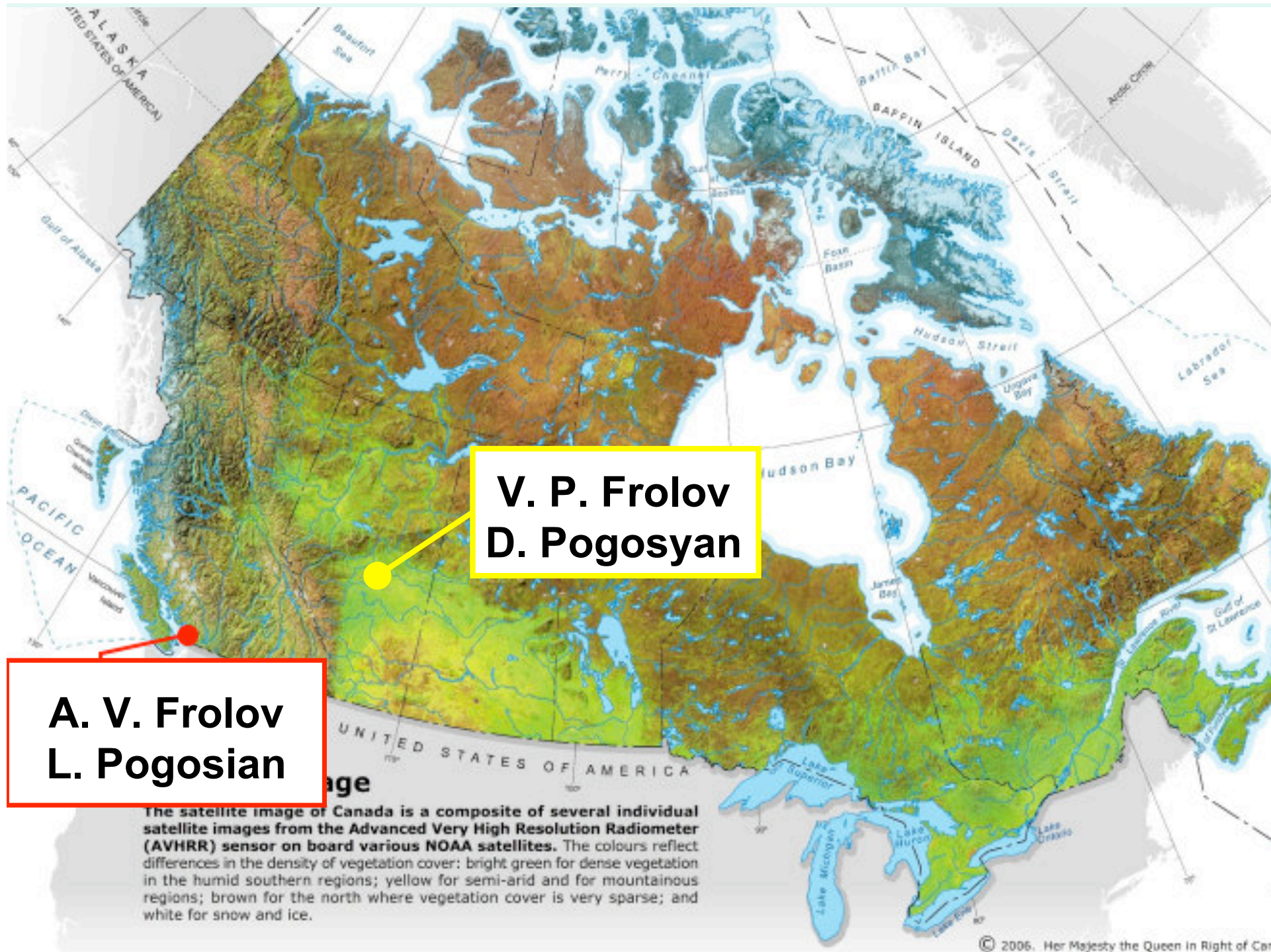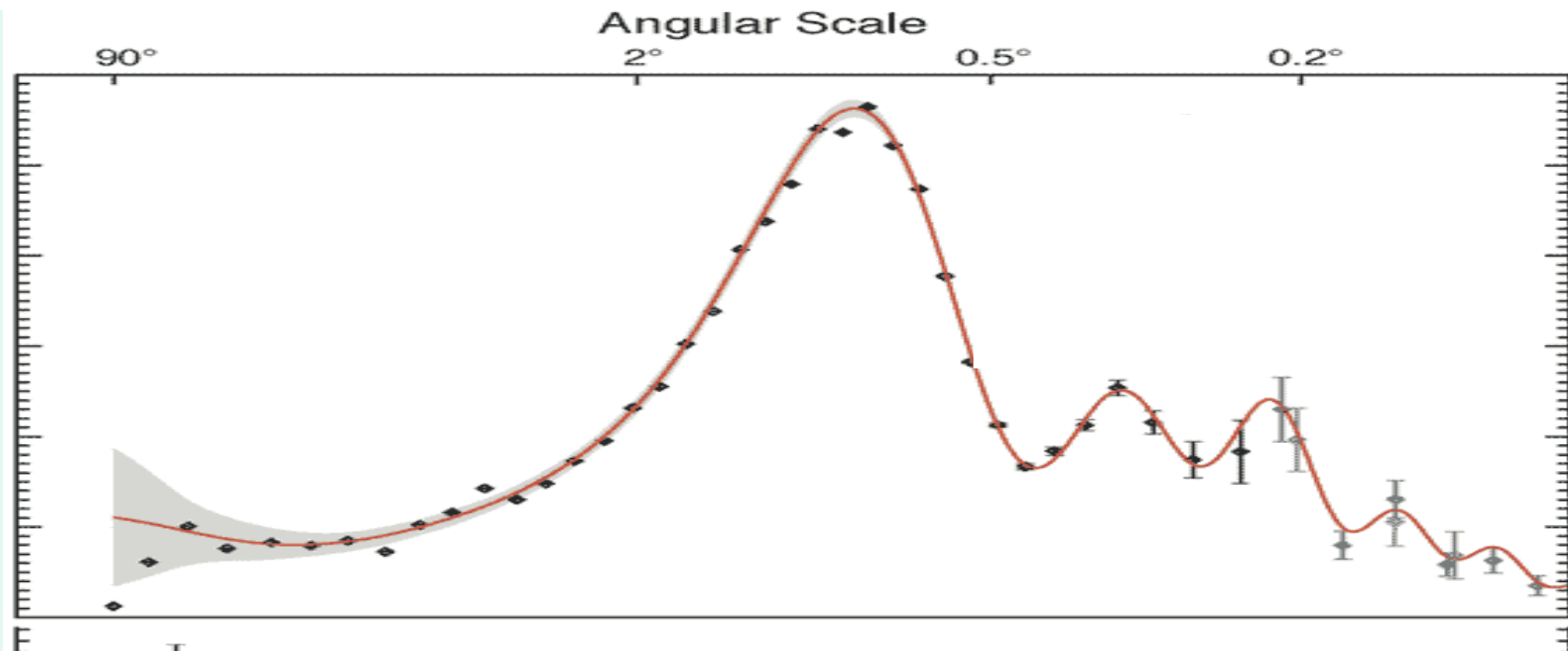# B-mode from strings

Levon Pogosian

Simon Fraser University

with
H. Tye (Cornell)
T. Vachaspati (Case)
I. Wasserman (Cornell)
**M. Wyman (Perimeter)**

V. P. Frolov
D. Pogosyan

A. V. Frolov
L. Pogosian

The satellite image of Canada is a composite of several individual satellite images from the Advanced Very High Resolution Radiometer (AVHRR) sensor on board various NOAA satellites. The colours reflect differences in the density of vegetation cover: bright green for dense vegetation in the humid southern regions; yellow for semi-arid and for mountainous regions; brown for the north where vegetation cover is very sparse; and white for snow and ice.

© 2006. Her Majesty the Queen in Right of Canada

Primordial perturbations:

- **predominantly passive (not active)**
- **nearly adiabatic**
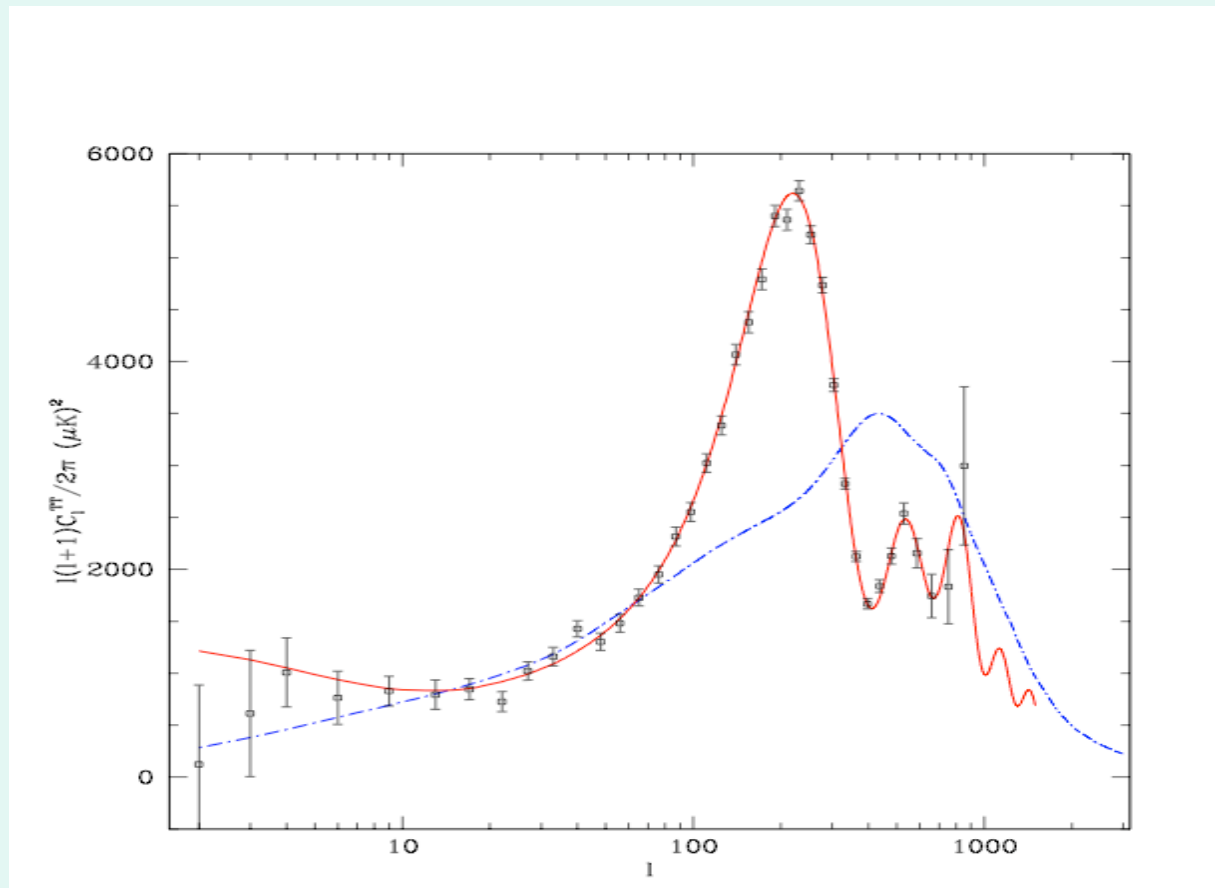- **nearly scale-invariant**

Active perturbations

CMB temperature anisotropy from strings
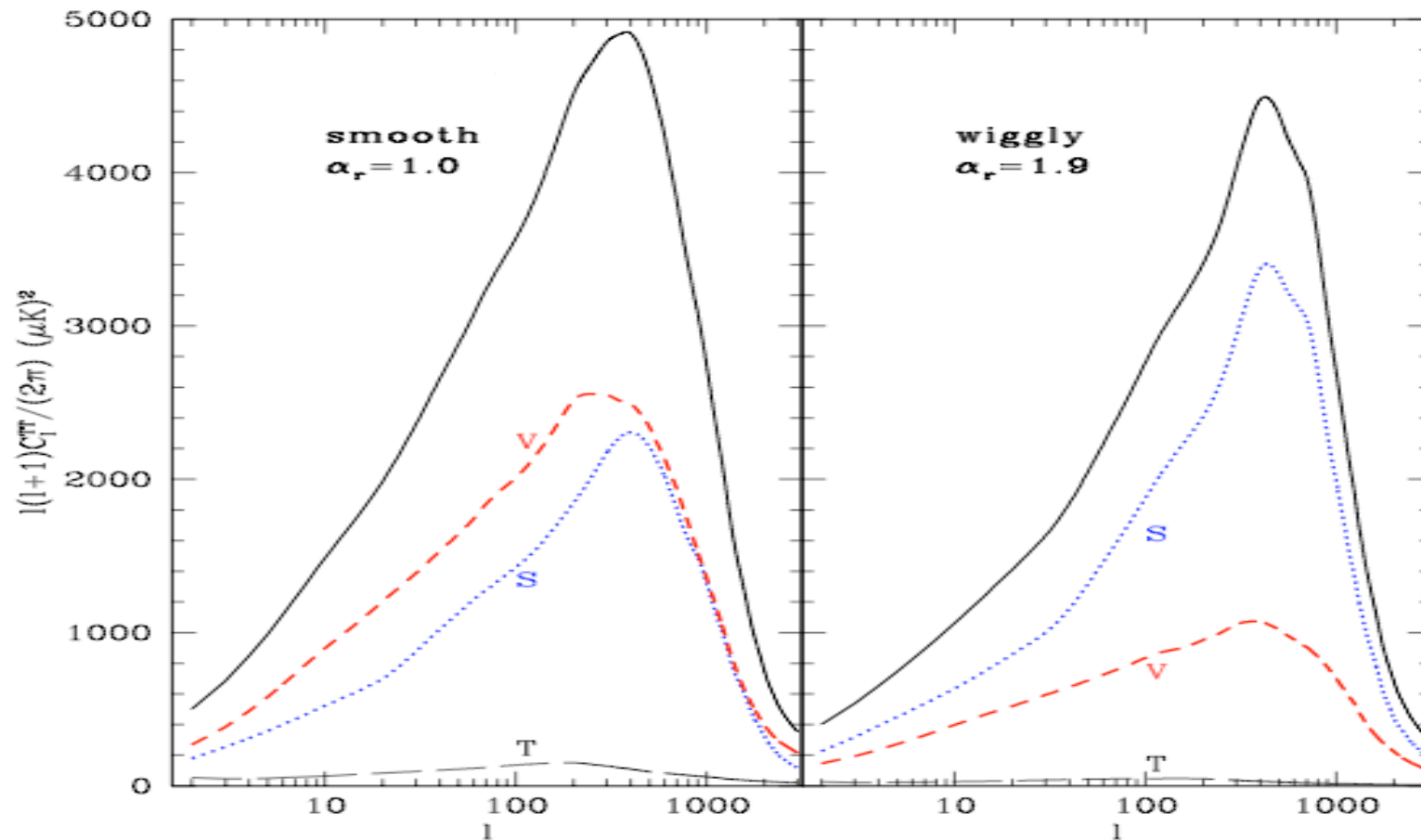
M.Wyman, L.Pogosian, I.Wasserman, astro-ph/0604141

Strings vs WMAP

- - - - - - - Wiggly local cosmic strings
—————— Inflation

String spectrum from Pogosian & Vachaspati, PRD'99

String induced CMB temperature anisotropy can't exceed ~10% of the total

The corresponding bound on $G\mu$ depends on the string model

Conservatively,

$$G\mu < 0.7 \times 10^{-6}$$

Do we need cosmic strings?

Produced after hybrid inflation

I. Tkachev, S. Khlebnikov, L. Kofman, A. Linde ('95-'98)

(KKLMMT, SUSY GUT,…)

Source of B-mode polarization

The segment model

Straight, randomly oriented, moving string segments

**Density, correlation length, wiggliness, rms v
matched to simulated networks**

Vincent, Hindmarsh, Sakellariadou (1996)
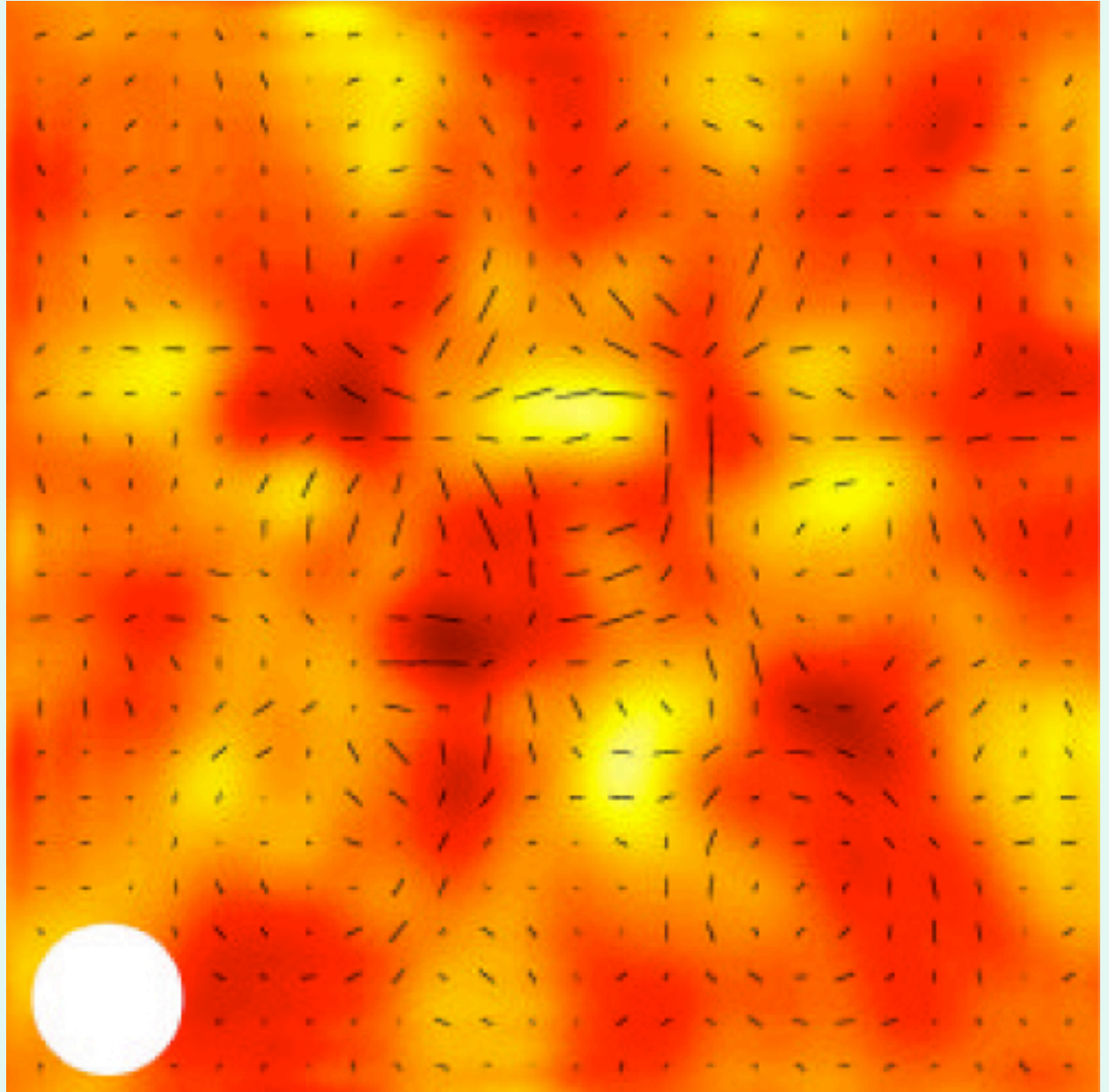**Albrecht, Battye, Robinson (1997)**
Pogosian & Vachaspati (1999)

Good enough for large scale features

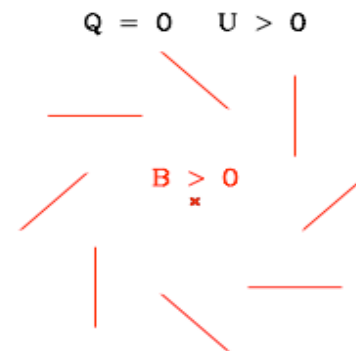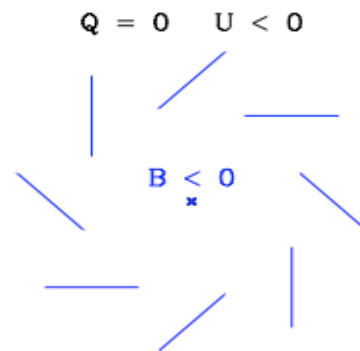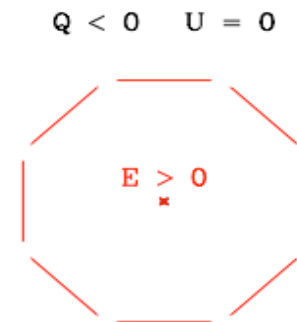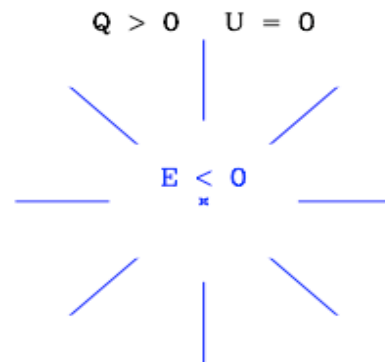**Incorporated into CMBFAST: publicly available as CMBACT**

CMB polarization

DASI
2002

E (gradient) and B (curl) modes

from M. Zaldarriaga, astro-ph/0305272

Sources of B-mode

Lensing of E-mode by large scale structures
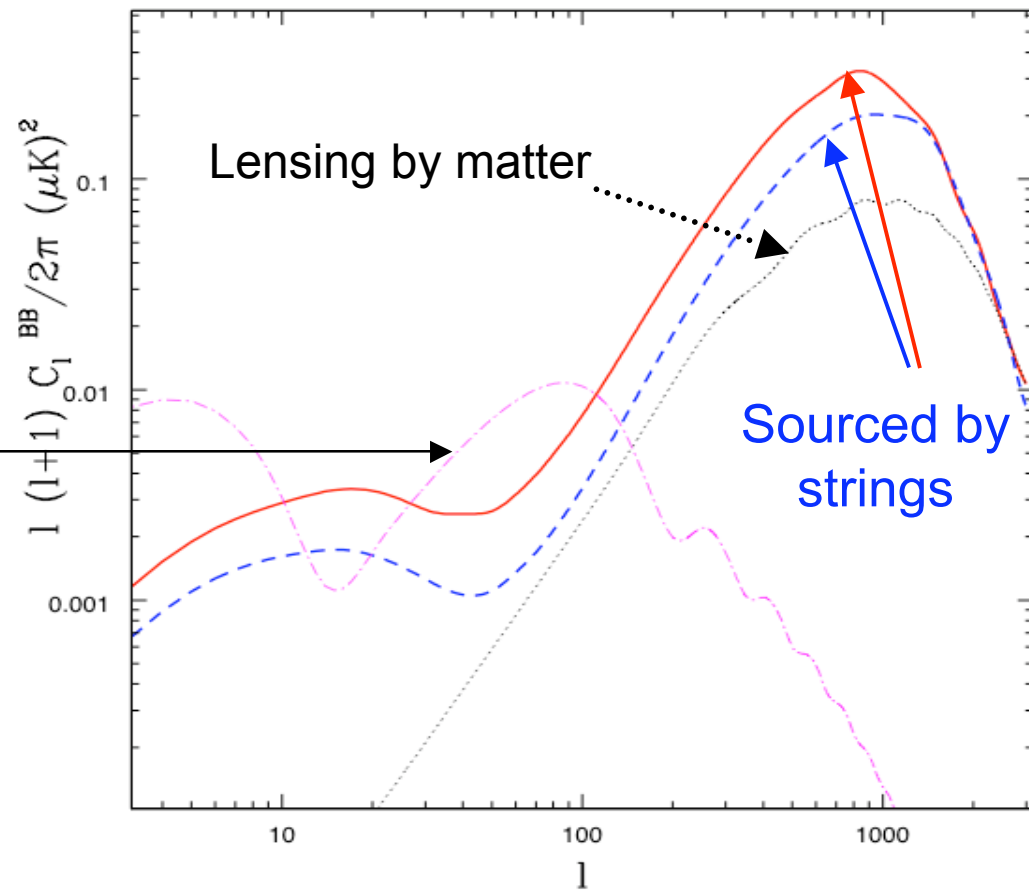(scalar modes)

The ISW effect from gravity waves
(tensor modes)

Anisotropic stress produced by defects
(**vector** and tensor modes)
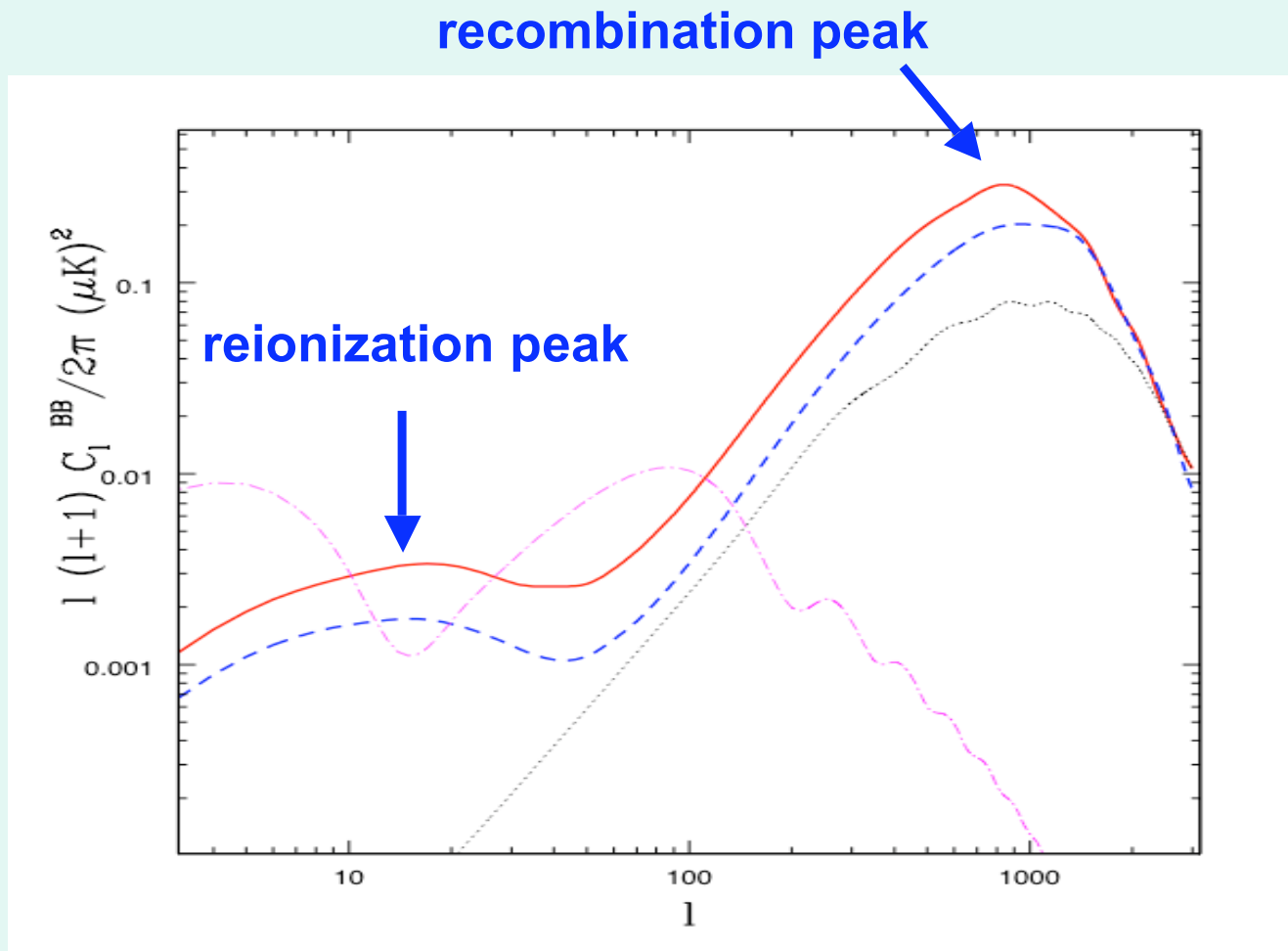
Magnetic fields
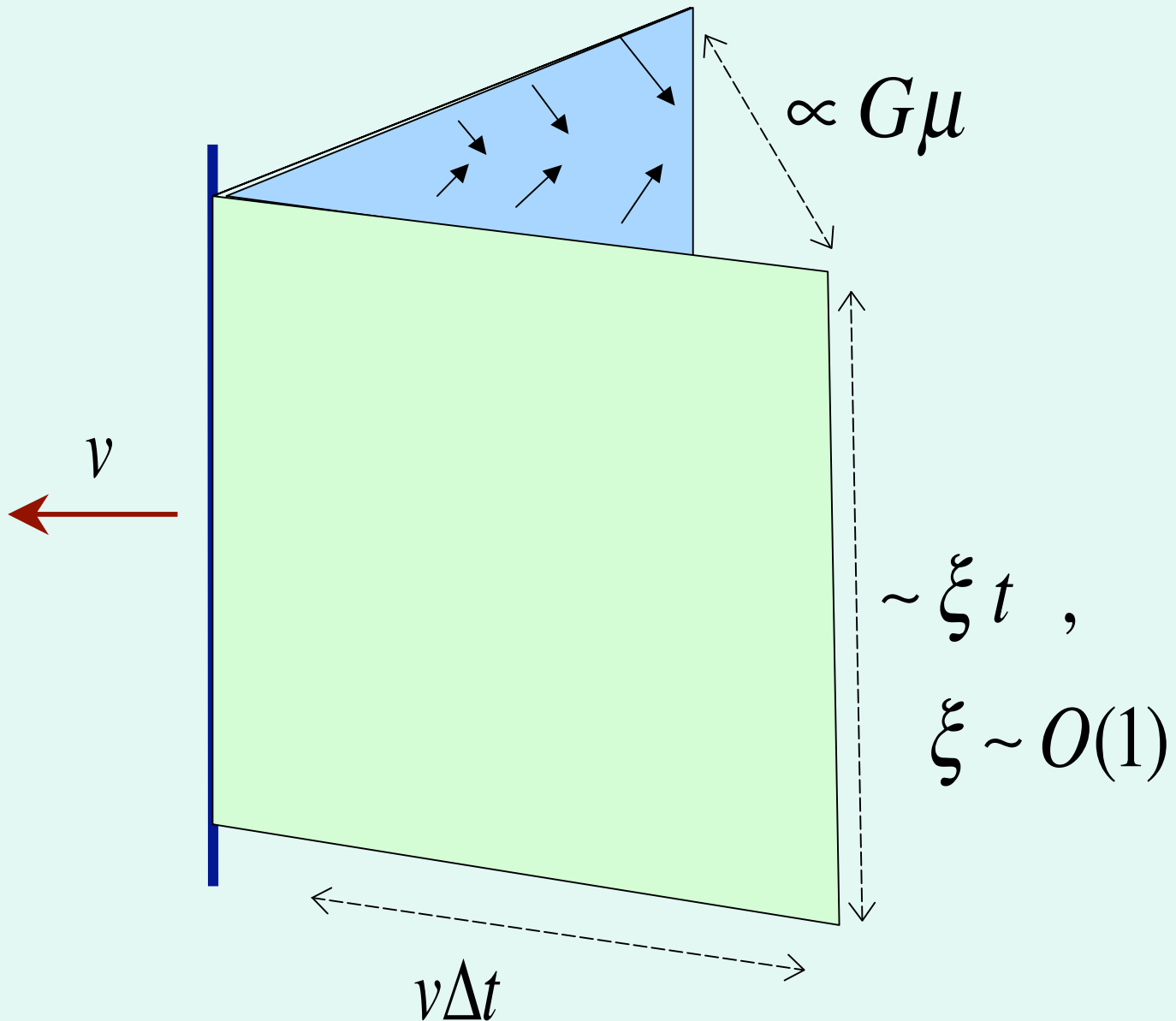(vector and tensor modes)

B-mode CMB polarization

M.Wyman, L.Pogosian, I.Wasserman, astro-ph/0604141

What determines the shape?

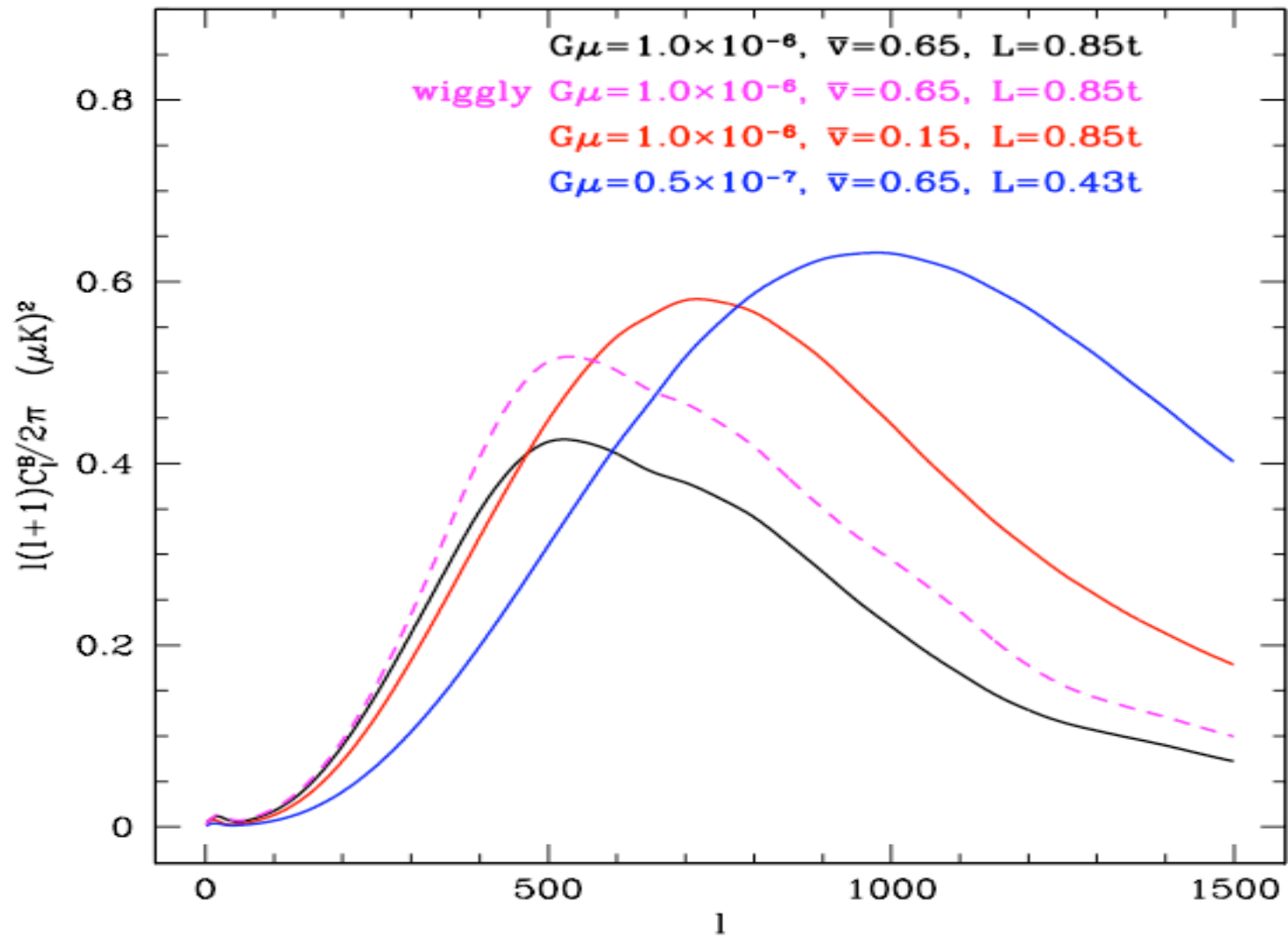**Contributing factors:** correlation length, velocity, density, tension, wiggliness
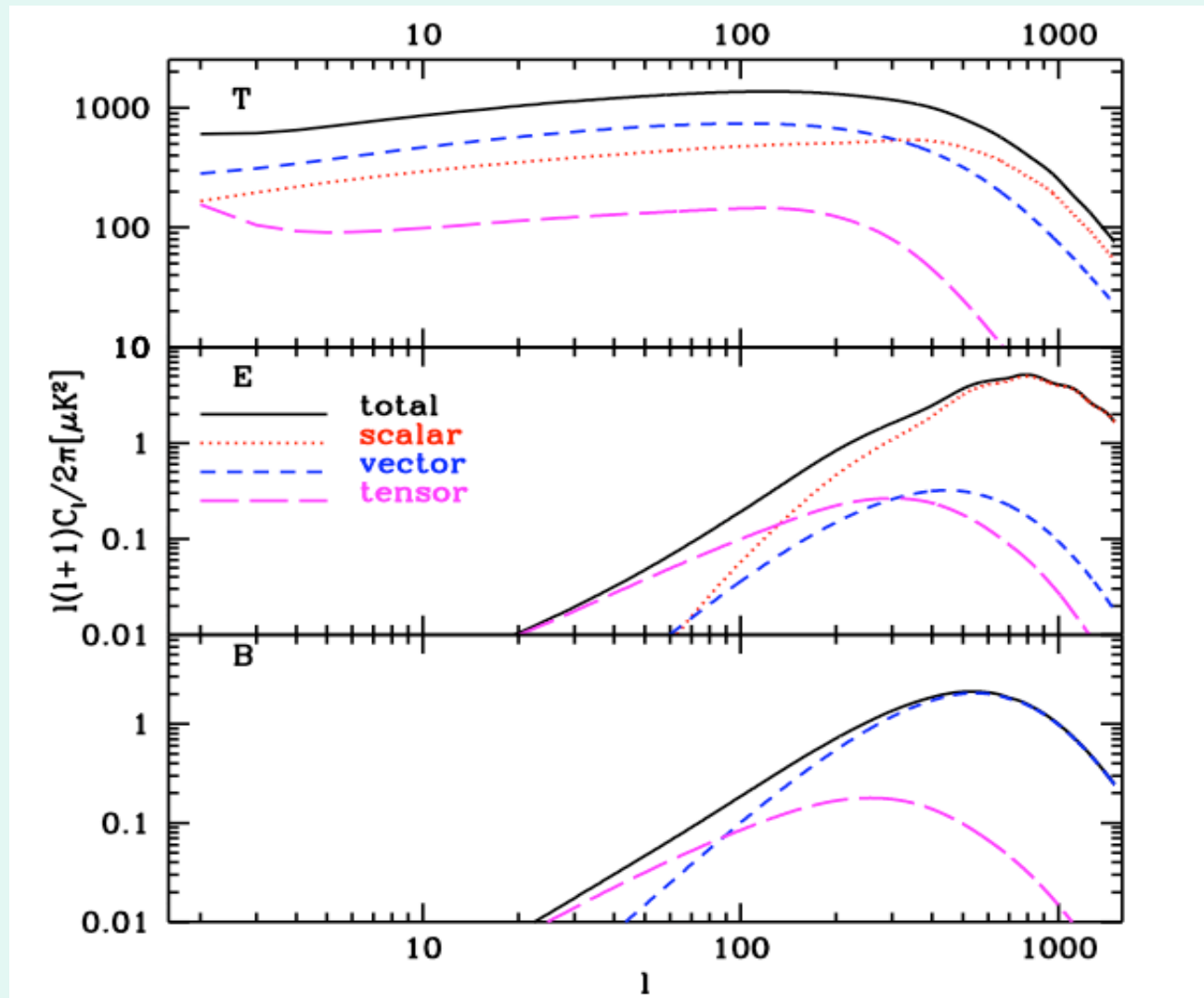
Strings at last scattering

$\propto G\mu$

v

$\sim \xi\, t$,

$\xi \sim O(1)$

$v\Delta t$

Where is the main peak?

Legend:
$G\mu=1.0\times10^{-6}$, $\bar{v}=0.65$, $L=0.85t$
wiggly $G\mu=1.0\times10^{-6}$, $\bar{v}=0.65$, $L=0.85t$
$G\mu=1.0\times10^{-6}$, $\bar{v}=0.15$, $L=0.85t$
$G\mu=0.5\times10^{-7}$, $\bar{v}=0.65$, $L=0.43t$

y-axis: $l(l+1)C_l^B/2\pi$ $(\mu K)^2$

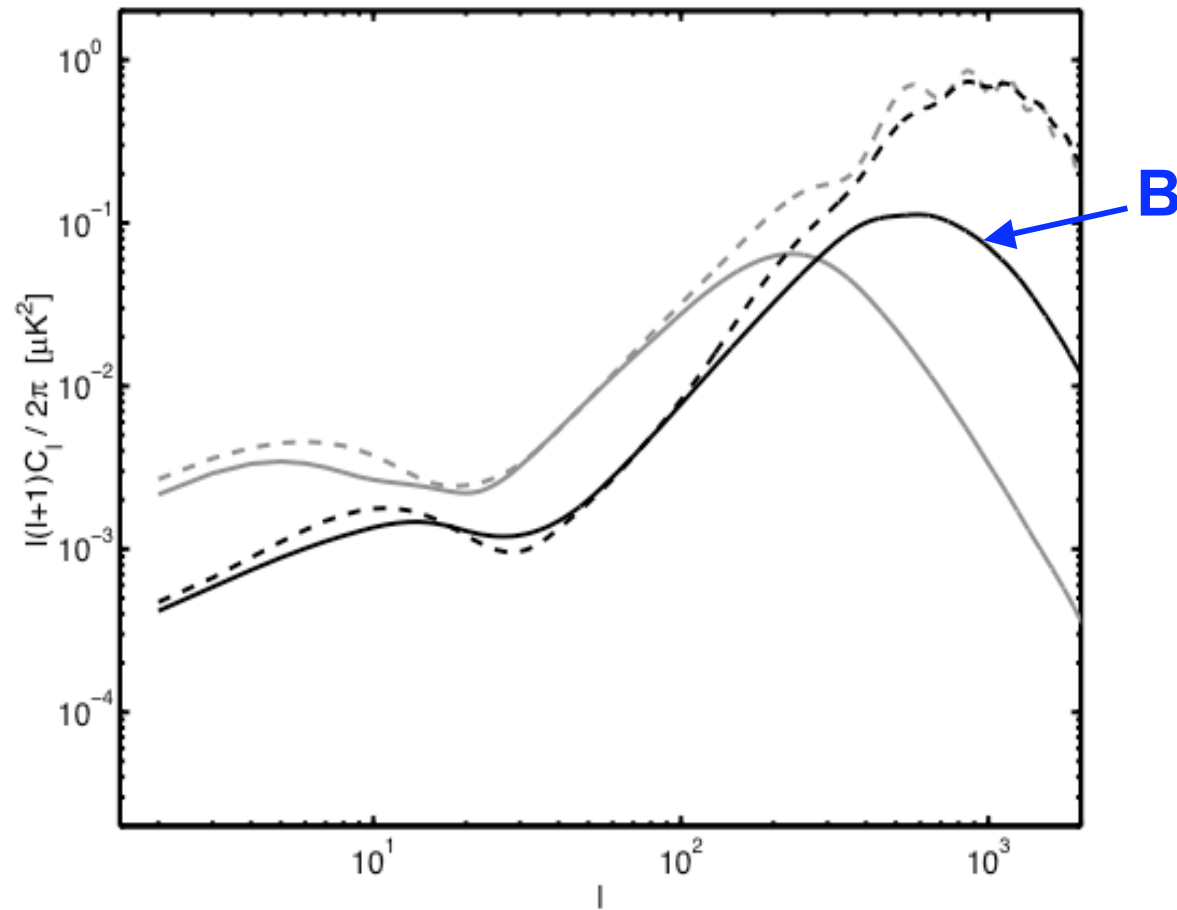x-axis: l

Global strings
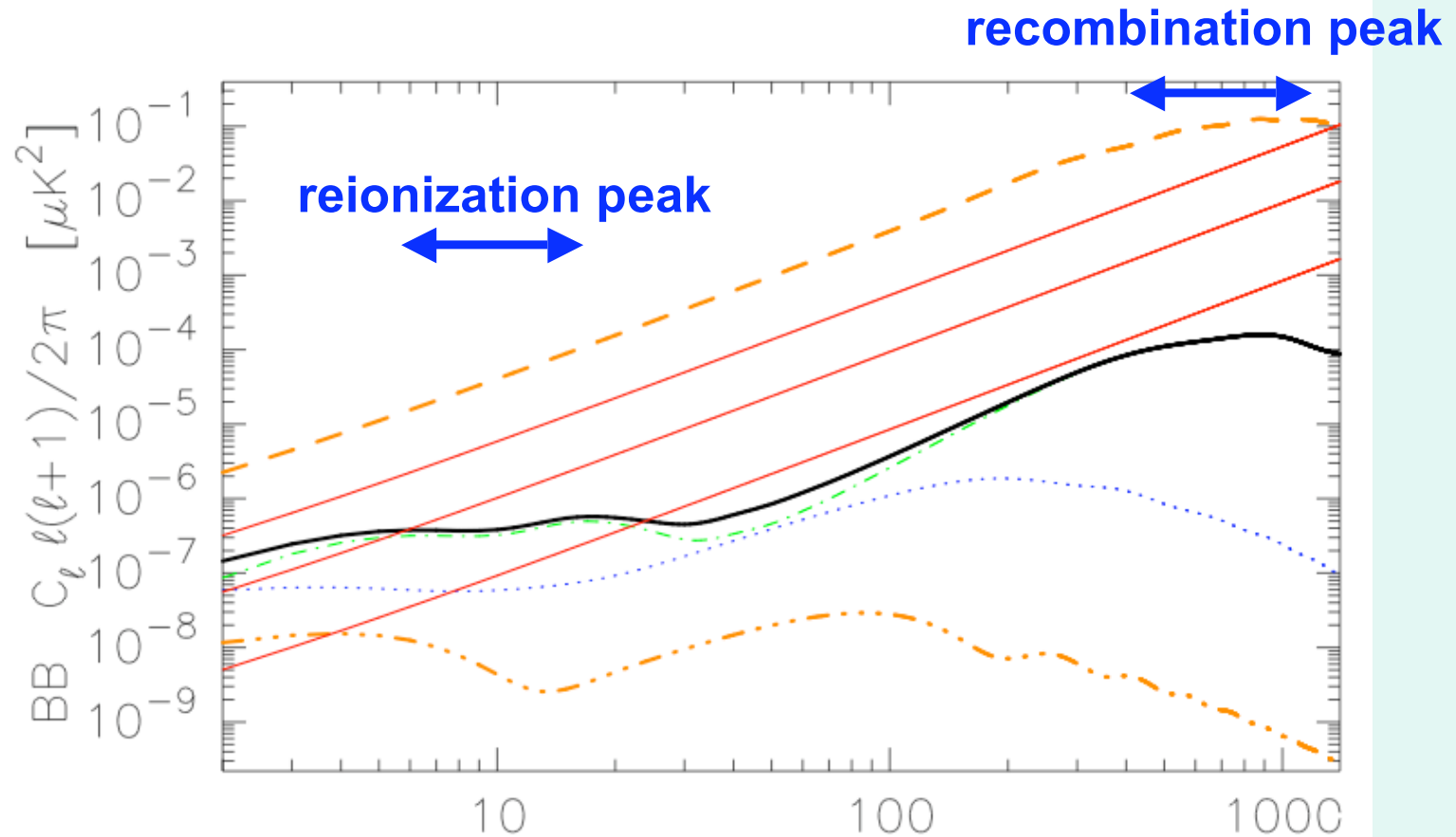## (Seljak, Pen, Turok, PRL'97)

"Standard" CDM: h=0.5, Ω_M=1, Ω_b=0.05

Field theory simulations, local U(1)
(Bevis, Hindmarsh, Kunz, Urrestilla, 0704.3800)

Prospects of detection

$$r = 10^{-6}, \quad G\mu = 10^{-8}$$

from Seljak & Slozar, astro-ph/0604143

Summary

In Hybrid Inflation models, including Brane Inflation,
string generated vector B-mode can
exceed the GW contribution

String B-mode spectrum has a distinct shape,
with a pronounced main peak at 500<l<1000

The magnitude and the exact peak position
are determined by properties of cosmic
string networks at last scattering