ABSTRACT

Asymptotically free gauge theories of the strong interactions are constructed and analyzed. The reasons for doing this are recounted, including a review of renormalization group techniques and their application to scaling phenomena. The renormalization group equations are derived for Yang-Mills theories. The parameters that enter into the equations are calculated to lowest order and it is shown that these theories are asymptotically free. More specifically the effective coupling constant, which determines the ultraviolet behavior of the theory, vanishes for large space-like momenta. Fermions are incorporated and the construction of realistic models is discussed. We propose that the strong interactions be mediated by a "color" gauge group which commutes with SU(3)xSU(3). The problem of symmetry breaking is discussed. It appears likely that this would have a dynamical origin. It is suggested that the gauge symmetry might not be broken, and that the severe infrared singularities prevent the occurrence of non-color singlet physical states. The deep inelastic structure functions, as well as the electron position total annihilation cross section are analyzed. Scaling obtains up to calculable logarithmic corrections, and the naive lightcone or parton model results follow. The problems of incorporating scalar mesons and breaking the symmetry by the Higgs mechanism are explained in detail.