where the summation is over quarks, gluons, and antiquarks. Here

$$s = (p_1 + p_2)^2 \;, \tag{24.28}$$

$$t = (p_1 - p_{\rm jet})^2 \;, \tag{24.29}$$

$$u = (p_2 - p_{\rm jet})^2 \;, \tag{24.30}$$

p_1 and p_2 are the momenta of the incoming p and p (or $\overline{p}$) and $\widehat{s}$, $\widehat{t}$, and $\widehat{u}$ are s, t, and u with $p_1 \to x_1 p_1$ and $p_2 \to x_2 p_2$. The partonic cross section $\widehat{s}\,[\,(d\widehat{\sigma})/(d\widehat{t}\,)\,]$ can be found in Ref. 2. Example: for the process $gg \to q\overline{q}$,

$$\widehat{s}\,\frac{d\sigma}{dt} = 3\alpha_s^2\,\frac{(\widehat{t}^{\,2} + \widehat{u}^2)}{8\widehat{s}}\left[\frac{4}{9\,\widehat{t}\,\widehat{u}} - \frac{1}{\widehat{s}^{\,2}}\right] . \tag{24.31}$$

The prediction of Eq. (24.27) is compared to data from the UA1 and UA2 collaborations in Fig. 33.5 in the Plots of Cross Sections and Related Quantities section of this *Review.*

24.5. One-particle inclusive distributions

In order to describe one-particle inclusive production in e^+e^- annihilation or deep inelastic scattering, it is convenient to introduce a fragmentation function $D_i^h\,(z,Q^2)/z$ which is the probability that a parton of type i and momentum p will fragment into a hadron of type h and momentum zp. The Q^2 evolution is predicted by QCD and is similar to that of the parton distribution functions [see section on Quantum Chromodynamics (Sec. 25 of this *Review*)]. The $D_i^h(z,Q^2)$ are normalized so that

$$\sum_h \int D_i^h\,(z,Q^2)dz = 1 \;. \tag{24.32}$$

If the contributions of the Z boson and three-jet events are neglected, the cross section for producing a hadron h in e^+e^- annihilation is given by

$$\frac{1}{\sigma_{\rm had}}\,\frac{d\sigma}{dz} = \frac{\sum_i e_i^2\,D_i^h\,(z,Q^2)}{\sum_i e_i^2} \;, \tag{24.33}$$

where e_i is the charge of quark-type i, $\sigma_{\rm had}$ is the total hadronic cross section, and the momentum of the hadron is $zE_{\rm cm}/2$.

In the case of deep inelastic muon scattering, the cross section for producing a hadron of energy E_h is given by

$$\frac{1}{\sigma_{\rm tot}}\,\frac{d\sigma}{dz} = \frac{\sum_i e_i^2\,q_i(x,Q^2)\,D_i^h(z,Q^2)}{\sum_i e_i^2\,q_i(x,Q^2)} \;, \tag{24.34}$$

where $E_h = \nu z$. (For the kinematics of deep inelastic scattering, see Sec. 23.4.2 of the Kinematics section of this *Review.*) The fragmentation functions for light and heavy quarks have a different z dependence; the former peak near $z = 0$. They are illustrated in Fig. 33.11 in the section on Plots of Cross Sections and Related Quantities (Sec. 33 of this *Review*).

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