

## Exercises 2 (11. April 2018)

6. Calculate the Sudakov form factor for the scales  $t_2 = 10, 100, 500 \text{ GeV}^2$  as a function of  $t_1$  and plot it as a function of  $t_1$ . Use  $q$  as the argument for  $\alpha_s$ , 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  $t_0 = 1 \text{ GeV}^2$  to and higher scale  $t = 100 \text{ GeV}^2$ . 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 ?