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Non-equilibrium in Cosmology

All the non-trivial features of the Universe we see around us, such as particles, stars, galaxies, and clusters of galaxies, are the result of non-equilibrium processes in the cosmic evolution. These lectures aim to provide some general background in cosmology and to examine specific, and notable, examples of departures from thermal equilibrium.

They will be organized as follows:

- 1) Overview of the thermal history of the Universe after the Big Bang: the relevant time-scales and the mechanism of particle decoupling from the thermal bath;
- 2) Explicit examples of cosmic relics: photons and the cosmic microwave background, neutrinos, and cold dark matter;
- 3) Baryogenesis: the generation of the baryon asymmetry of the Universe;
- 4) The formation of cosmic structures (galaxies, clusters of galaxies): from the Vlasov equation to the renormalization group.