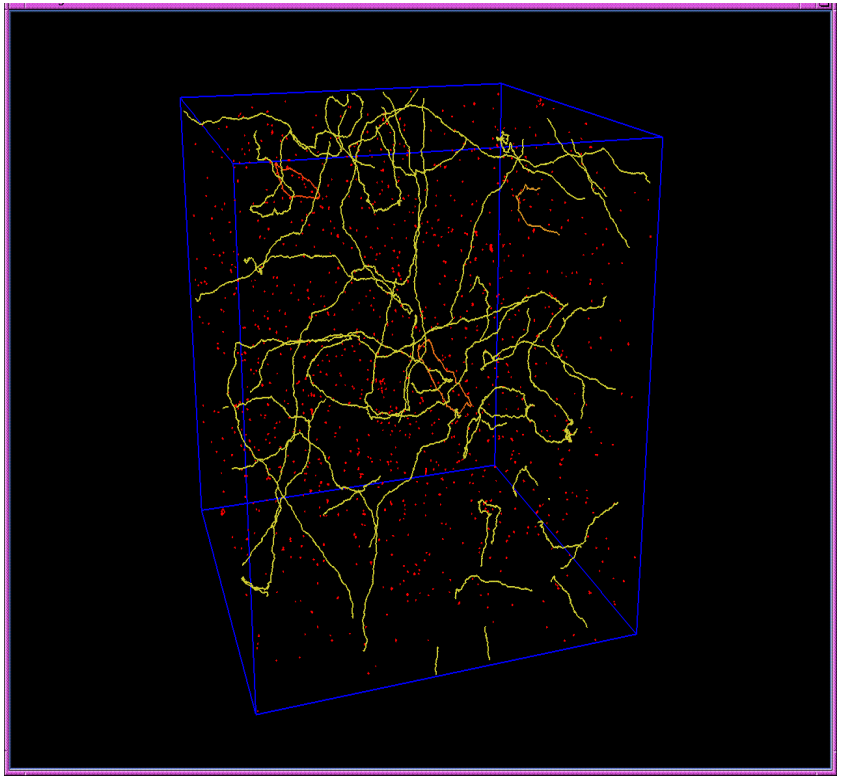
FUTURE OPPORTUNITIES FOR THE DETECTION OF TOPOLOGICAL DEFECTS



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STRINGS IN THE ABELIAN-HIGGS MODEL

LAGRANGIAN : $\mathcal{L} = |D_\mu \Phi|^2 - \frac{1}{4} F_{\mu\nu} F^{\mu\nu} - \frac{1}{4}\lambda \left(|\Phi|^2 - \eta^2\right)^2$

VORTEX FIELD CONFIGURATION

$$\Phi(r,\theta) = f(r)\exp[in\theta]$$

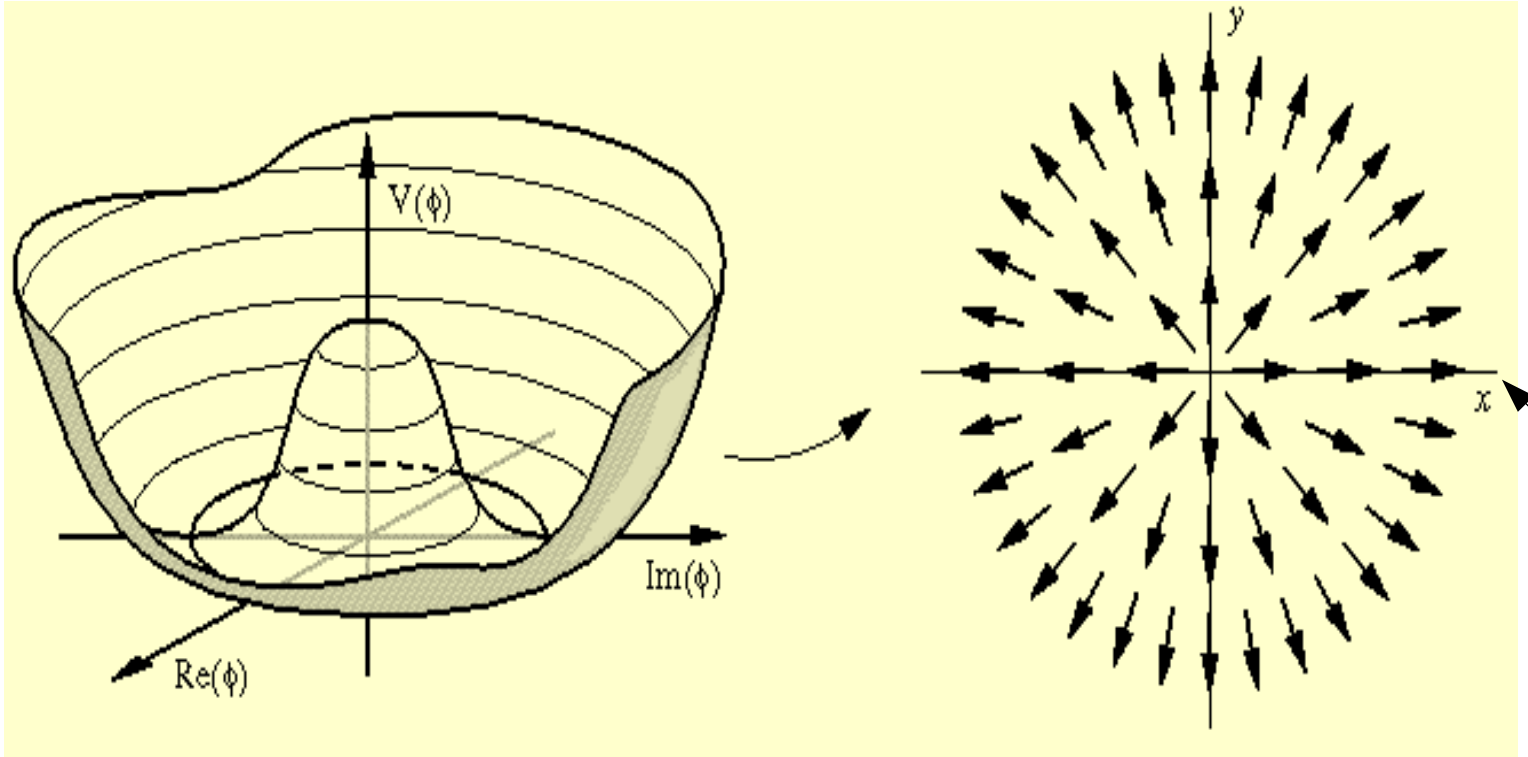
$$A_\theta(r) = \frac{n\alpha(r)}{er}$$

MASS / UNIT LENGTH

$$G\mu \approx \left(\frac{\eta}{M_{\rm pl}}\right)^2$$

CORE WIDTH

$$\Delta \sim \eta^{-1}$$

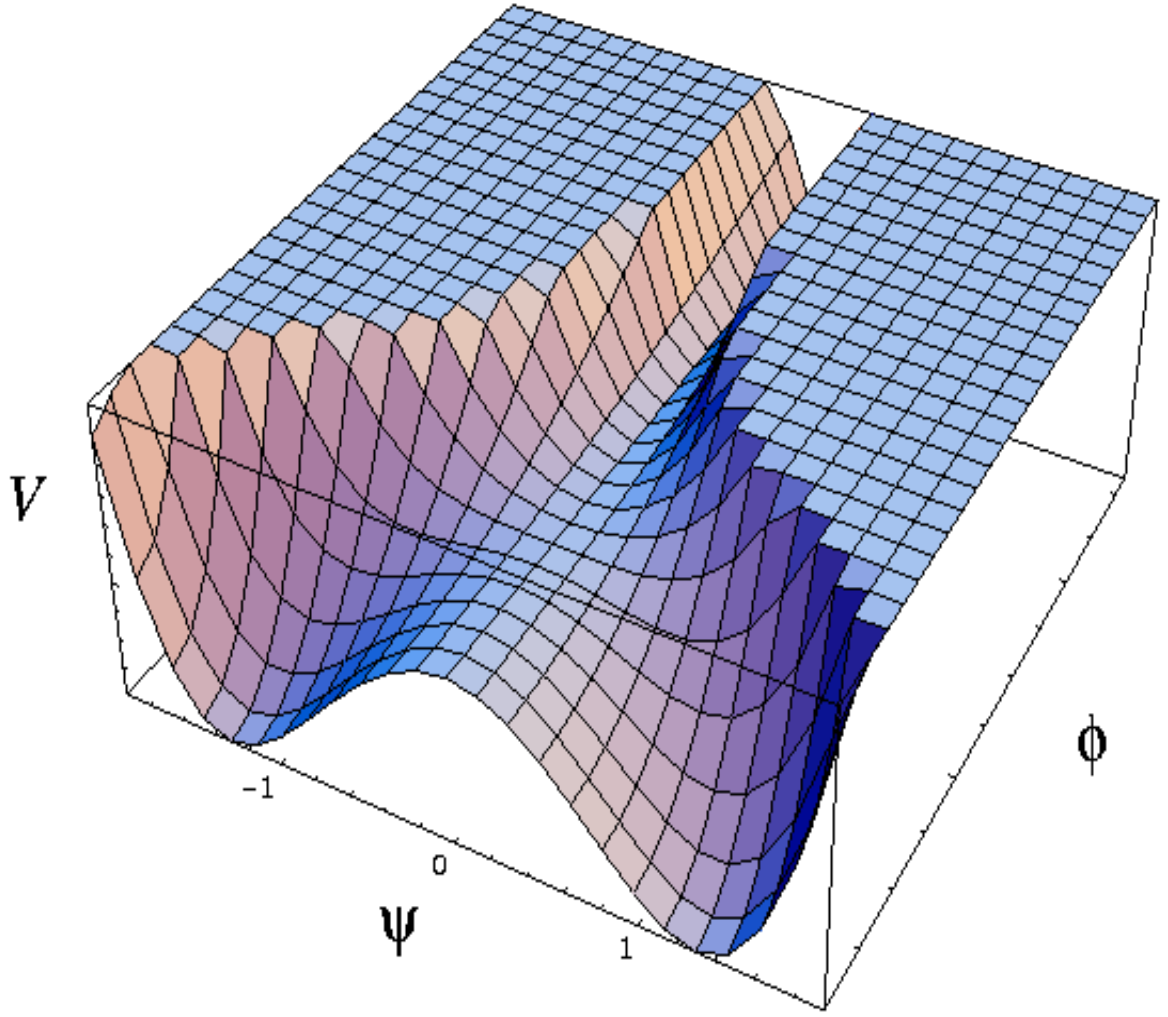


VORTEX FIELD CONFIGURATION

(LINDE 1994,
COPELAND et al 1994)

HYBRID INFLATION

$$V(\phi,\psi) = \frac{1}{2}m^2\phi^2 + \frac{\lambda}{4}(|\psi|^2 - \eta^2)^2 + \frac{1}{2}g\phi^2|\psi|^2$$



INFLATON DIRECTION
DESTABILIZED AT

$$\phi_c = \sqrt{\frac{\lambda\eta^2}{g}}$$

$$\phi > \phi_c \quad \rightarrow \quad m_\psi^2 > 0$$

$$\phi < \phi_c \quad \rightarrow \quad m_\psi^2 < 0$$

PHASE TRANSITION
& FORMATION OF STRINGS

A FEW NUMBERS !

$$\frac{\Delta T}{T} \sim \frac{\Delta \rho}{\rho} \sim 8\pi G\mu \sim 10^{-5}$$ for a GUT scale phase transition

Models which produce topological defects are constrained to have low, possibly undetectable inflation generated B-modes

Consider a potential : $V(\phi) = V_0 F(\phi/M_{\rm pl})$

Typically, one finds $\frac{G\mu}{c^2} = 2\pi a \left(\frac{V_0}{M_{\rm pl}}\right)^{1/2}$

a is model dependent

$$\rightarrow \mathcal{P}_{\rm T} \propto \left(\frac{G\mu/c^2}{a}\right)^2 F(\phi/M_{\rm pl}) \quad \& \quad r < 10^{-3}\frac{F}{a^2}$$

Examples : $F(x) = 1 - \frac{\gamma}{x^4}$, $F(x) = A + B\log x$, $F(x) = 1 + Ax^p$

Brane inflation

SUSY hybrid inflation

WAYS TO DETECT COSMIC STRINGS

- Temperature power spectrum

  - strongest present limit which will be improved by Planck

- Direct detection of the Kaiser-Stebbins effect

  - line-like discontinuities
  - non-Gaussianity

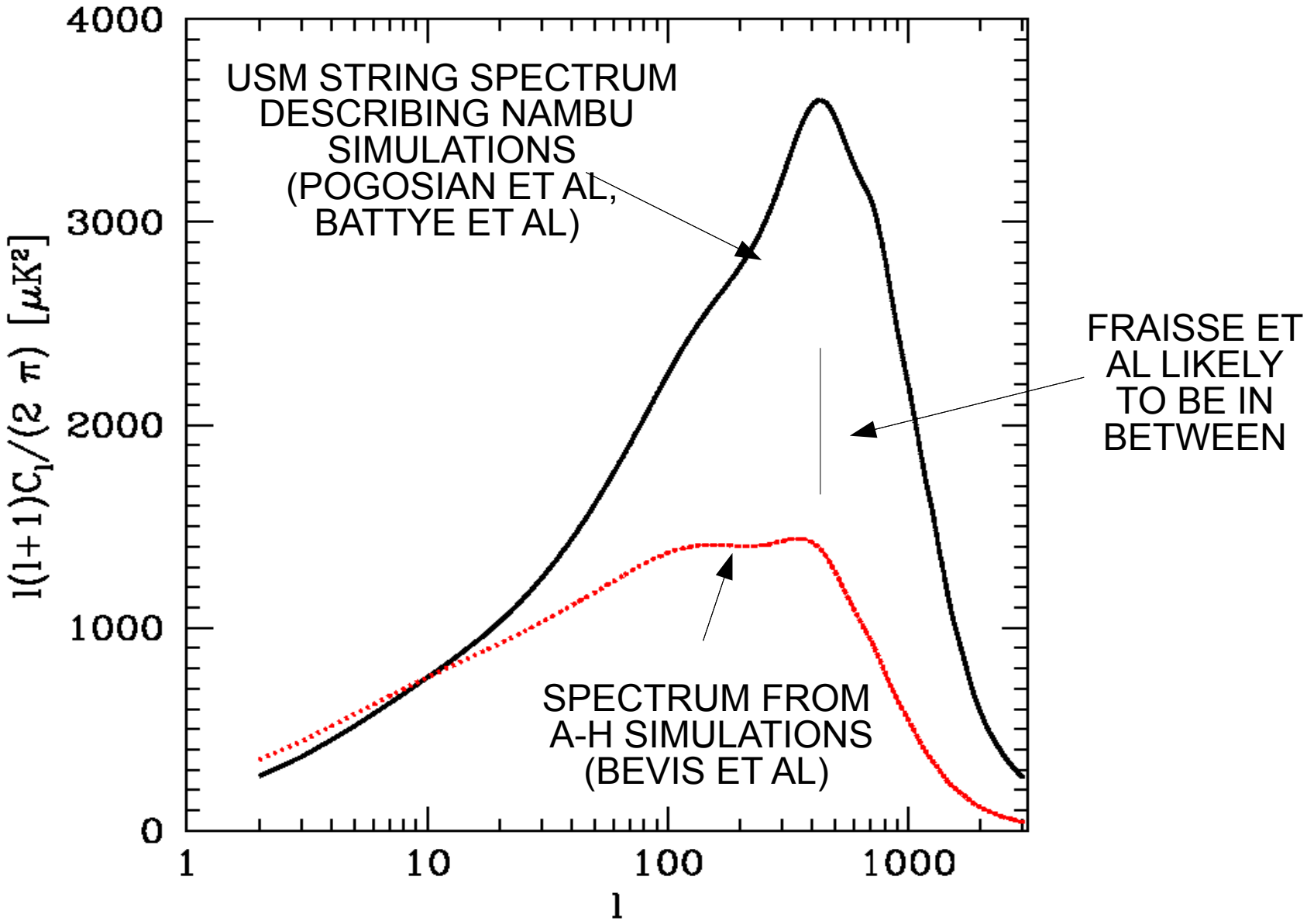
- B-modes

  - defect models naturally produce vector and tensor modes

- Pulsar timing / Gravitational lensing etc

  - no relevant to the discussion here

2 POSSIBLE STRING SPECTRA

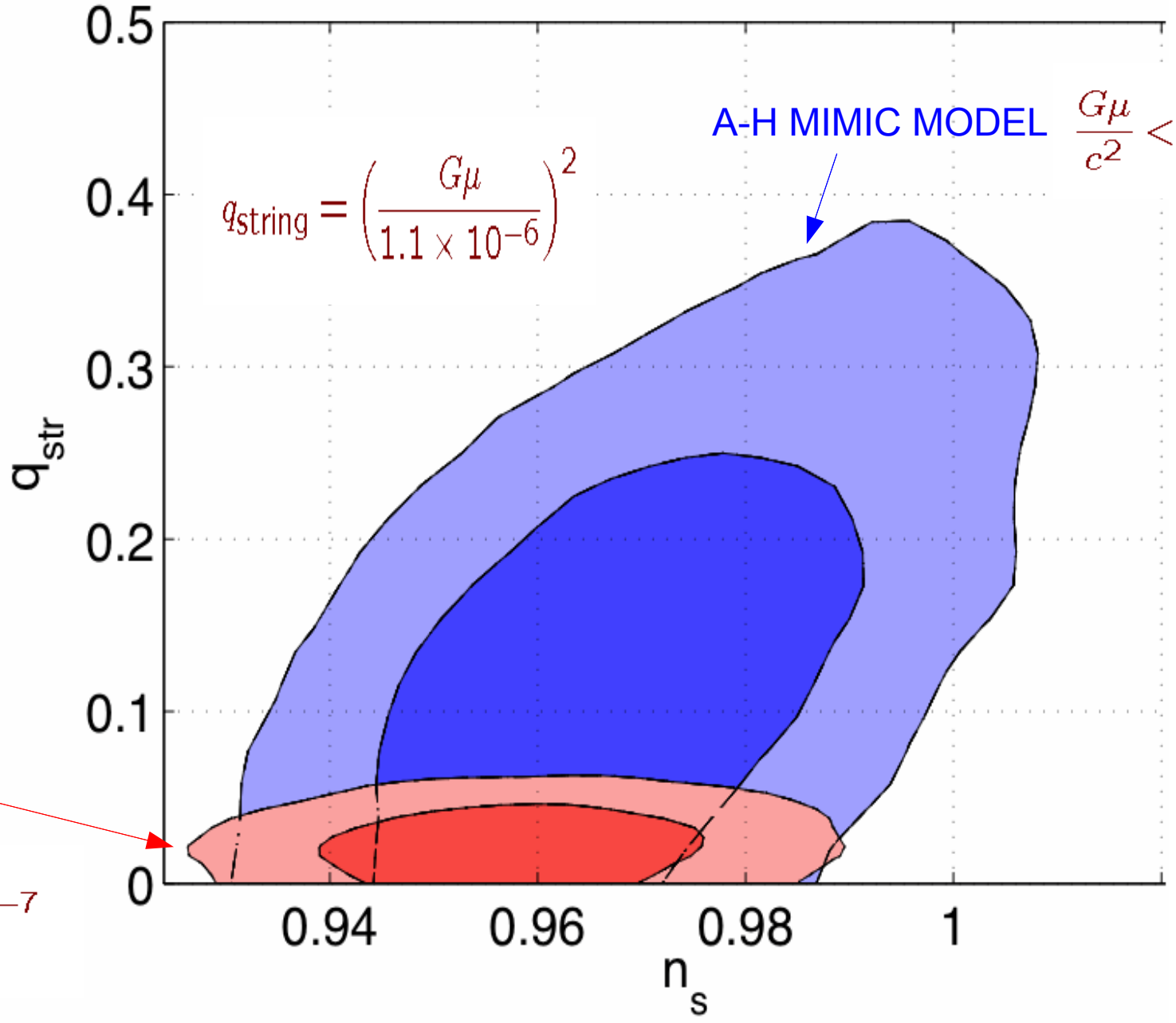


NEITHER LOOK LIKE THE WMAP DATA – CONSTRAIN A SUBDOMINANT COMPONENT !

UP TO DATE CONSTRAINTS

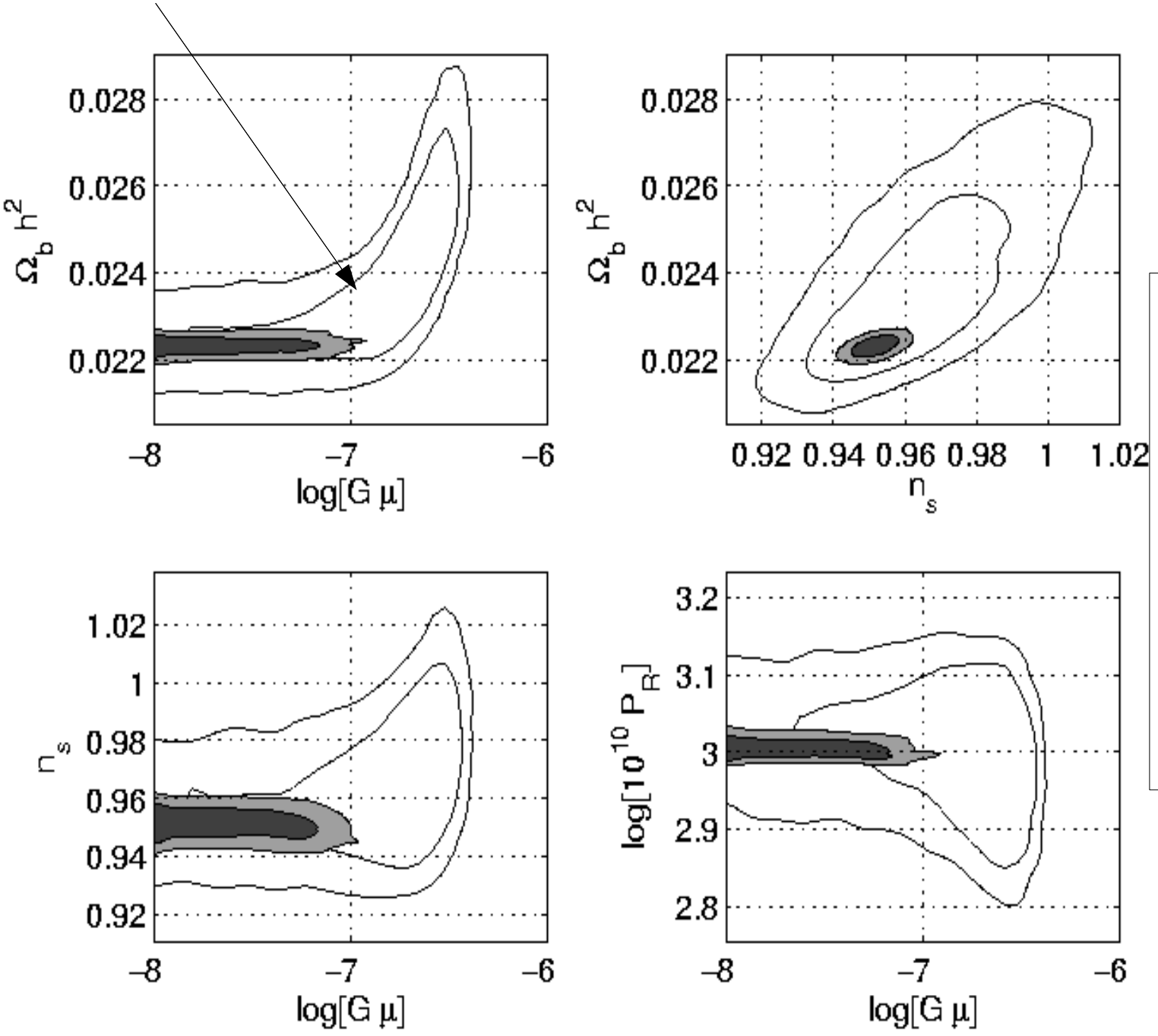
(Battye & Moss, 2010)

BASED ON CMB (WMAP5+OTHERS) + SDSS (TEGMARK ET AL) + BBN (PETTINI ET AL)



SIMULATED PLANCK DATA

(Battye, Garbrecht, Moss, Stoica, 2008)



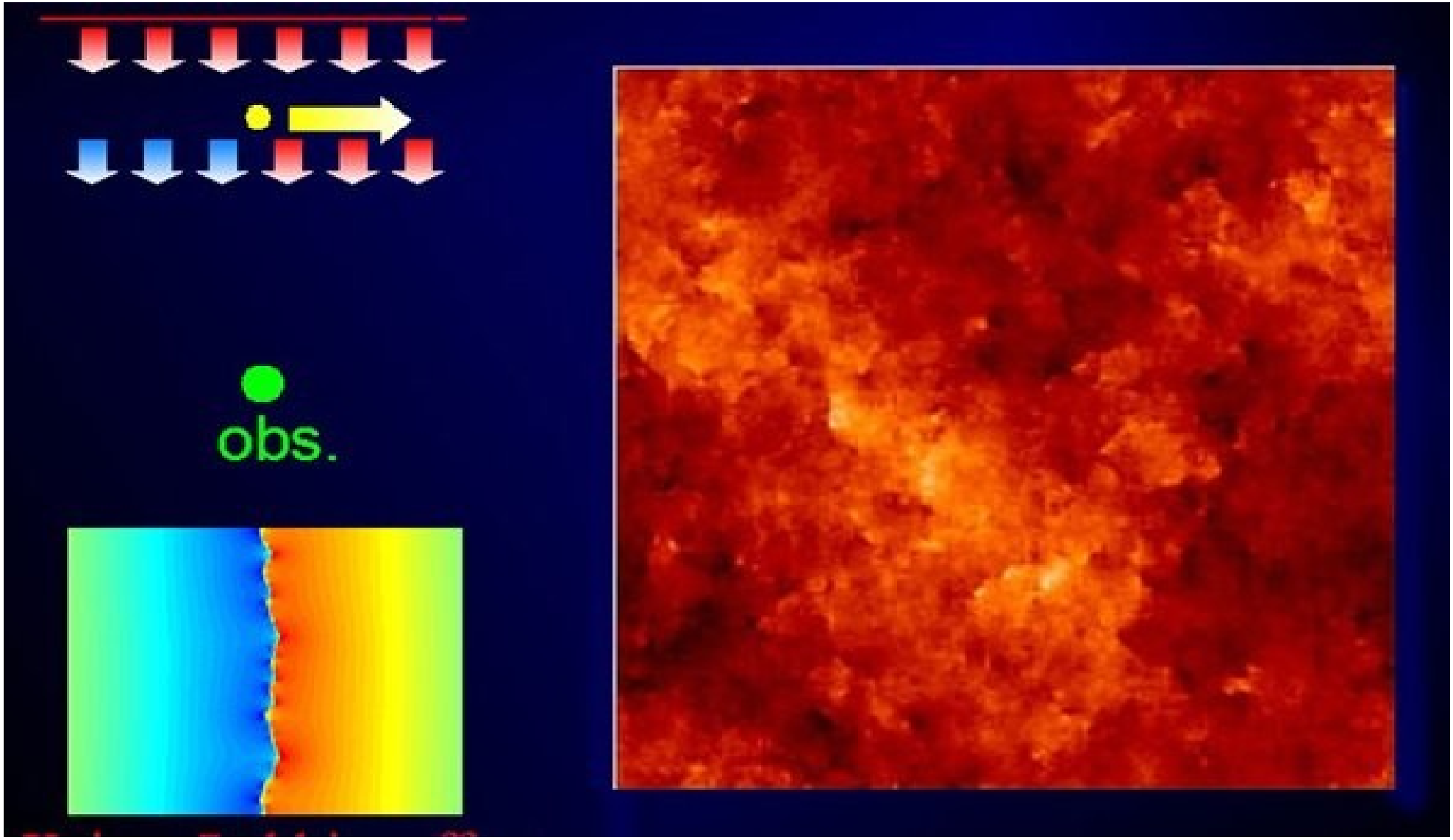
Projected constraint

$$\frac{G\mu}{c^2} < 7 \times 10^{-8}$$

based on TT, TE & EE

DIRECT DETECTION & NON-GAUSSIANITY

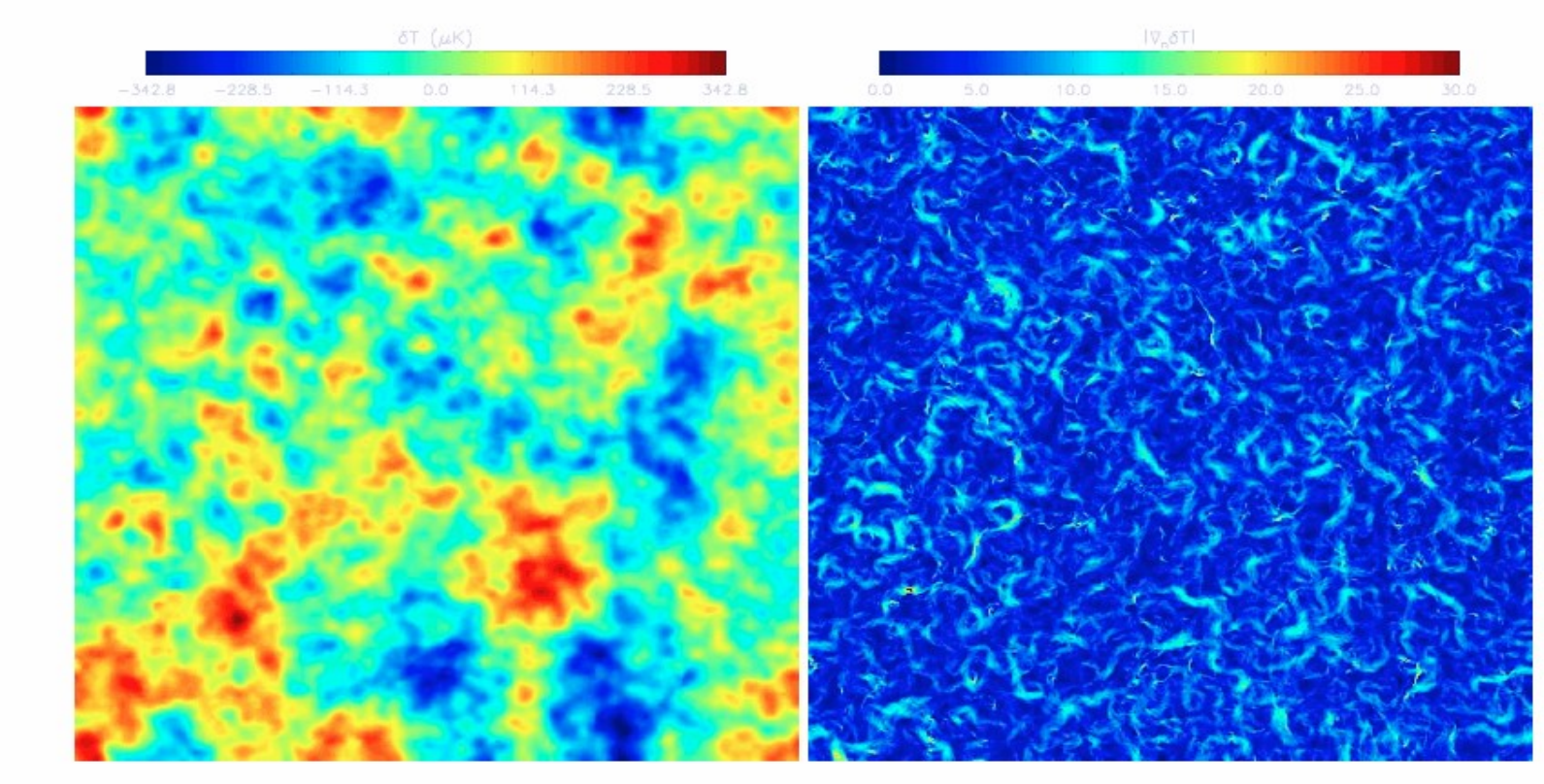
KAISER-STEBBINS EFFECT



CMB ANISOTROPY : $\frac{\Delta T}{T} = 8\pi G\mu\gamma v$

(Bennett, Bouchet. Stebbins)

RECENT WORK



(Fraisse,Ringeval, Spegel & Bouchet, 2008)

Temperature

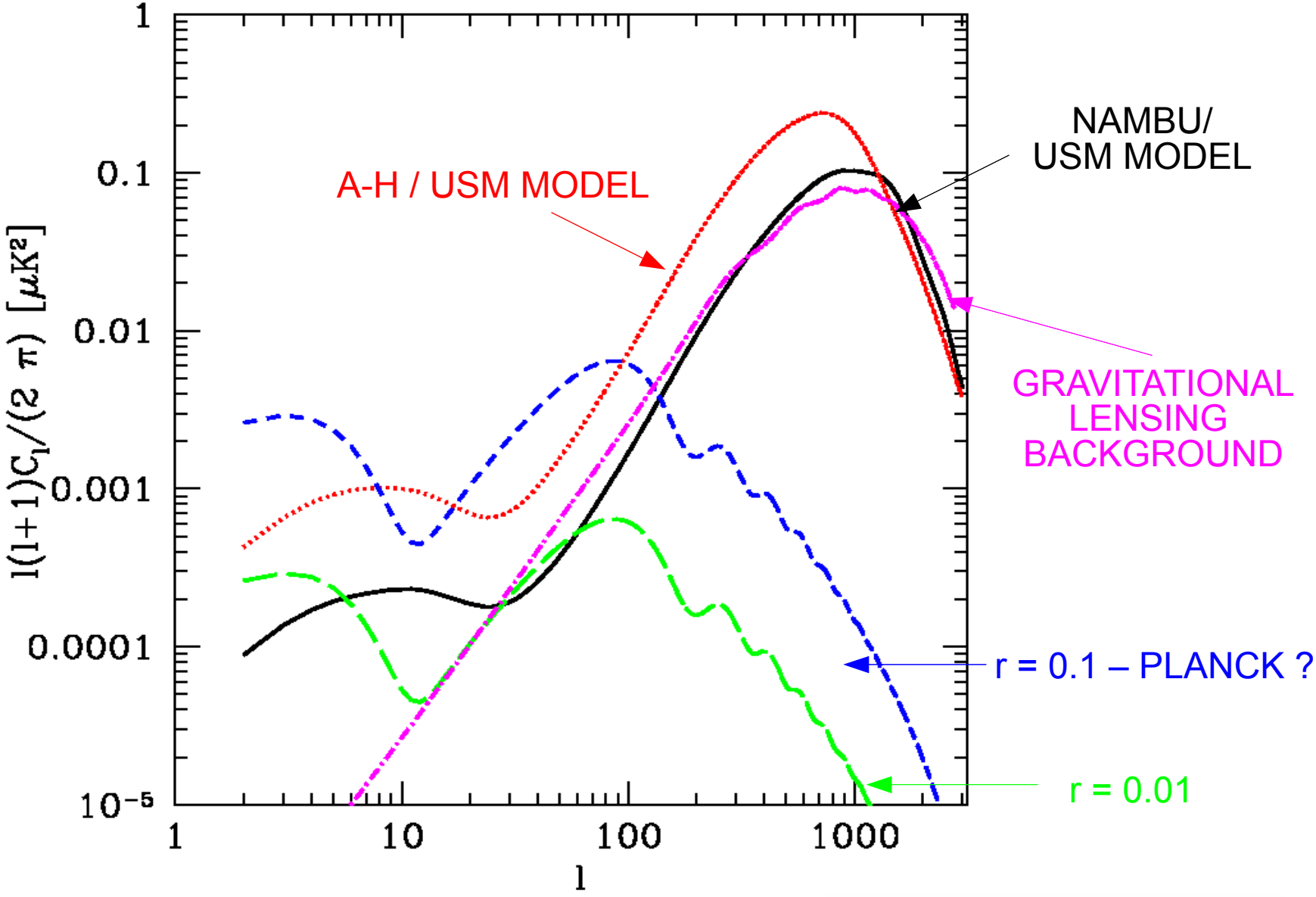
Temperature gradient

Also Bispectrum and Trispectrum :

- Hindmarsh, Ringeval & Suyama
- Regan & Shellard

→ sensitvity & resolution

B-MODE POLARIZATION



Limit from present data (eg QuAD) → $\frac{G\mu}{c^2} < 5.5 \times 10^{-7}$

SUMMARY & CONCLUSIONS

- Present CMB constraint:

$\frac{G\mu}{c^2} < 2.5 \times 10^{-7}$ (NAMBU SIMULATIONS) $\frac{G\mu}{c^2} < 6 \times 10^{-7}$ (ABELIAN-HIGGS SIMULATIONS)

  - about factor of 4 improvement expected from Planck

- Direct detection & non-Gaussianity

  - requires high resolution
  - improvements beyond Planck possible (Wandelt Talk)

- B-modes

  - Models with strings → low r
  - Defect models produce B-modes via vectors
  - Nambu case difficult due to potential confusion with lensing