Problem 9: Simple estimate of the transition temperature

Calculate the transition temperature for the transition from an ideal QGP with three active quark flavors to a hadron gas at vanishing baryo-chemical potential assuming that the pressure and the entropy density of the hadron gas can be describes by $p_{\mathrm{HG}} = g_{\mathrm{HG}} a T^4$ and $\varepsilon_{HG} = 3 g_{\mathrm{HG}} a T^4$ with $g_{\mathrm{HG}} \approx 12$ ($a = \pi^2/90$.)

Problem 10: ^{3}He/d ratio in the statistical model

Calculate the ratio ^{3}He/d in the statistical model for $T = 156\,\mathrm{MeV}$ and a vanishing chemical potential μ ($m_{\mathrm{d}} = 1.8756\,\mathrm{GeV}/c^2$, $m_{^3\mathrm{He}} = 2.8932\,\mathrm{GeV}/c^2$). Does the calculated ratio agree with data? Are quantum statistical effects important?

Problem 11: Lifetime of the QGP and the mixed phase in the Bjorken model

Calculate the lifetime of the QGP and the mixed phase in the 1d Bjorken model assuming that the hadron gas around T_c can be characterized by a degeneracy factor $g_{\mathrm{HG}} \approx 12$. Assume three active quark flavors in the QGP and $T_c = 155\,\mathrm{MeV}$. Consider two different values for the initial energy density at $\tau_0 = 1\,\mathrm{fm}/c$: $\varepsilon_0 = 5\,\mathrm{GeV/fm}^3$ and $14\,\mathrm{GeV/fm}^3$.

Problem 12: Calculation of v_2 and v_4

The text file dndphi.txt contains azimuthal angles drawn from the distribution

$$dn/d\varphi = 1 + 2v_2 \cos(2\varphi) + 2v_4 \cos(4\varphi).$$

Write a jupyther notebook that reads the text file and calculates $v_2\{2\}$ and $v_4\{2\}$. Estimate the statistical uncertainties. (*Hint:* the python tool `itertools.combinations()` might come in handy.)