两岸粒子物理与宇宙学研讨会
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Problematic *WMAP* Cosmology

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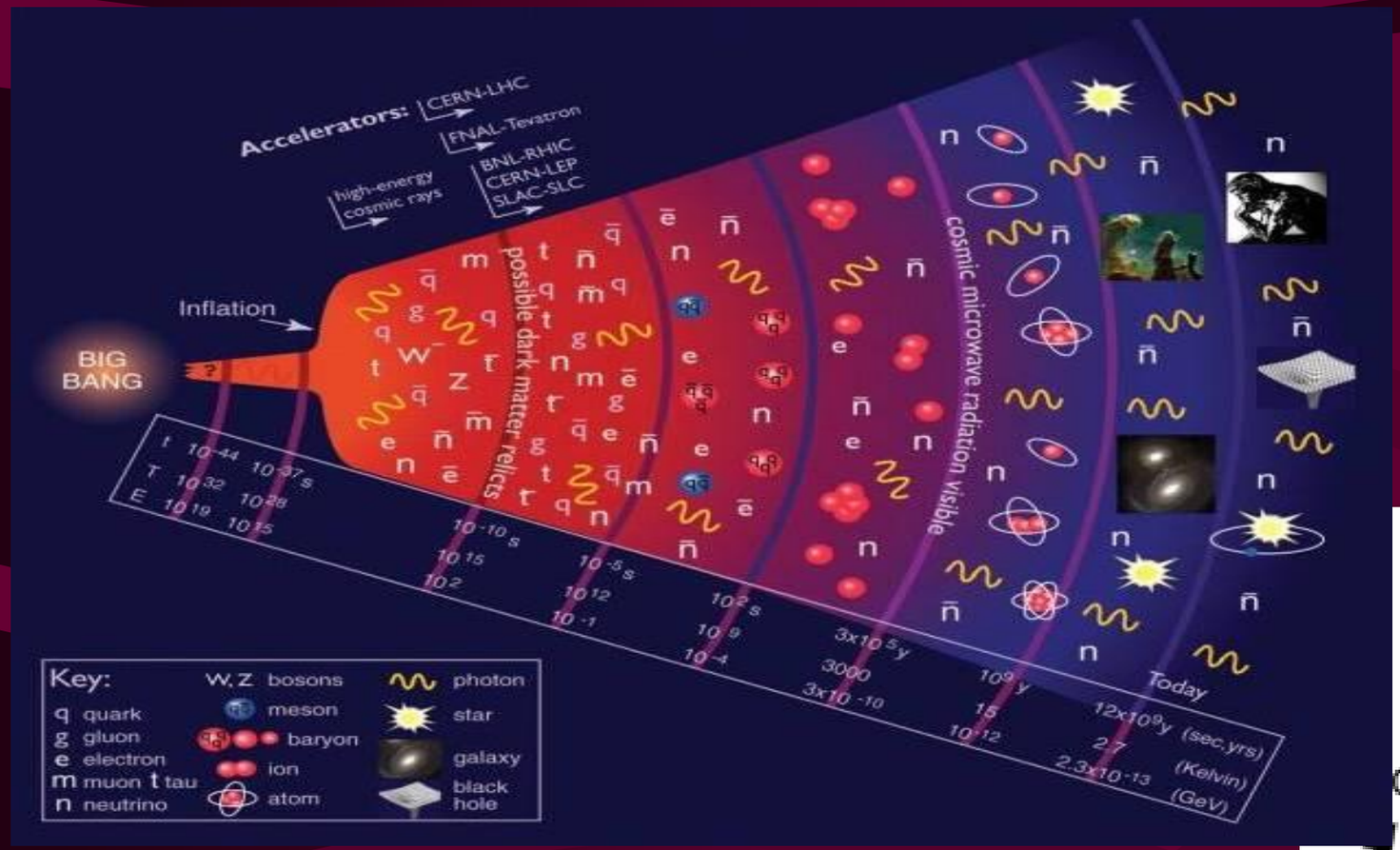
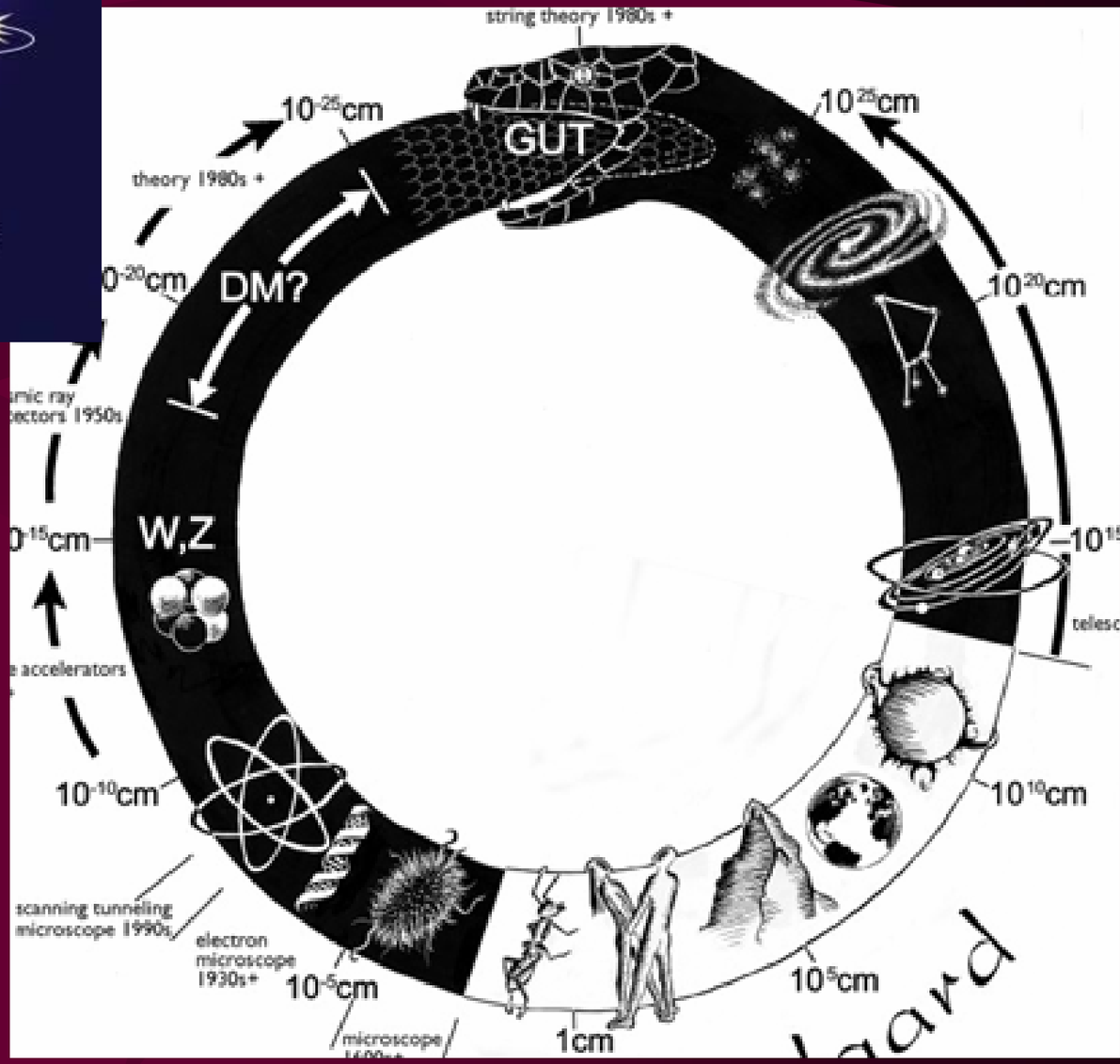
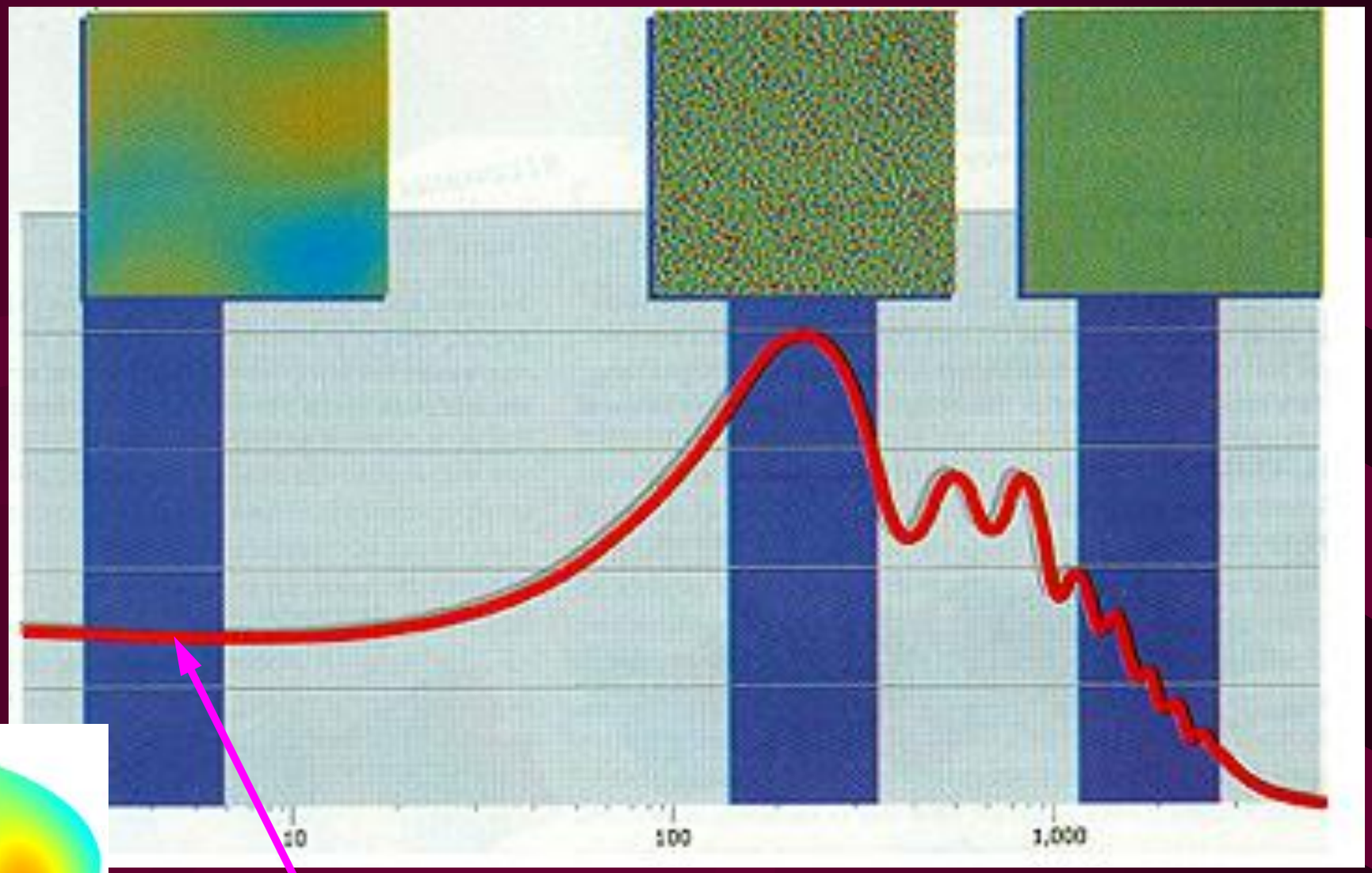
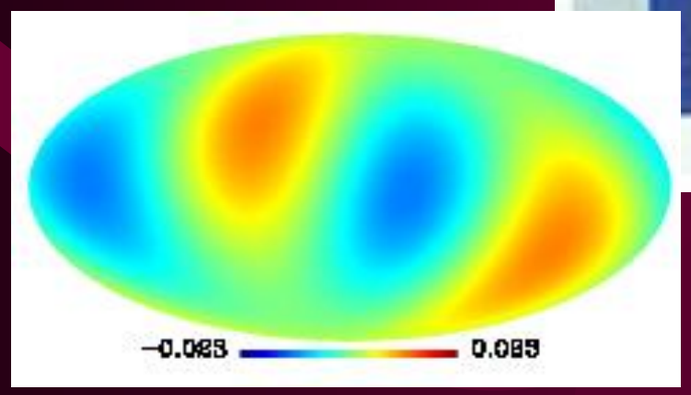
I. Dipole effect on CMB map
II. Artificial anisotropy in *WMAP* CMB map
III. What about *Planck* ?
IV. Impact on cosmology and physics


Accelerators:
CERN-LHC
FNAL-Tevatron
BNL-RHIC
CERN-LEP
SLAC-SLC
high-energy cosmic rays
Inflation
BIG BANG
possible dark matter relics
cosmic microwave radiation visible
Today
Key:
q quark
g gluon
e electron
m muon t tau
n neutrino
W,Z bosons
meson
baryon
ion
atom
photon
star
galaxy
black hole


string theory 1980s +
10^{-25}cm
GUT
10^{25}cm
theory 1980s +
10^{-20}cm
DM?
10^{20}cm
10^{-15}cm
W,Z
10^{-10}cm
10^{10}cm
scanning tunneling microscope 1990s
electron microscope 1930s+
10^{-5}cm
10^{5}cm
1cm



$$Q \approx 1000\ \mu\mathrm{K}^2$$

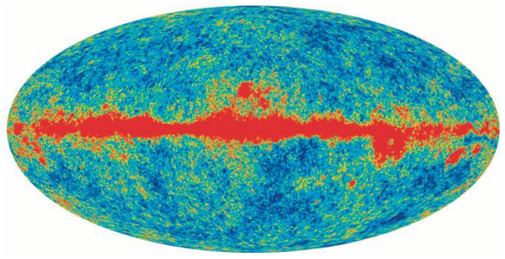


ΛCDM

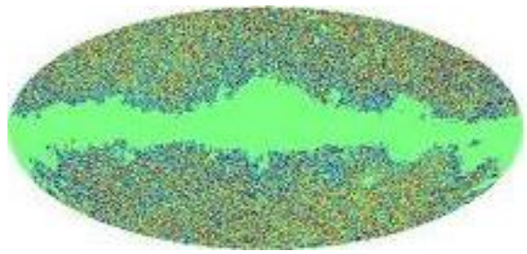
I. Dipole Effect on CMB Map

1、 Contaminations in CMB Experiments

(1) Foreground



mask



- **radio sources**
- **diffuse foreground**

process	template
dust emission	T_d
free-free emission	T_H
synchrotron emission	T_s

template fits

$$T_{clean} = T_{obs} - (c_d T_d + c_H T_H + c_s T_s)$$

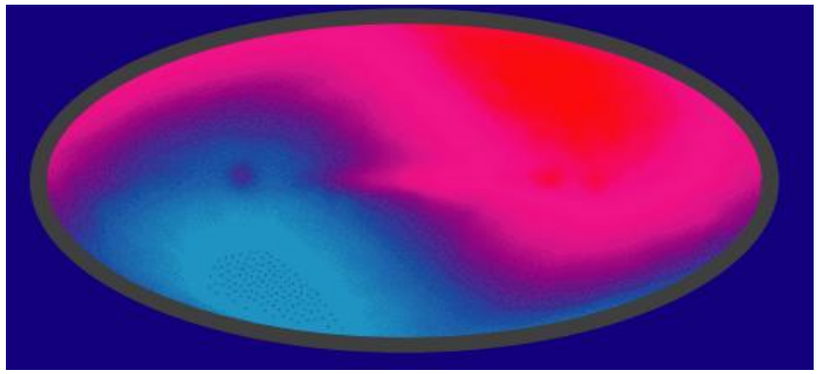
$$\mathrm{Var}\,(T_{clean}) = \min \longrightarrow c_d \; c_H \; c_s$$

“aesthetic criteria”

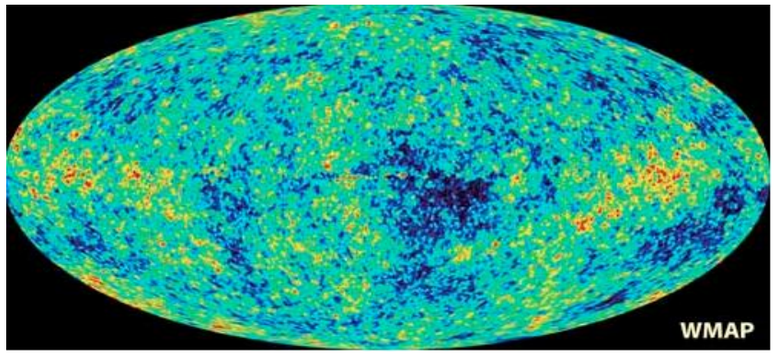
(2)、Dipole contamination

- Dipole's amplitude

$$T_{dipole}(t) = \frac{T_0}{c}\,\mathbf{v}(t)\cdot\mathbf{n}(t)$$



$\Delta T_d \sim 3\,\mathrm{mK}$



$\Delta T_{CMB} \sim 50\,\mu\mathrm{K}$

(3) Error in calculated dipole $T_d = \frac{T_0}{c}\mathbf{v}\cdot\mathbf{n}$

- CMB dipole direction

$$\Delta T_d = \frac{T_0}{c}\Delta\mathbf{v}\cdot\mathbf{n}$$

$$\Delta \mathrm{v} \sim 10' \Rightarrow \Delta T_d \sim 30\,\mu\mathrm{K} \quad (\Delta T_{CMB} \sim 50\,\mu\mathrm{K})$$

- Sidelobe contamination

$$T_s(p(t)) = \sum_{p'_s} G'(p'_s) T_d(p_s)/N \qquad T_{CMB}(p) = T(p) - T_s(p)$$

$$\Delta T_s(p(t)) = \frac{T_0}{c}\mathbf{v}'(t)\cdot\sum_{p'_s}\frac{\Delta G'(p'_s)}{N}\mathbf{n}'(p'_s) = \frac{T_0}{c}\mathbf{v}'(t)\cdot\Delta\mathbf{n}'_s$$

$$\Delta\mathbf{n}'_s \sim 10'$$

（4）Remove dipole-error-induced deviation

- Produce template maps

  ΔT_x : take $\Delta \mathrm{n} = \Delta \mathrm{n}_\mathrm{x} = 1'$, along the scan path $\{p(t)\}$

  calculate temperature deviation $\Delta T_x(p) = -\frac{T_0}{c}\,\mathrm{v}(t)\cdot \Delta \mathrm{n}_\mathrm{x}$

  ΔT_y :

  ΔT_z :

- Produce cleaned map

$$T_{clean} = T_{obs} - (c_x \Delta T_x + c_y \Delta T_y + c_z \Delta T_z)$$

$$\mathrm{Var}(T_{clean}) = \min \Rightarrow c_x \;\; c_y \;\; c_z$$

“aesthetic criteria”

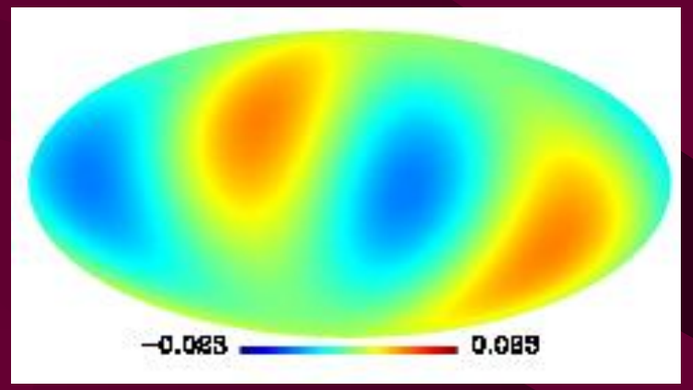
After correcting the timing error

$$Q_{Clean} \approx (-3.2 \pm 3.5)\,\mu\mathrm{K}^2$$

WMAP raw data + (our pipeline + 7' offset)

WMAP release

Axis of Evil

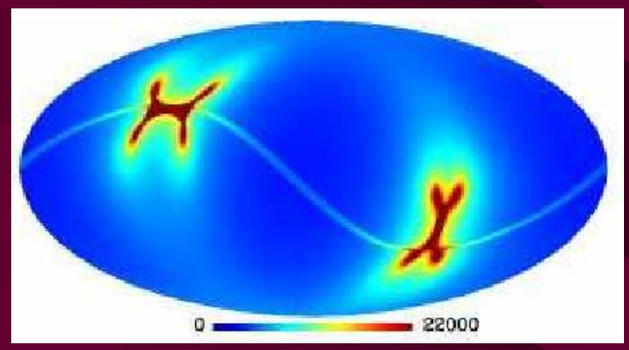


$$Q_{WMAP} \approx 113\,\mu\mathrm{K}^2$$

III. What about *Planck* ?

Can *Planck* abstain from the artificial anisotropy induced by dipole error + scan ?

- timing/pointing
- dipole direction
- sidelobe contamination



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OBSERVATIONAL SCAN-INDUCED ARTIFICIAL COSMIC MICROWAVE BACKGROUND ANISOTROPY

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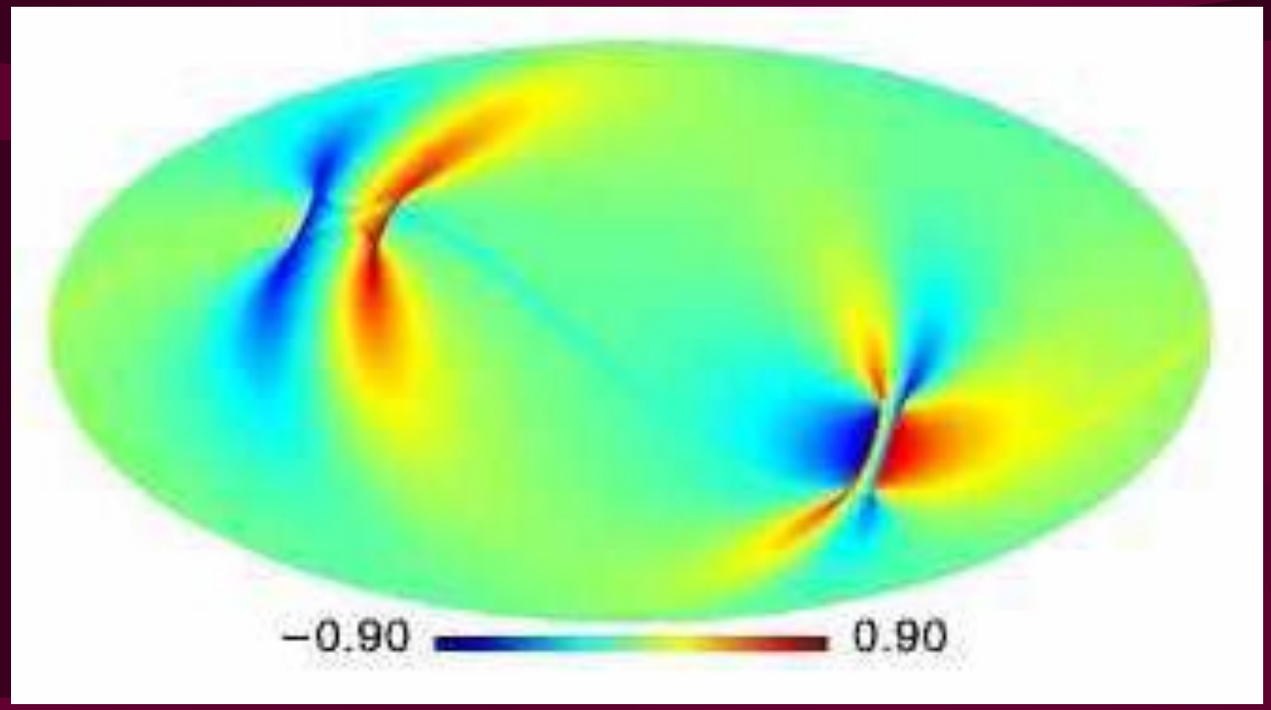
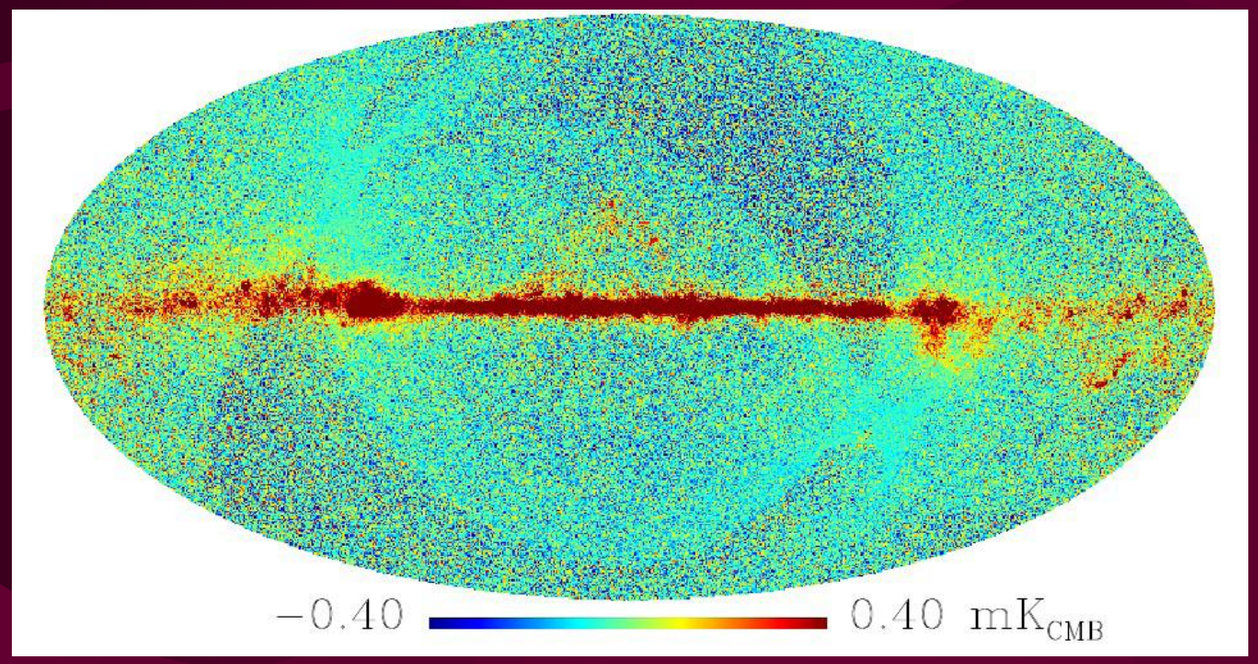
"The scan-induced anisotropy is a common problem for all sweep missions and, like the foreground emissions, has to be removed from observed maps. Without doing so, CMB maps from *COBE*, *WMAP*, and *Planck* as well, are not reliable for studying the CMB anisotropy."



Liu & Li 2011 *ApJ*



Planck 2011

IV. Impact on Cosmology and Physics

A&G
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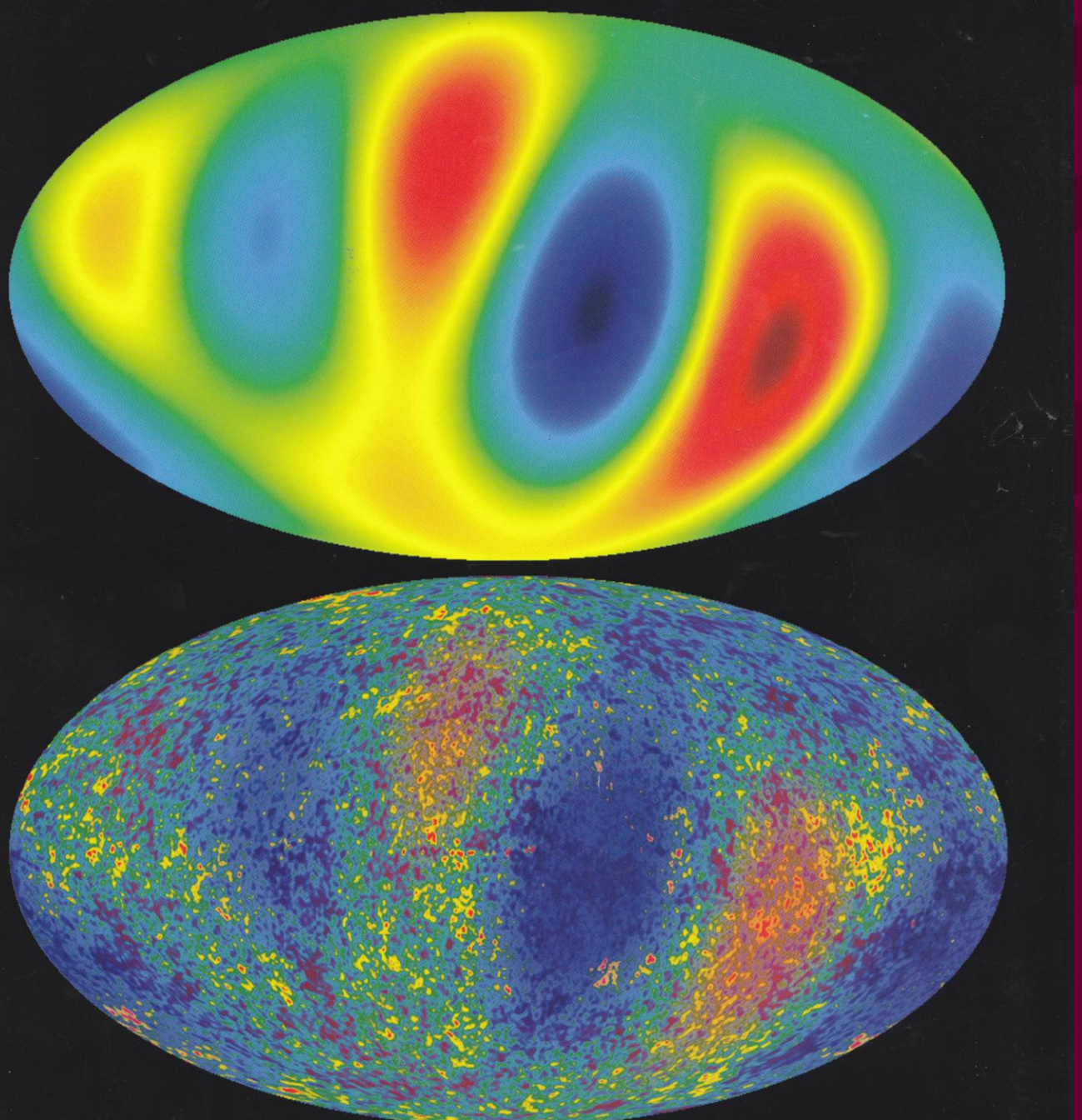
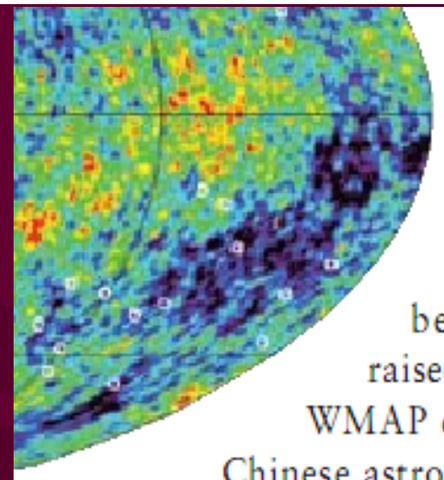
October 2010 • Vol. 51 • Issue 5

WMAP cosmology questioned

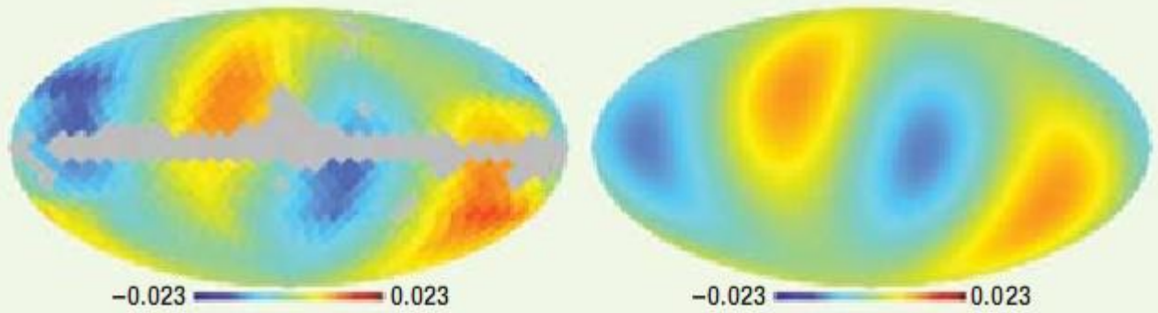


Is everything we know about the universe wrong?

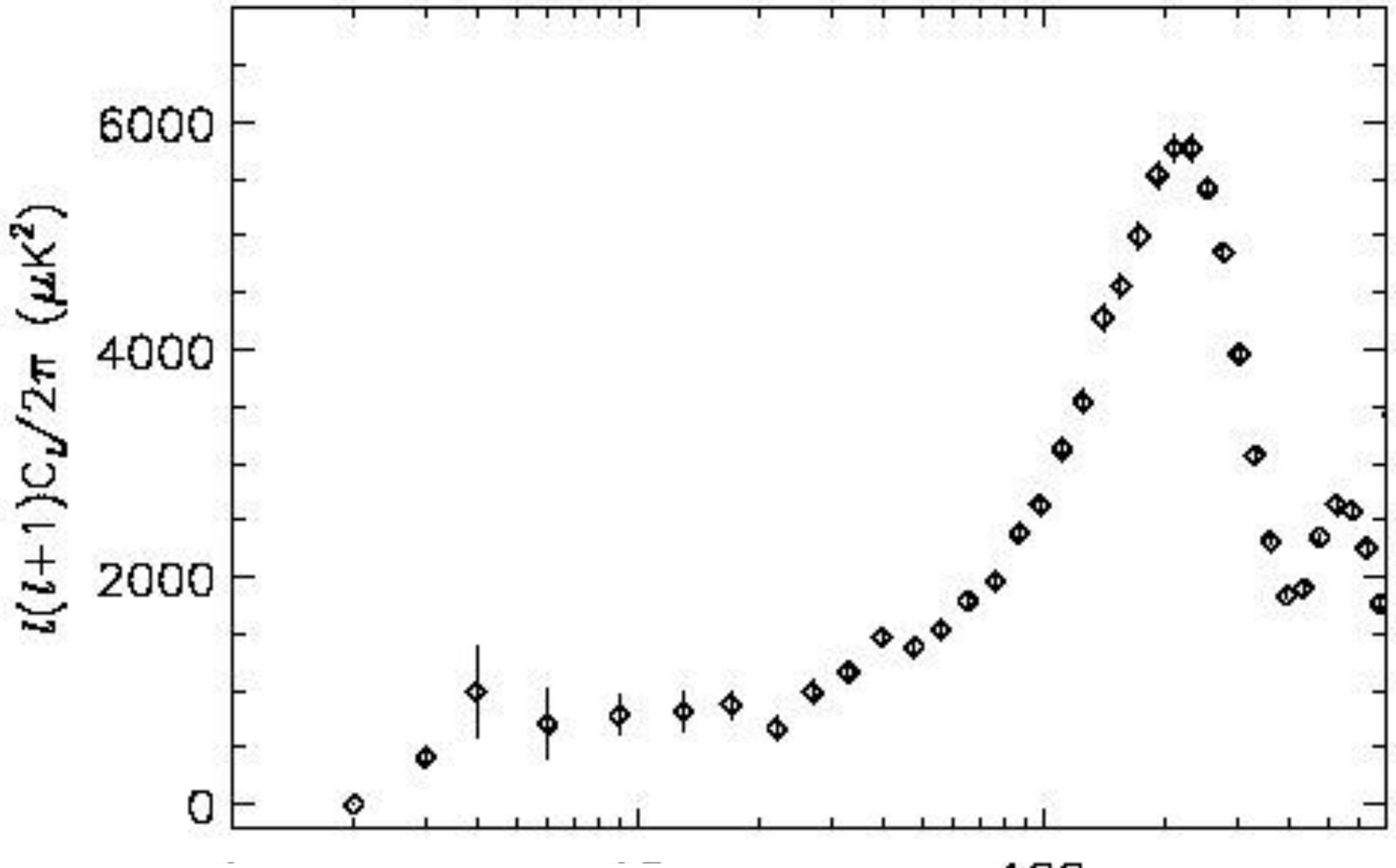


Axis of evil and 25.6 ms

Since our WMAP beam paper was submitted there have been other criticisms raised about the official WMAP data reduction. Two Chinese astronomers, Liu and Li (2010), have suggested that confusion over a tiny 25.6 ms offset between recorded timings of where WMAP was pointing and when the CMB temperature was measured may be enough to explain several anomalies found at very large scales in the official WMAP maps. Various authors have remarked that the largest scale components (quadrupole etc) align with the ecliptic. These anomalies are usually termed



3 (Left): The temperature map produced from the Liu and Li (2010) simulation comprising only a dipole and map-making software including the 25.6ms timing offset with no inclusion of primordial fluctuations. (Right): The official WMAP CMB large-scale (quadrupole) "map". Both panels are in galactic coordinates and in units of mK. There is a remarkable similarity between the large-scale (quadrupole) features in both maps even though the simulated map knows nothing about the real universe! (Liu and Li 2010)

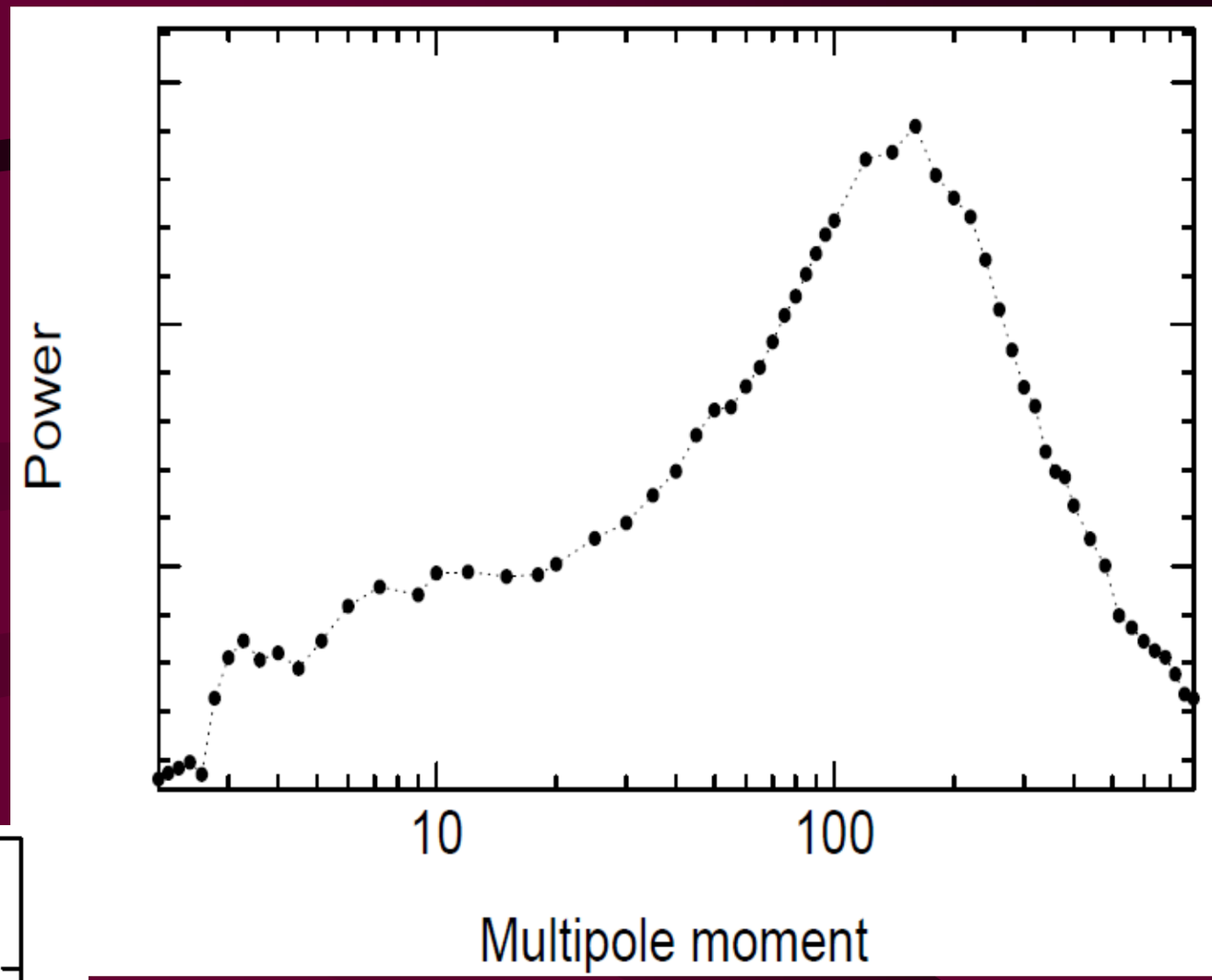


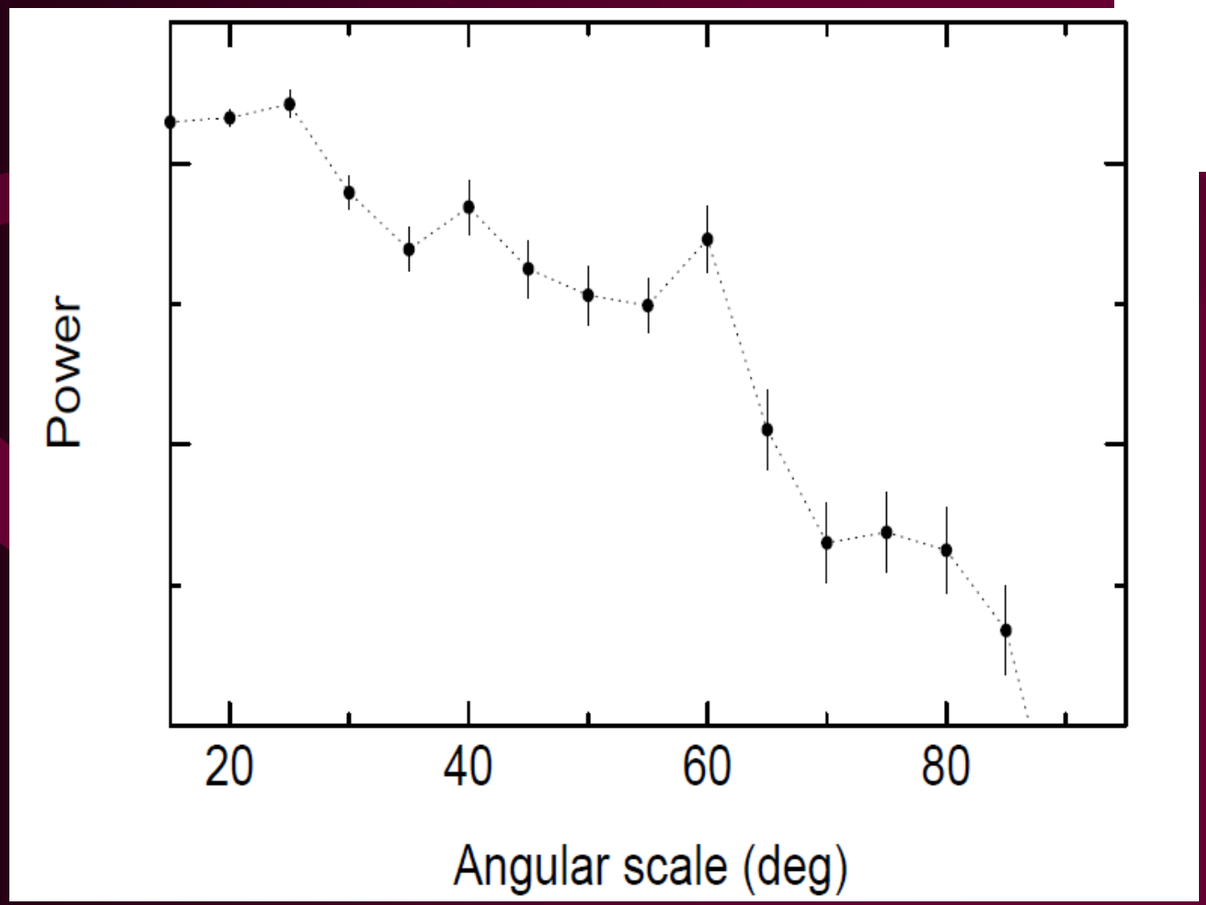
$$Q_{Clean} \approx (-3.2 \pm 3.5)\,\mu\mathrm{K}^2$$

→ Cold and stable very early universe

no quantum fluctuation?

Large scale CMB — a window to the early universe





- Accelerating Universe

⇒ G + Λ in the present universe

- Zero Quadrupole

⇒ Λ + G in the very early universe

3、新物理

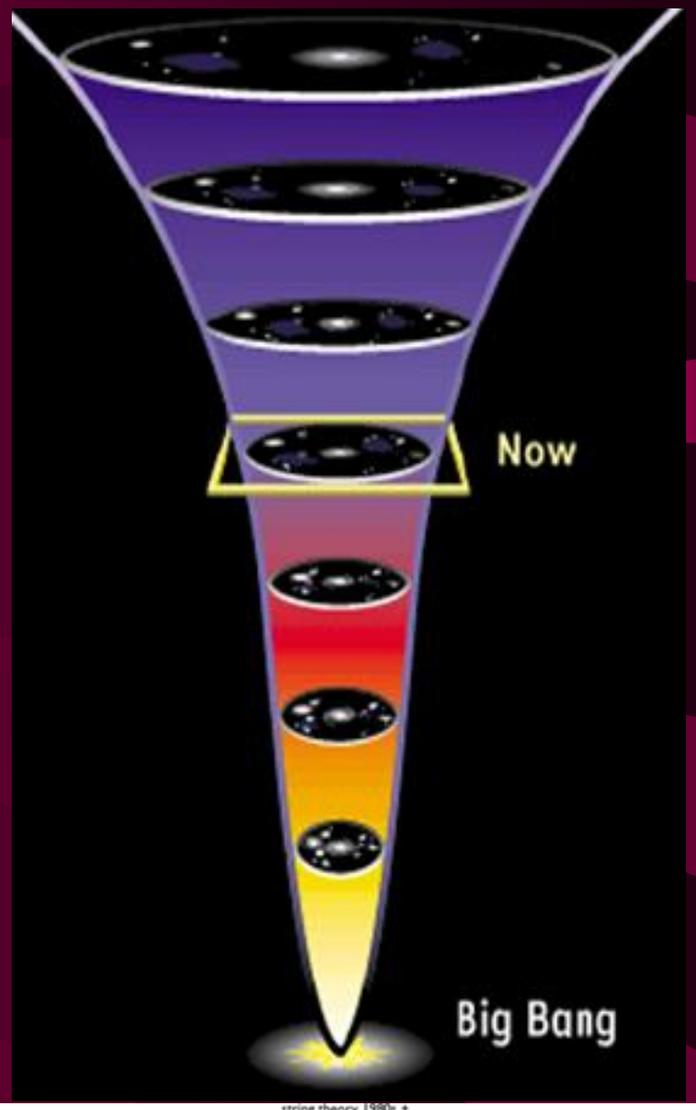
大统一？

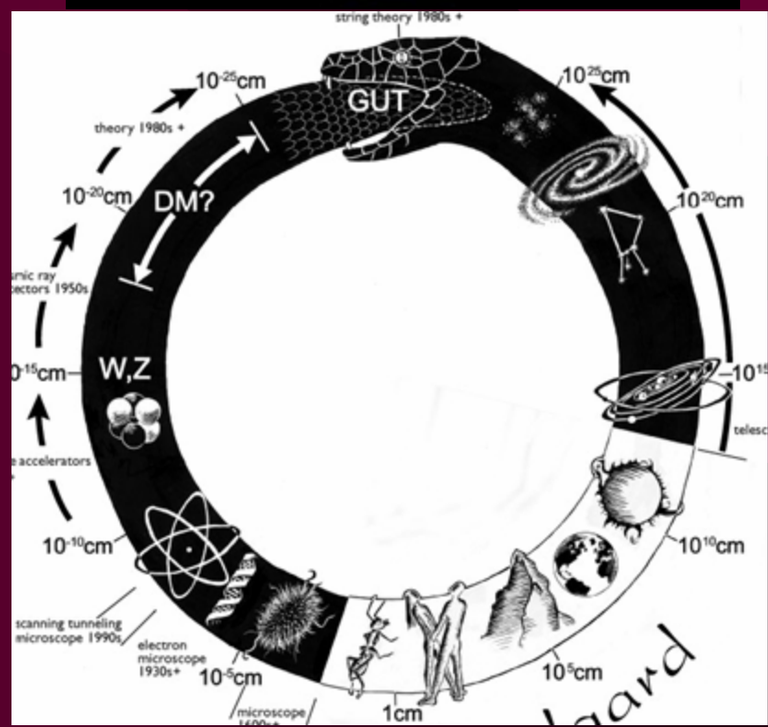
泰勒斯： 万物皆由水构成

赫拉克利特:

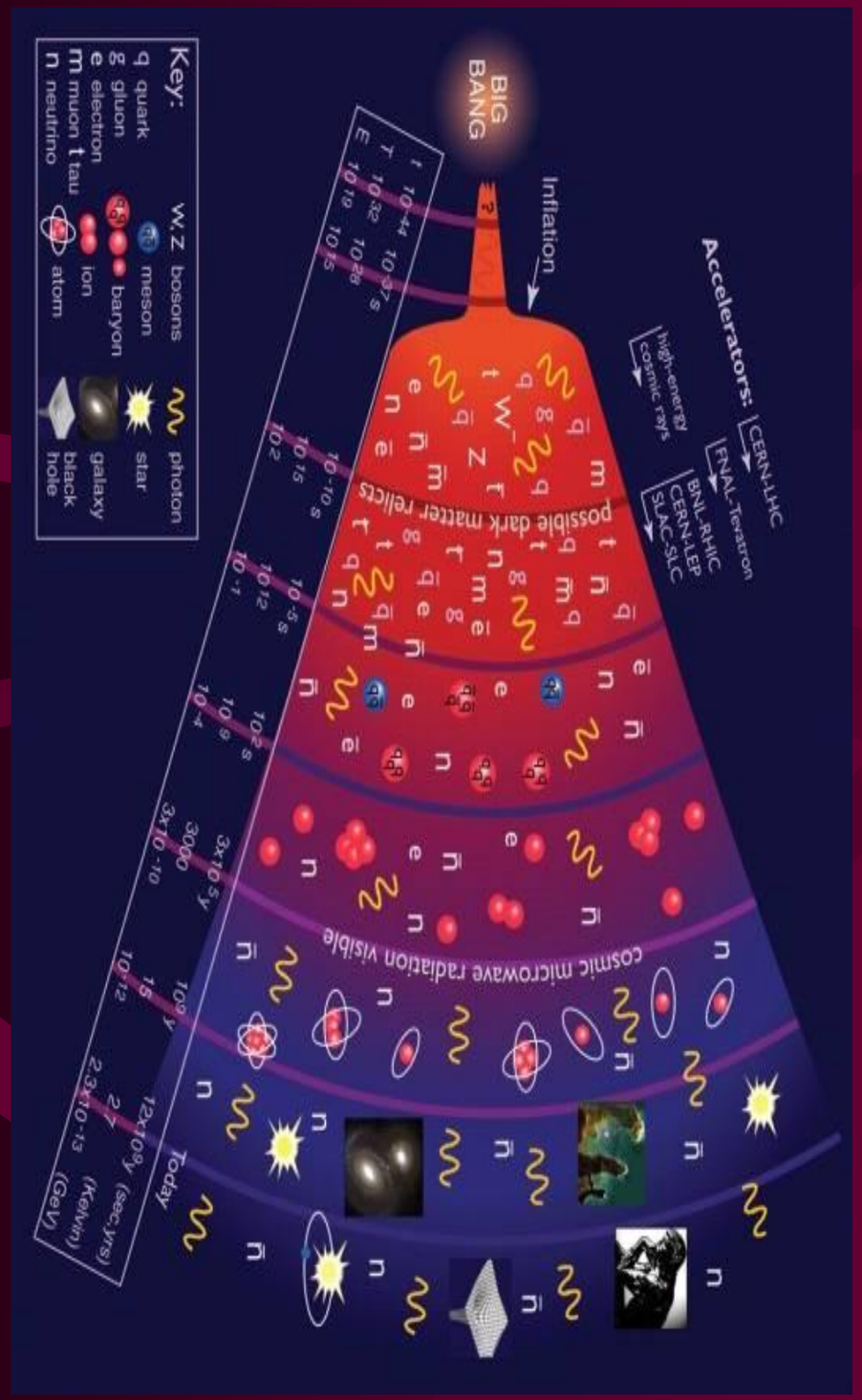
从一切产生一，从一产生一切

Planck → 大统一 → 一切





宇宙的热历史



温度（K）	能量（eV）	时间（秒）	时代	物理过程
10^{32}	10^{28}	10^{-44}	Planck	
10^{28}	10^{24}	10^{-36}	大统一	
		$10^{-35,-33}$	暴胀	暴胀
10^{15}	10^{11}	10^{-10}	电弱统一	
10^{13}	10^{9}	10^{-6}	强子	夸克禁闭
10^{11}	10^{7}	10^{-2}	轻子	
10^{10}	10^{6}	1	弱力出现	中微子脱耦
5×10^{9}	5×10^{5}	5	电子对湮灭	电子对湮灭
10^{9}	10^{5}	10^{2} (3分)	核合成	轻核素生成
3×10^{3}	0.3	10^{13} (30万年)	复合	物质－辐射退耦 宇宙背景辐射
		10^{16} (4亿年)	第一代恒星生成	再电离
			星系；星系团	大尺度结构形成 开始加速膨胀
2.7	3×10^{-4}	4×10^{17} (137亿年)	现代	

道生一

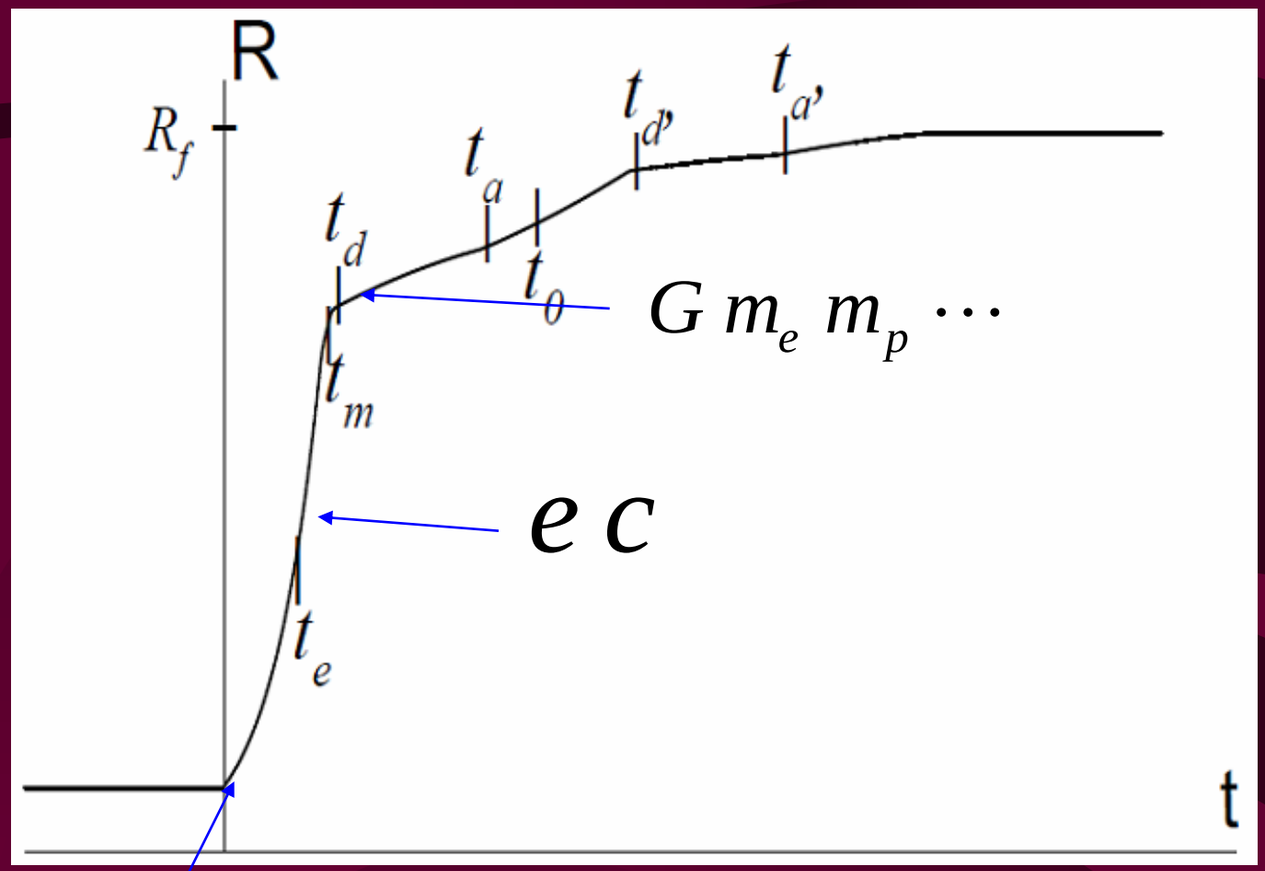
一生二

二生三

三生万物

万物负阴而抱阳

冲气以为和



$R_i\ \Lambda_a\ \Lambda_r$:随机

道 → 一 → 引 斥 → 引、斥 希格斯场 → M DE

“统一” 新物理

A R (h)

: Thank you

Key Lab. of Particle Astrophysics IHEP/CAS

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