Penrose Compactification: Horizon Problem, Asymptotic Symmetries, Primordial Memory!

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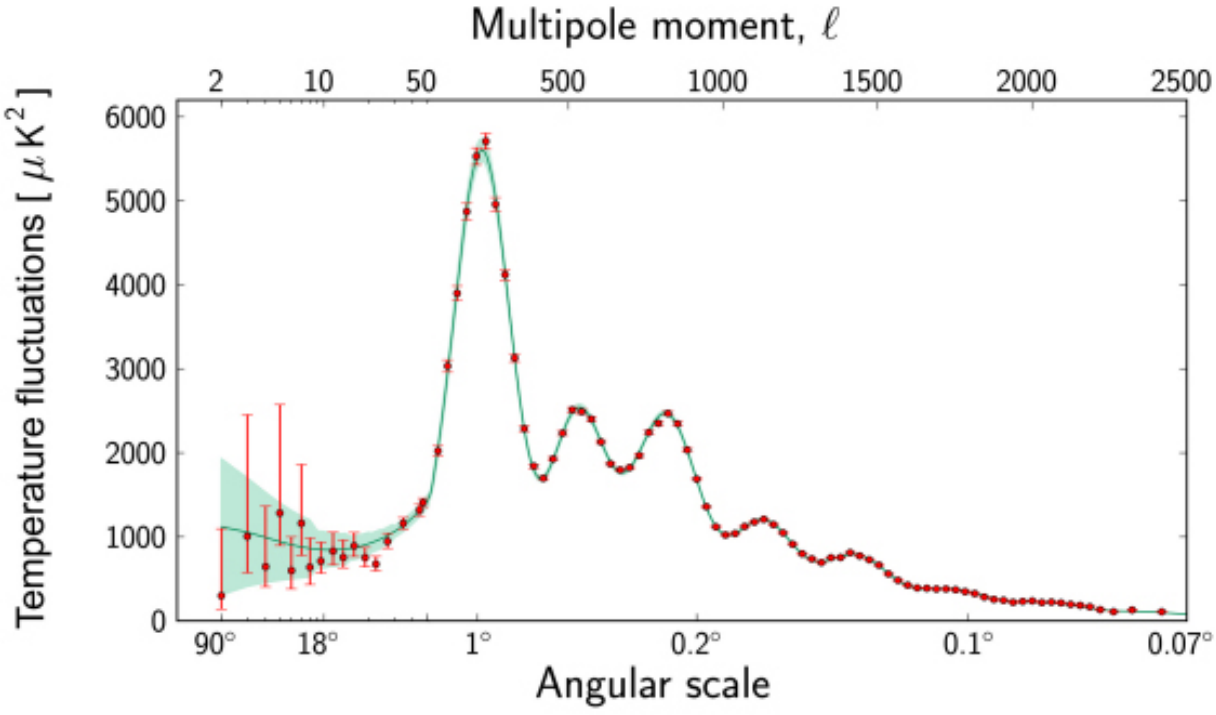
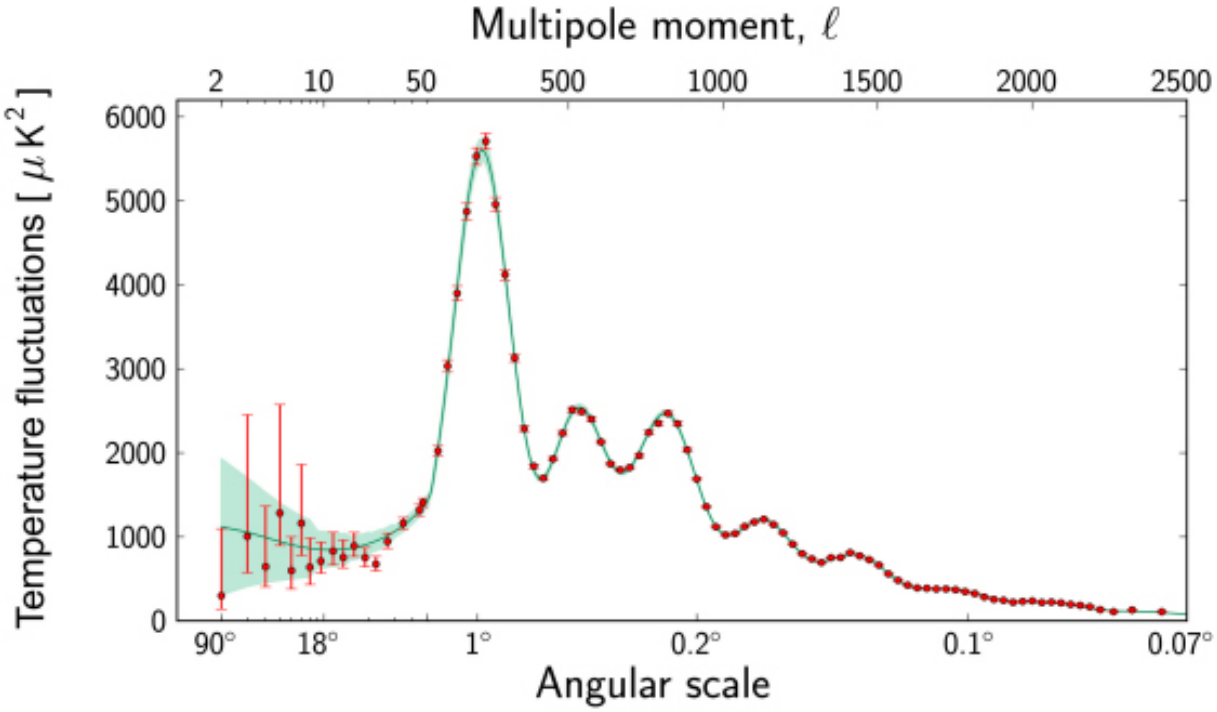
IPNP Meeting, 19/05/26

Big-Bang as a Mirror



- Adiabatic
- Gaussian
- No anisotropic tensor/vector modes
- In phase

Big-Bang as a Mirror



- Adiabatic
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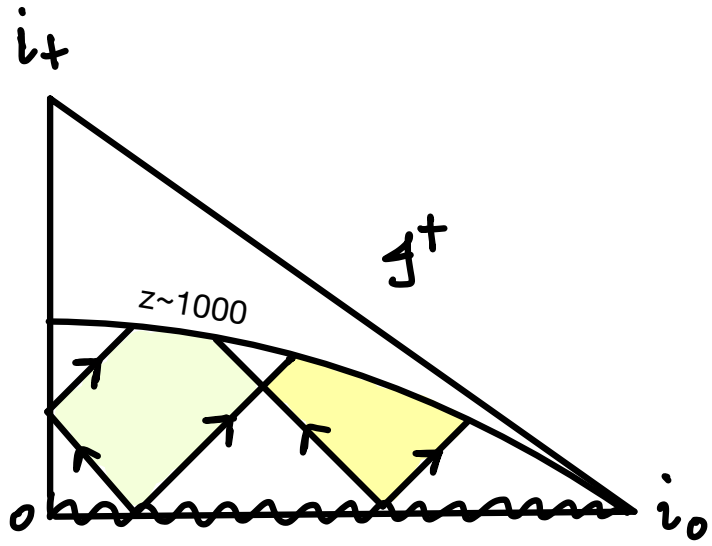
Reflecting boundary conditions!

$$a(\tau) = -a(-\tau)$$

Problems with Extending Radiation Era to the Bang

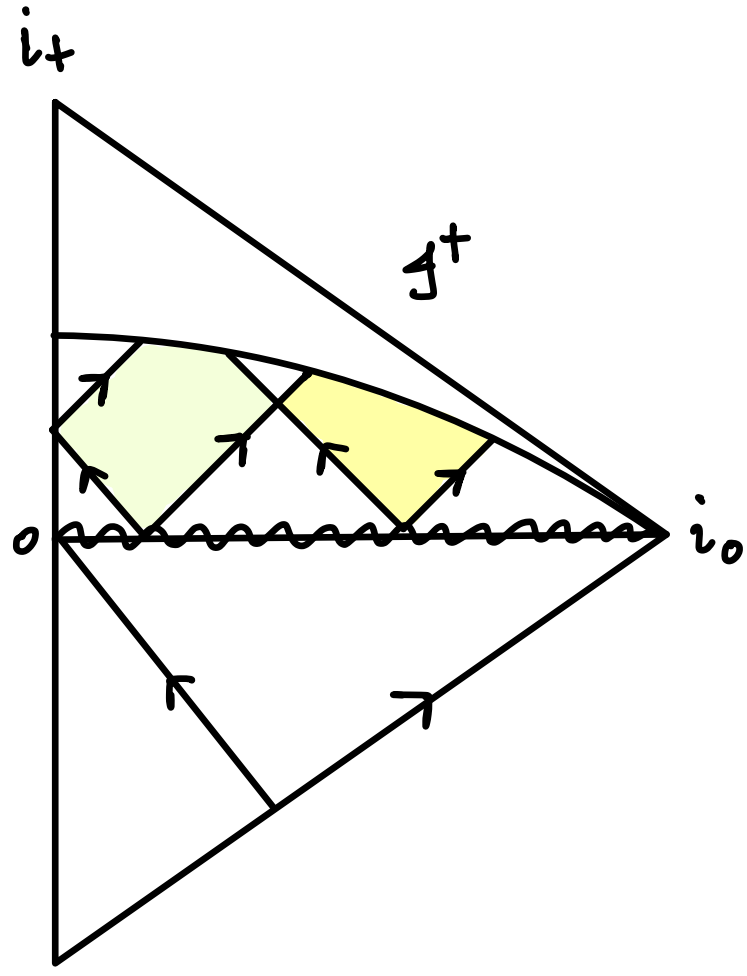
- Horizon Problem
- Overproduction of dark matter/ thermalization of gravitons
- How to get scale-invariant power spectrum?

Horizon Problem



Radiation

Horizon Problem



Inflation

Horizon Problem

- N. Turok and L. Boyle, Gravitational entropy and the flatness, homogeneity and isotropy puzzles, Phys. Lett. B 849, 138443 (2024), arXiv:2201.07279 [hep-th].

Horizon Problem

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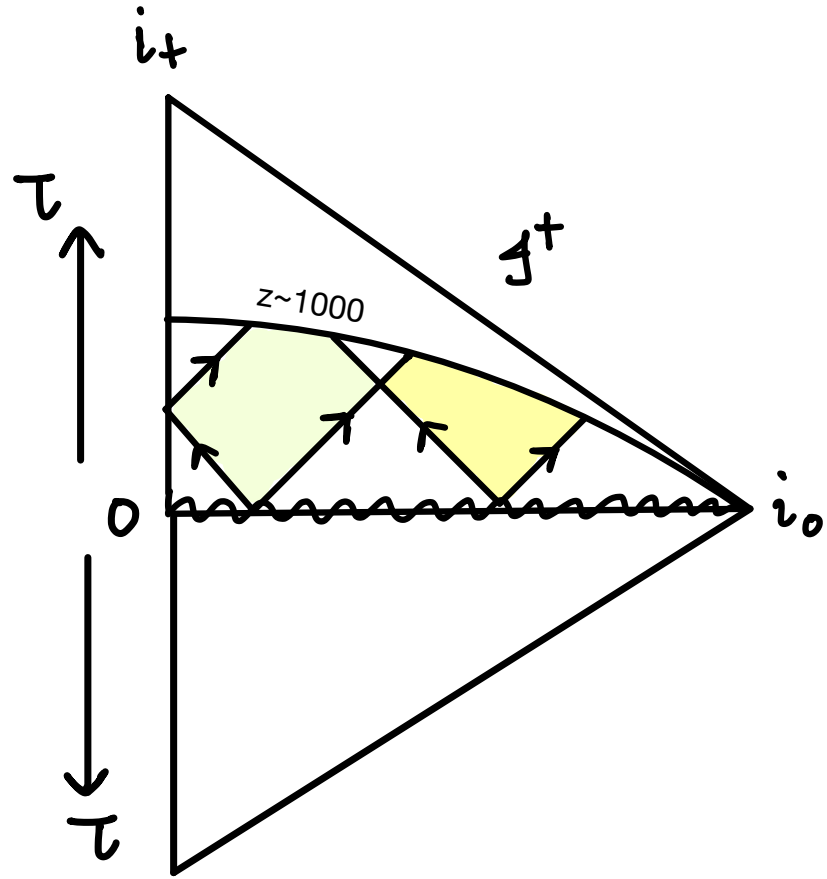
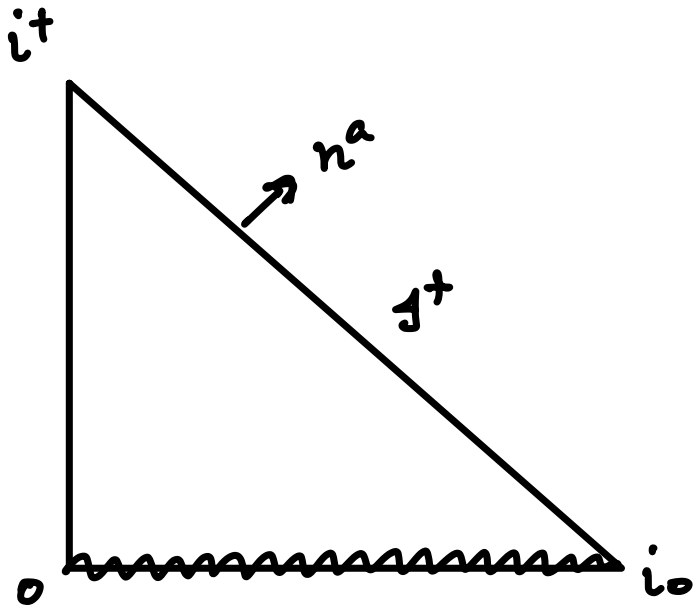


Asymptotic Symmetry of Radiating FRW Spaces



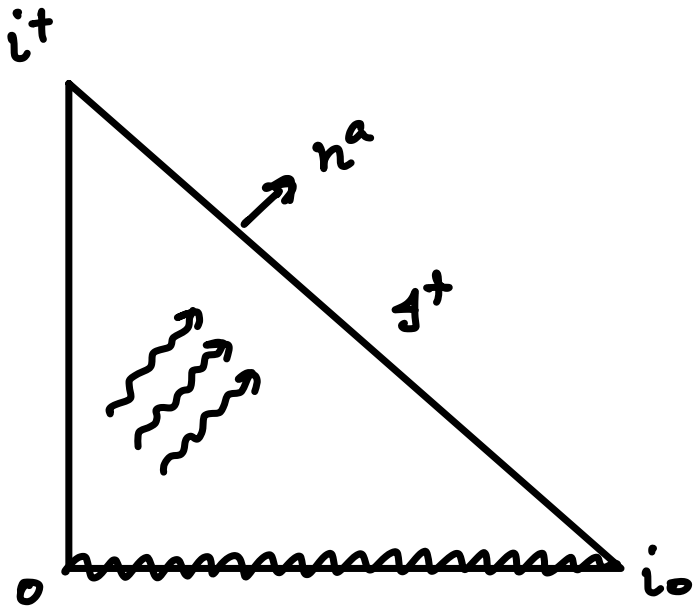
- $ds^2 = a^2(\tau)\left(-d\tau^2 + d\underline{x}^2\right)$
- $a^2(\tau) = \tau^{s/1-s}$; $0 < s < 1$
- $s = 1/2$ for radiation
- symmetry group of $\mathcal{I}^+$:

$$\mathcal{B}_s = SO(3,1) \ltimes \mathcal{S}_s$$

$$\pounds_\xi q_{ab} = 2\alpha q_{ab} \quad ; \quad \pounds_\xi n^a = -(1+s)\alpha n^a$$

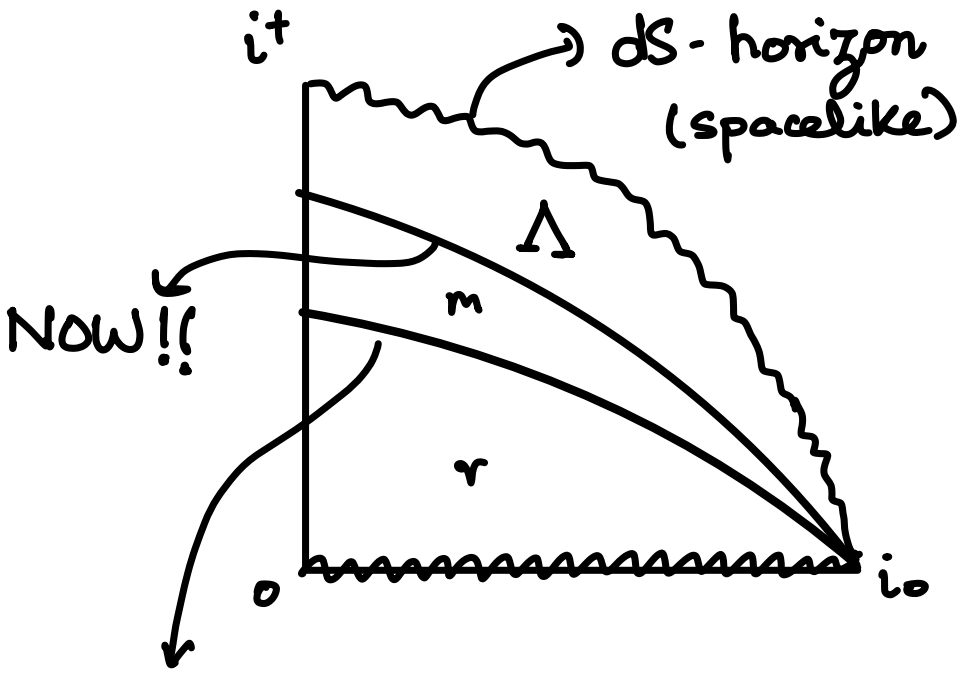
Primordial Gravitational Wave Memory

- Zeldovich (1974) → linear
- Christodoulou (1990s) → non-linear
- Strominger & Zhiboedov (2014) → (Relation to Asymptotic symmetries)



$$\Delta C_{ab} = \mathcal{L}_\xi C_{ab}$$

Real World



- Hope to measure primordial gravitational waves from LISA !!

- $\Delta C_{ab}^{observed} - \Delta C_{ab}^{theoretical}$

$\propto$

$0 < \Omega_r < 1$

↓

Critical density of radiation