

QUANTUM ASPECTS OF COSMOLOGY AND ASTROPHYSICS

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1. Review of General Relativity and Cosmology.

2. Review on Quantum Field theory in flat space.

Quantum Fields and Vacuum state, Quantum vacuum fluctuations, Particle interpretation of Quantum fields.

3. Quantum Fields in a curved background.

Particle creation in a curved background.

4. Quantum Fields in Expanding universe.

Quantum fields in the de Sitter Universe. Massless and massive scalar fields.

5. Applications to Early Universe Cosmology:

Scalar Field Inflation; Density Perturbations during Inflation; Connection with Cosmic Microwave Background Observations.

6. Gravitational Waves

Cosmological tensor perturbations generated during Inflation.

7. Unruh effect.

Accelerated observers. Unruh temperature.

8. Hawking Radiation.

Thermodynamics of Black Holes.

9. Quantum Tunneling and Quantum Cosmology.

Bubble nucleation; Phase transitions; Creation of the universe from Nothing.

Bibliography

S. Carroll, *Spacetime and Geometry*

S. Weinberg, *Gravitation and Cosmology*

S. W. Hawking and G. Ellis, *The large scale structure of spacetime*

S. Weinberg, *Cosmology*

S. Mukhanov, *Physical Foundations of Cosmology*

A.Liddle, *Cosmological Inflation and Large Scale Structure*

Birrell and Davies, *Quantum Fields in Curved Space*

S. Mukhanov and S. Winitzki, *Introduction to Quantum Effects in Gravity*

Assessment by the evaluation of **weekly homework** assignments.