

# 9

## Partons

Equipped with the formalism of Chapter 8, we can now turn to the experimental information and ask the question, "Can small-wavelength photons resolve the quarks inside the proton target?"

### 9.1 Bjorken Scaling

If simple, point-like, spin- $\frac{1}{2}$  quarks reside inside the proton, we should be able to illuminate them with a small-wavelength (large  $-q^2$ ) virtual photon beam (Fig. 9.1). The fact that such photons break up the proton target can be handled by using the inelastic form factors discussed in the previous chapter. The sign that there are structureless particles inside a complex system like a proton is that for small wavelengths, the proton described by (8.43) suddenly starts behaving like a free Dirac particle (a quark) and (8.43) turns into (8.41). The proton structure functions thus become simply

$$\begin{aligned} 2W_1^{\text{point}} &= \frac{Q^2}{2m^2} \delta\left(x - \frac{Q^2}{2m}\right), \\ W_2^{\text{point}} &= \delta\left(x - \frac{Q^2}{2m}\right). \end{aligned} \quad (9.1)$$

For convenience, we have introduced the positive variable

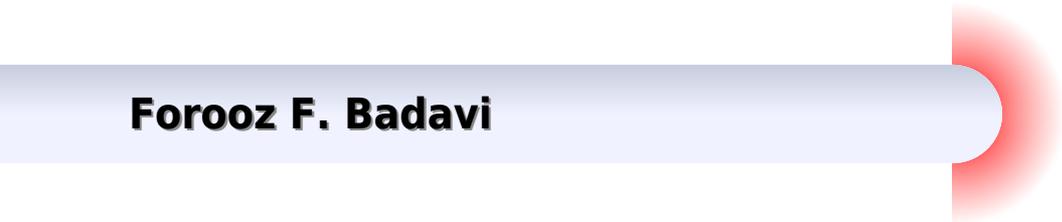
$$Q^2 = -q^2.$$

Here,  $m$  is the quark mass; the "point" notation reminds us the quark is a structureless Dirac particle. Equation (9.1) can be pictured as



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**Forooz F. Badavi**



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Collins, Alan D. Martin, E. J. Squires, 1989-06-06 This readable introduction to particle physics and cosmology discusses the interaction of these two fundamental branches of physics and considers recent advances beyond the standard models Eight chapters comprise a brief introduction to the gauge theories of the strong and the electroweak interactions the so called grand unified theories and general relativity Ten more chapters address recent concepts such as composite fermions and bosons supersymmetry quantum gravity supergravity and strings theories and relate them to modern cosmology and experimental astronomy

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