Pramāṇa, Vol. 15, No. 1, July 1980, pp. 97–100, © Printed in India.

Structure function of pion and its compositeness

M K PARIDA
Post-Graduate Department of Physics, Sambalpur Univerity, Jyoti Vihar, Burla 768 017, India

MS received 11 March 1980; revised 19 May 1980

Abstract. Using recent data on pion structure function and a rigorous inequality obtained recently using unitarity analyticity and Bjorken scaling a numerical upper bound on the wave-function-renormalisation constant of pion is computed. By the (somewhat drastic) act of neglecting the sea, it is shown that the bare part of the pion can be no more than 38%.

Keywords. Pion structure function; renormalisation constant; compositeness; unitarity; Bjorken scaling; analyticity.

1. Introduction

Recently some attention has been focussed on estimating the degree of compositeness of a particle from a knowledge of the numerical value of its wave-function-renormalisation constant. Fractional value of the renormalisation constant has been interpreted as the manifestation of the degree of compositeness of the particle. Using unitarity, analyticity, Bjorken scaling and the available data on the structure functions of the proton, Broadhurst (1972) was able to obtain a numerical upper bound on the wave-function-renormalization constant, Z_2, for the proton. Later Baluni and Broadhurst (1973) carried out a more rigorous analysis using unitarity, analyticity and the experimental data on πN scattering. A more sophisticated computation by Baluni and Broadhurst (1977) reveals that $Z_2 \leqslant 0{\cdot}25$ which implies that proton is at least 75% composite.

Since pion is the least massive of hadrons taking part in strong interaction, estimation of its compositeness may also furnish information on the lower limit of the degree of compositeness of other hadrons. To our knowledge there does not exist any numerical upper bound on the wave-function-renormalisation constant Z_3 of the pion. However, recently, theoretically rigorous upper bounds on, Z_3, have been derived (Parida and Giri 1977, 1978) in terms of integrals involving structure functions of the pion. But since the experimental data on the pion structure functions were not available at that time it was not possible to evaluate the upper bound numerically. In this paper we evaluate the upper bound on Z_3 numerically, using the recently published data on the pion structure function (Newman *et al* 1979). Several aspects of this result are also discussed.