



LECTURE COURSE IN THE QUANTUM UNIVERSE RESEARCH SCHOOL

Summer Term 2024

Theoretical Cosmology and Astroparticle Physics

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Course Description:

This lecture will provide an introduction to the basics of high energy astroparticle physics and cosmology and their theoretical foundations. The following topics will be covered:

- **Thermodynamics in early universe:** particle decoupling, Big Bang Nucleosynthesis, recombination and photon decoupling, Boltzmann equation, Cold Dark Matter freeze-out, hot Dark matter;
- **Dark Matter :** evidence and candidates, WIMP phenomenology and constraints, alternatives to thermal freeze-out;
- **Baryogenesis:** criteria and mechanisms. Baryon number violation in Standard Model, sphalerons, out-of-equilibrium decay, leptogenesis, electroweak baryogenesis, Higgs effective potential at high temperature, electroweak phase transition,
- **Inflation:** motivations and models;
- **Theory of perturbations:** scalar and metric fluctuations; initial conditions
- **Theory of Large Scale Structures:** gravitational instability, acoustic oscillations
- **Cosmic Microwave Background:** Sachs-Wolfe effect, anisotropies, delayed recombination, determination of cosmological parameters;
- **Quantum initial conditions** inflaton fluctuations, curvature perturbations, gravitational waves

Prerequisites:

bachelor level knowledge of theoretical physics (classical field theory, basic quantum mechanics and thermodynamics)

Date and Place: Wed 11:00–12:30, SR 2, Building 2a, Bahrenfeld
Fri, 11:00–12:30, SR 2, Building 2a, Bahrenfeld

Starting on: 3 April 2024
