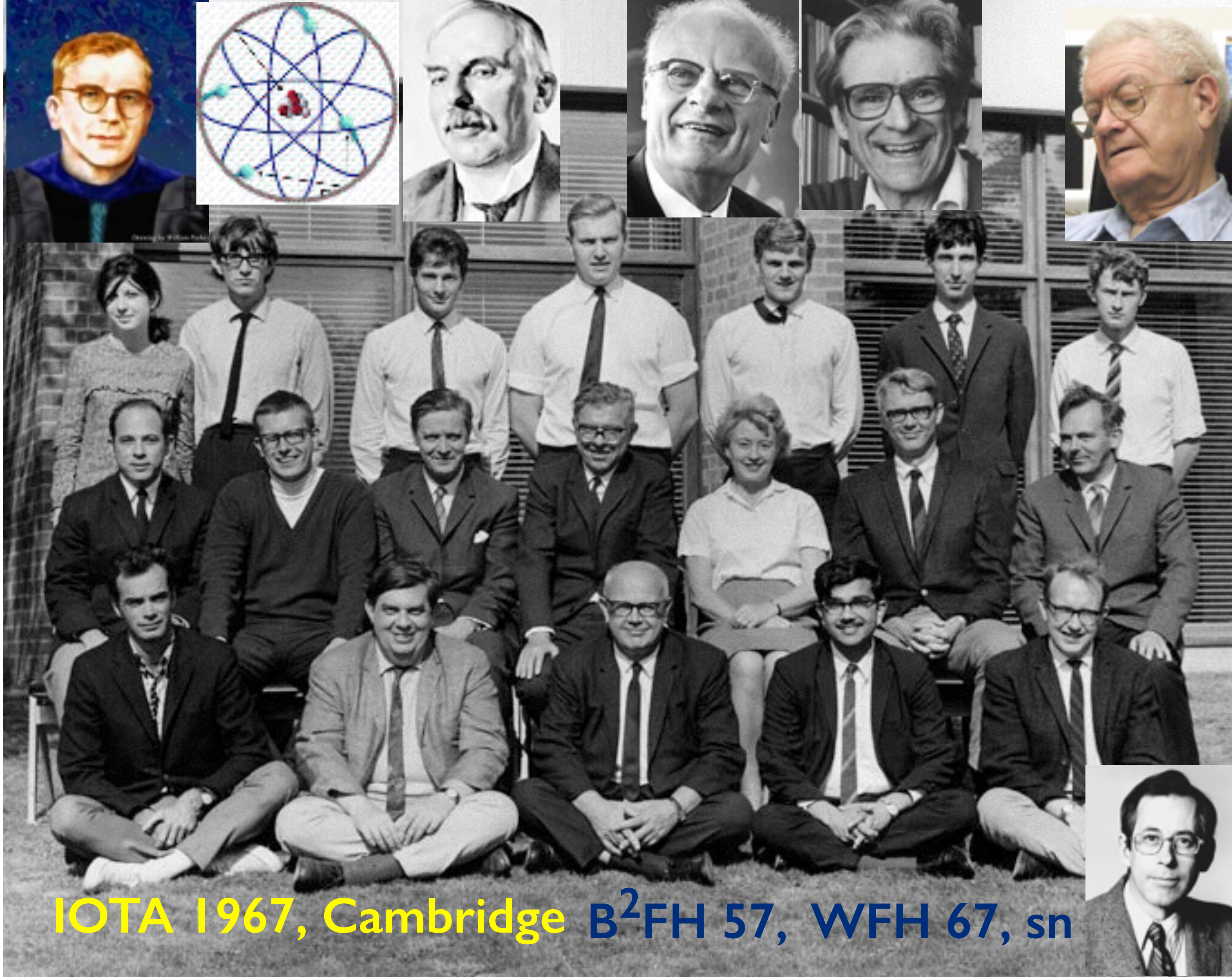
95% CL on ***running*** *d*$\mathbf{n_s}$*/dln****k****, running of running,* ***r*** *=Tensor-to-Scalar ratio (GW),*
isocurvature modes *for axions (<3.9%), baryons, neutrinos, curvatons (<0.25%)*

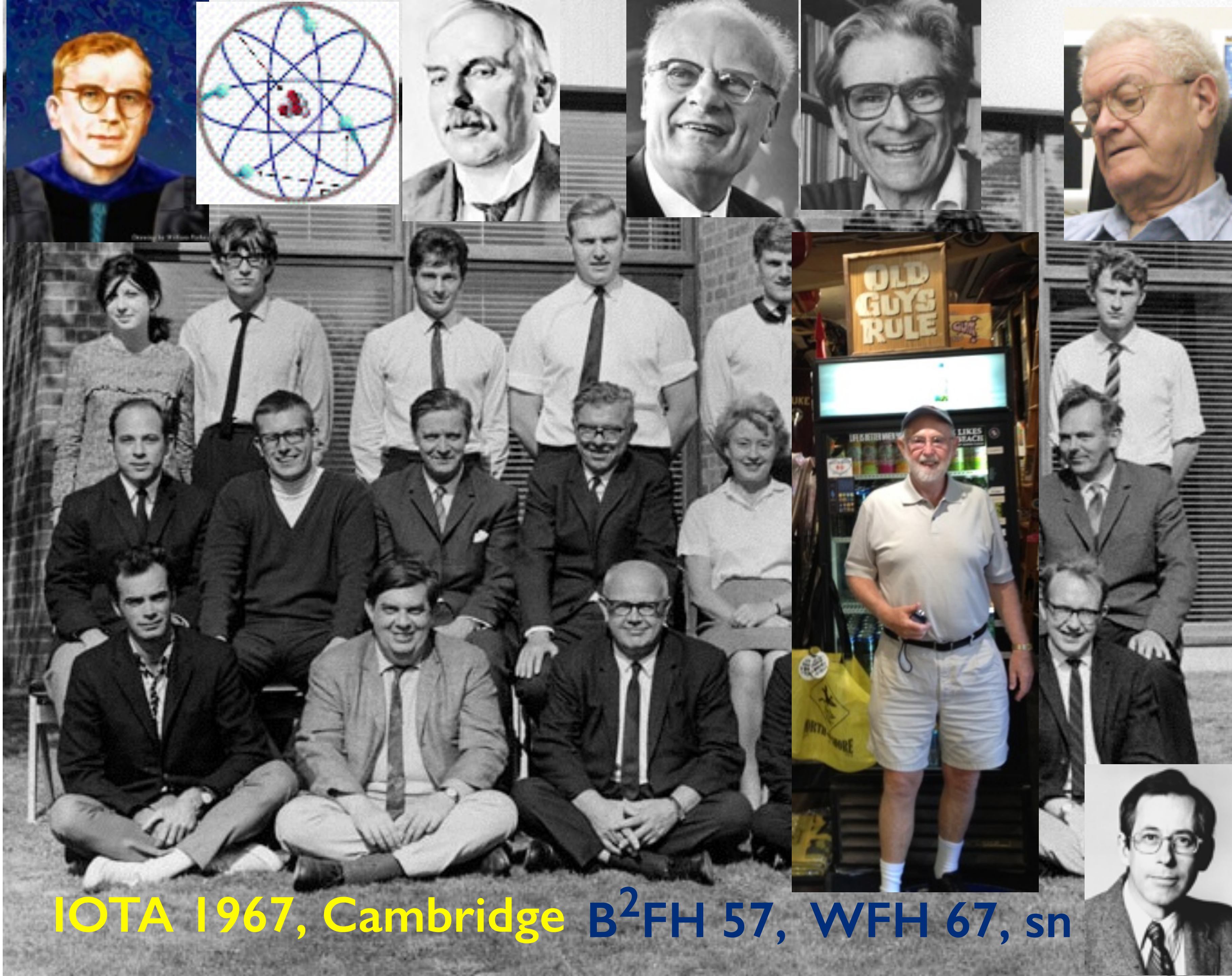
small shift in the pie chart make-up of the Universe



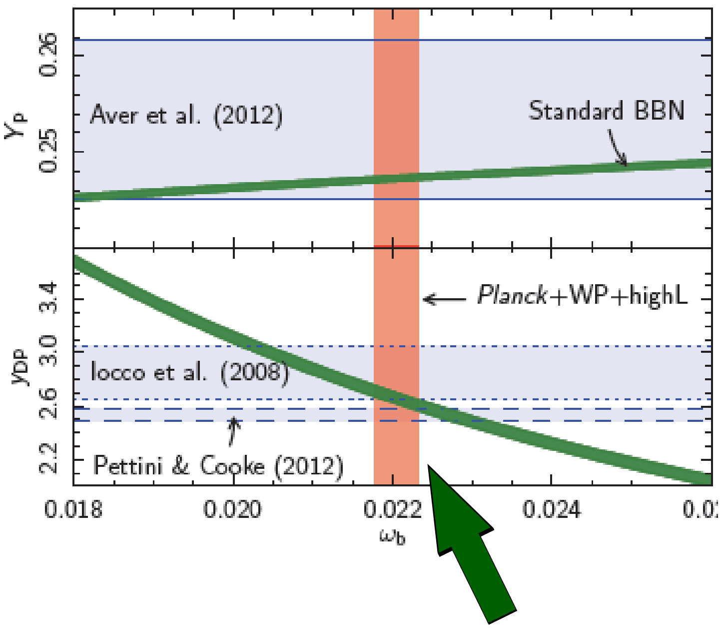


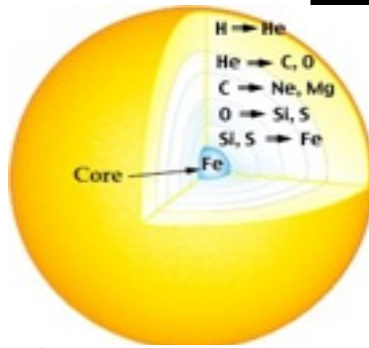
Radiation:
0.005%
Chemical Elements:
(other than H & He) 0.025%
Neutrinos:
> 0.47%
Stars:
0.5%
$\Omega_{total} = 1$
Free
H & He:
4.3%
Dark Matter:
Ω_{dm}=26.0 ± 1%
Dark Energy:
Ω_{de} = 69.2 ± 1.0%
Gravity Waves
Ω_{GW} ~10^{-14} - 10^{-10} LIGO
$\Omega_{BlackHoles}$ ~10^{-7}

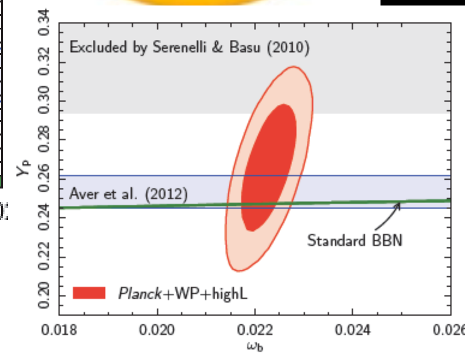

IOTA 1967, Cambridge B^{2}FH 57, WFH 67, sn


OLD GUYS RULE
IOTA 1967, Cambridge B^2FH 57, WFH 67, sn

Baryometers







Nobel Prize 84 Willy Fowler + Chandra -sekhar

	pre-boom	boom+	boom+cbi	boom+cbi+acbar	wmap1+
	January 2000	January 2002	June 2002	January 2003	March 2003
$\Omega_b h^2$	$0.0339^{+0.0443}_{-0.0246}$	$0.0222^{+0.0025}_{-0.0021}$	$0.0221^{+0.0024}_{-0.0020}$	$0.0221^{+0.0023}_{-0.0018}$	$0.0233^{+0.0013}_{-0.0013}$

0.0226 +- 0.0006 wmap3+acbar+cbi+... LSS

0.0233 +- 0.0005 wmap5+acbar+cbi+b03+.+WL+LSS+SN1+Lya

0.02217 +- 0.00033 Planck13+CMBLensing

0.02214 +- 0.00024 Planck13+WP+hiL+BAO

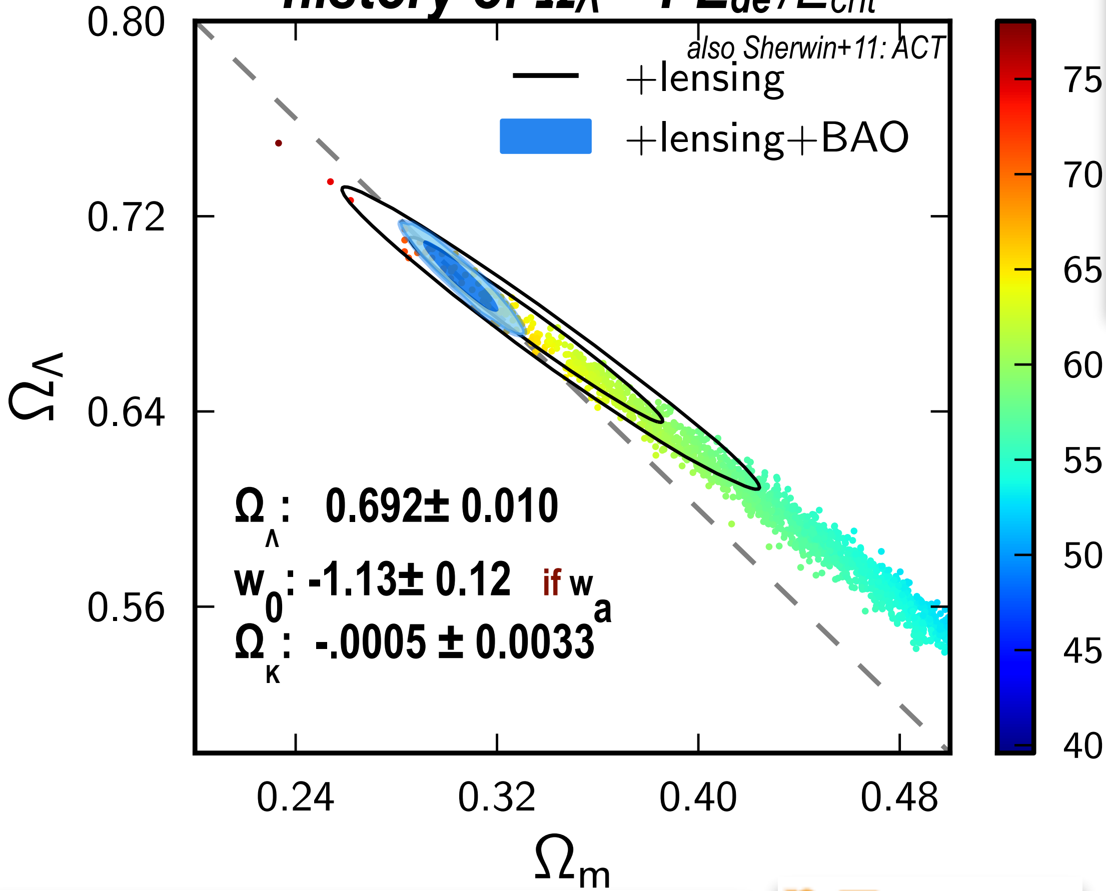
Dark Energy => inflation now

*CMB **lensing breaks "geometrical degeneracy"**:*

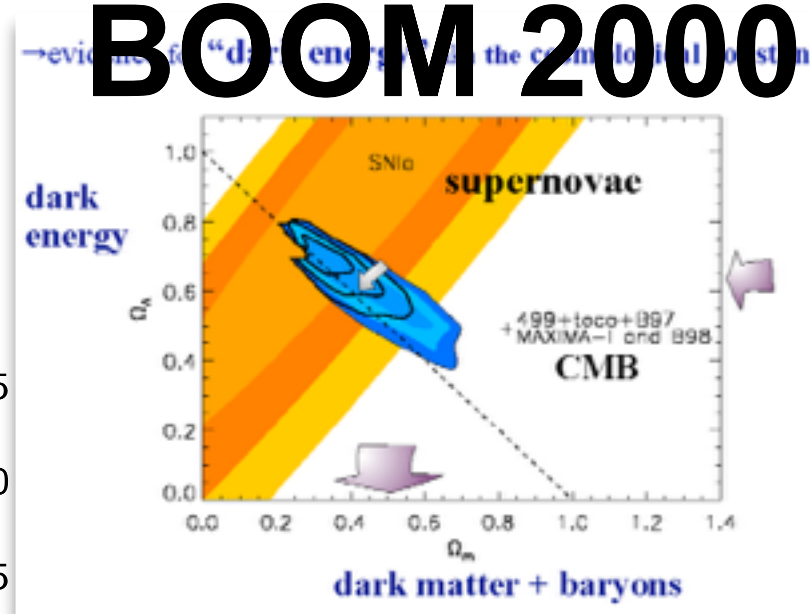
Planck alone cf. Planck+BAO

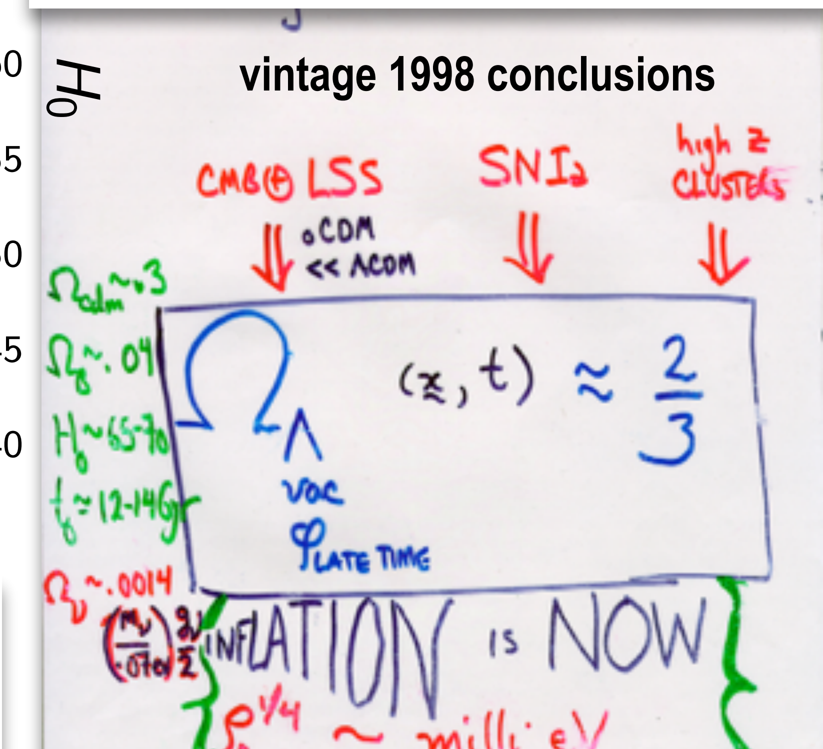
Planck1.3 cf. CMB+LSS

history of $\Omega_\Lambda = PE_{de}/E_{crit}$



BOOM 2000





B+Jaffe'96,'98

$\Omega_\Lambda \approx 2/3 \pm .07$ +LSS

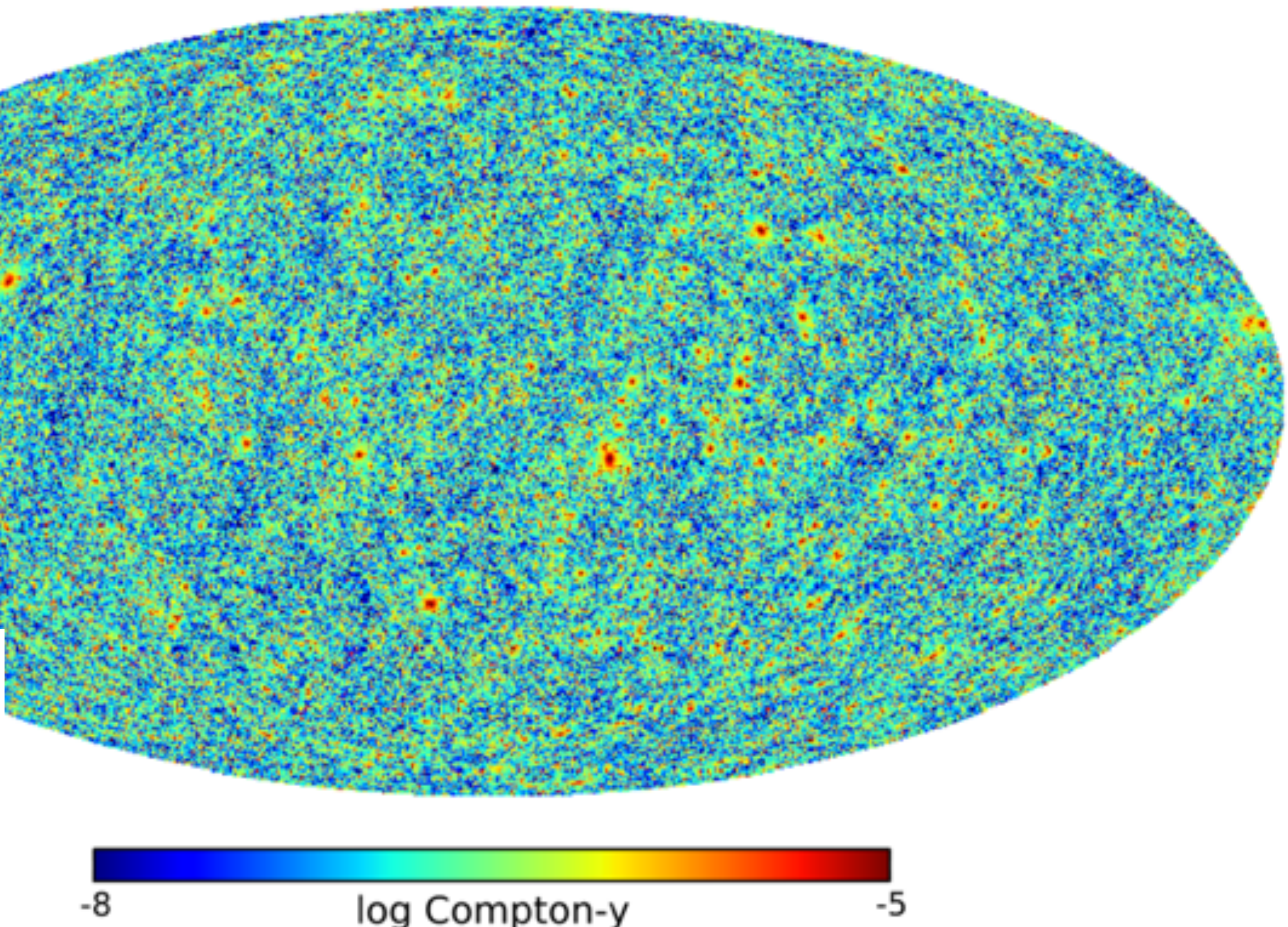
$n_s =$
$.98 \pm .07$
$.96 \pm .06$

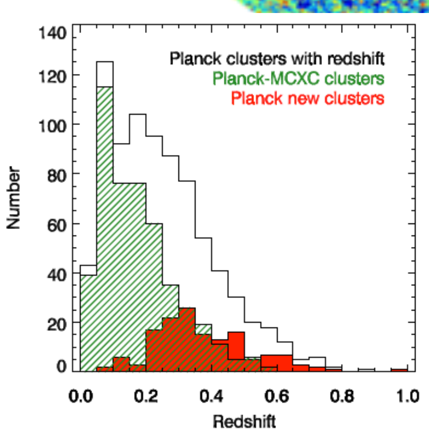
the **Cosmic Web of Clusters**, seen thru Compton cooling of high pressure electrons by the CMB

tSZ effect

Lightcone Simulation of 35000 Clusters > 2×10^{13} M_{sun} to z=0.5 in projected pressure

Alvarez, Bond, Hajian, Stein, Battaglia, Emberson,..2014





how to characterize map errors? by SIMs inhomogeneous, CIB contamination, ..

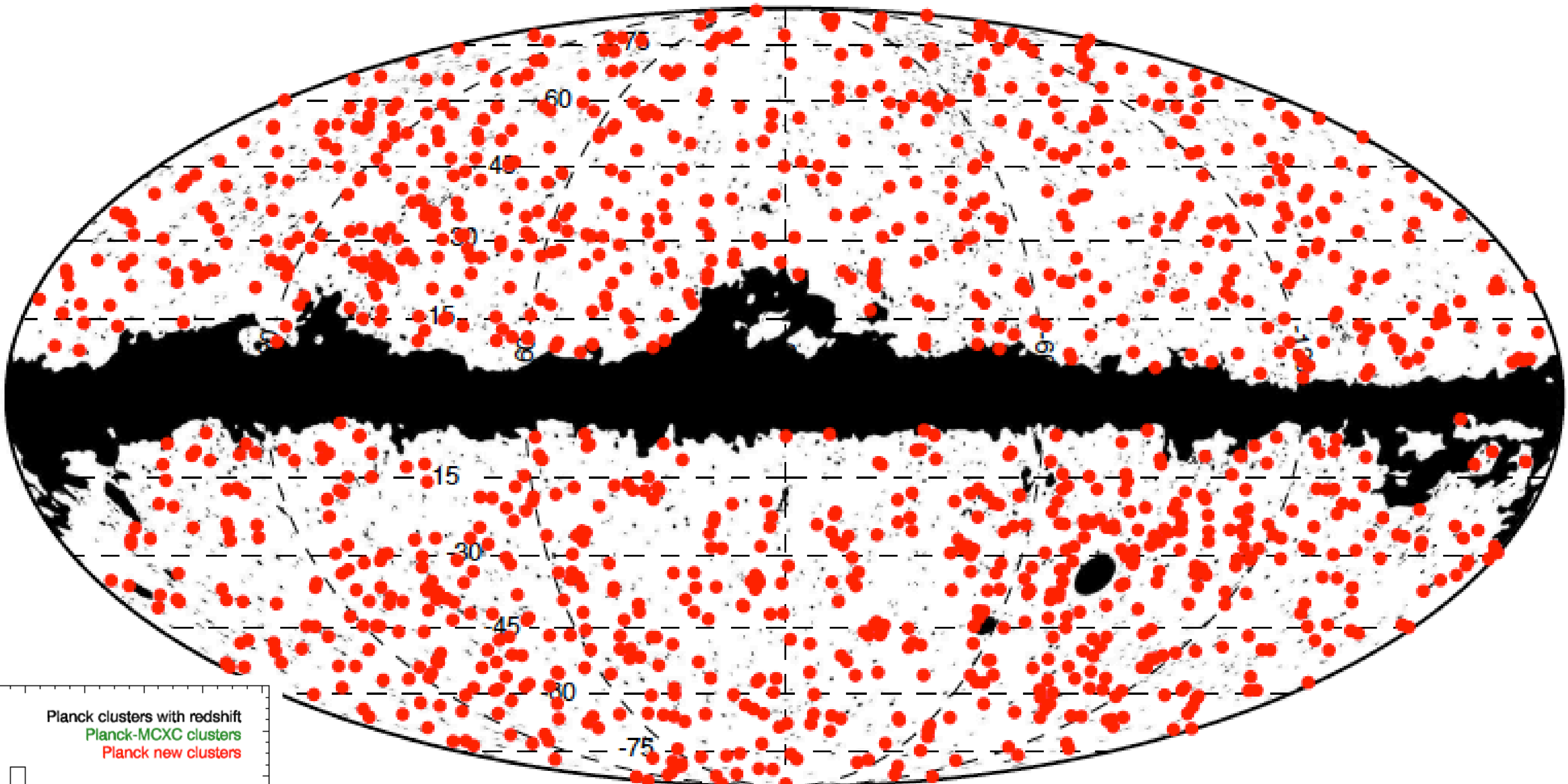
Compton cooling of high pressure / entropy electrons by the CMB

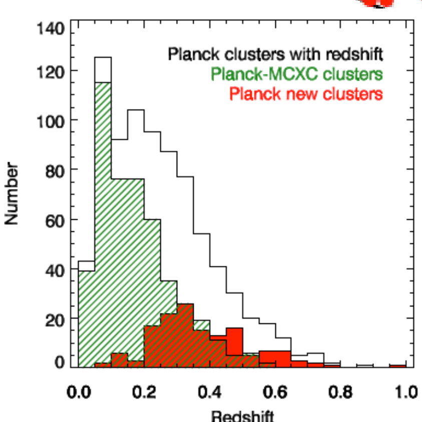
thermal SZ effect **Planck2013 1227 clusters, SPT 224 =>747cls, ACT 91 cls**

PSZ: 1227 clusters, 861 confirmed, 178 by Planck + 683 known, rest in class 1, 2, 3

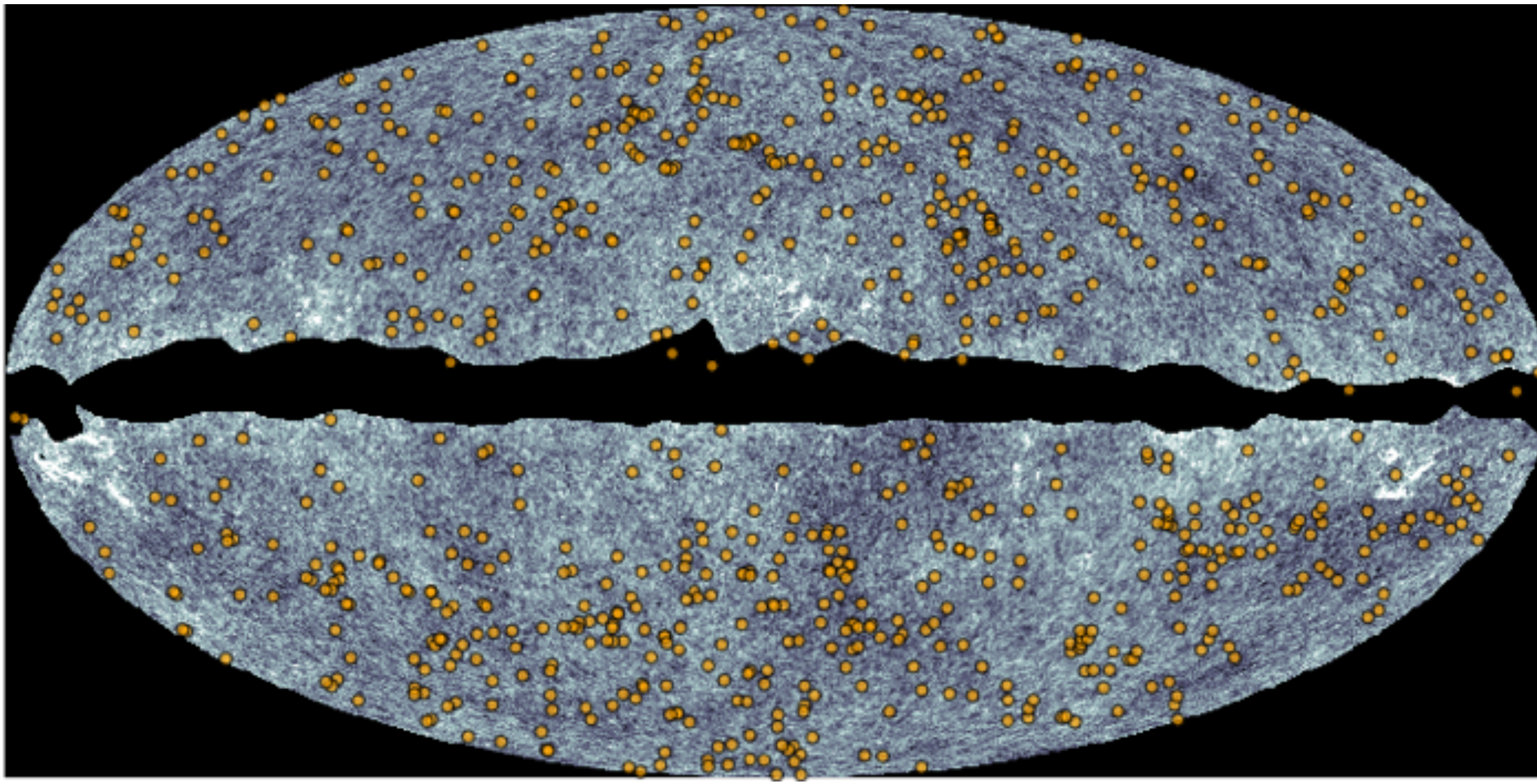
cf. X-ray sample from ROSAT+ All-sky distribution of MCXC clusters ~1600 *(Piffaretti et 10)*

REFLEX, BCS, SGP, NEP, MACS, CIZA, 400SD, 160SD, SHARC, WARPS, EMSS





Hajian, Battaglia, Spergel, Bond, Pfrommer, Sievers 2013 **Planck + WMAP9 x ROSAT (RBC subset of MXCC)**



CBI pol to Apr'05 @Chile **CBI2**

53+35 cls **(>=40)**

thermal SZ clusters

QUaD @SP

230 cls => 1227

Planck09.4

52+ bolometers
+ HEMTs @L2
9 frequencies

WMAP @L2 **to 2010**

2004 2006 2008 **LHC** 2011

Bpol @L2

224 (=> **747**)

2005 2007 2009

Acbar@SP
~1 blind

>96
OVRO /BIMA array
38 cls

SZA@Cal
3 cls (z>1), x?

AMIBA
6 cls

SPT
1000 bolos
@SPole

ACT **23+68~91 cls**
3000 bolos
3 freqs @Chile

AMI
7+1 cls >=50+25

APEX
~400 bolos@Chile
~25 cls

GBT Mustang
4 cls (~25 CLASH)

80s-**90s**
Ryle
OVRO

SCUBA2
12000 bolos
JCMT @Hawaii

SPTpol
ACTpol
ALMA
CCAT@Chile
LMT@Mexico

thermal SZ clusters

CBI pol to Apr'05 @Chile CBI2

53+35 cls (>=40)

QUaD @SP

230 cls => 1227

Planck09.4

Planck PSZ, cnts, ymap

861 confirmed, 178 by Planck + 683 known, most z<.4,

many ~ 10^{15} M_{sun} 0.<z<0.8

52+ bolometers
+ HEMTs @L2

9 frequencies

WMAP @L2 to 2010

Reichardt+12, Benson@ESLAB13
100 cl cosmology, 400 with S/N > 5
now, 747 summer 2013 2500 deg^2

Menanteau+12, Hasselfield+12
ACT Celestial Equator cls, 68 (49+19 in SDSS, half z>.5, 1 z~1.1 10^{15} M_{sun}
502 sq deg =>91 in 952 deg^2, 0.1<z<1.3

100% purity for S/N>5. 60% > 4.5
No significant evidence of SZ/BCG offset
M_{SZ}-N_{200} weak correlation, large scatter

2004 2006

2005 2007

224 (=> 747)

SPT
1000 bolos
@SPole

>96
OVRO
/BIMA
array

38 cls

Acbar@SP
~1 blind

SZA@Cal

3 cls (z>1), x?

AMIBA

6 cls

ACT

23+68~91 cls

3000 bolos
3 freqs @Chile

AMI

7+1 cls >=50+25

APEX
~400 bolos@Chile

~25 cls

SCUBA2
12000 bolos
JCMT @Hawaii

SPTpol
ACTpol

ALMA

CCAT@Chile

LMT@Mexico

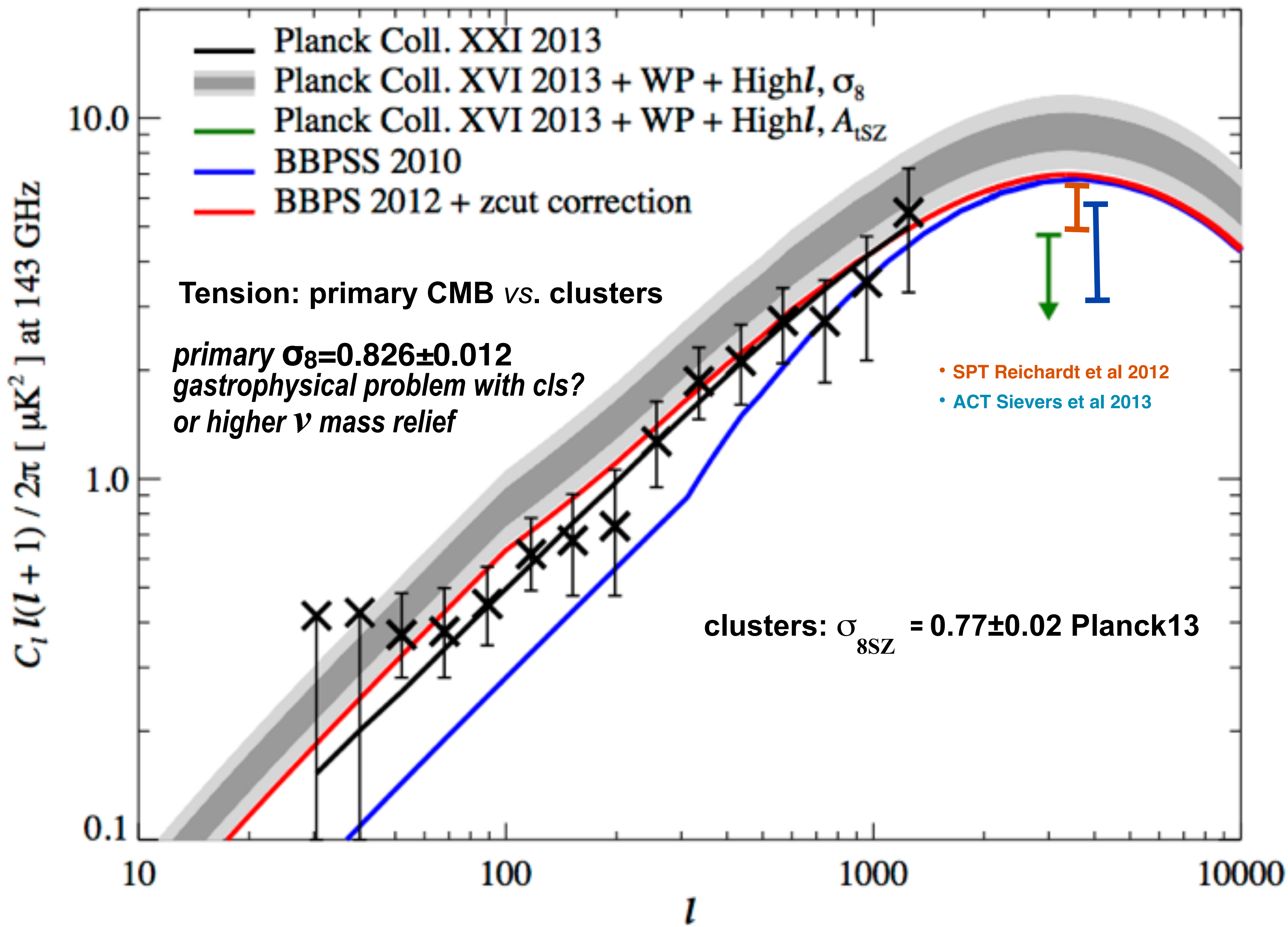
80s-90s
Ryle
OVRO

GBT Mustang

4 cls (~25 CLASH)

SZ power spectrum from ymaps

thermal SZ clusters



Burst of tSZ papers in 2013 Planck

Planck Intermediate Results. XIII. Constraints on peculiar velocities
Planck 2013 results. XXI. Cosmology with the all-sky Planck Compton parameter y-map
Planck 2013 results. XX. Cosmology from Sunyaev–Zeldovich cluster counts
Planck 2013 results. XXIX. Planck catalogue of Sunyaev–Zeldovich sources

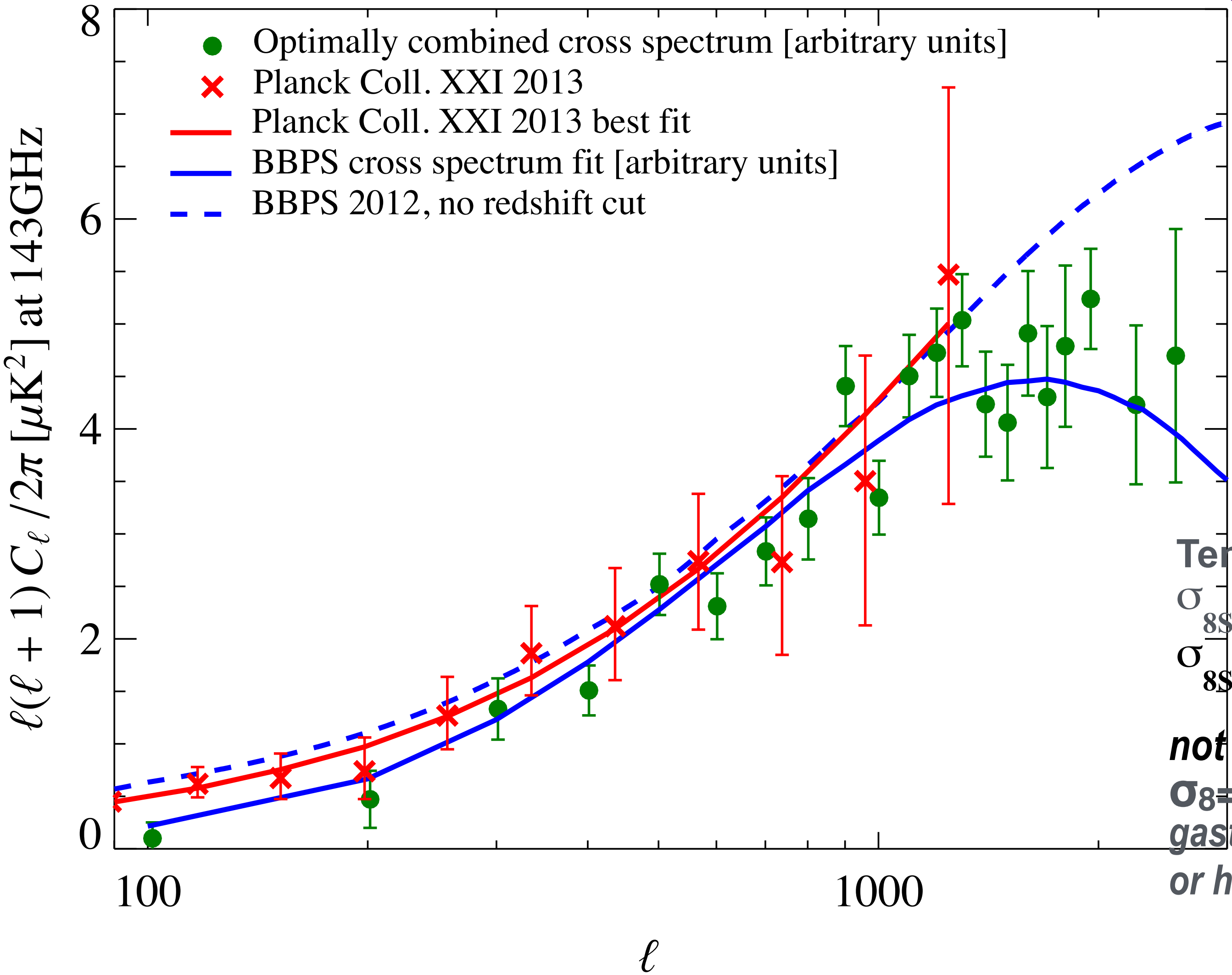
$\sim \sigma_{8SZ}^{7.4}\,\Omega_m^{1.9}$ **for L~ 1000**

$\sigma_{8SZ}\,(\Omega_m/0.30)^{0.26}$ **= 0.80 +- 0.02**

e.g., **= 0.796 +- 0.011** for "AGN feedback"

σ_{8SZ} **= 0.812 +- 0.010 cl+WMAP9**

= 0.812 +- 0.008 cl+Planck2013



Tension: primary *vs*. clusters

σ_{8SZ} **= 0.77±0.02 P13 cls**

σ_{8SZ} **= 0.812 ± 0.010 X-cl+WMAP9**

= 0.812 +- 0.008 X-cl+Planck2013

not as bad cf. primary

σ_8=0.826±0.012

gastrophysical problem with cls?

or higher ν mass relief

Hajian, Battaglia, Spergel, Bond, Pfrommer, Sievers 2013 **Planck + WMAP9 x ROSAT (RBC subset of MXCC)**

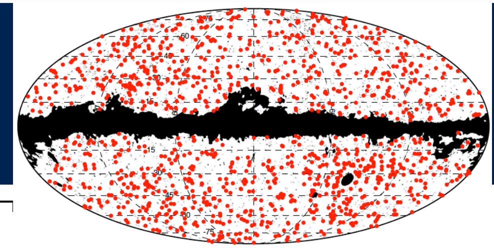
Compton cooling of high pressure / entropy electrons by the CMB

thermal SZ effect **Planck2013 1227 clusters, SPT 224 =>747cls, ACT 91 cls**

PSZ: 1227 clusters, 861 confirmed, 178 by Planck + 683 known, rest in class 1, 2, 3

cf. X-ray sample from ROSAT+ All-sky distribution of MCXC clusters ~1600 *(Piffaretti et 10)*

REFLEX, BCS, SGP, NEP, MACS, CIZA, 400SD, 160SD, SHARC, WARPS, EMSS



Tension: primary *vs.* clusters

σ_{8SZ} = 0.77±0.02 *(Ω_m=0.29±0.02)*

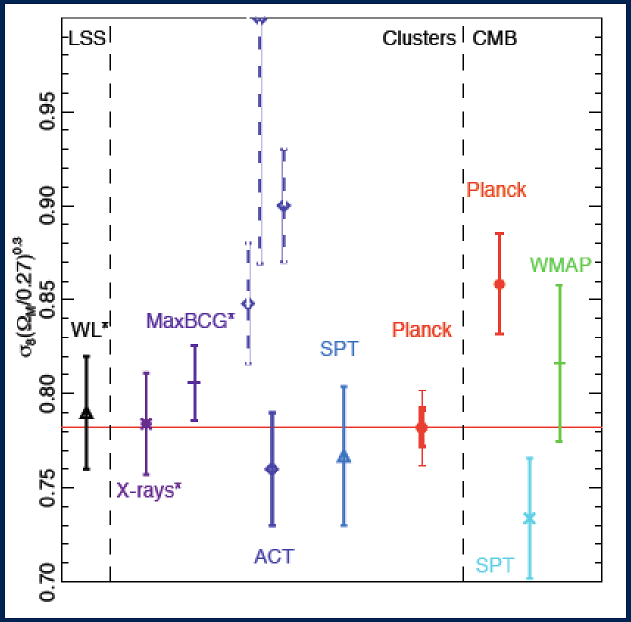
σ_{8SZ} = 0.812 +- 0.010 cl+WMAP9

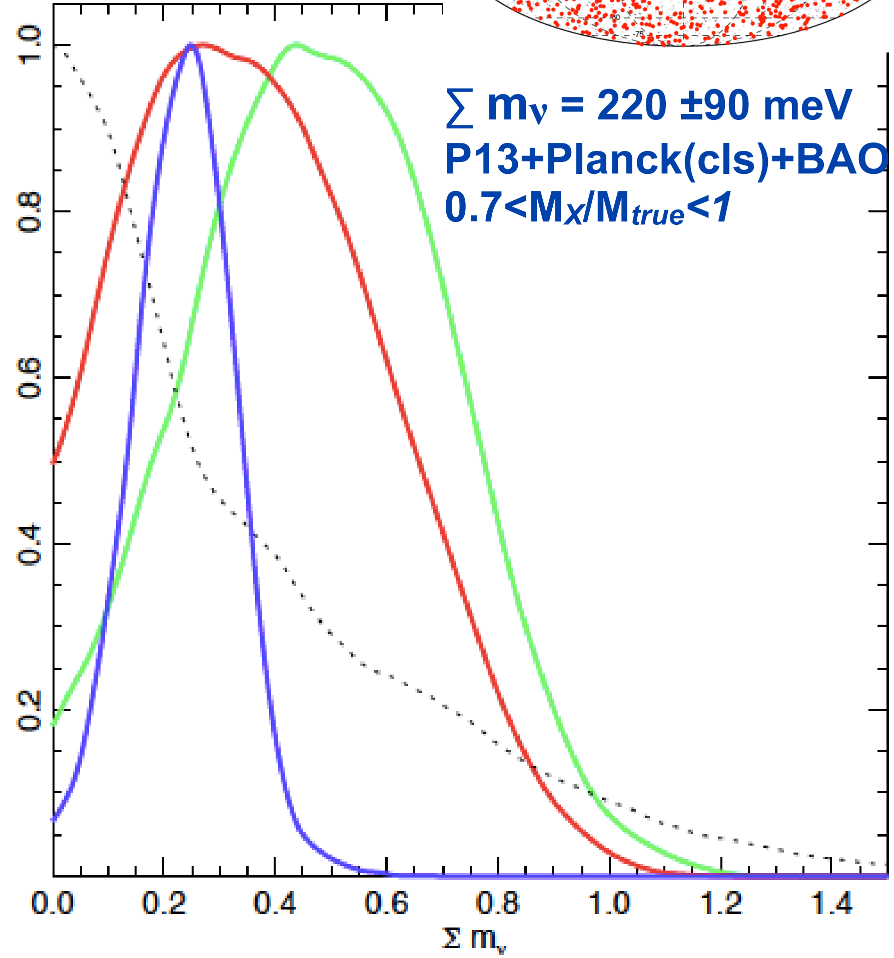
= 0.812 +- 0.008 cl+Planck2013 *cf.*

primary σ_8=0.826±0.012

gastrophysical problem with cls?

or higher ν mass relief of tension?



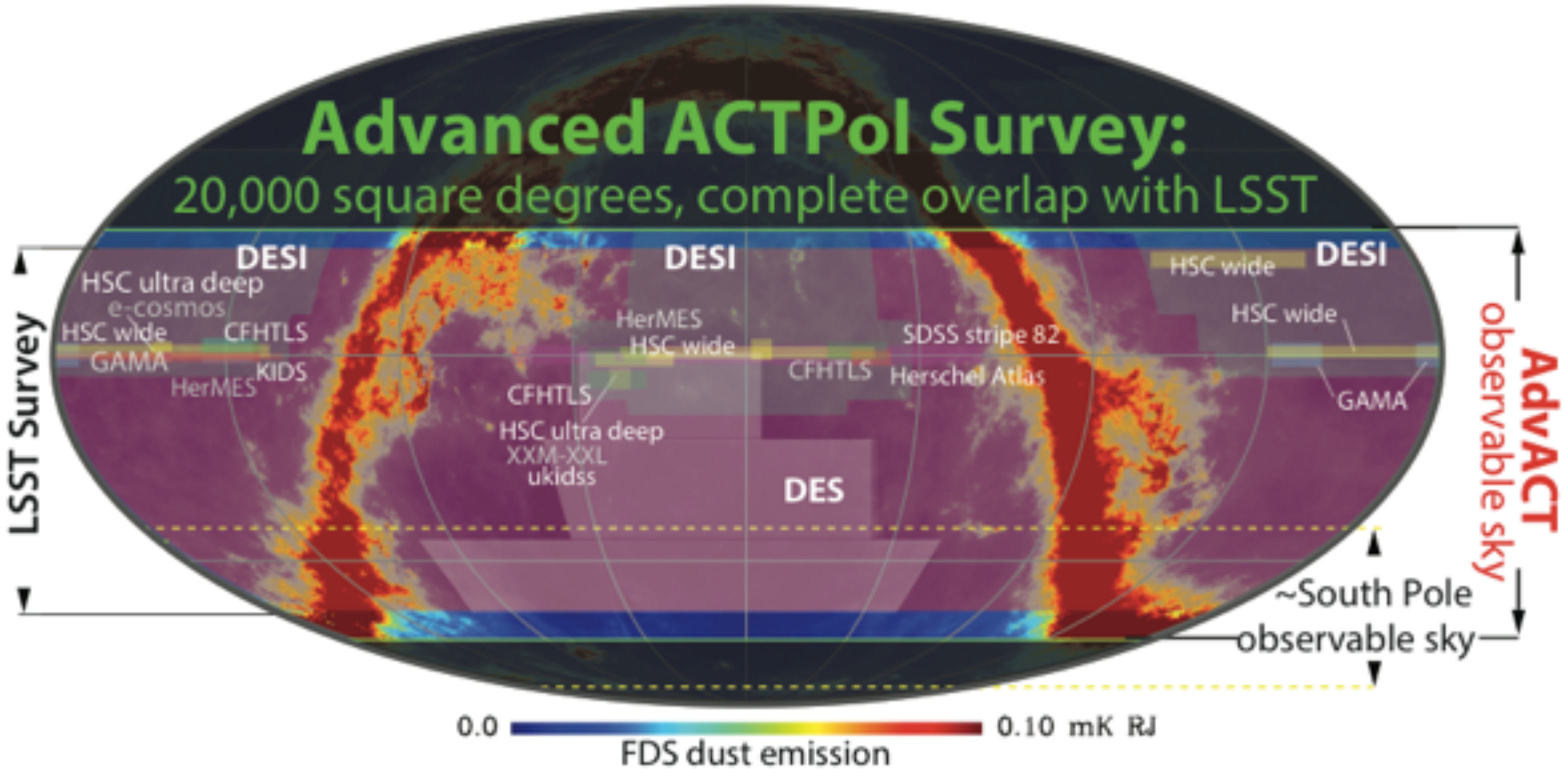


The ACT Collaboration

ACT, now ACTpol, => Advanced ACTpol

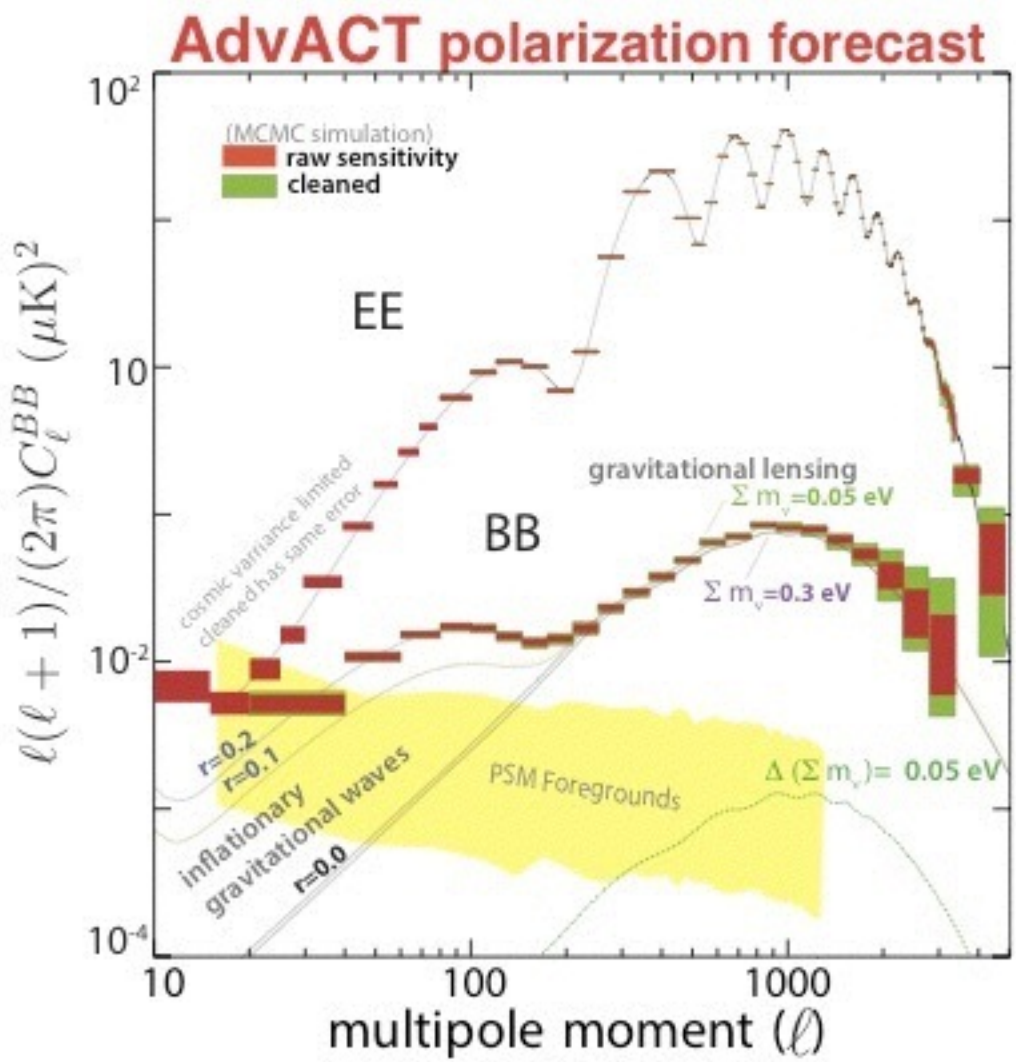
CITA ICAT · CARDIFF UNIVERSITY PRIFYSGOL CAERDYD · Carnegie Mellon University · HAVERFORD · IAS · INAOE · NASA · NIST · Stony Brook University · UBC · Berkeley · MIAMI · MICHIGAN · Penn

Advanced ACTPol (AdvACT) Observations



- ~20,000 deg^2 survey (f_{sky}~0.5) with complete LSST overlap as well as DES, ALMA, and other observatories located in Chile
- Substantial overlap with spectroscopic surveys (SDSS, PFS, DESI)

AdvACT: Power Spectra



S/N B-mode detections for r > 0.01 are measured in independent frequency bands (90 & 150 GHz) and on many patches across the sky => cross-checks

Error bars before and after foreground cleaning

Varying amplitudes of the gravitational lensing signal for different values of the sum of the neutrino masses

P13: r from TT < 0.12 *95% CL*

Error bars above shown for r = 0.2

BICEP2 => r=0.20 +.07-.05 - fgnds

Neutrino Physics from the Cosmic Microwave Background and Large Scale Structure

[astro-ph.CO] 20 Sep 2013

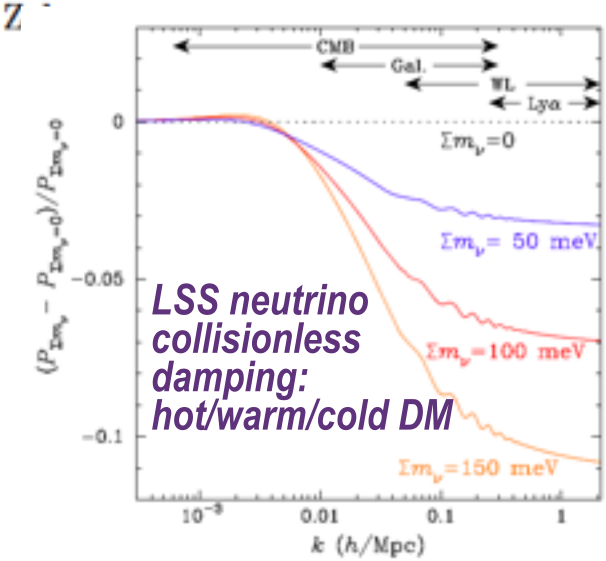
Topical Conveners: K.N. Abazajian, J.E. Carlstrom, A.T. Lee

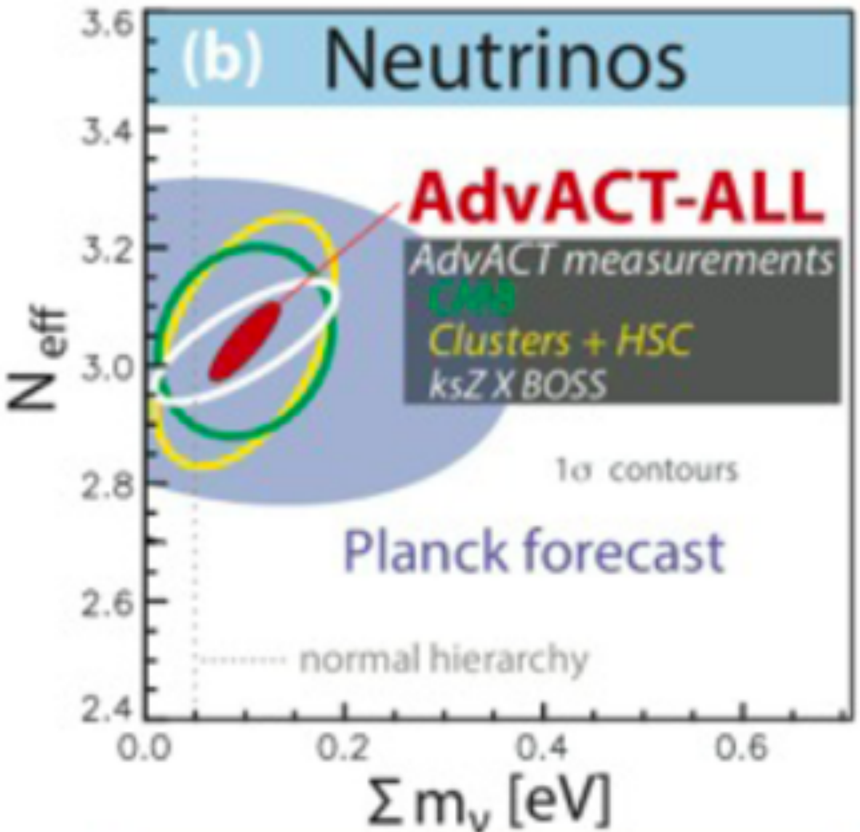
K.N. Abazajian, K. Arnold, J. Austermann, B.A. Benson, C. Bischoff, J. Bock, J.R. Bond, J. Borrill, E. Calabrese, J.E. Carlstrom, C.S. Carvalho, C.L. Chang, H.C. Chiang, S. Church, A. Cooray, T.M. Crawford, K.S. Dawson, S. Das, M.J. Devlin, M. Dobbs, S. Dodelson, O. Doré, J. Dunkley, J. Errard, A. Fraisse, J. Gallicchio, N.W. Halverson, S. Hanany, S.R. Hildebrandt, A. Hincks, R. Hlozek, G. Holder, W.L. Holzapfel, K. Honscheid, W. Hu, J. Hubmayr, K. Irwin, W.C. Jones, M. Kamionkowski, B. Keating, R. Keisler, L. Knox, E. Komatsu, J. Kovac, C.-L. Kuo, C. Lawrence, A.T. Lee, E. Leitch, E. Linder, P. Lubin, J. McMahon, A. Miller, L. Newburgh, M.D. Niemack, H. Nguyen, H.T. Nguyen, L. Page, C. Pryke, C.L. Reichardt, J.E. Ruhl, N. Sehgal, U. Seljak, J. Sievers, E. Silverstein, A. Slosar, K.M. Smith, D. Spergel, S.T. Staggs, A. Stark, R. Stompor, A.G. Vieregg, G. Wang, S. Watson, E.J. Wollack, W.L.K. Wu, K.W. Yoon, and O. Z

Snowmass2013: ν, inflation, dark energy, ..

cosmology experiments are fundamental to fundamental physics;
=> US P5 recommendation DOE labs support CMB experiments

"Provide increased particle physics funding of CMB research and projects, as part of the core particle physics program, in the context of continued multiagency Partnerships."





$\sum m_\nu$ > 60 meV oscillations

P13+WP+ACT/SPT+BAO

$\sum m_\nu$ < 230 meV 95% CL

=220 ±90 meV + Planck(cls)

$N_{\nu eff}$ =3.086 theory if 3 flavours

P13+WP+ACT/SPT+BAO

$N_{\nu eff}$ =3.22 ±0.27

Probes of the Damping Tail

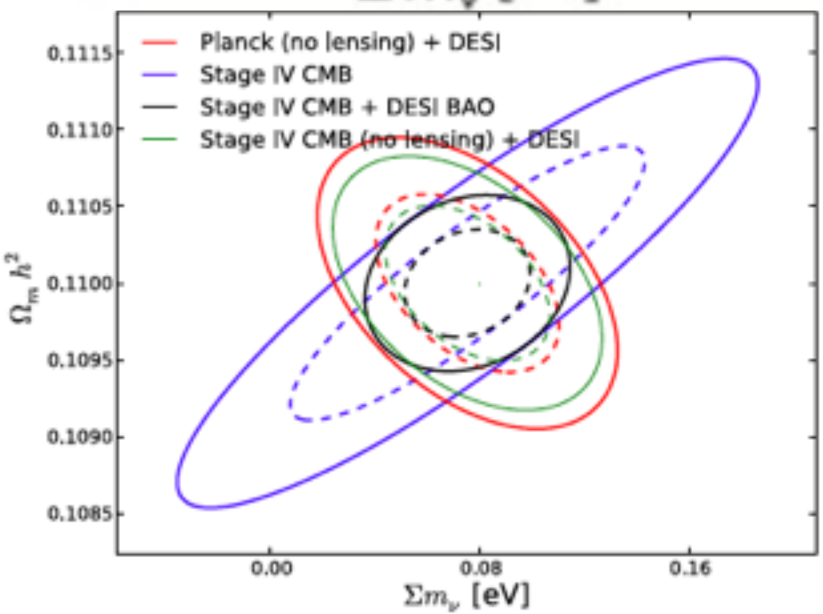
SPT11+WMAP7:

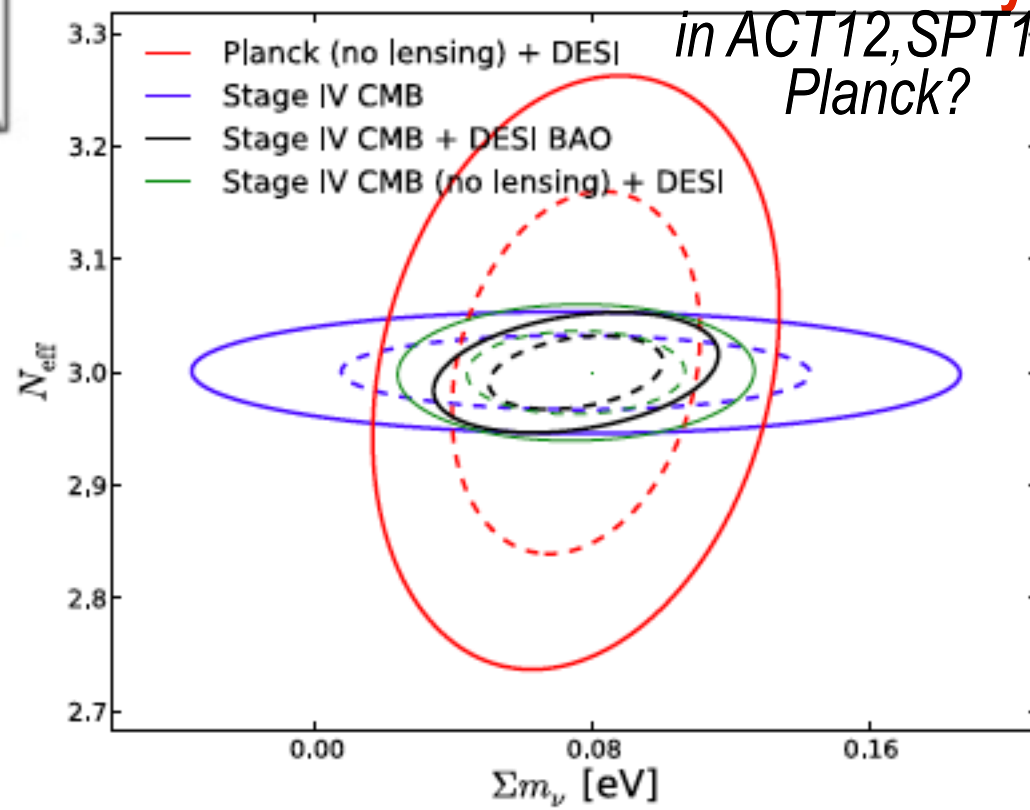
Y_P=.30 *cf.* .25

N_{eff}=4 *cf.* 3.06

1st XeM also shows the damping tail anomaly

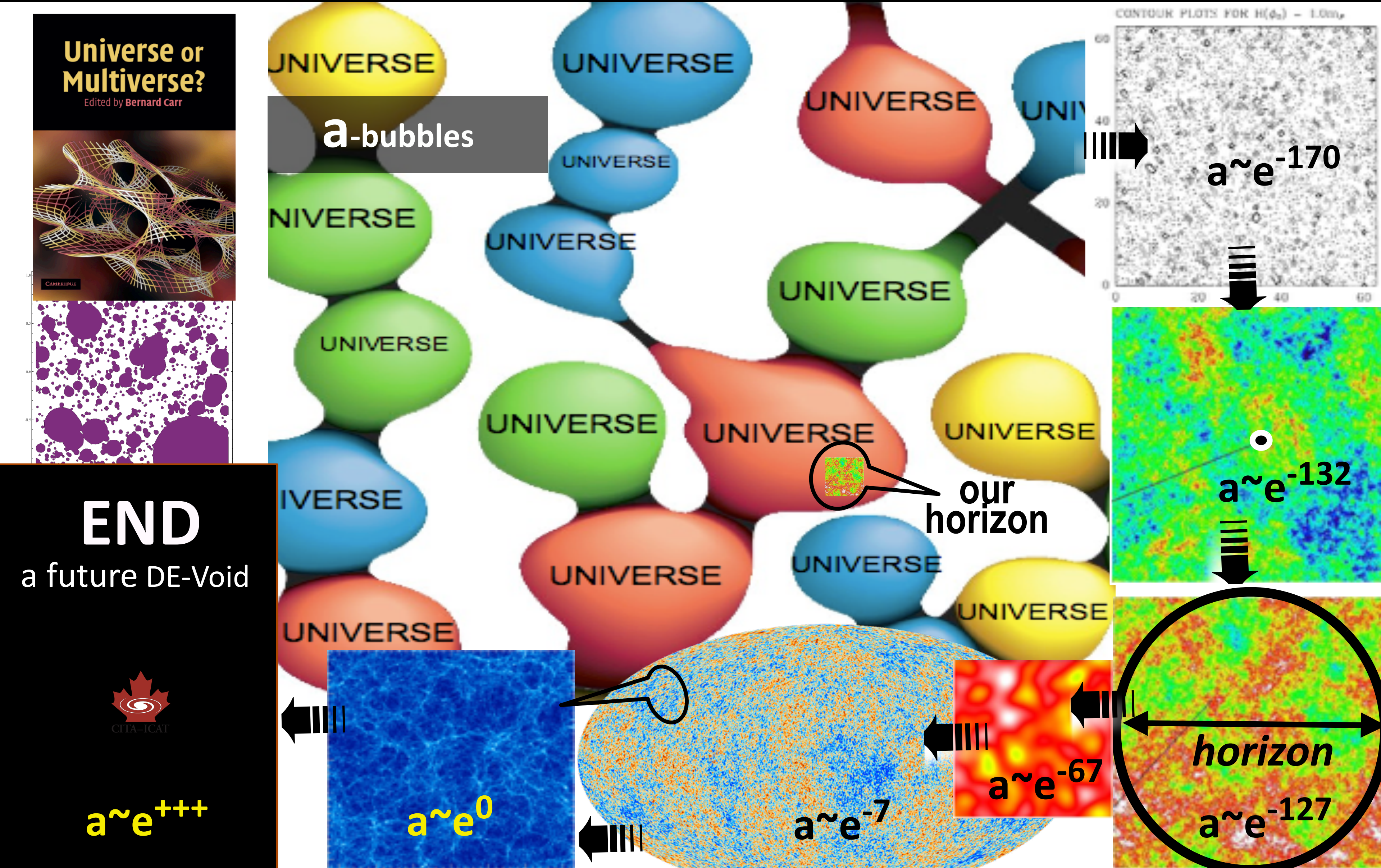
in ACT12, SPT12, Planck?





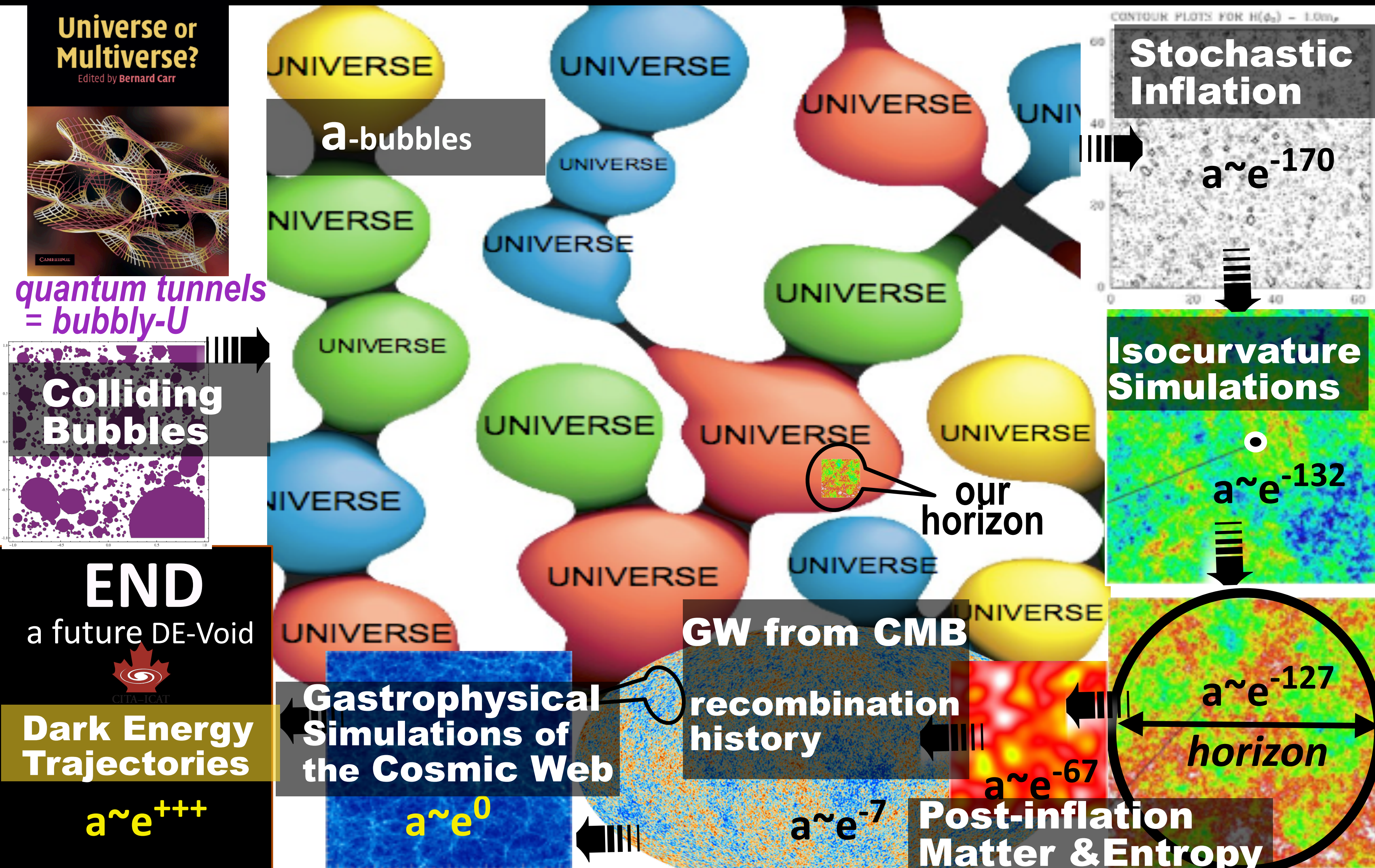
ultra-Ultra Large Scale Structure of the Universe

Horizons: the ultimate-speed constraint on light & information



ultra-Ultra Large Scale Structure of the Universe

Horizons: the ultimate-speed constraint on light & information



Art is forever young

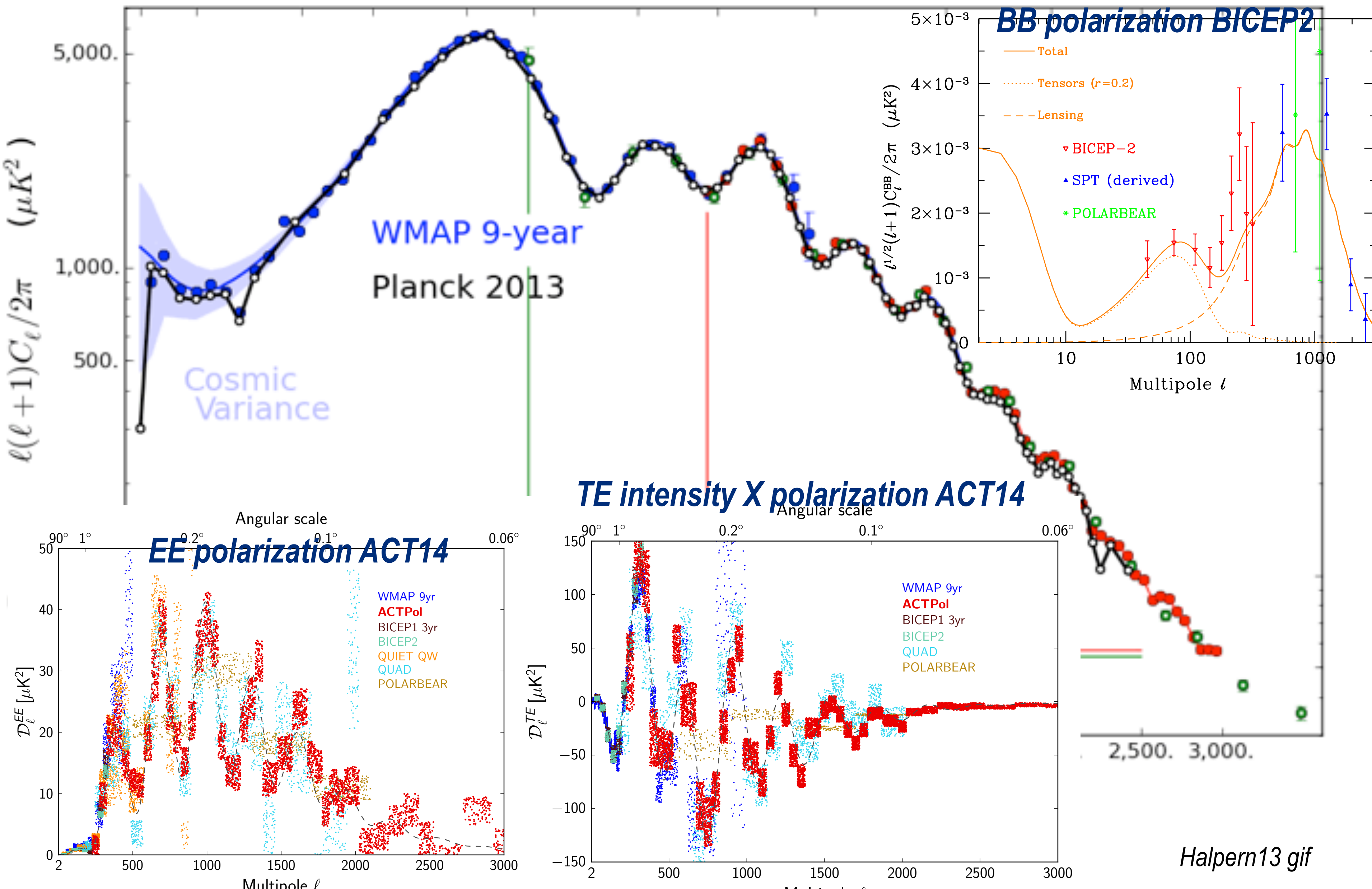
So… *aloha* &

Party-on Art!

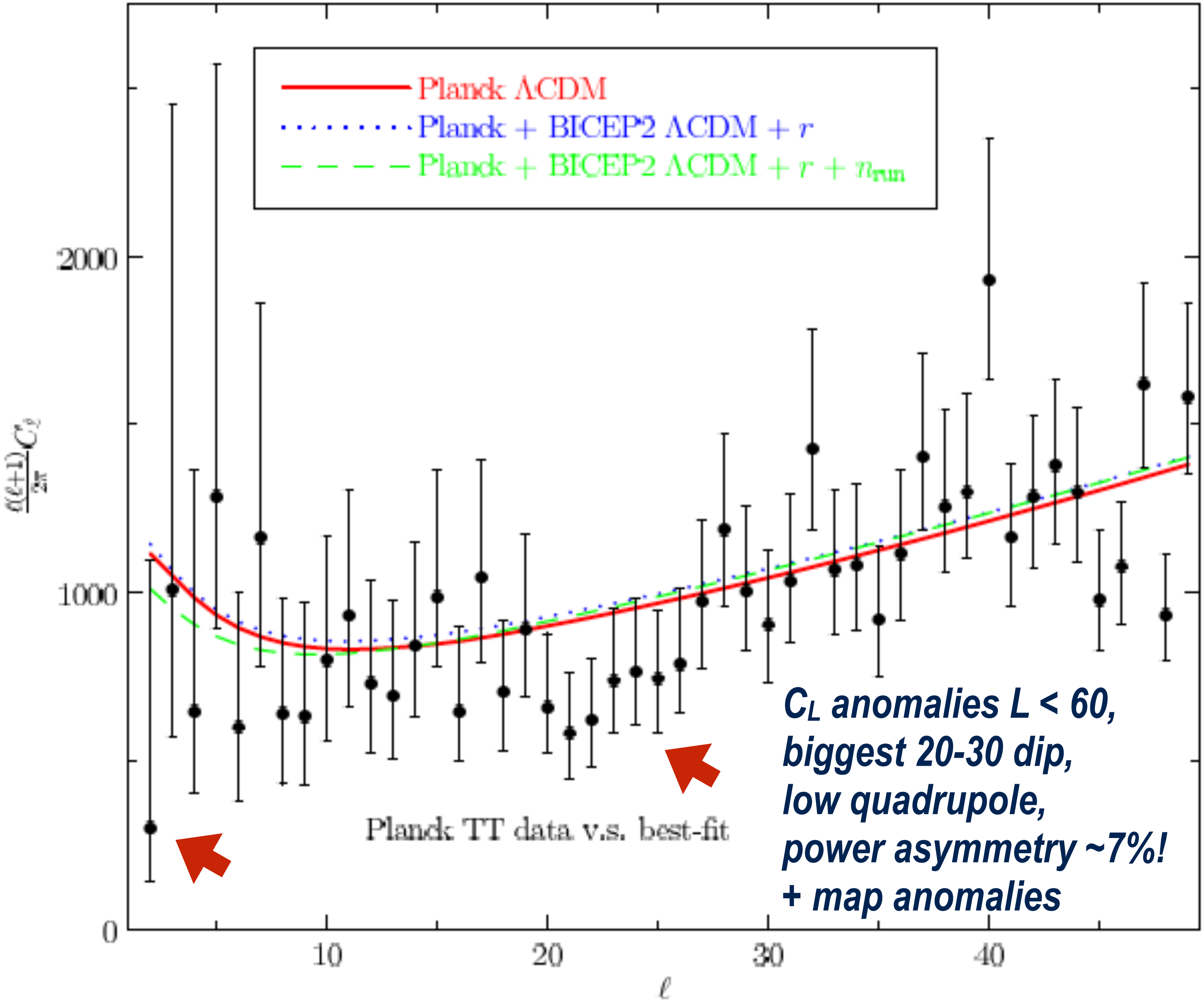
END

bicep2
GW xtra

harmonic analysis of the *'music of the spheres'*
=> inharmonious, coloured noise in the CMB

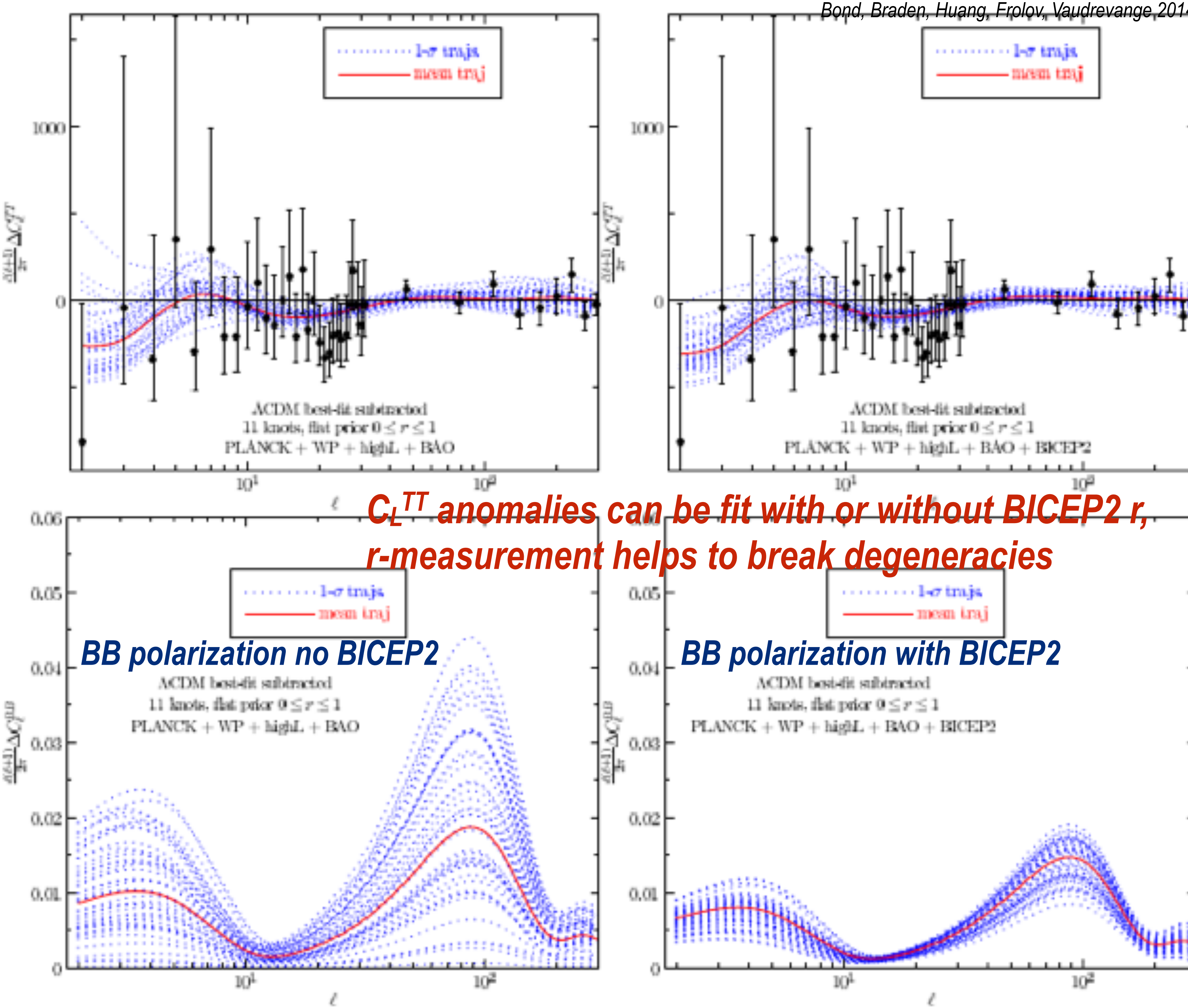


Bond, Braden, Huang, Frolov, Vaudrevange 2014



C_L anomalies L < 60,
biggest 20-30 dip,
low quadrupole,
power asymmetry ~7%!
+ map anomalies

Bond, Braden, Huang, Frolov, Vaudrevange 2014



C_L^{TT} anomalies can be fit with or without BICEP2 r, r-measurement helps to break degeneracies

BB polarization no BICEP2

BB polarization with BICEP2

Power Deviation from fiducial $<\zeta|T><\zeta|T>+<\delta\zeta\delta\zeta|T>-<\zeta\zeta|free>$

byproduct, cf. quadratic $P_{\zeta\zeta}$ reconstruction, extra C_s/C_{tot} & regularizer $P^{(i)}_{\zeta\zeta}$

Quadratic expansions in mode functions: which function to expand (ln $P_{\zeta\zeta}$),

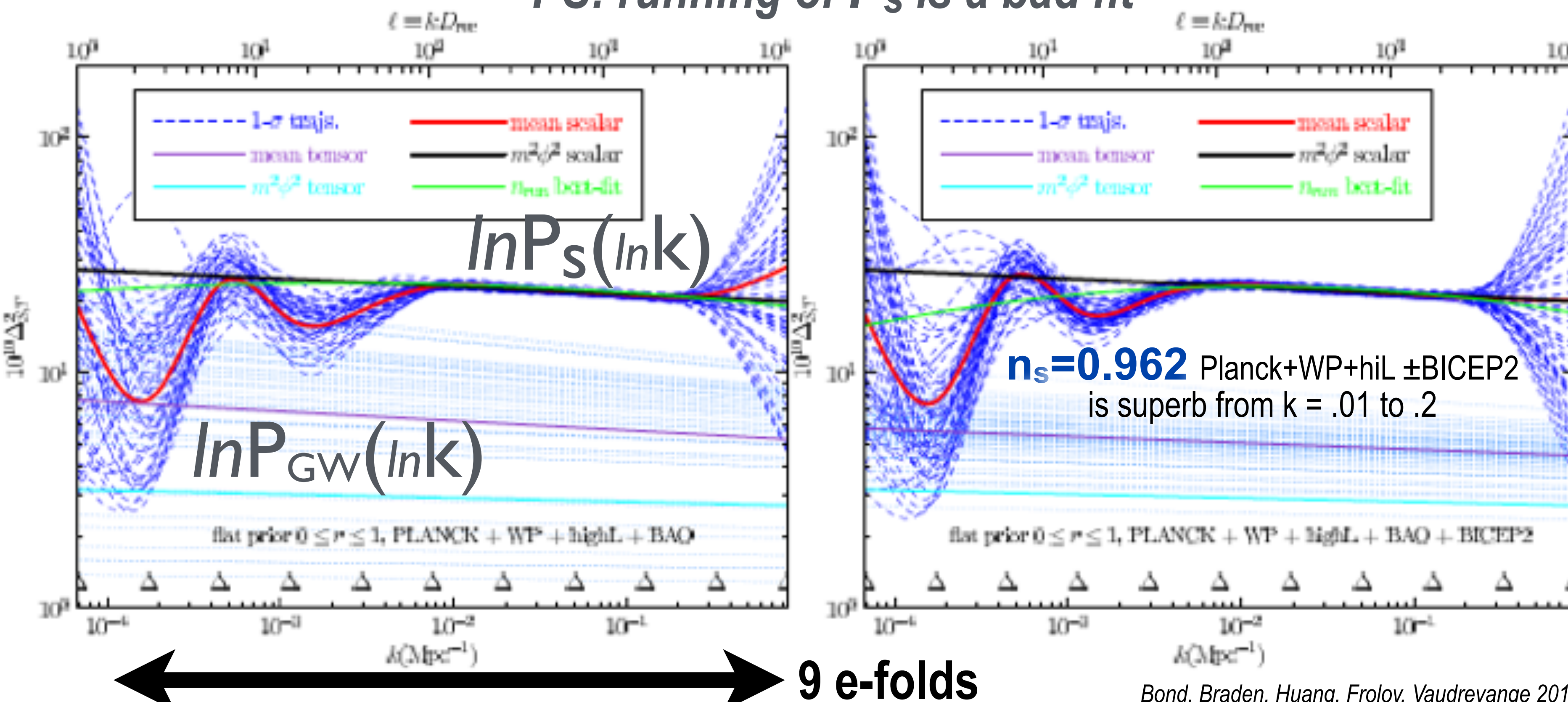
which modes (cubic B-spline), number?, priors on amplitudes, etc.

maxL solutions with Fisher/Hessian errors are Wiener-filtered maps!

here MCMC <power> trajectory, 1 sigma mean+fluctuation trajectories

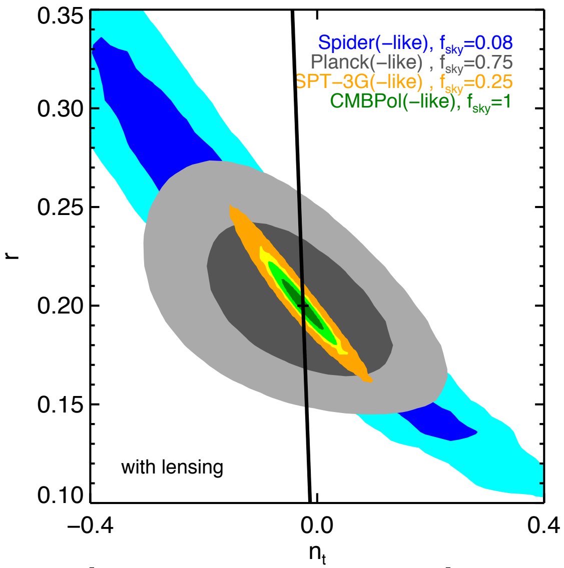
no strong evidence for oscillation patterns, cutoffs, local features; a change on large L<100 scales

PS: running of P_s is a bad fit



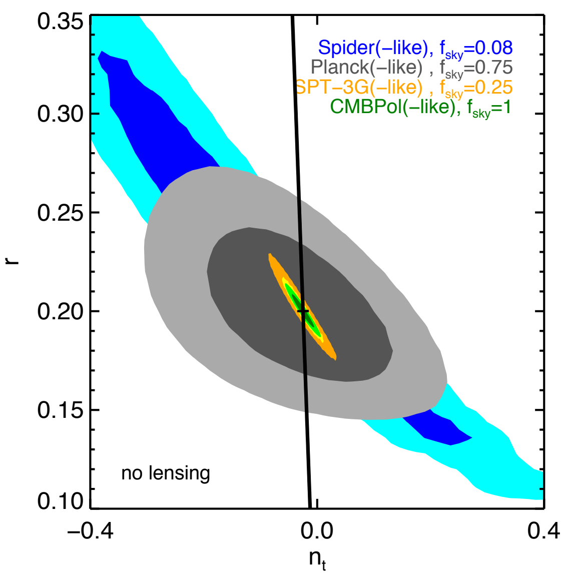
Bond, Braden, Huang, Frolov, Vaudrevange 2014

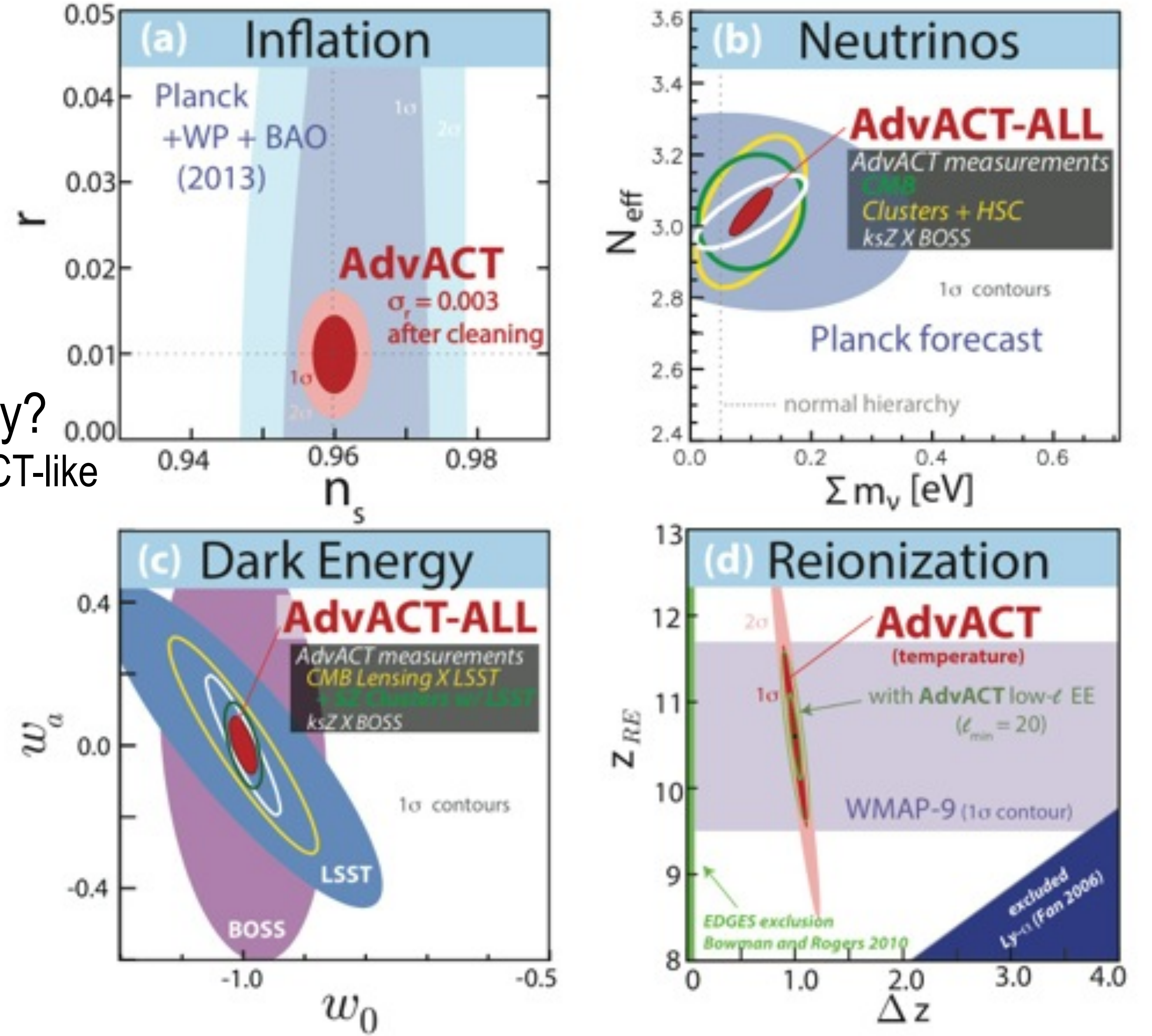
AdvACT: Cosmological Forecasts & Planck2.5, Spider, future SPT3g, CMBpol



testing tensor consistency?

better f_{sky}=25% for spt3g/AdvACT-like than current 6% goal for spt3g

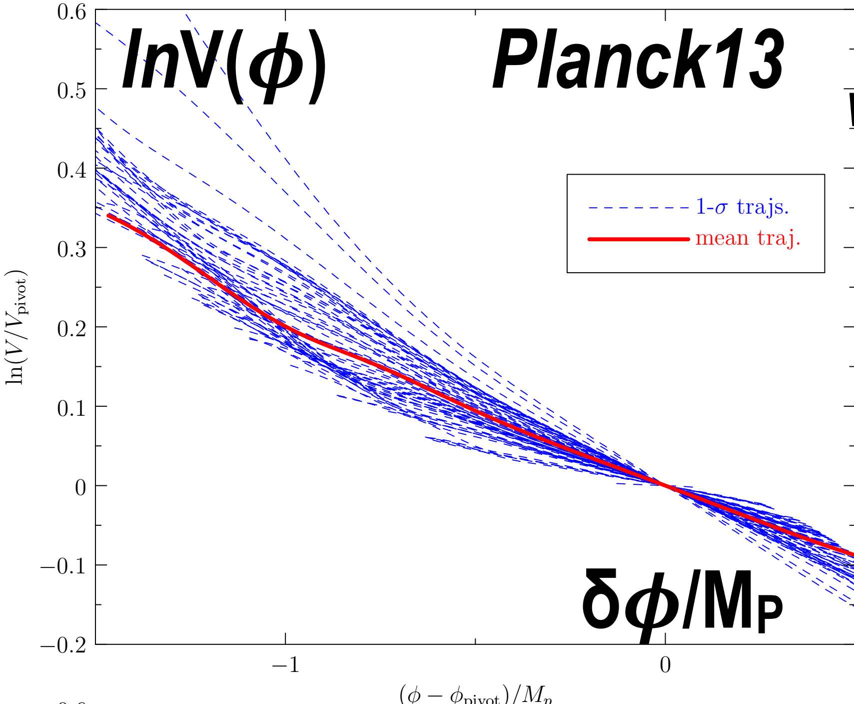


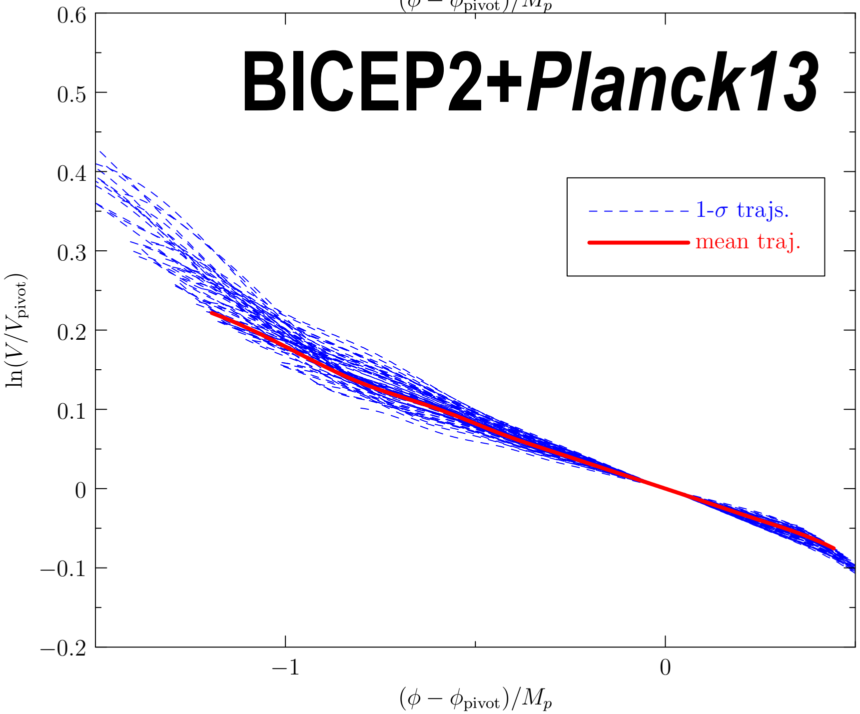


what is the **inflaton's V(ϕ)**?

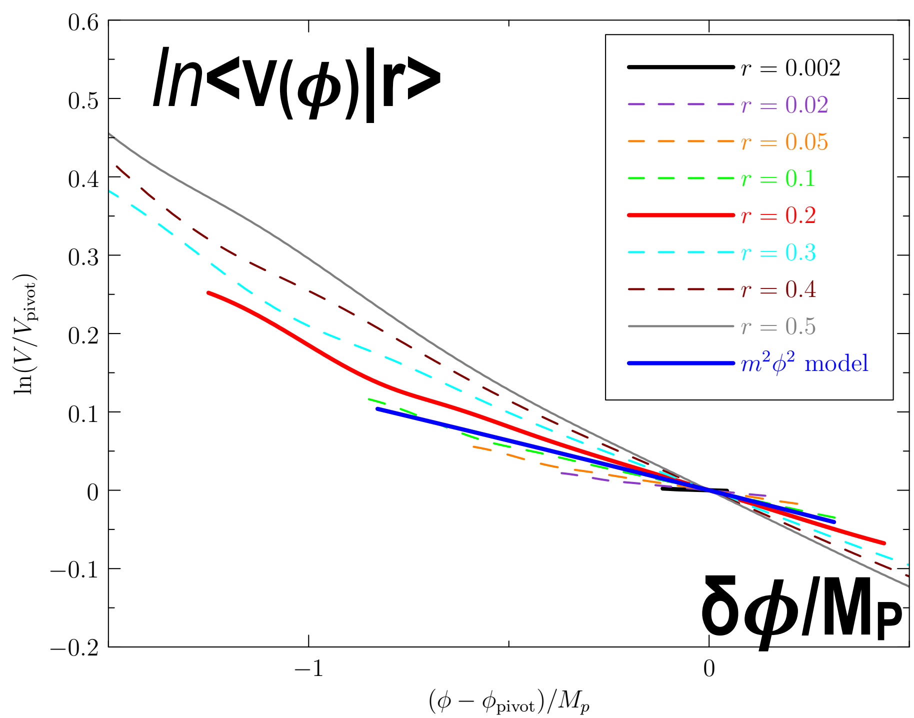
we **reconstruct** *the* ***scalar curvature powe*** *(isotropic strain) & the early universe* ***acceleration histories*** *as well*

detecting r ~ 0.2 =>
V(ϕ) shape cannot be too flat over the observable range





Reconstructed mean potential (without BICEP constraint)



simplest is V(ϕ) ~ $m^2\phi^2$