

P2IO meeting @ Orsay

2012. 3. 28

Primordial perturbations from very early universe

Shuntaro Mizuno

Postdoc @ LPT, Cosmology group
(Bartjan van Tent)

Cosmic Microwave Background (CMB)

electrons are captured by protons at ~ 3000 K (**recombination**), and photons start traveling freely (**decoupling**)

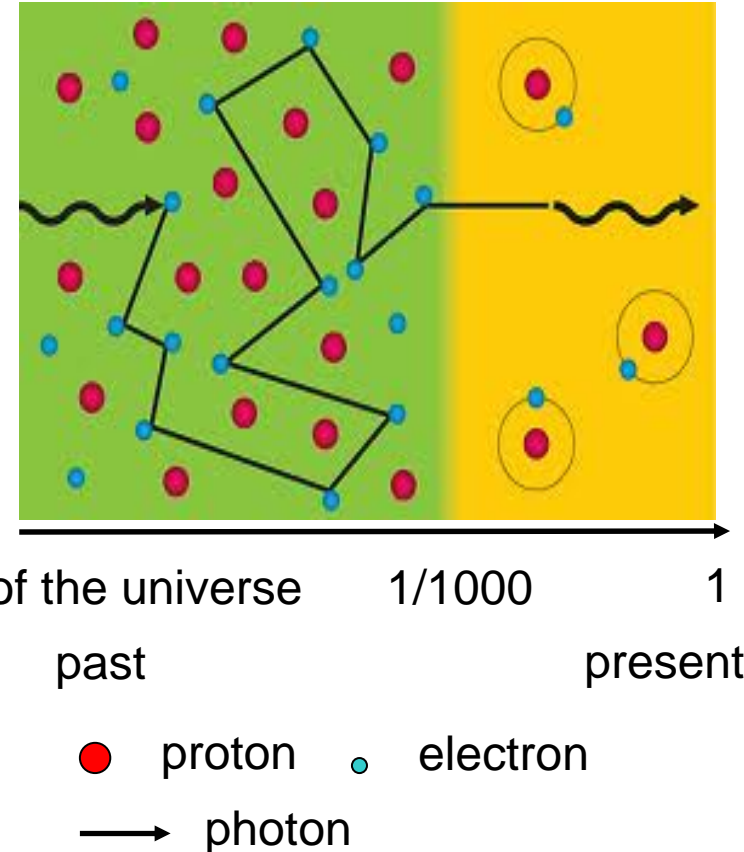


photons keep **Planck distribution** with their wavelength stretched by the cosmic expansion



Now observed as the black body radiation with $T \sim 2.7$ K

Discovered by Penzias and Wilson (1965)
Nobel prize in Physics (1978)

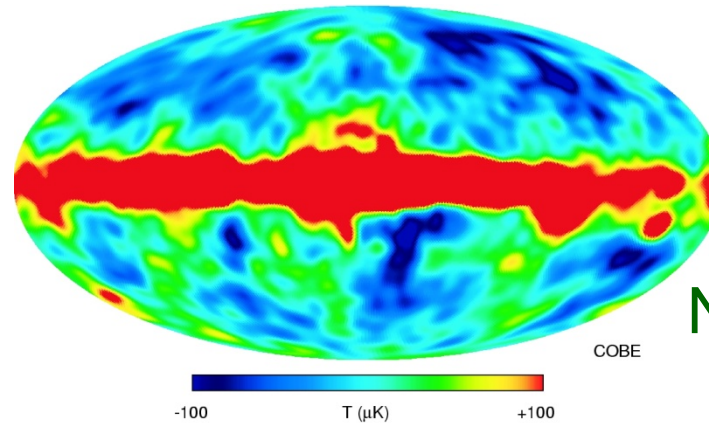


Anisotropies of the CMB

COBE (1992)



Mather, Smooth et al

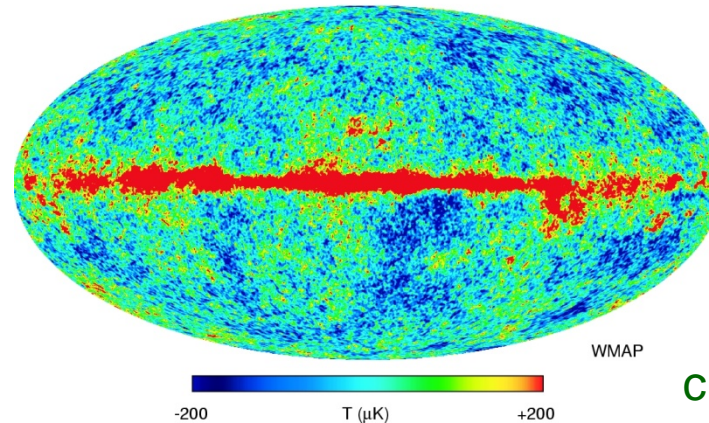


Discovery of the fluctuations

$$\Delta T/T \sim 10^5$$

Nobel prize in physics (2006)

WMAP (2003)



Observe more detailed fluctuations

credit: WMAP, NASA

These small fluctuations will be galaxies and LSS at late time

Requiring the tiny perturbations in the very early universe

My previous works

- These perturbations are thought to be generated by cosmic inflation
- But there are many early universe models which predict almost same power spectrum and consistent with current observations
- **The statistical property of the fluctuations like non-Gaussianity will be powerful tool to distinguish early universe models**

Examples of the published papers :

- **Bouncing universe model**

K. Koyama, S. M., F. Vernizzi, D. Wands

‘Non-Gaussianities from ekpyrotic collapse with multiple fields’,

Journal of Cosmology and Astroparticle Physics, 0711, 024 (2007) [Cited: 65 times]

- **String theory motivated inflation model**

F. Arroja, S. M., K. Koyama,

‘Non-gaussianity from the bispectrum in general multiple field inflation’,

Journal of Cosmology and Astroparticle Physics, 0808, 015 (2008) [Cited: 76 times]

My current works (1)

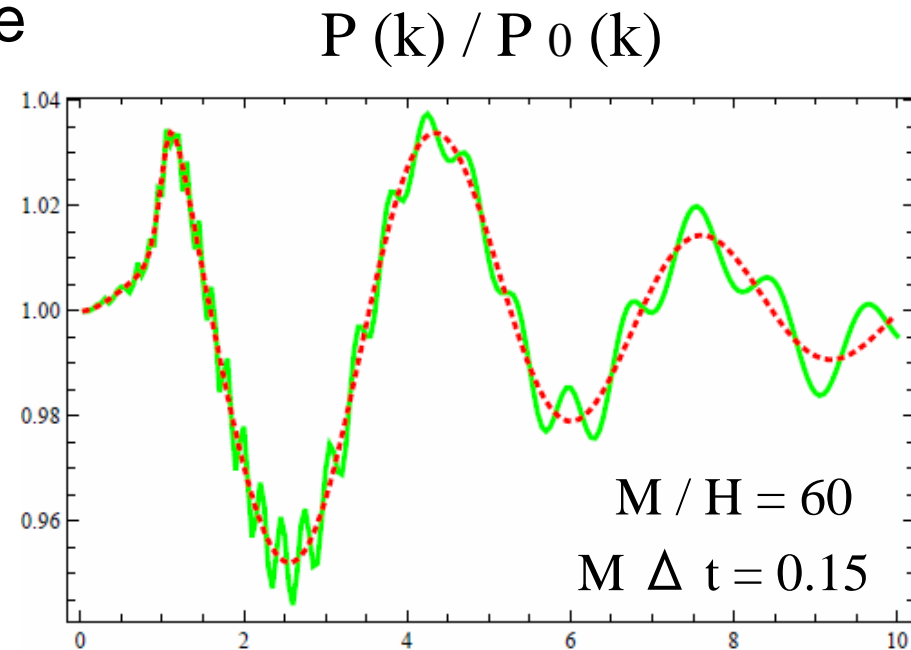
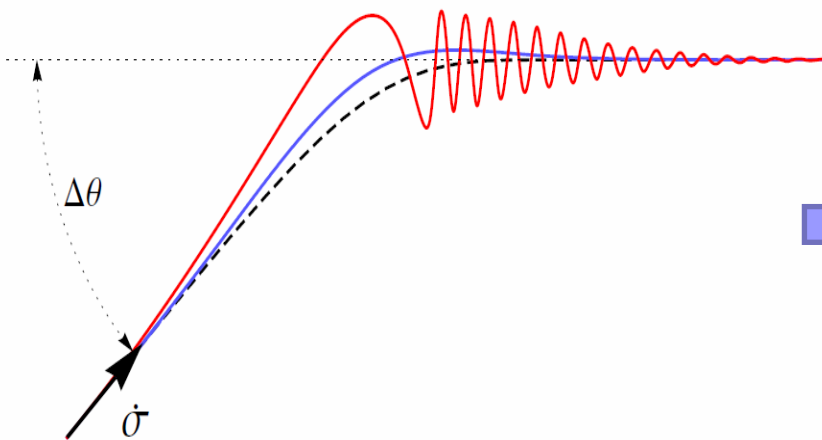
Multiple field inflation with mass hierarchies

with Gao and Langlois (APC, Paris 7)

- Conventional wisdom

If $M > H$, we can integrate them out

- Inflation with a turn in field space



We need to be careful about integrating out heavy modes

(k / k_0)

Consequence of heavy mode can be observed by future experiments

My current works (2)

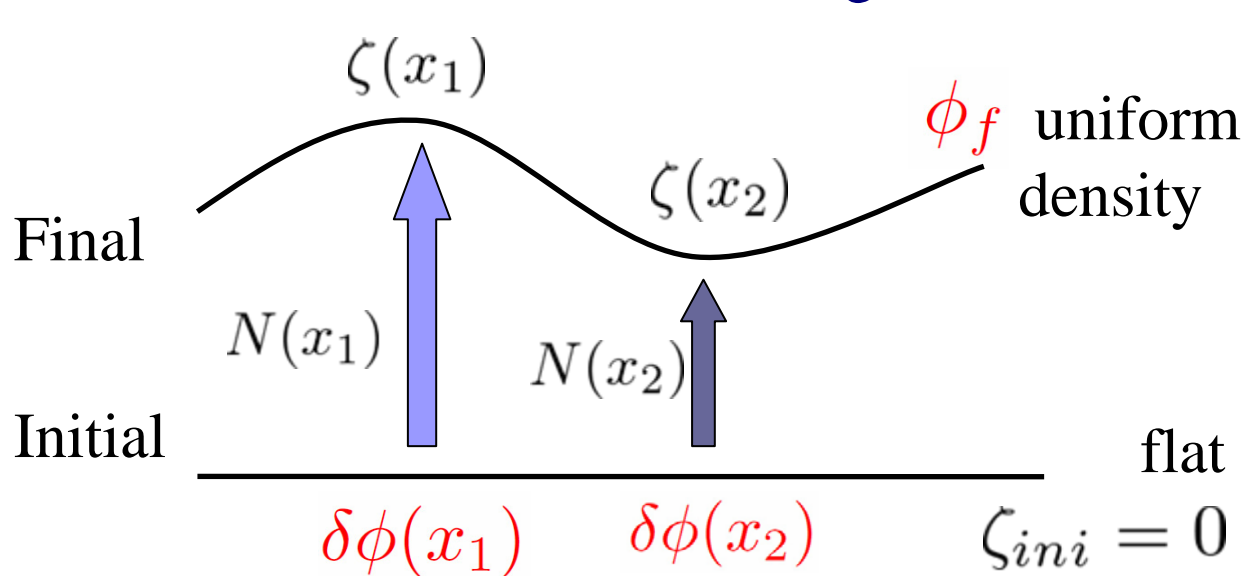
Non-Gaussianity in general multi-field inflation

with Tzavara and van Tent (LPT, Orsay)

- δN formalism

Curvature perturbations on superhorizon scales
= fluctuations in local e-folding number

$$\zeta = N(t, x) - N_0(t)$$



$$N = \int dt H$$

$$\uparrow$$
$$N_0(\phi)$$

Simple and very intuitive approach, but in some situation,

Long-wavelength approach works more efficient