

Problem set 5 – Quark Gluon Plasma Physics – SS 2023

Discussion in the lecture: Friday May 26

5.1 Ratios of light nuclei in the statistical model

- a) Calculate the ratio $d : {}^3\text{He} : {}^4\text{He}$ in the statistical model for $T = 156.5\text{MeV}$ and a vanishing chemical potential μ (nuclear masses: $m_d = 1.8756\text{GeV}/c^2$, $m_{{}^3\text{He}} = 2.8084\text{GeV}/c^2$, $m_{{}^4\text{He}} = 3.7274\text{GeV}/c^2$).
- b) Plot the particle density n per spin degree of freedom as a function of the mass m for $T = 156.5\text{MeV}$
 - i) taking quantum statistics into account
 - ii) in the Boltzmann approximation
 - iii) in the Boltzmann approximation using the large argument approximation $K_\nu(x) \approx \sqrt{\frac{\pi}{2x}}e^{-x}$ of the modified Bessel functions of the second kind.

What do you conclude?

- c) Do the calculated ratios agree with data from the LHC and the light nuclei abundances in the early Universe?