PHYSICS AT THE TERA SCALE
Helmholtz Alliance

Exercises 2 (17. August 2020)

6. Calculate the Sudakov form factor for the scales $t_2 = 10, 100, 500$ GeV^2 as a function of t_1 and plot it as a function of t_1. Use q as the argument for α_s, and check the differences. For the z integral use $z_{min} = 0.01$ and $z_{max} = 0.99$.

$$\log \Delta_S = - \int_{t_1}^{t_2} \frac{dt}{t} \int_{z_{min}}^{z_{max}} dz \frac{\alpha_s}{2\pi} P(z)$$

   Use the gluon and also the quark splitting functions :

$$P_{gg} = 6 \left(\frac{1-z}{z} + \frac{z}{1-z} + z(1-z) \right)$$

   and

$$P_{qq} = \frac{4}{3} \frac{1+z^2}{1-z}$$

7. write a program to evolve a parton density $g(x) = 3(1-x)^5/x$ from a starting scale $t_0 = 1$ GeV^2 to and higher scale $t = 100$ GeV^2. Do the evolution only with fixed $\alpha_s = 0.1$ and an approximate gluon splitting function $P_{gg} = 6(\frac{1}{z} + \frac{1}{1-z})$. To avoid the divergent regions use $z_{min} = \epsilon$ and $z_{max} = 1 - \epsilon$ with $\epsilon = 0.1$. Calculate the Sudakov form factor for evolving from t_1 to t_2 using only the $\frac{1}{(1-z)}$ part of the splitting function. Generate z according to P_{gg}. Repeat the branching until you reach the scale t. Plot the $xg(x)$ as a function of x for the starting distribution and for the evolved distribution. Repeat the same exercise but with $P_{qq} = \frac{4}{3}\frac{1+z^2}{1-z}$.

   Calculate and plot the transverse momentum of the parton after the evolution. At the starting scale the partons can have a intrinsic k_t, which is generated by a gauss distribution with $\mu = 0$ and $\sigma = 0.7$ (use generating a gauss distribution from Exercise 1).

   Compare the k_t distribution using P_{gg} and P_{qq}. What is different ?