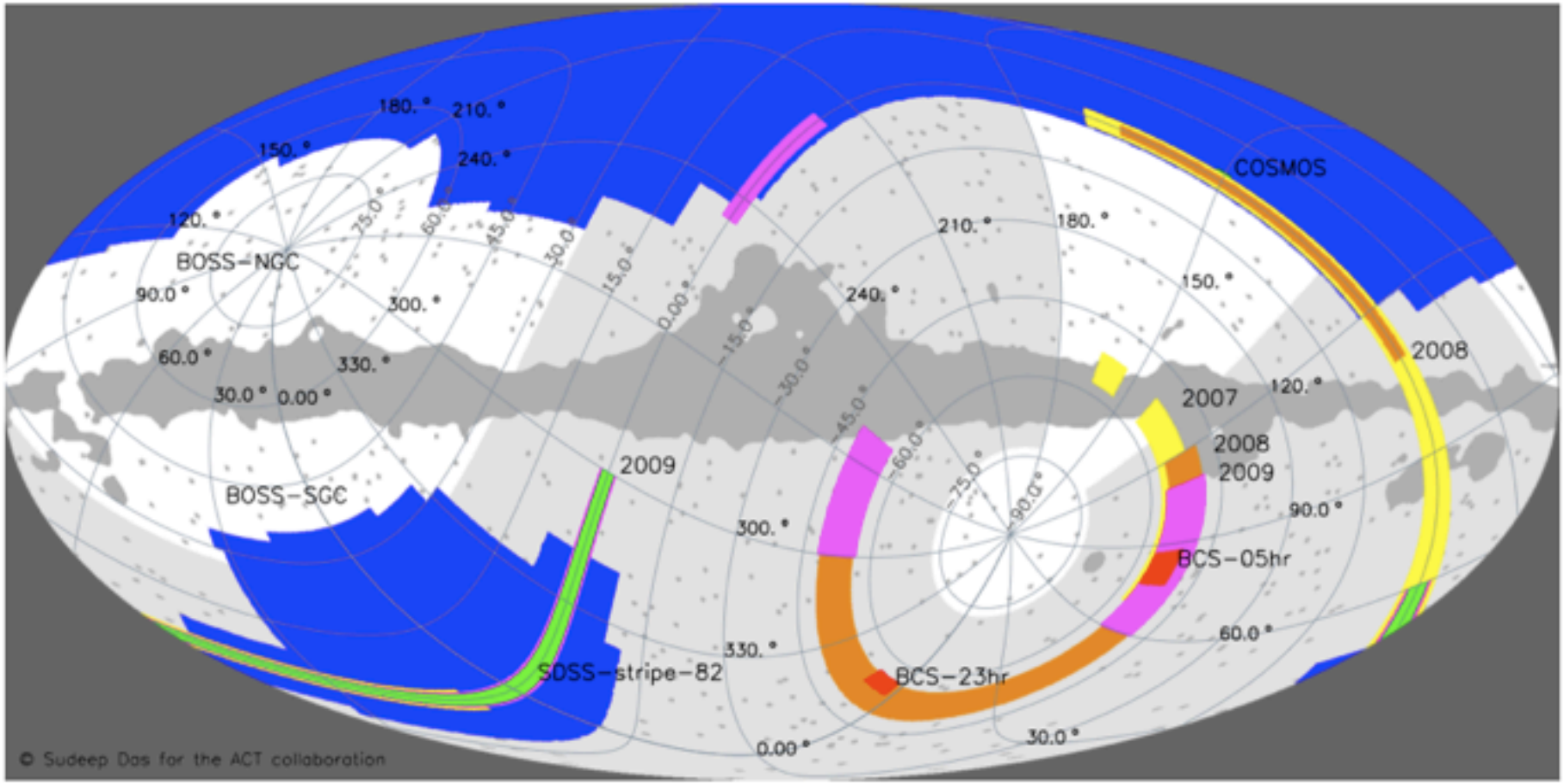
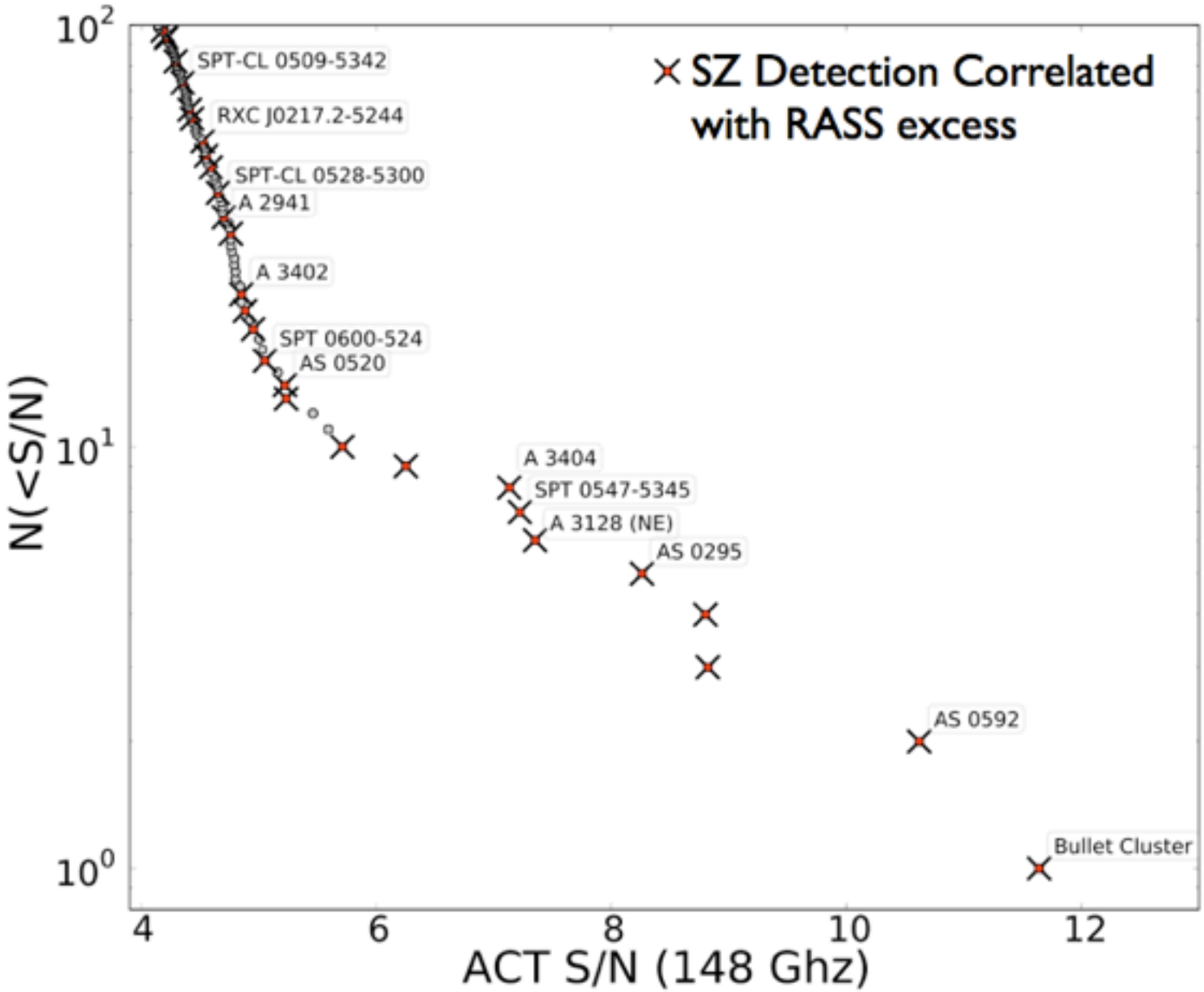
ACT Survey Coverage



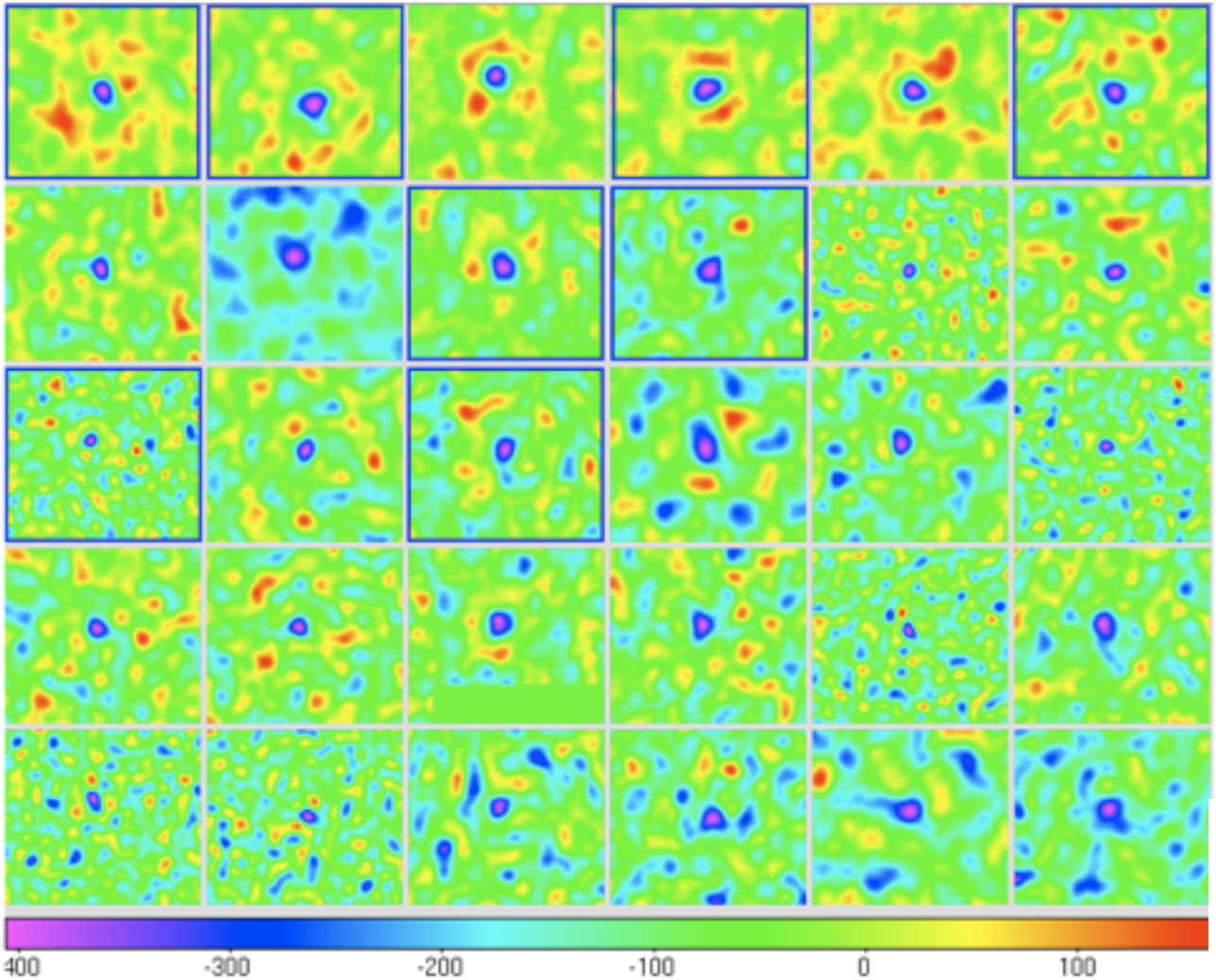
2007	2009	Stripe 82	BCS
2008	ACT Range	BOSS	Masked

Tobias A. Marriage etal ACTers

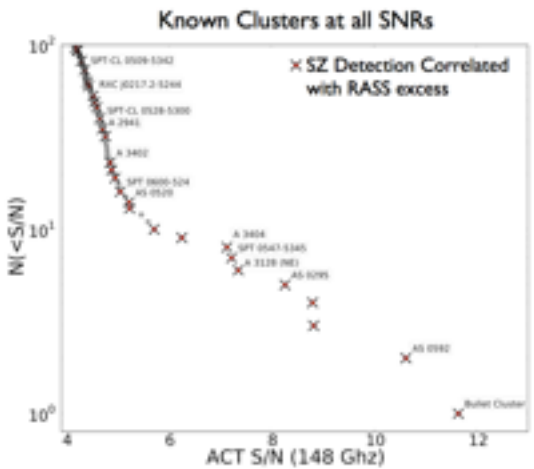
Fall 2009


Known Clusters at all SNRs
SZ Detection Correlated with RASS excess
SPT-CL 0509-5342
RXC J0217.2-5244
SPT-CL 0528-5300
A 2941
A 3402
SPT 0600-524
AS 0520
A 3404
SPT 0547-5345
A 3128 (NE)
AS 0295
AS 0592
Bullet Cluster
N(<S/N)
10^2
10^1
10^0
4
6
8
10
12
ACT S/N (148 Ghz)

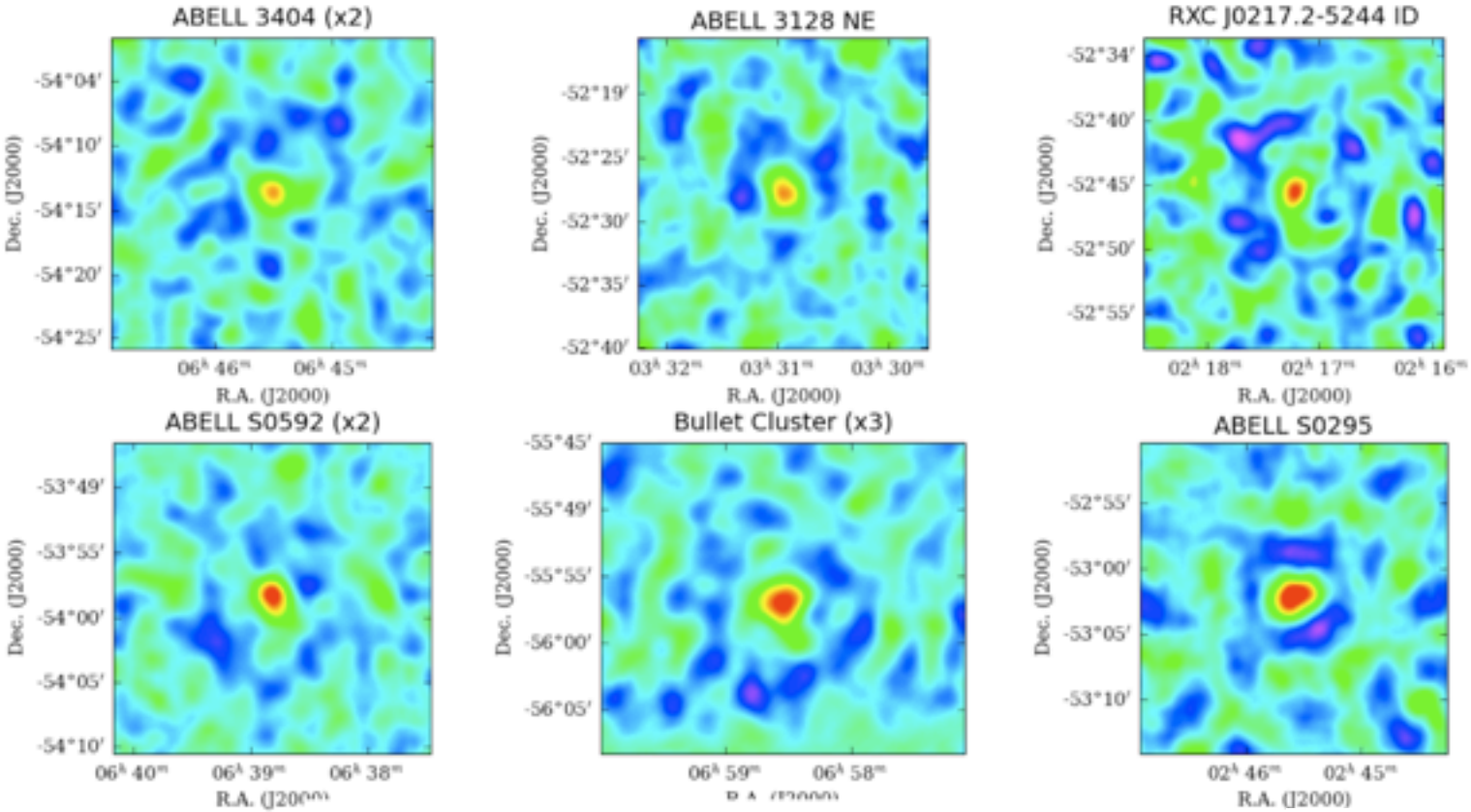
148 GHz SZ Decrements : Previously Known

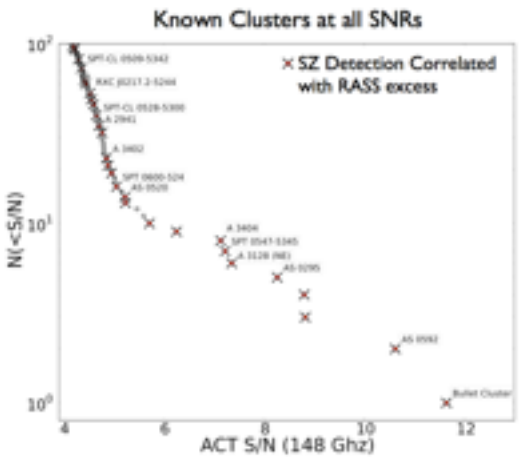


δT_{CMB} [μK] (Only for top left candidate)



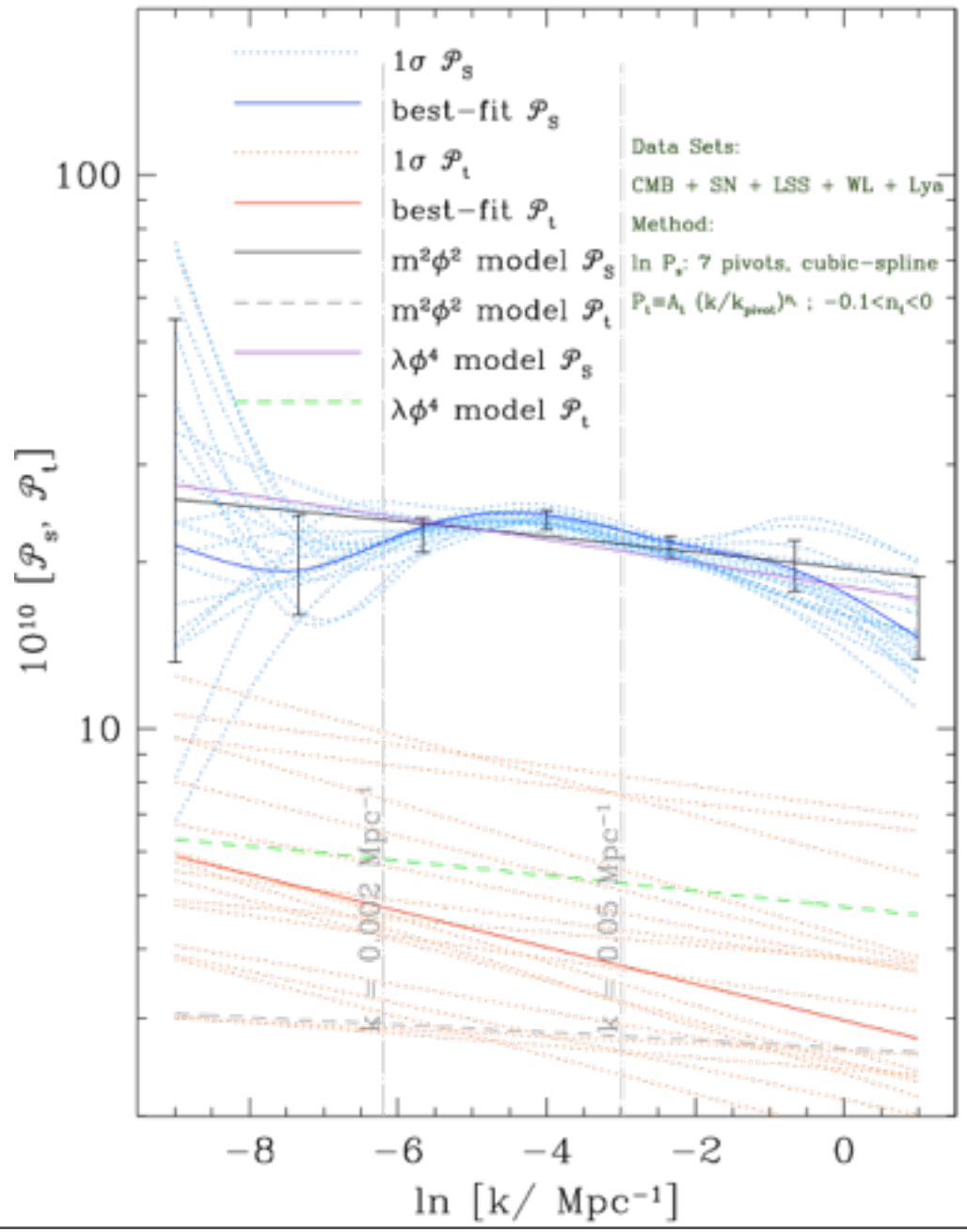
Some Known Clusters

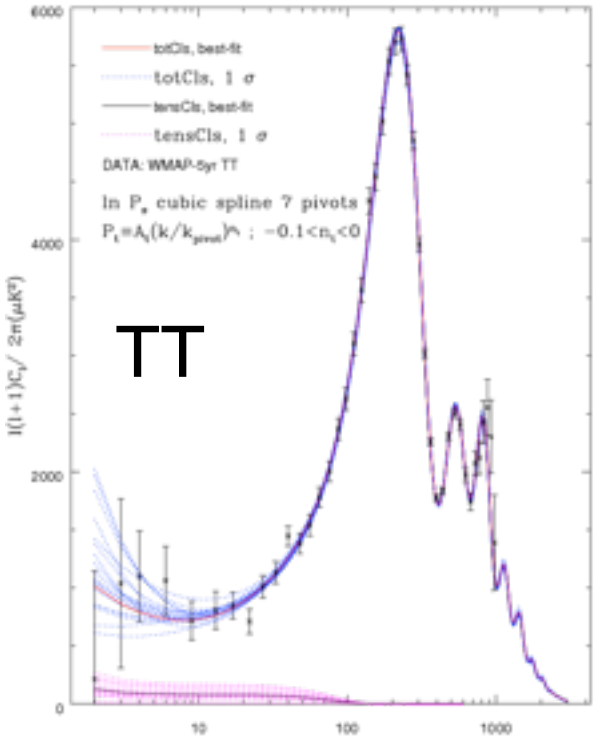


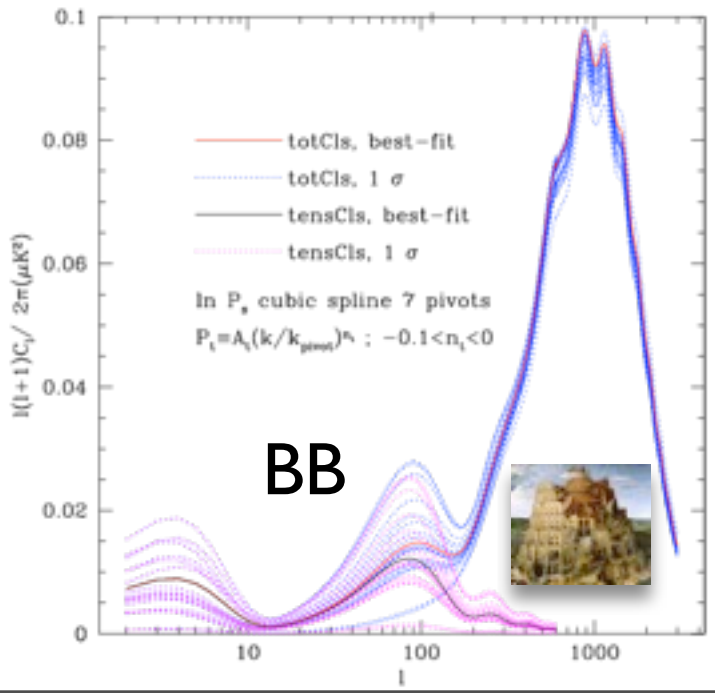


end

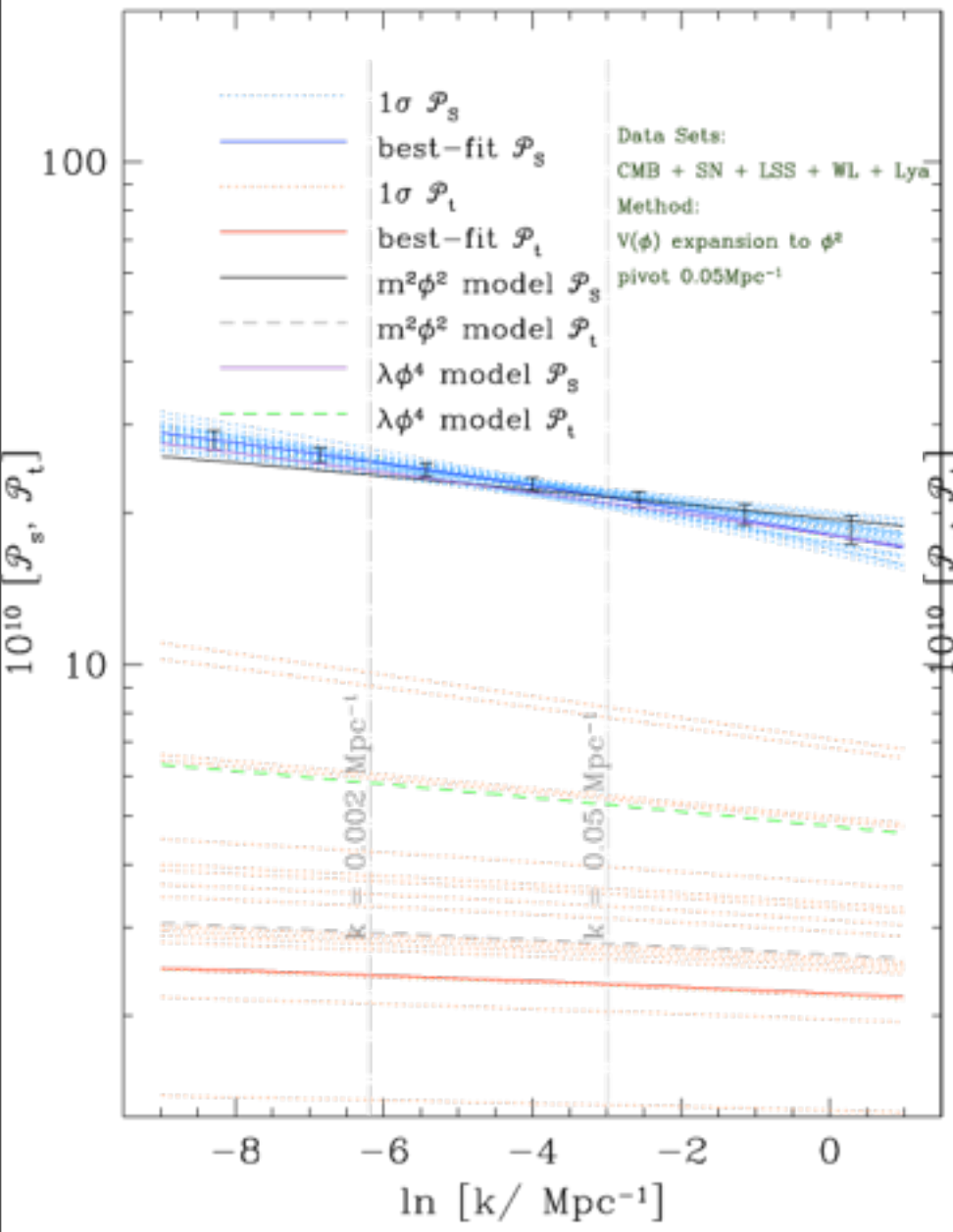
partially-blind scalar power trajecteries & usual r-n_t tensor - no consistency relation. Nov09 data



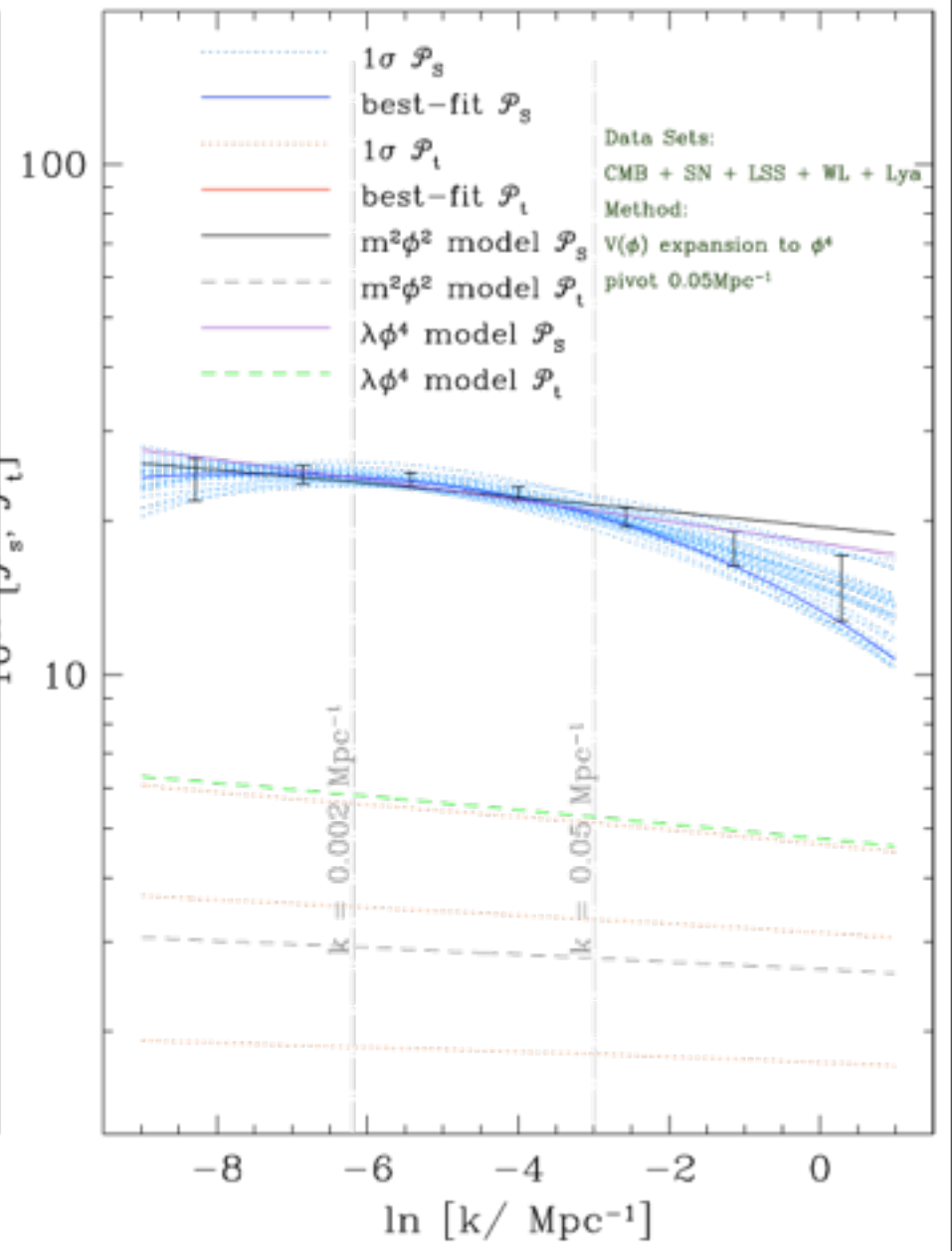




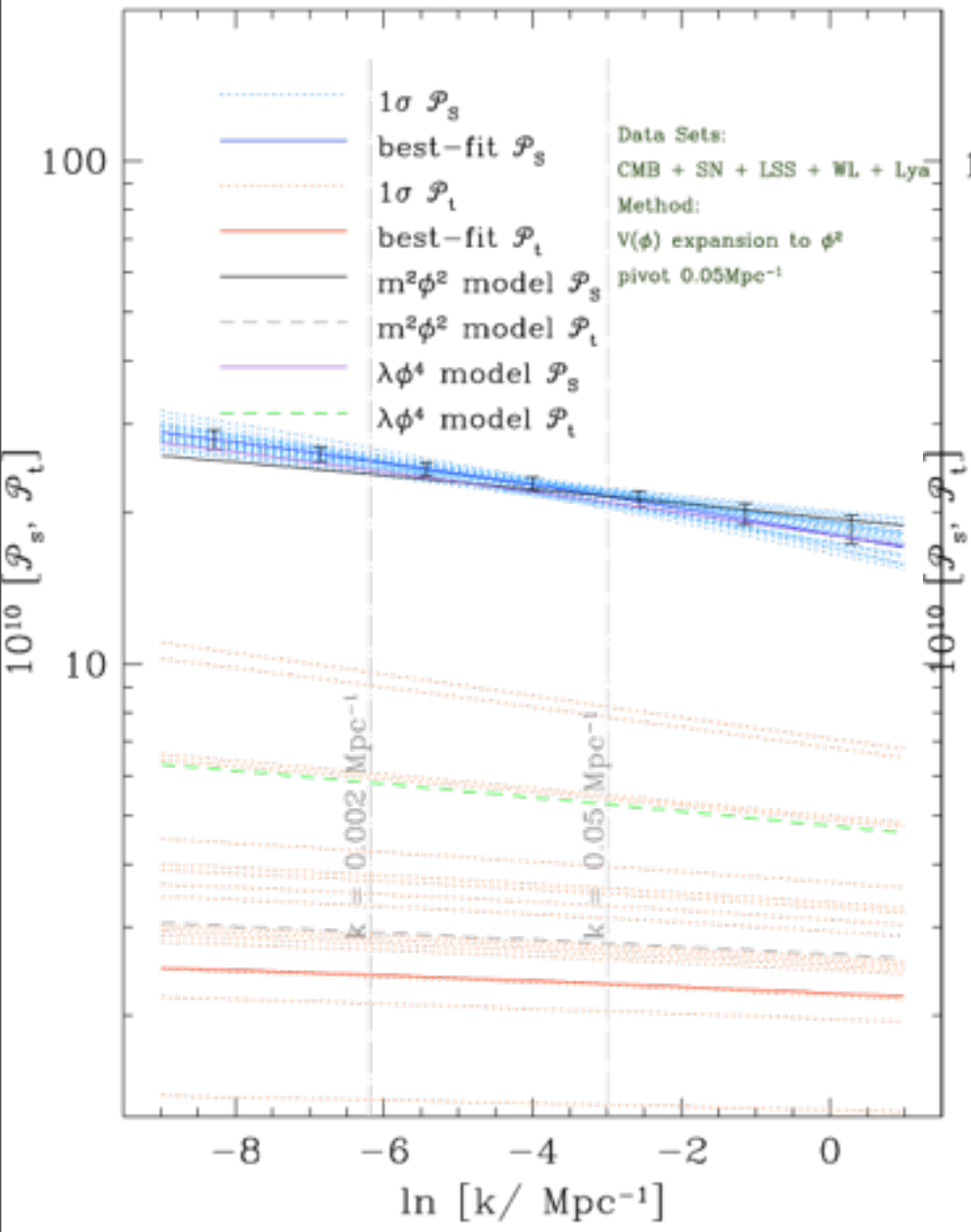
quadratic potential about a pivot point



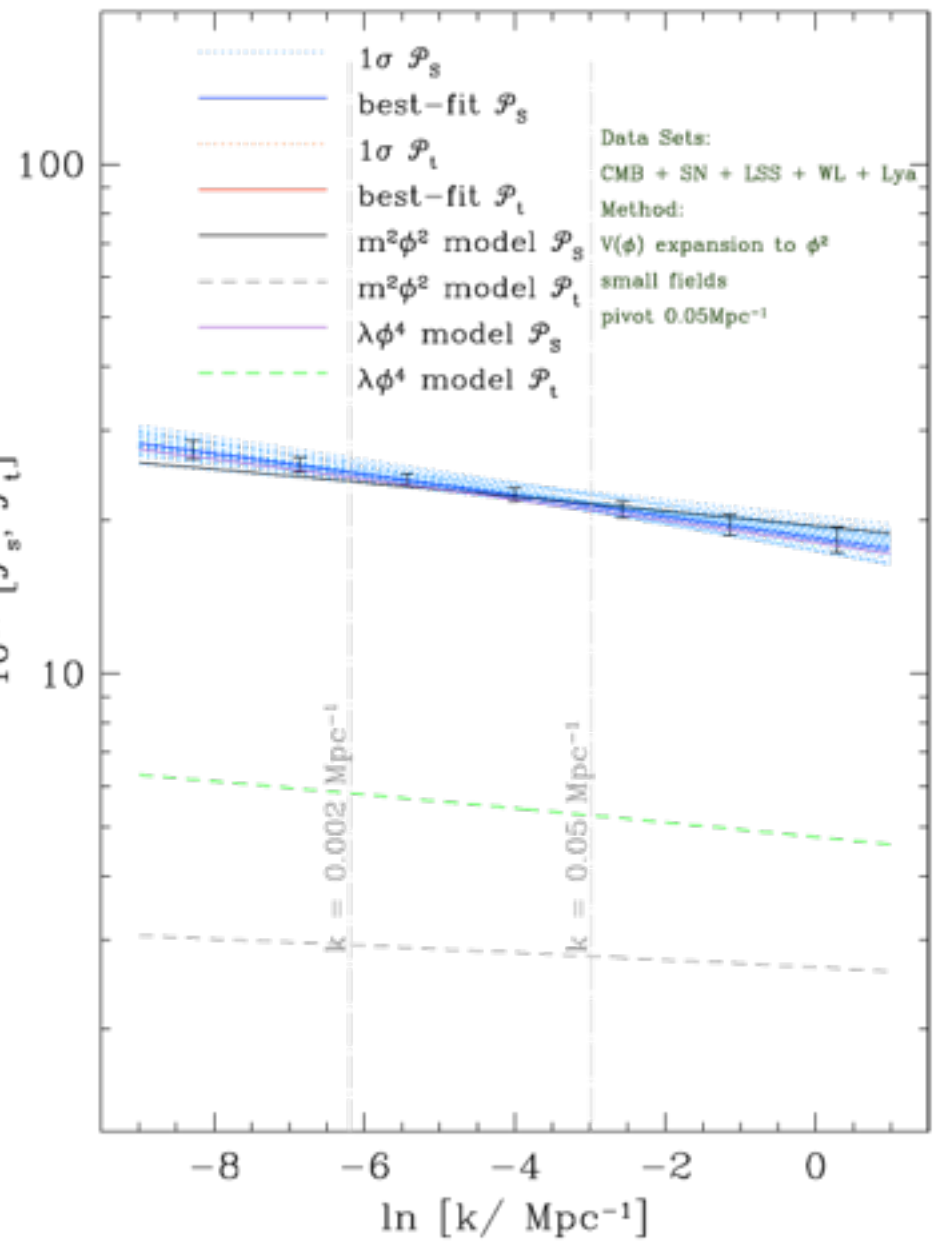
quartic potential about a pivot point



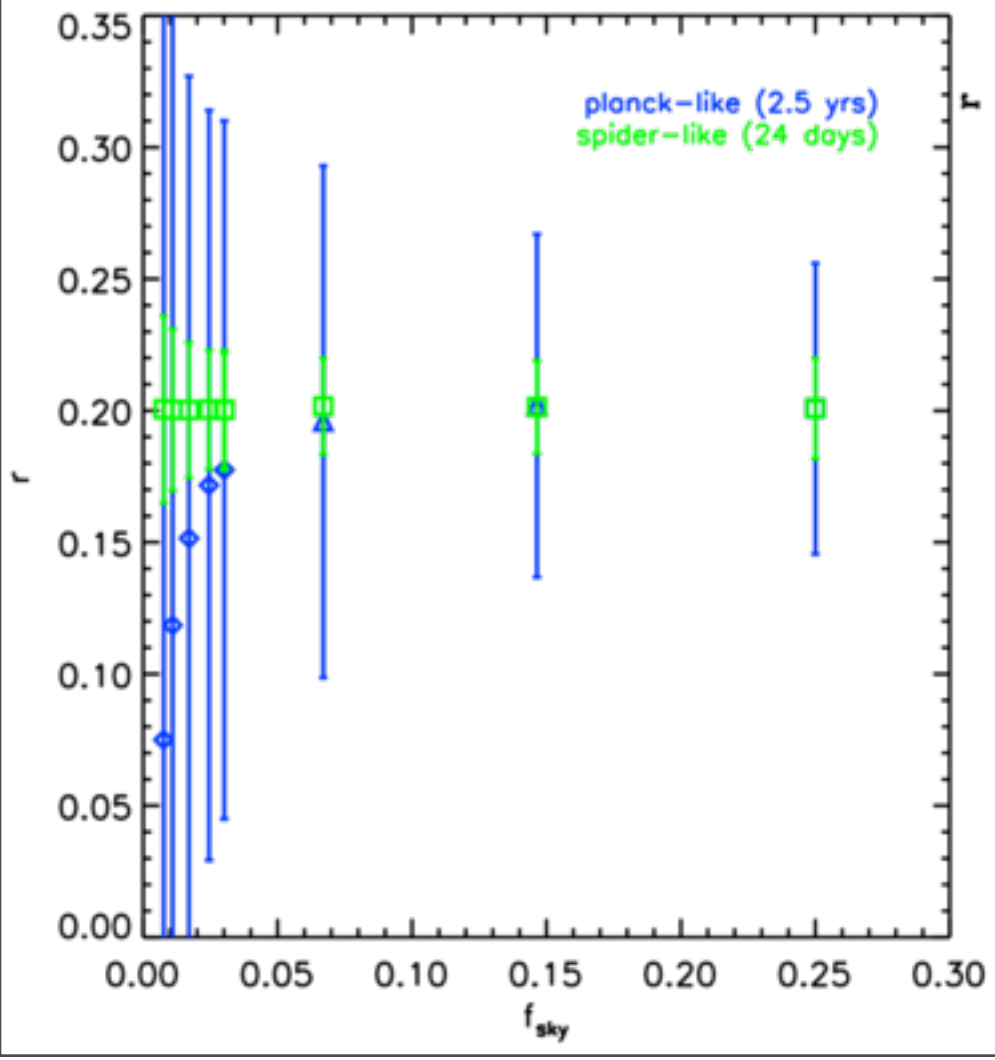
quadratic potential about a pivot point

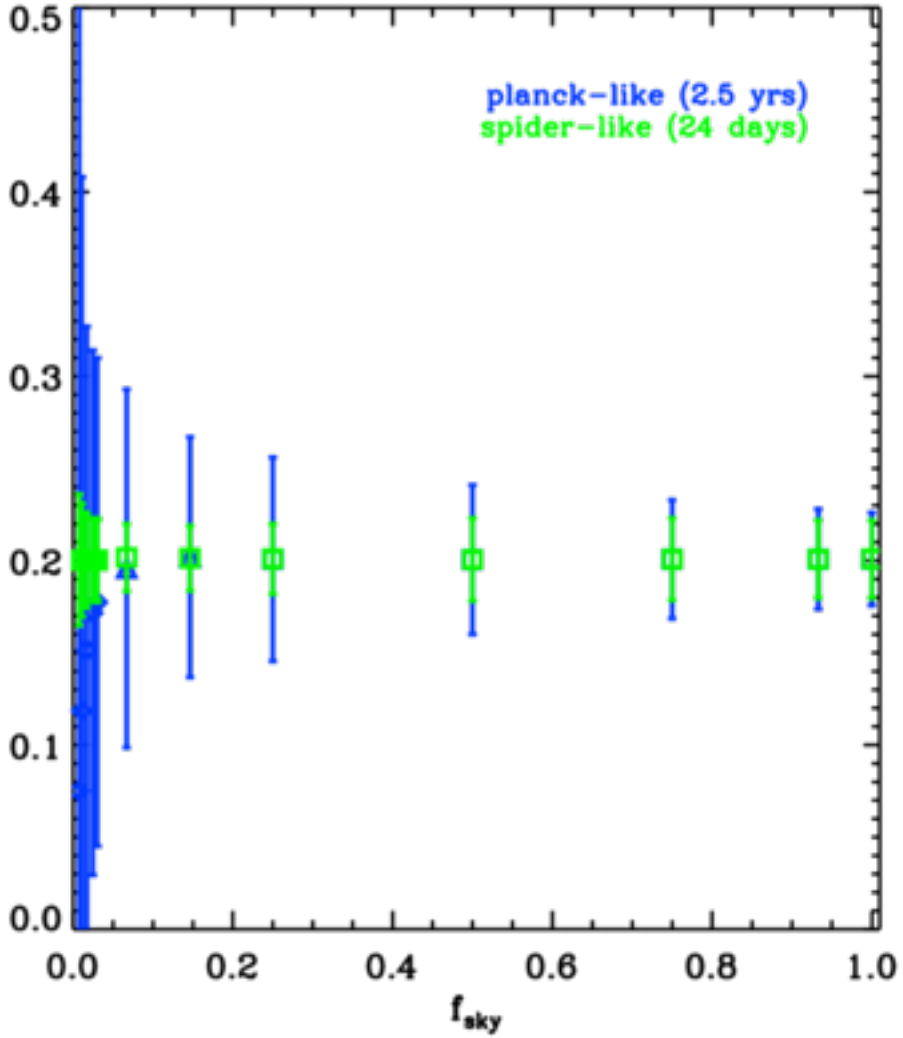


same, with a small field constraint



how do errors in r vary with sky fraction? (disentangle E/B mixing by direct Likelihood in Q,U)





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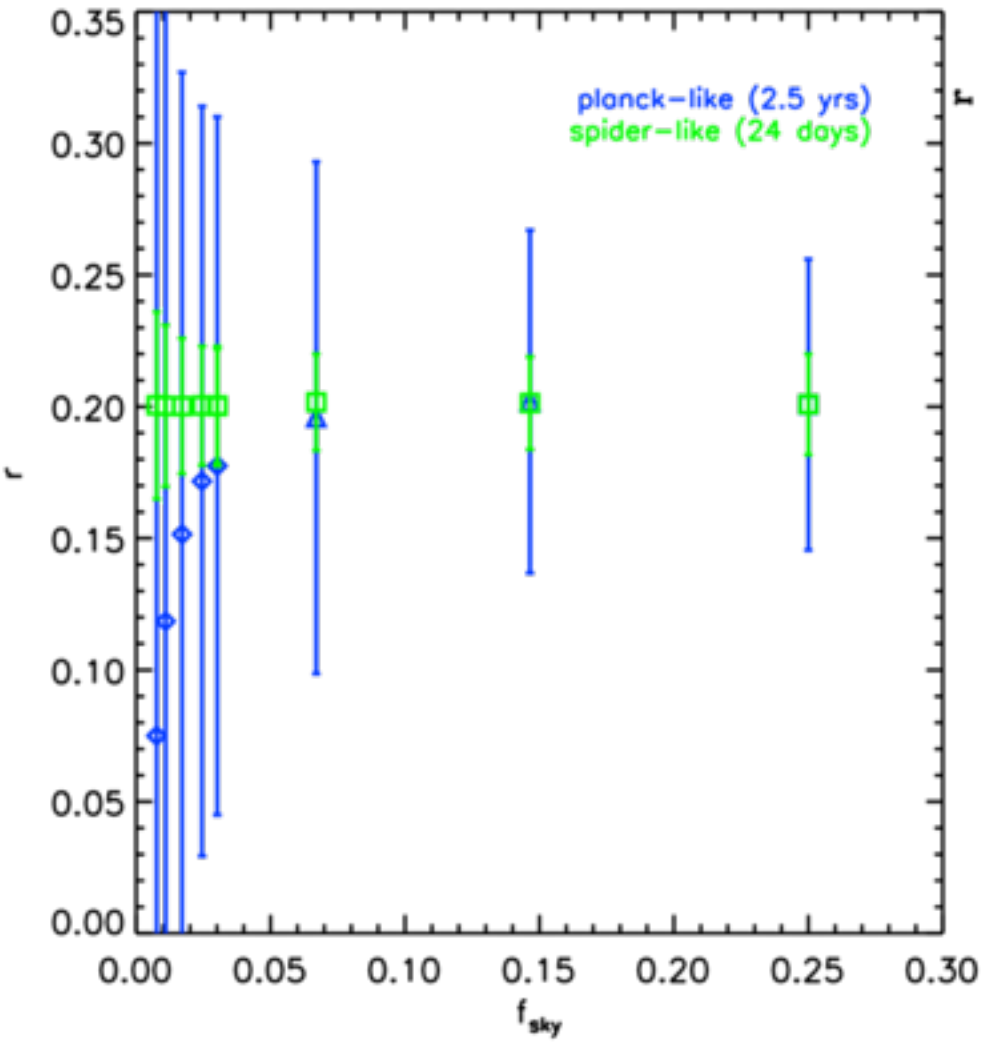

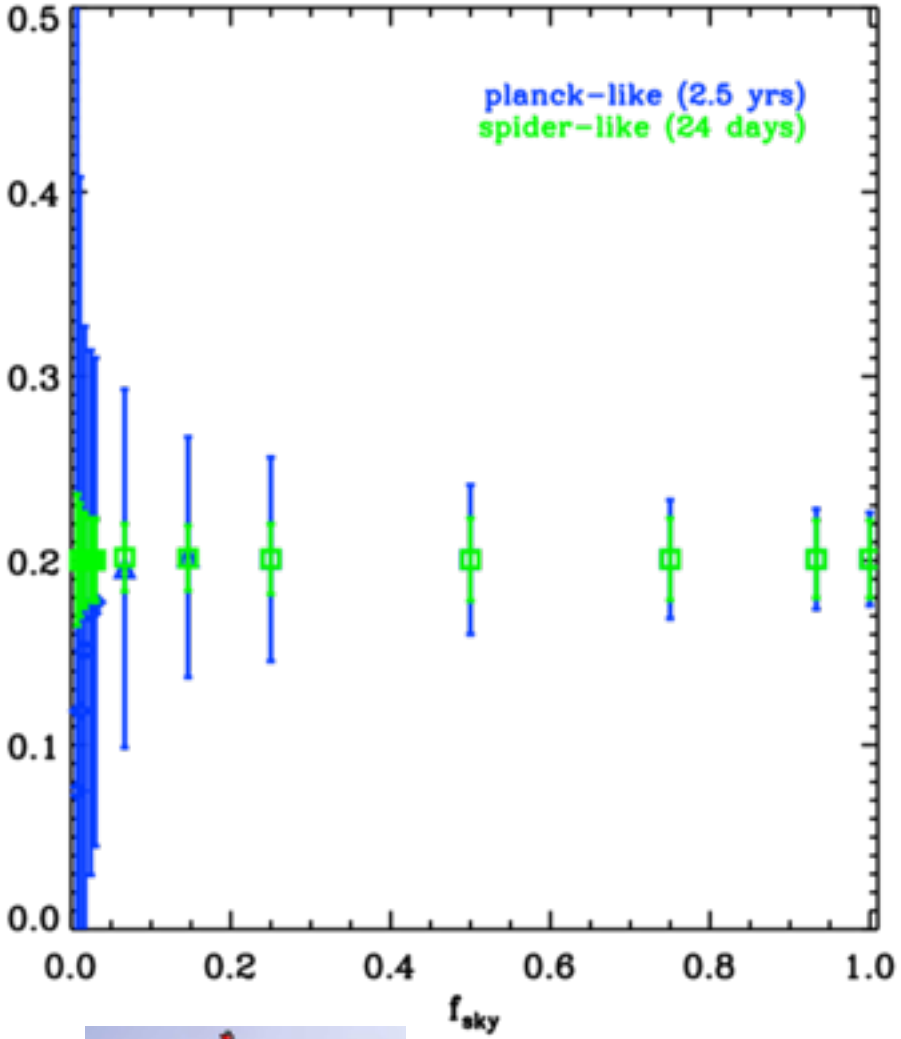

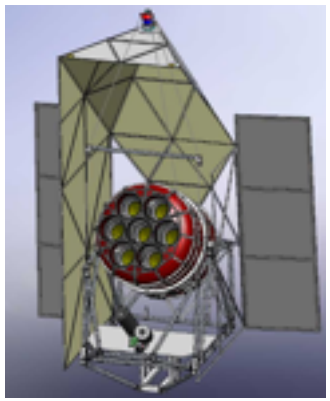

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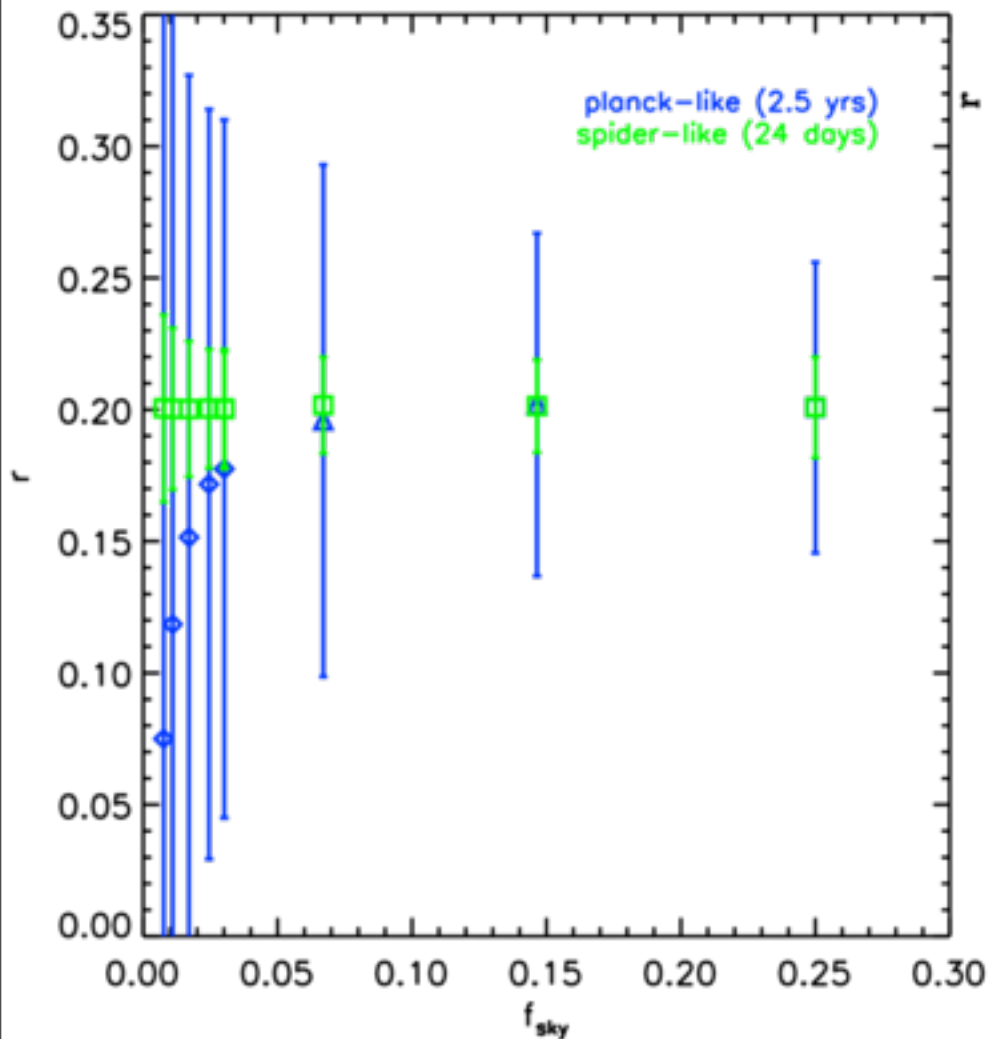
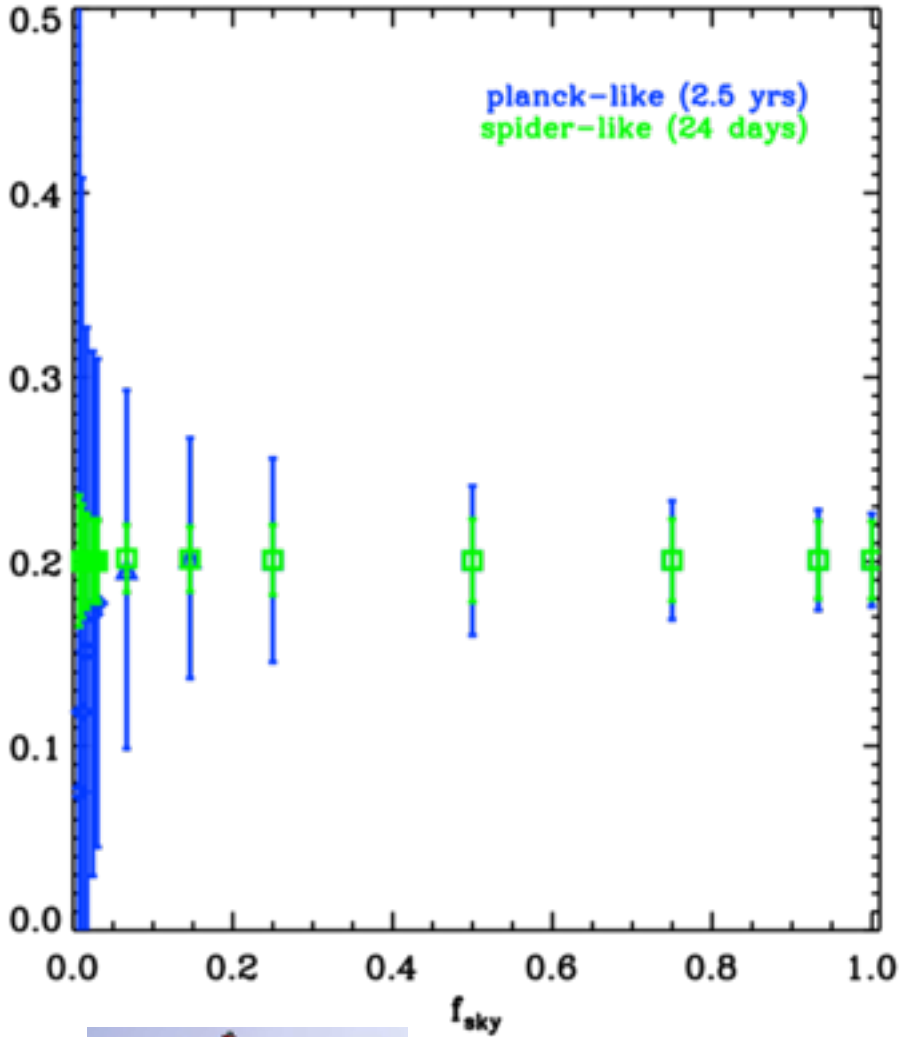
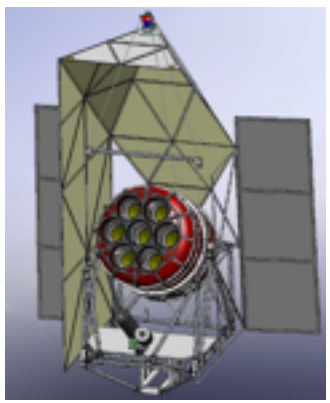
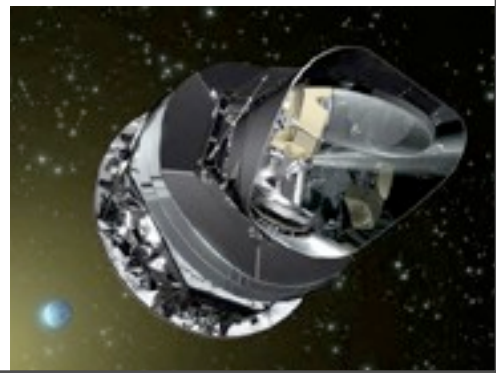




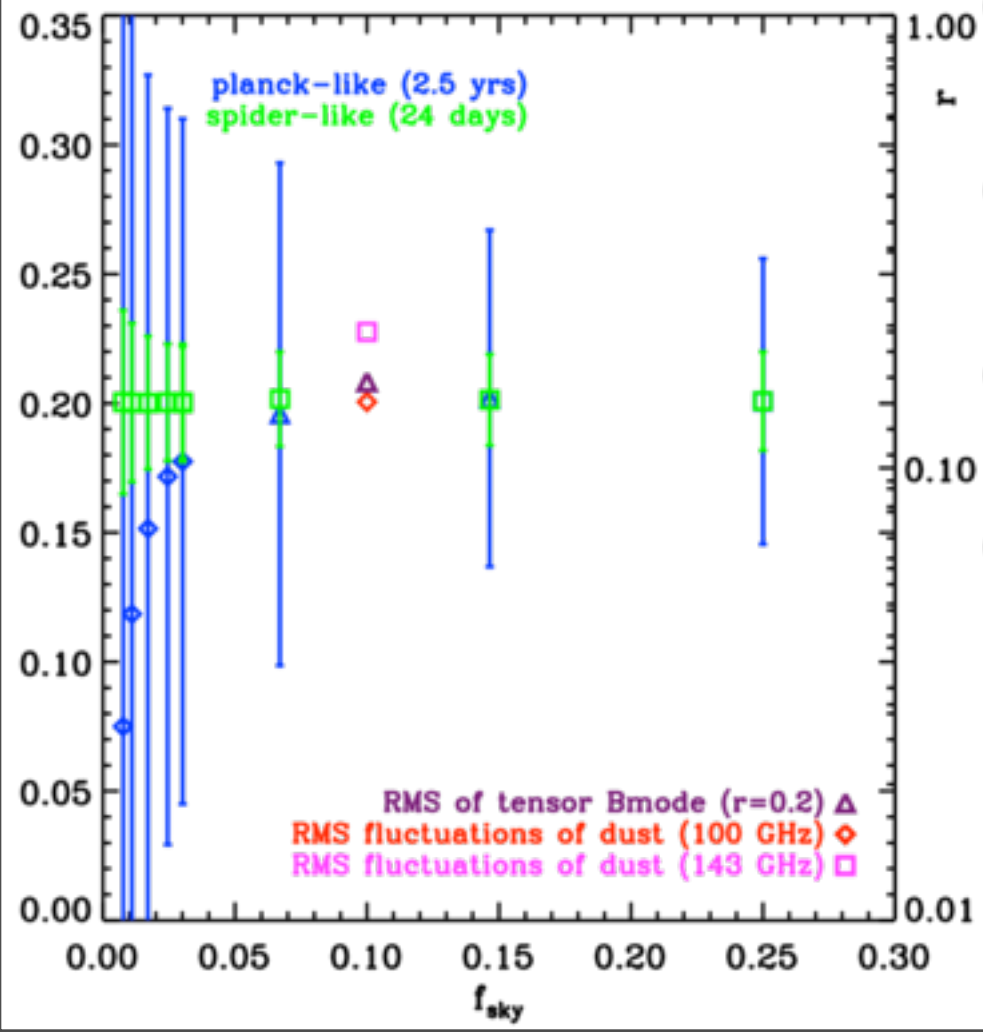


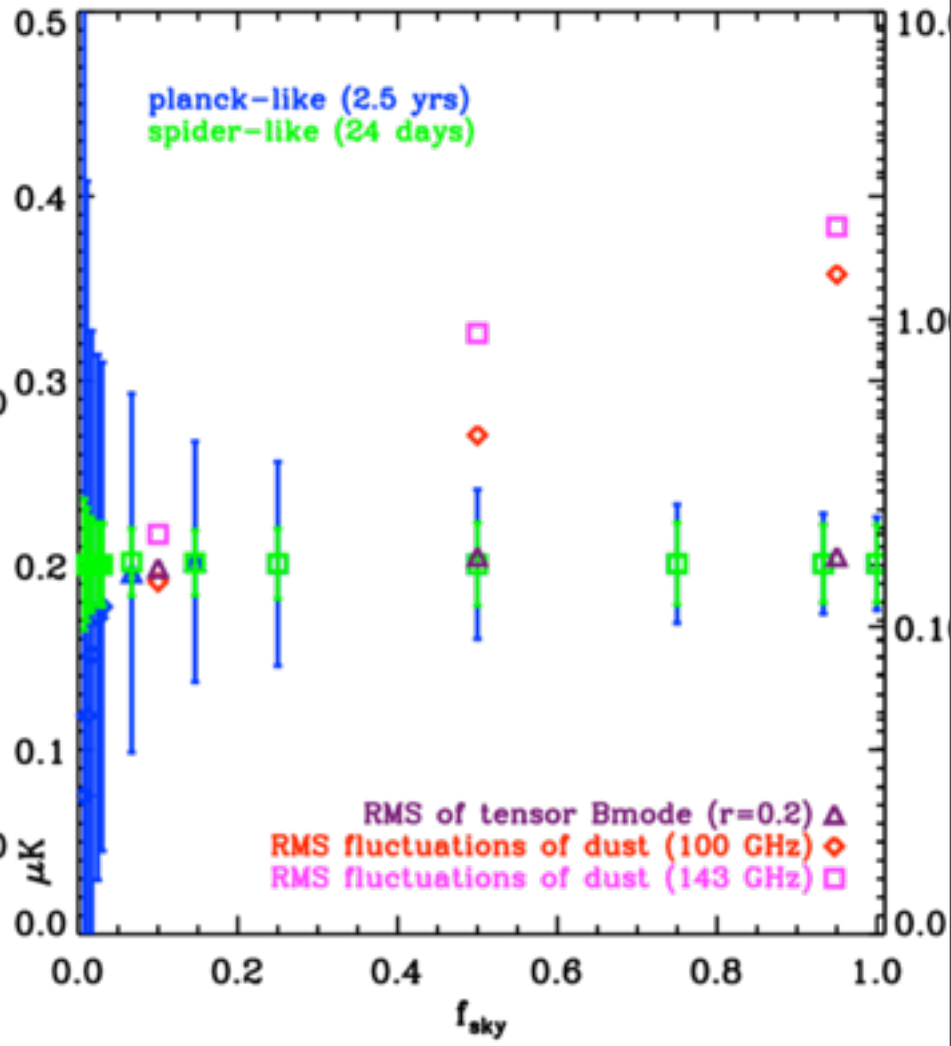


go for low dust patches of sky - from ground, e.g., Keck/spud

or balloons Spider deep/shallow

Planck can use almost all sky and low-dust patches





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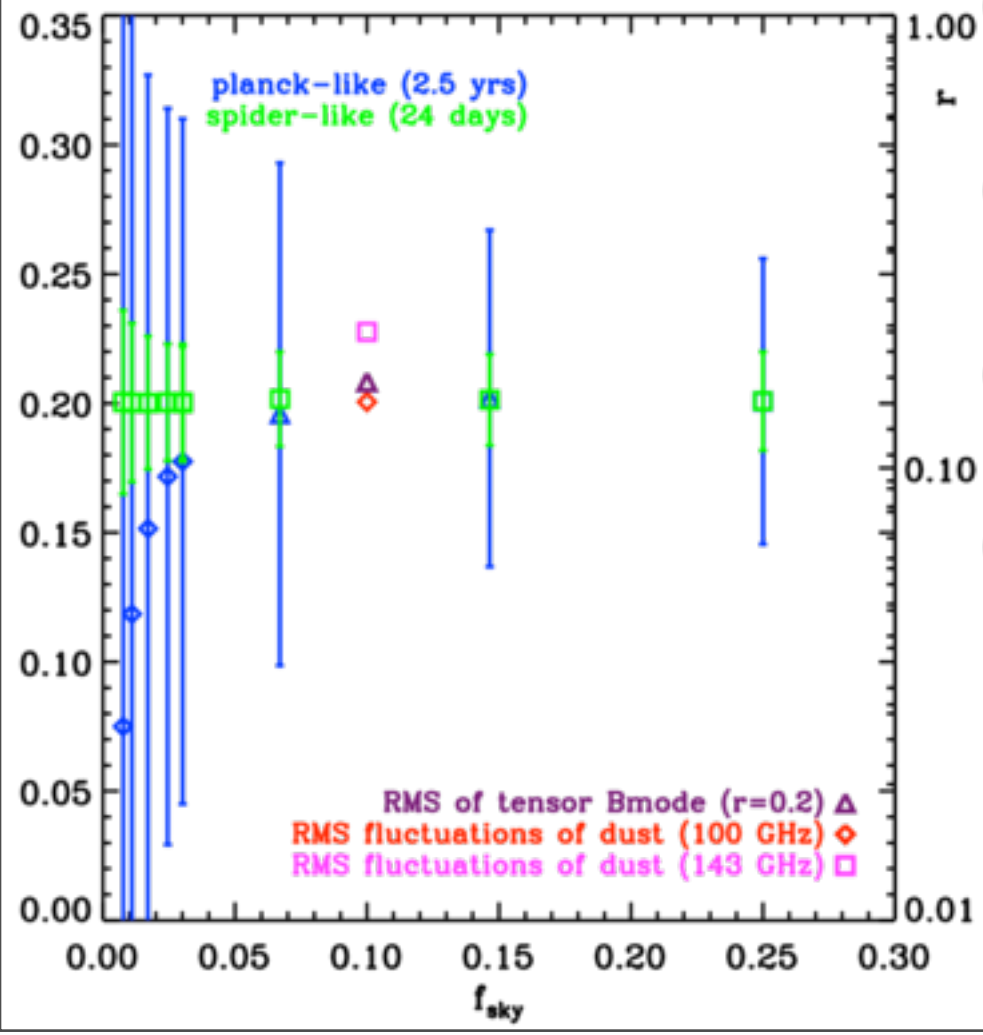

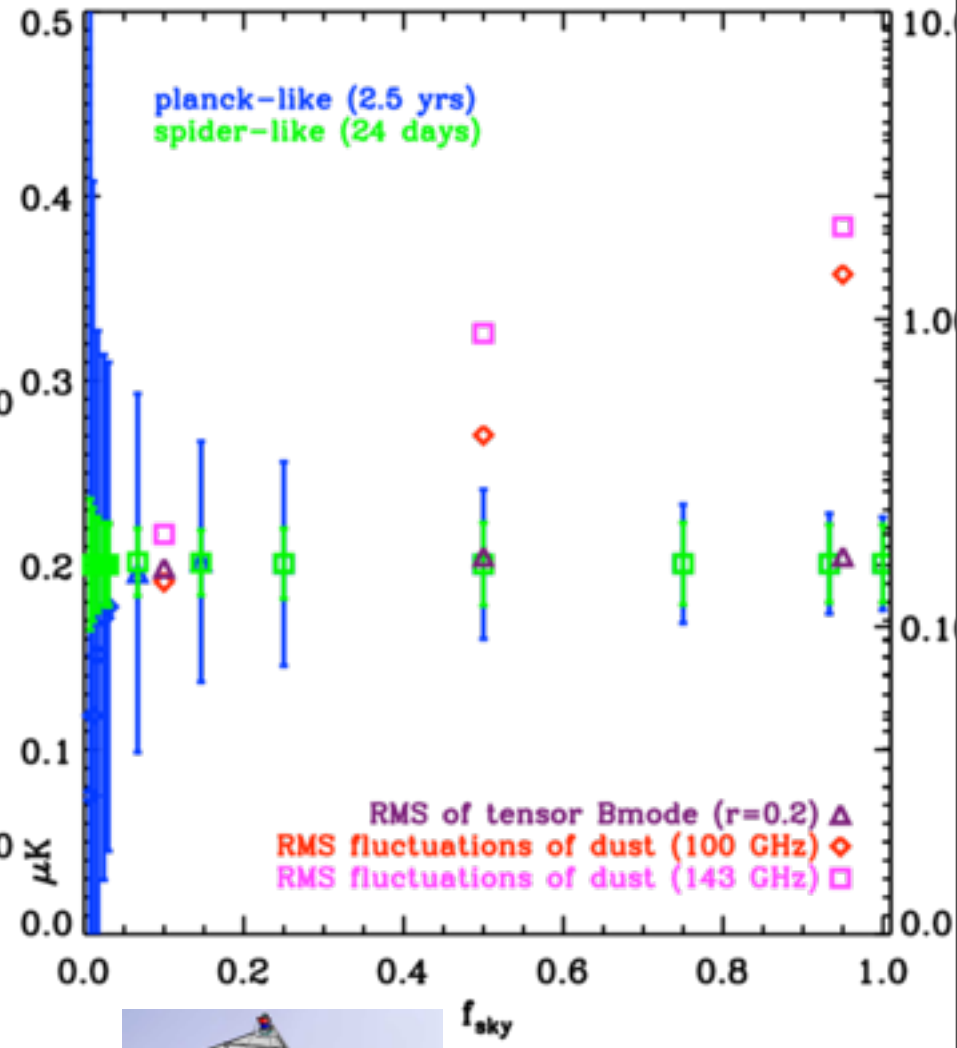

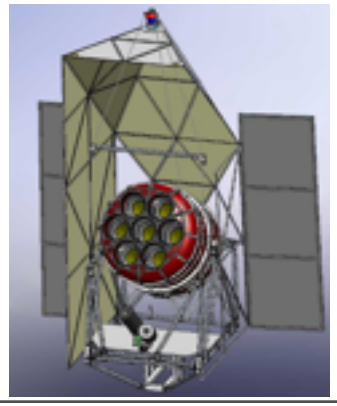

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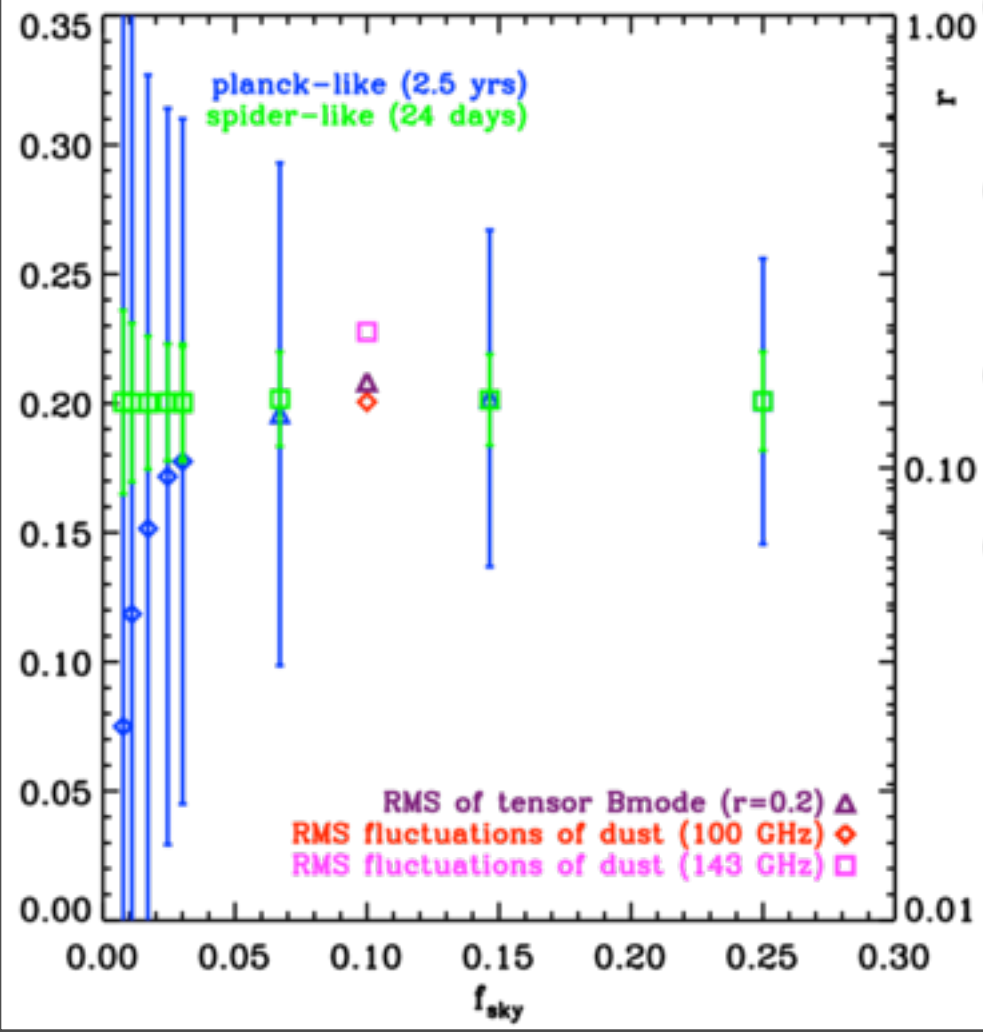
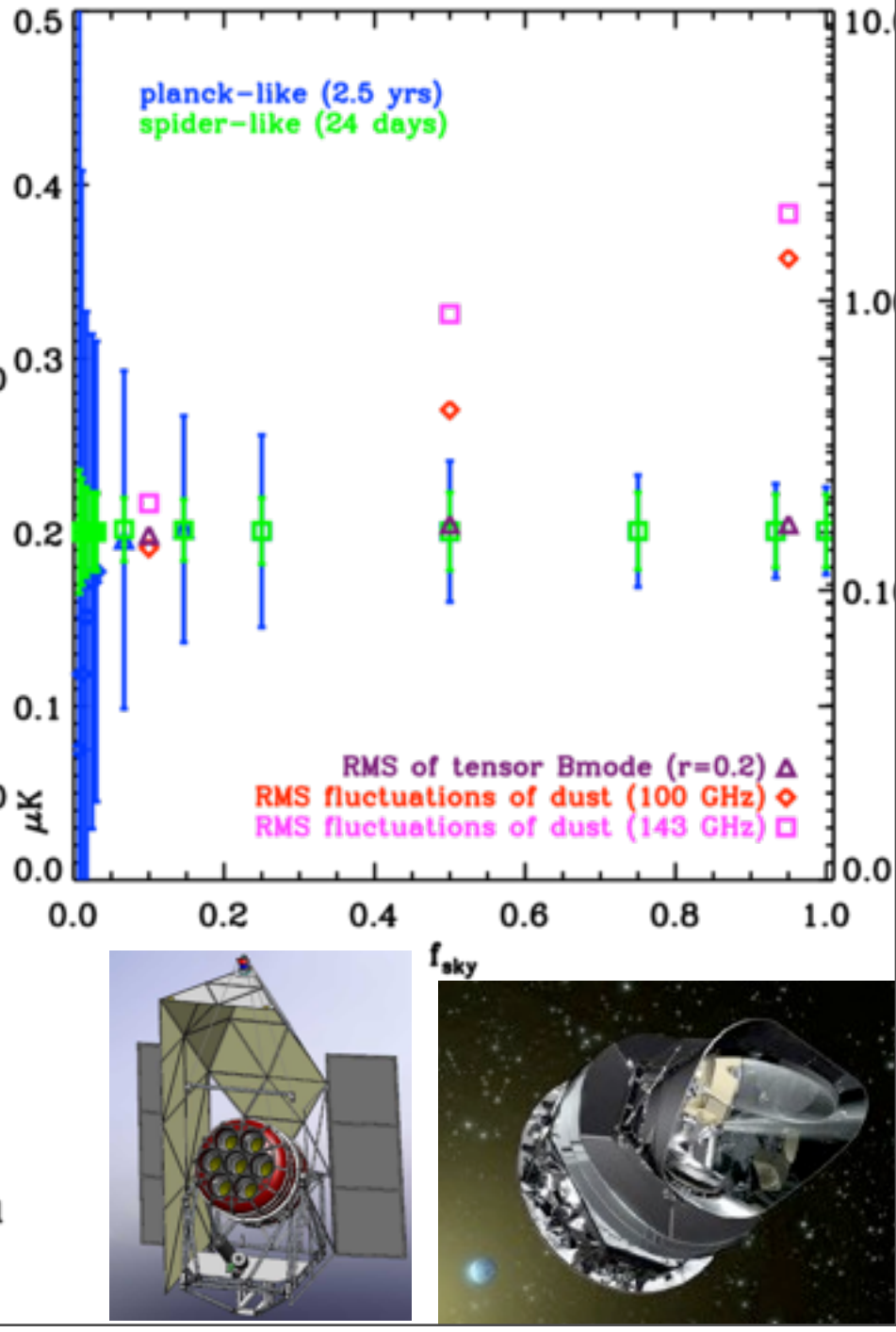
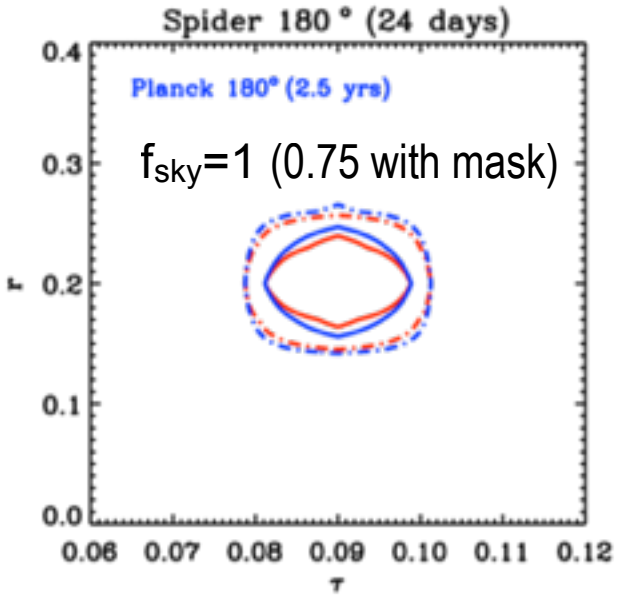
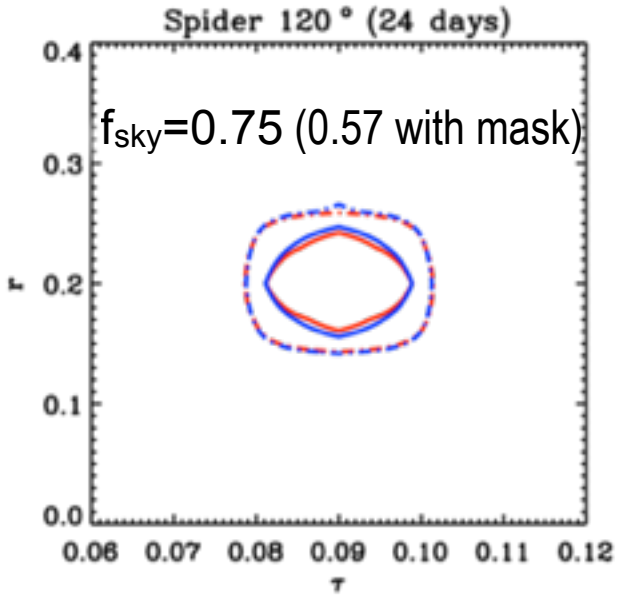
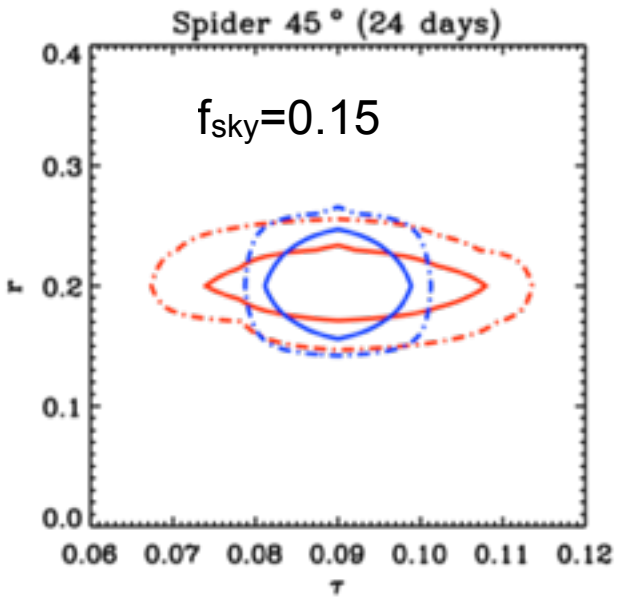


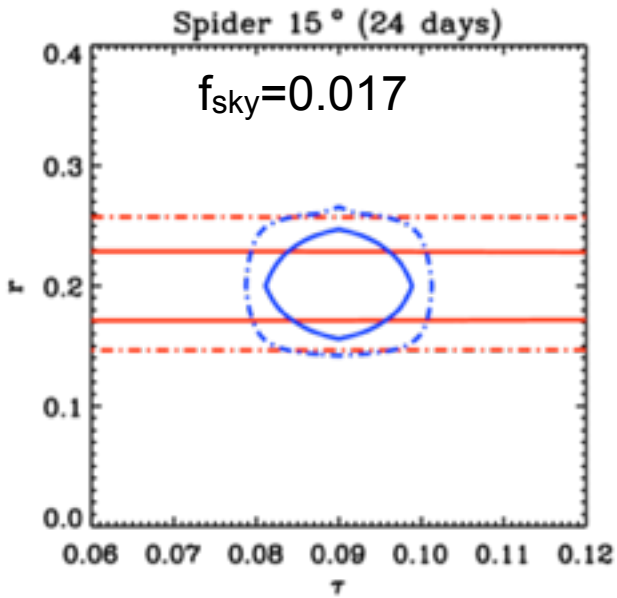


r-τ

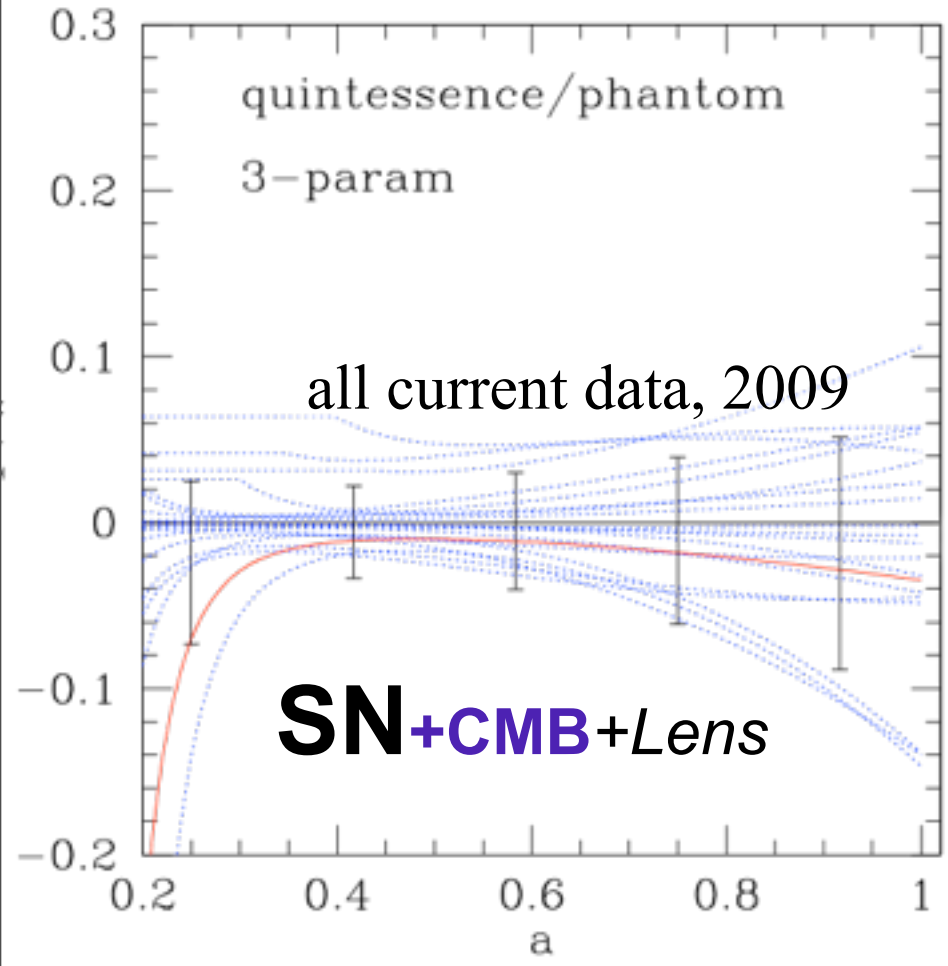

Spider 180 ° (24 days)
Planck 180° (2.5 yrs)
f_{sky}=1 (0.75 with mask)
r
τ
0.0
0.1
0.2
0.3
0.4
0.06
0.07
0.08
0.09
0.10
0.11
0.12

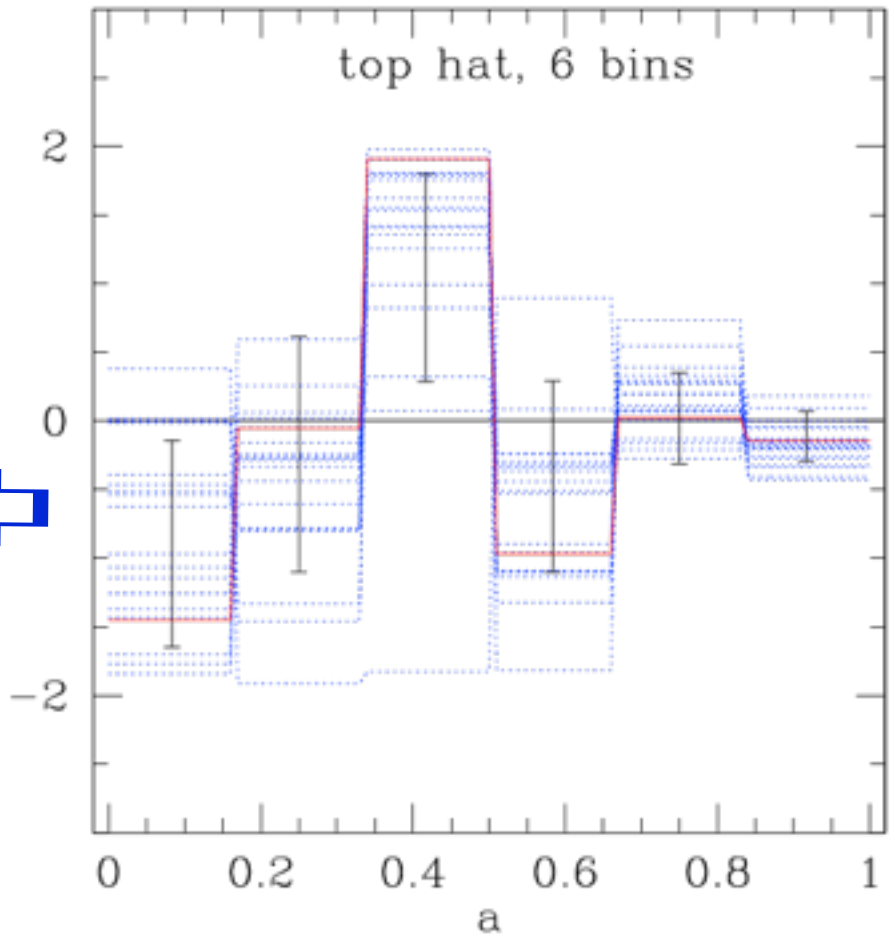

Spider 120 ° (24 days)
f_{sky}=0.75 (0.57 with mask)
r
τ
0.0
0.1
0.2
0.3
0.4
0.06
0.07
0.08
0.09
0.10
0.11
0.12


Spider 45 ° (24 days)
f_{sky}=0.15
r
τ
0.0
0.1
0.2
0.3
0.4
0.06
0.07
0.08
0.09
0.10
0.11
0.12


Spider 15 ° (24 days)
f_{sky}=0.017
r
τ
0.0
0.1
0.2
0.3
0.4
0.06
0.07
0.08
0.09
0.10
0.11
0.12

is the dark energy "vacuum potential energy" ?

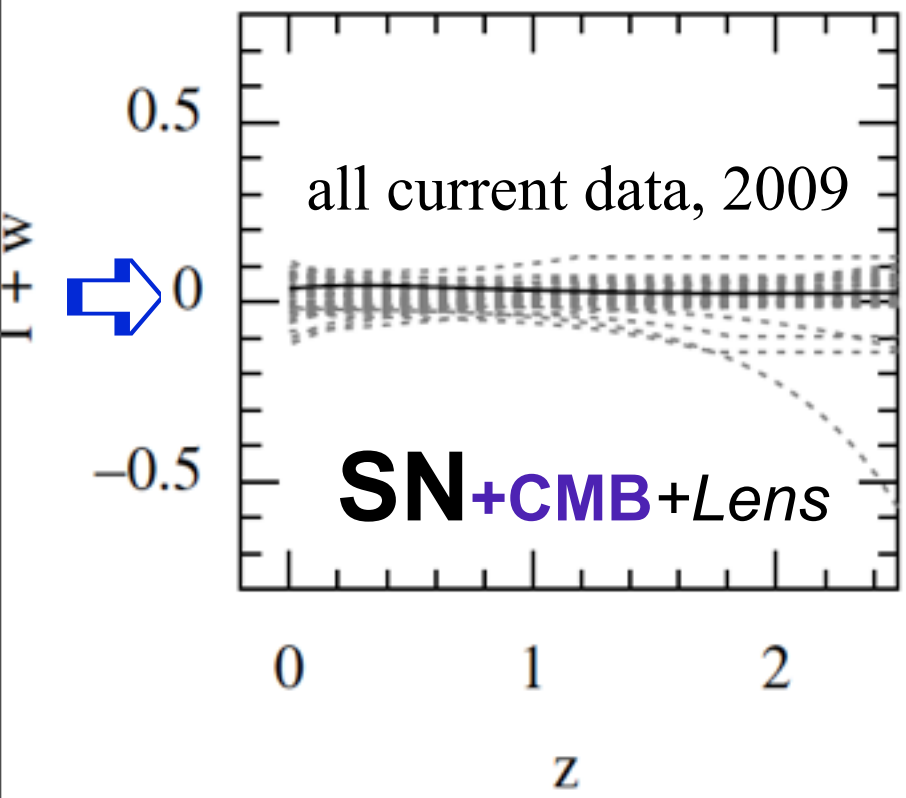


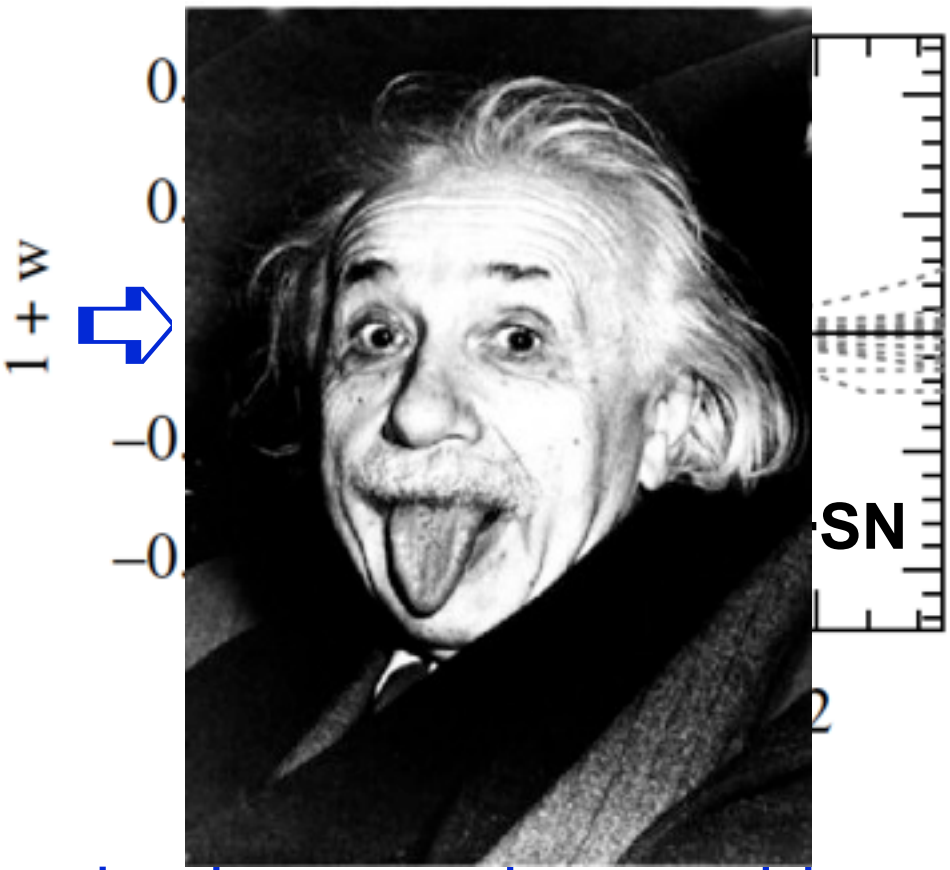


TEST: within errors, energy-density does not change with expansion ⇨Einstein's cosmological constant is best fit so far

ρ_Λ(time,space) ?

is the dark energy "vacuum potential energy" ?





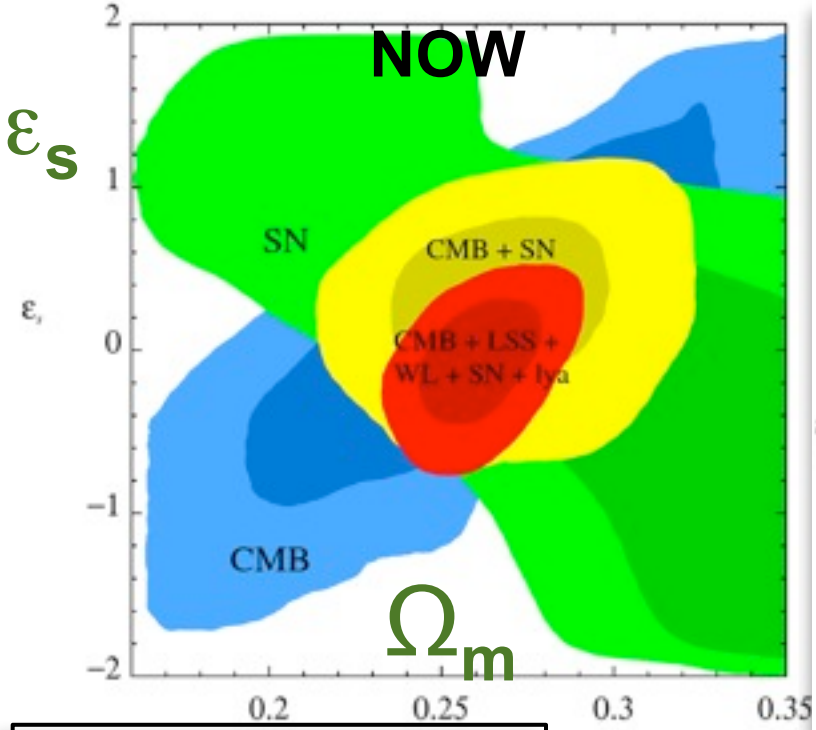
TEST: within errors, energy-density does not change with expansion ⇨Einstein's cosmological constant is best fit so far

Beyond Einstein panel: LISA+JDEM

Forecast: JDEM-SN (2500 hi-z + 500 low-z)

+ DUNE-WL (50% sky, gals @z = 0.1-1.1, 35/min^2) + Planck1yr

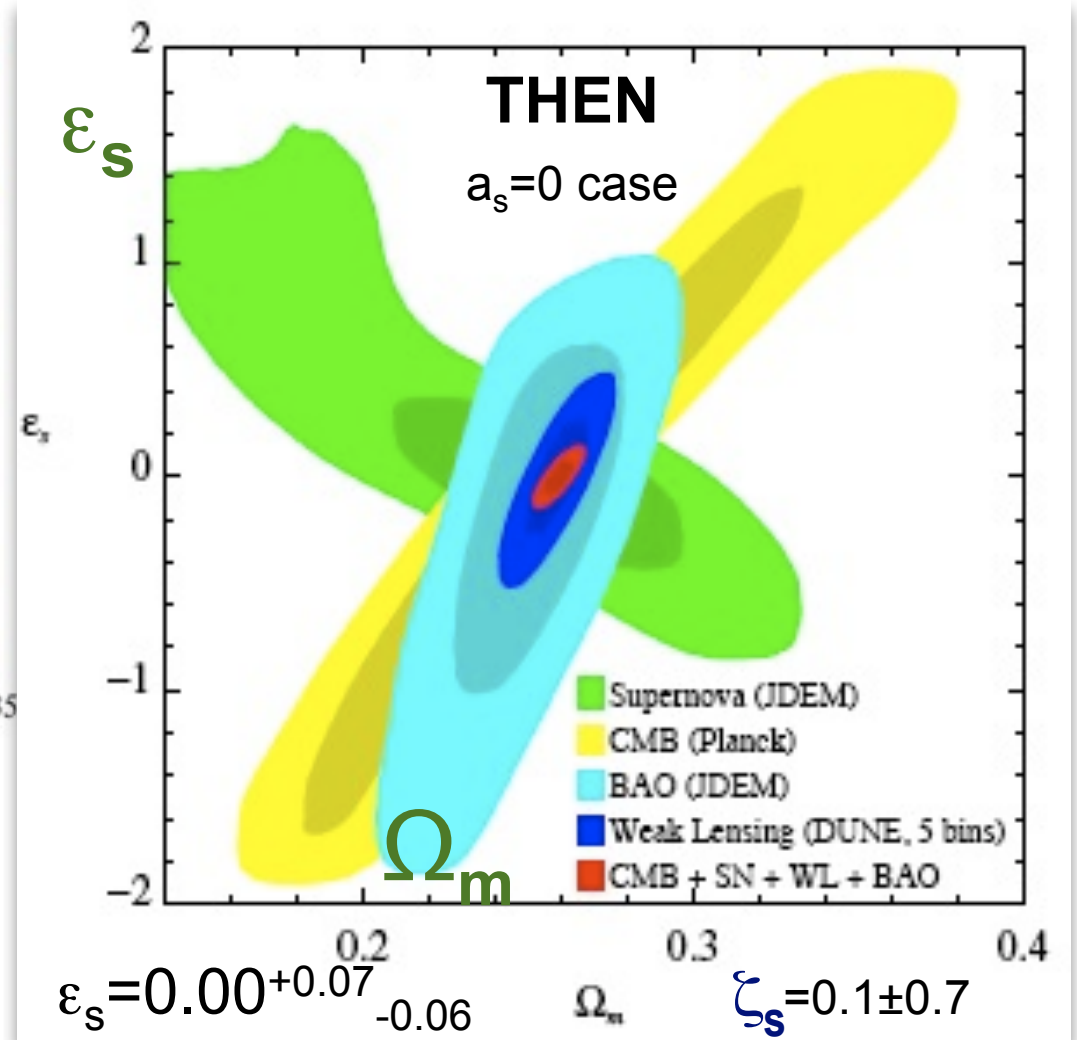
now ESA /Euclid — ESA (+NASA/CSA)



$1+w_0 = -0.0 \pm 0.06$

$\varepsilon_s = (d\ln V/d\psi)^2/4$ @pivot a_{eq} $= -.03 + .26 - .30$ 2

$\varsigma_s = \pm 1.001\, d^2\ln V/d\psi^2 /4$ $= 0.1 \pm 0.7$



$\varepsilon_s = 0.00^{+0.07}_{-0.06}$ Ω_m $\varsigma_s = 0.1 \pm 0.7$

cannot reconstruct the quintessence potential, just the slope ε_s & ~hubble drag

very early U early to middle to now U **very late U**

inflation *string theory/landscape/higher dimensions* **dark energy**

$V_{eff}(\psi_{inf})$? partial shape reconstruction reconstruct gradient $V_{eff}(\psi_{inf})$?

$K_{eff}(\psi_{inf})$? $K_{eff}(\psi_{inf})$?

$1-n_s \sim 2\varepsilon_s + 4\varsigma_s$ x.9999 & $r \sim 16\varepsilon_s$ slow roll

2 solutions: nearly uniform acceleration & small ς_s

$\varepsilon_s \sim .017 +- .007$; $\varepsilon_s < .025$ 95% from r

low energy inflation with tiny ε_s

$2\varsigma_s \sim .017 +- .007$

errors go to +− .0012 Planck+JDEM+DUNE

$\varepsilon_s = (d\ln V/d\psi)^2/4$ @a_{eq}

$\varepsilon_s \sim$ -.03 + .26 -.30

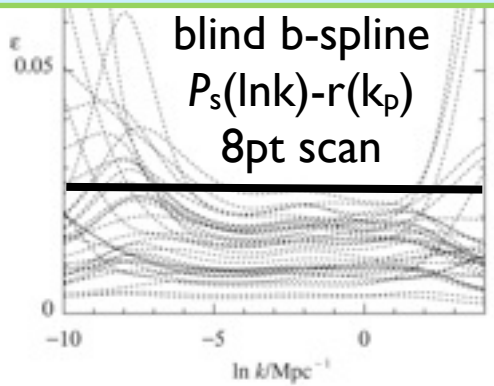
to +− .07 Planck+JDEM+DUNE

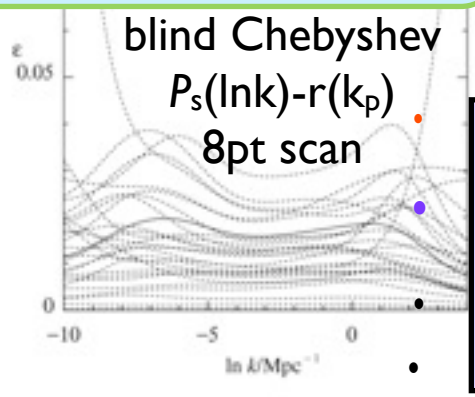
$\varsigma_s = +- 1.001 d^2\ln V/d\psi^2/4$ @a_{eq}

$\varsigma_s \sim$ 0.1 +.6 -.7

to +.6-.7; +-.3 Planck+JDEM+DUNE

- a_s < 0.36 (z_s >2.0) • to a_s to <0.21 (z_s >3.7)





we ignore z_dec and z_bbn constraints on Ω_Q (a)
much further trajectory extrapolation needed.

prior sensitivity sqrt(ε): ε=0.00 +.09-.13 & ε>0 (since phantom is ~ baroque): ε=0.00+.20

late-inflaton field is < Planck mass

coupled-DE 5th force constraints are strong

INFLATION THEN

PROBES NOW

"standard inflation space": $\mathbf{n_s}$ $\mathbf{dn_s/d\ln k}$ $\mathbf{r}$ **@k-pivots**

$\mathbf{n_s(kp)}$**=.962 +-.013** (+-.005 Planck1) **.959 +- .011 all data**

$\mathbf{r=P_t/P_s(kp')}$ **< 0.40**$_{\mathbf{cmb}}$ **95% CL (+-.03 P1, +- .01 Spider+P2.5)**

$\mathbf{dn_s/d\ln k\ (kp)}$ **=-.016 +- .019** (+-.005 Planck1)

(partially) blind trajectories **e.g.,** $\mathbf{n_s(k)}$ **and** $\mathbf{r(kp)}$**,** ***are better***

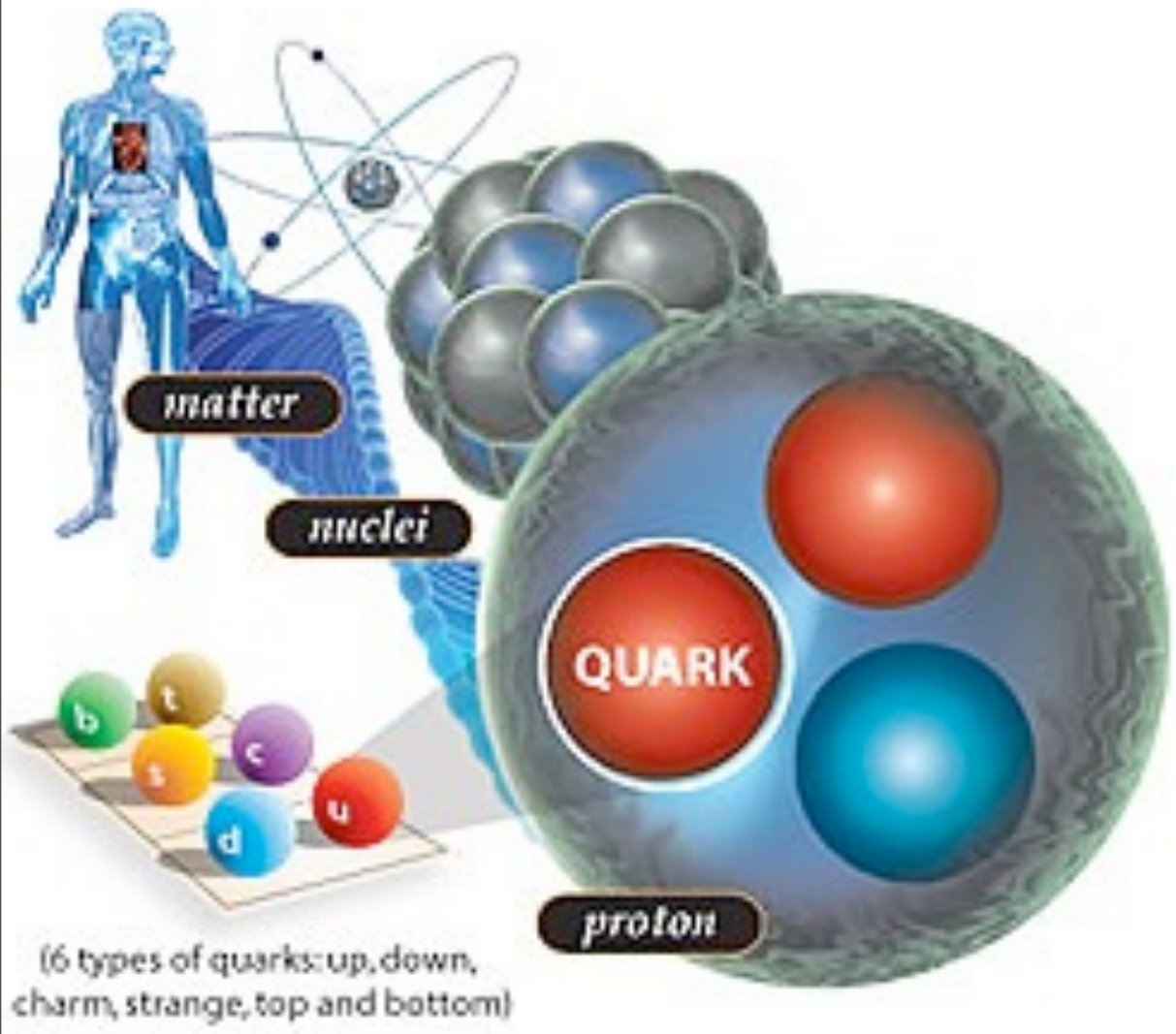
local quadratic non-G constraint: -9< f_{NL}<111 ⇒ -4< f_{NL}<80 WMAP5 (± 5-10 Planck1yr)

CBI10: add a cosmic string template⇒$\mathbf{n_s}$<1 @2σ & string tension limit $G\mu < 2.8 \times 10^{-7}$

the Weighty Matter of the Cosmos: *what is the Universe made of?*

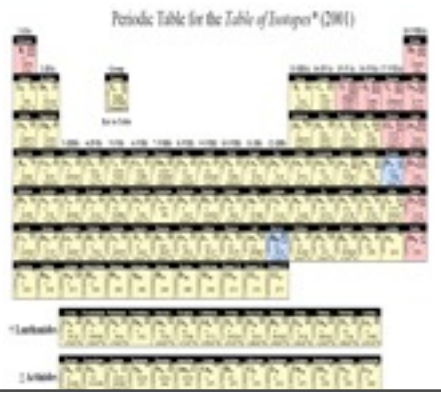
Greek GUT: 4 elements/ 4 qualities+ 5th element: *quintessence* aether

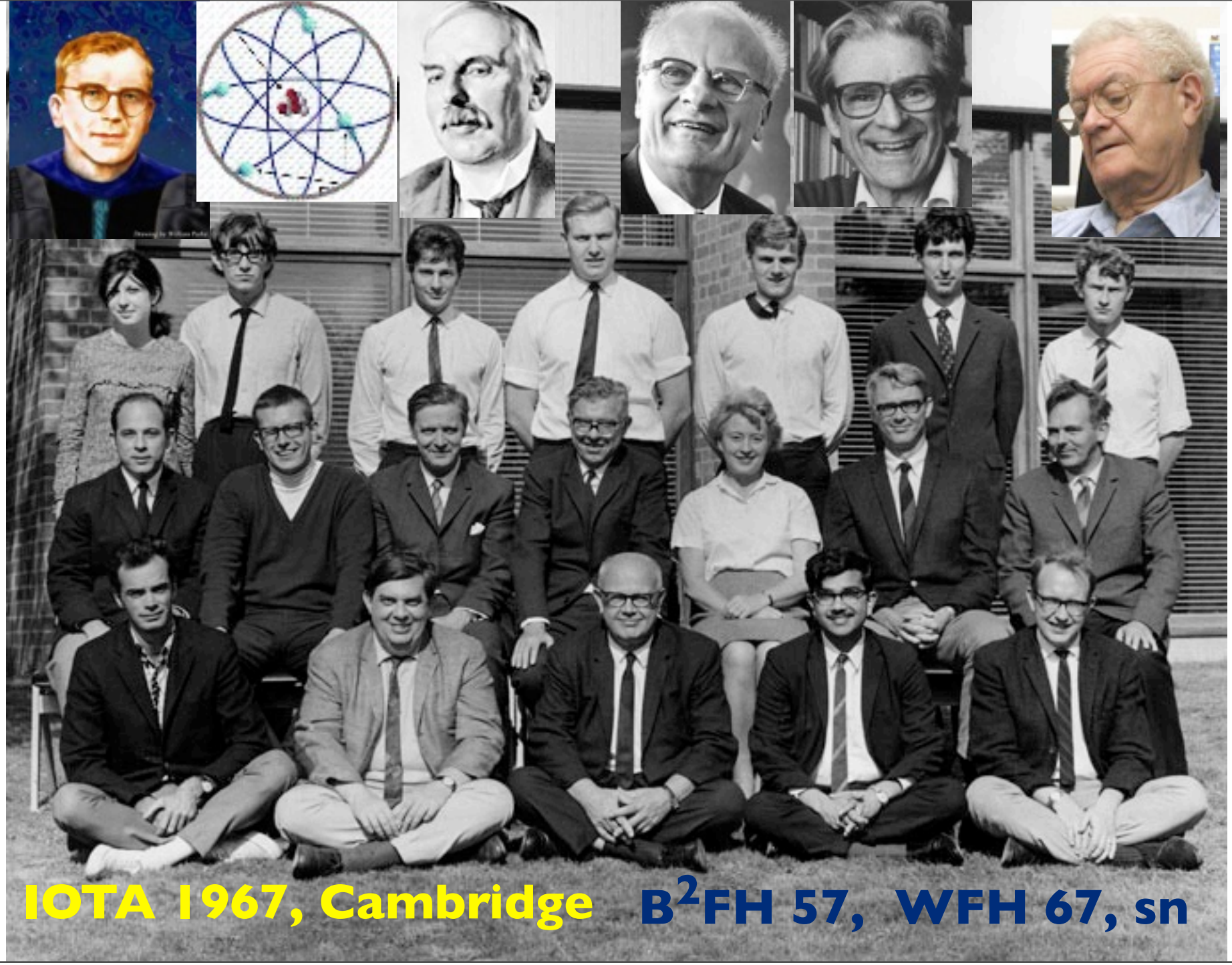
water (Thales), air (Anaximenes), earth (Xenophanes), and fire (Heraclitus). Empedocles unified theory of all 4. Plato 4 of 5 geometrical crystal-like solids as atoms. Aristotle prevailed: elements as combinations of qualities



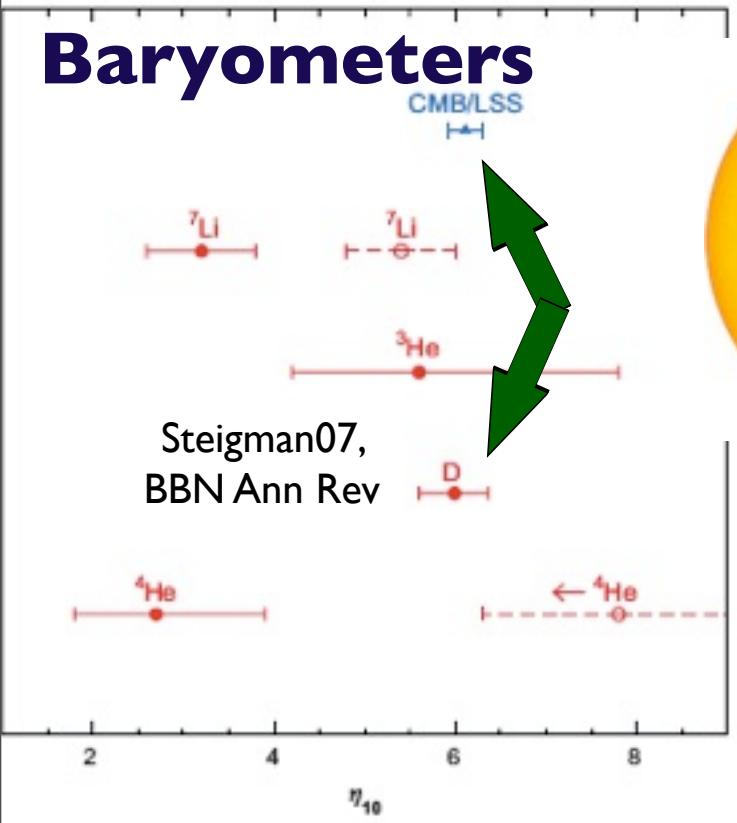
- ✓ **GAMOW (40s, early 50s) HOT BIG BANG**
- ✓ **Hoyle etal (40s, ...) SSM Eternal Inflation with PreHeating BANGs**

Nuclear Fundamental Physics: 40s-80s.. ***Hydrogen (75%) & Helium (25%) Deuterium, Lithium from the first minutes; Carbon, Oxygen, Iron,.. from exploding stars***

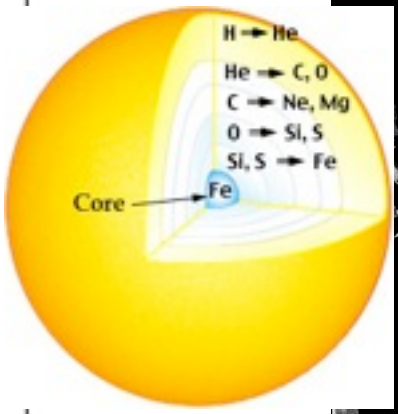



IOTA 1967, Cambridge
B²FH 57, WFH 67, sn

Baryometers



Steigman07, BBN Ann Rev



Nobel Prize 84 Willy Fowler + Chandra -sekhar

$$\eta_{10} \equiv 10^{10}(n_B/n_\gamma) \equiv 274\ \Omega_B h^2$$

$\Omega_b h^2$

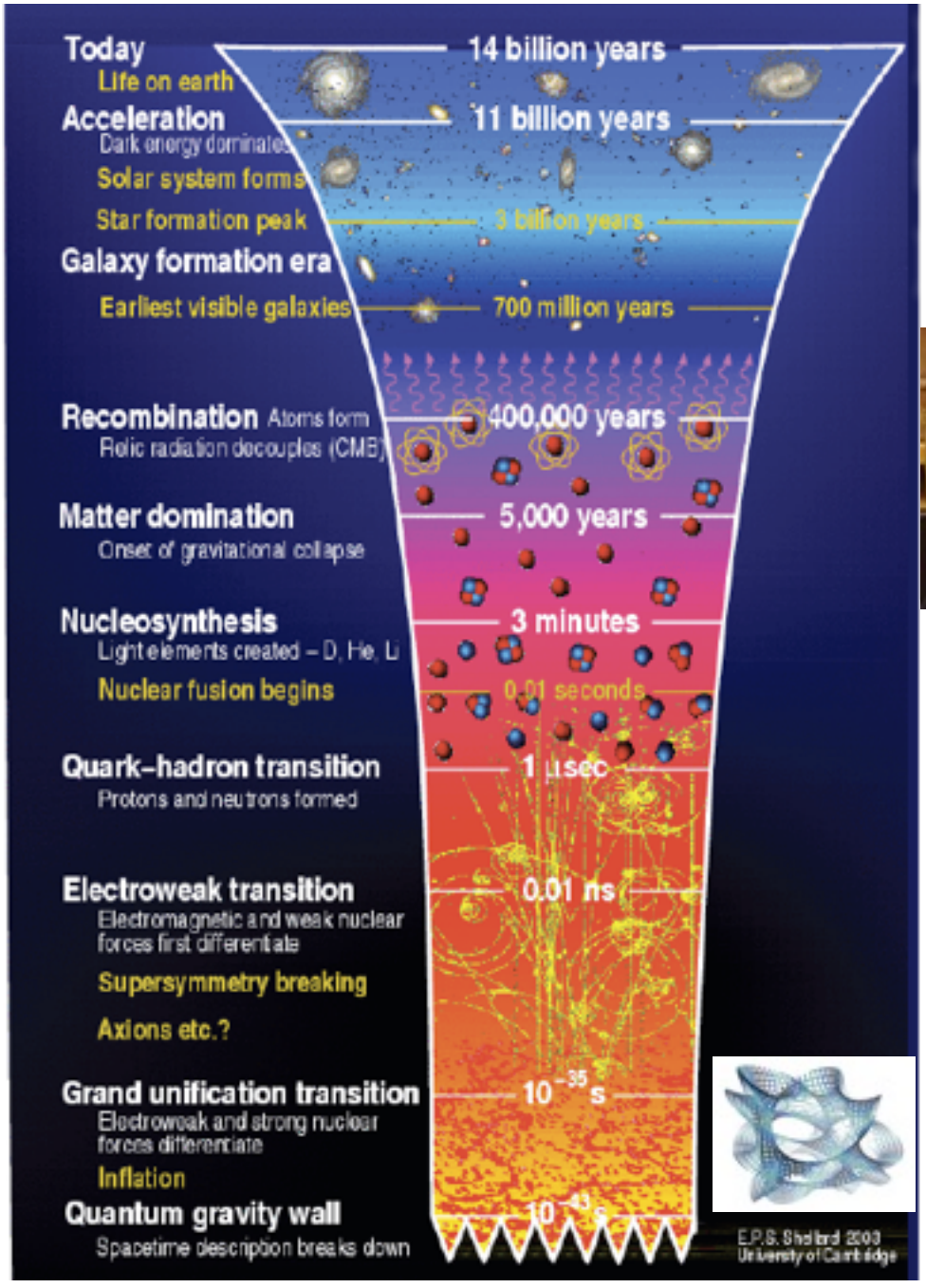
January 2000	January 2002	June 2002	January 2003	March 2003
$0.0339^{+0.0443}_{-0.0246}$	$0.0222^{+0.0025}_{-0.0021}$	$0.0221^{+0.0024}_{-0.0020}$	$0.0221^{+0.0023}_{-0.0018}$	$0.0233^{+0.0013}_{-0.0013}$

0.0223 ± 0.0007 0.0226 +- 0.0006 wmap3+acbar+cbi+... LSS

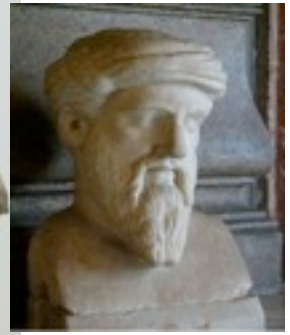
0.0233 +- 0.0005 wmap5+acbar+cbi+b03+.+WL+LSS+SN1+Lya

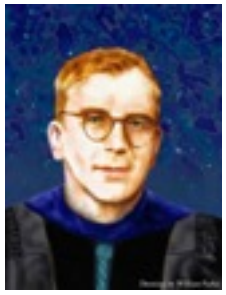
cosmic baryon number $\mathbf{n_b}$=0.261 ±.005 /m^3

$\Omega_{dm}h^2$=0.1145 ±0.0023 Ω_m=0.268 ±.012 Ω_Λ=0.736 ±.012

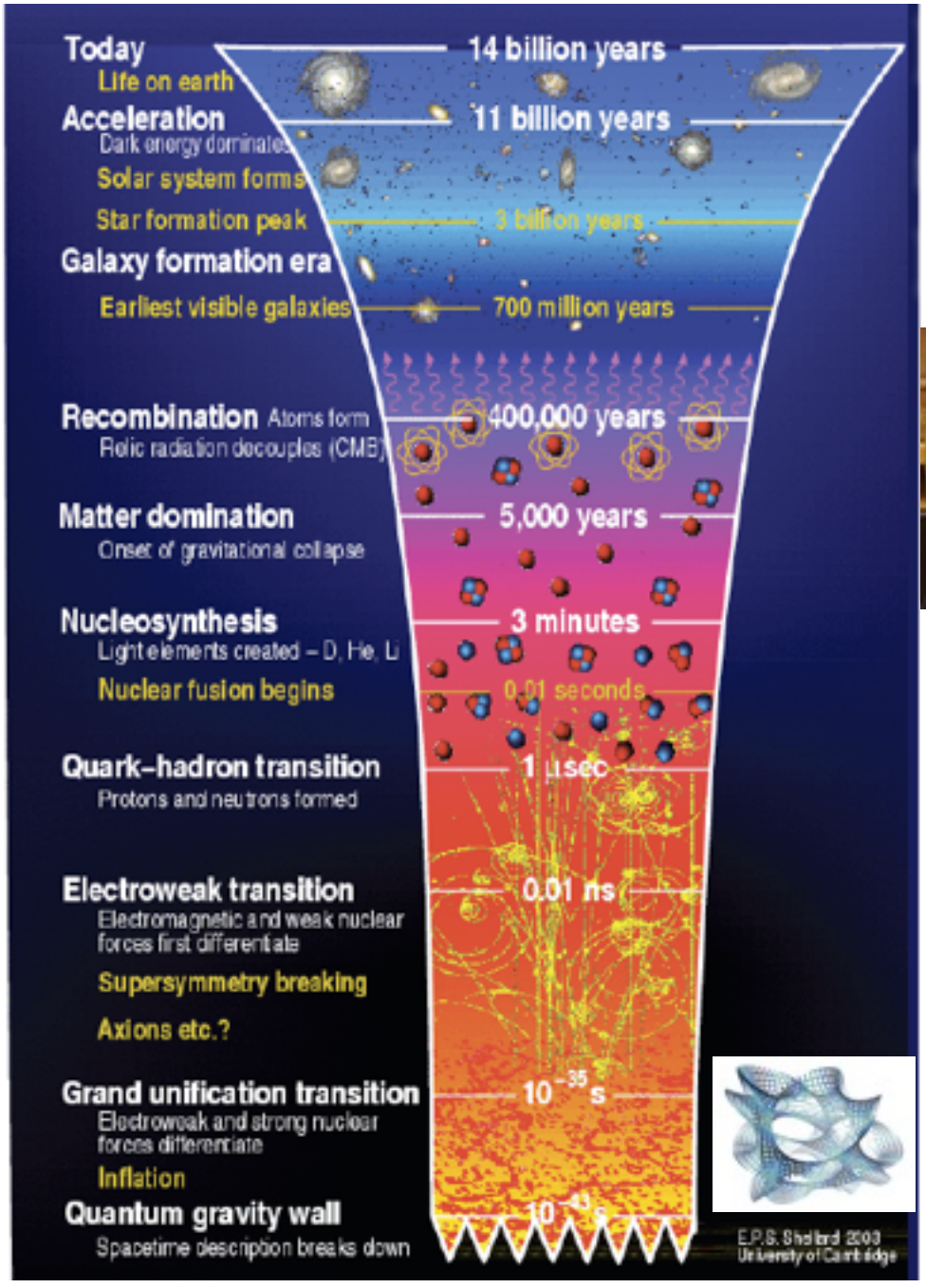


IT from BIT

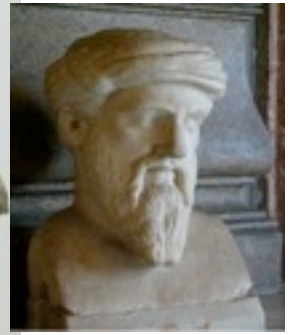


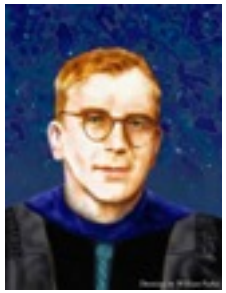


the Meaning may change but the Facts will remain



IT from BIT



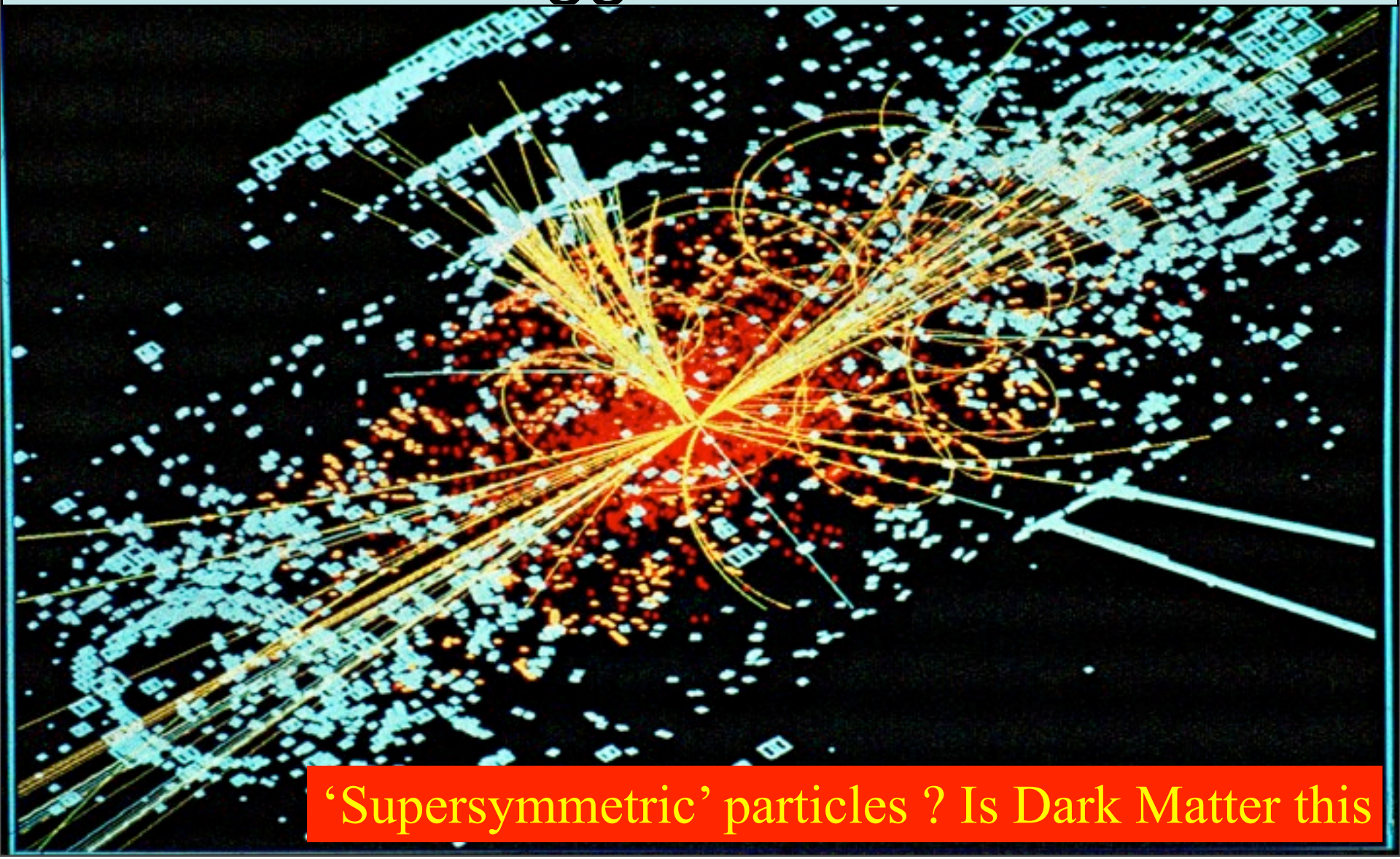


the Meaning may change but the Facts will remain

ρ_Λ =vacuum potential energy density Sakharov~67

If Dark Matter interacts with ordinary matter by more than gravity, we may "see" it at the Large Hadronic Collider 2009+ or at SNOlab 2010+ in Sudbury Canada

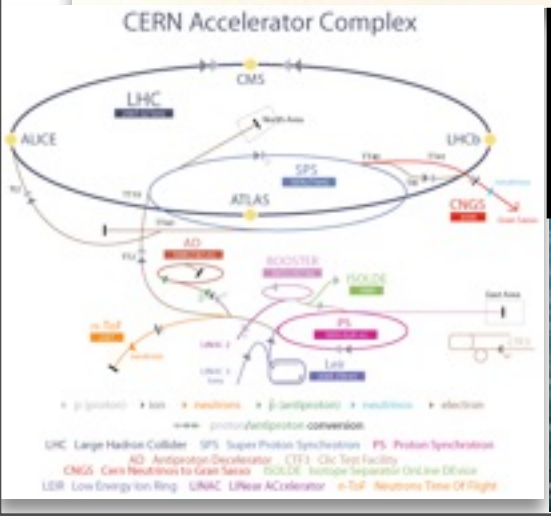
A Simulated Higgs Event in CMS: LHC

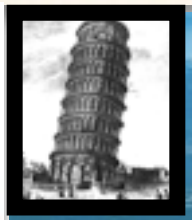


extra-“ordinary” matter

vacuum potential preheats into

Primordial





Galileo’s Accelerator

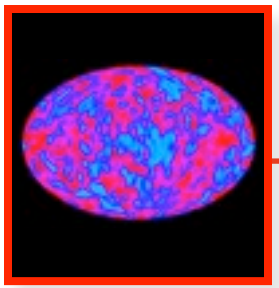
LHC “new first light” Dec09
@CERN “cosmic” accelerator

what is **mass?**
vacuum potential

dark matter

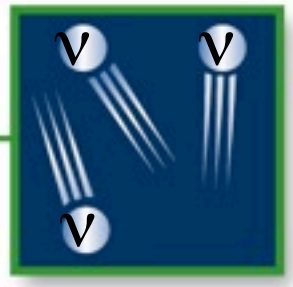
antimatter asymmetry

extra dimensions



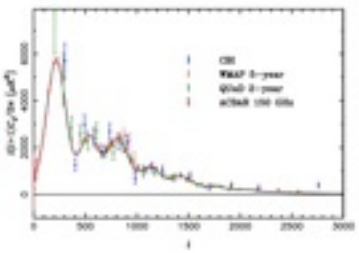
Radiation:
0.005%

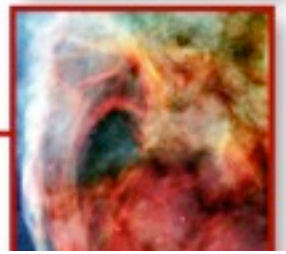
Chemical Elements:
(other than H & He) 0.025%



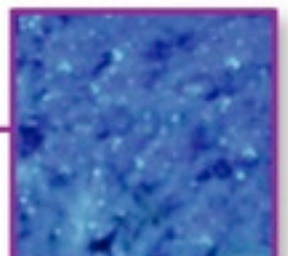
Neutrinos:
0.47%

Stars:
0.5%





Free
H & He:
4.3%



Dark Matter:

$\Omega_{dm}=20.7 \pm 5\%$

Dark Energy:

$\Omega_{\Lambda} = 75 \pm 3\%$

Gravity Waves

Ω_{GW} ~10^{-14} - 10^{-10} LIGO

$\Omega_{BlackHoles}$ ~10^{-7}