THE π-MESONIC ATOM AND CORRECTIONS TO THE DISPERSION RELATIONS

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RECENTLY there appeared a series of papers[1] devoted to various corrections to the dispersion relations. All those effects due to the mass difference between the neutral and the charged mesons and to the electromagnetic interaction proved to be too small to explain the Puppi-Stanghellini puzzle.[2] This consists in the fact that the dispersion relations for the process $\pi^- + p \rightarrow \pi^- + p$ agree with experiment with the choice of $f^2 = 0.04$ for the coupling constant of the nucleon-meson interaction up to the resonance, whereas $f^2 = 0.08$ after the resonance. Such a marked energy dependence of f^2 contradicts the results of other methods for the determination of f^2, which give the value $f^2 = 0.08$ for the above energy region. The aim of this paper is to estimate the magnitude of the corrections due to the π mesonic atom.

The appearance of a state with only a nucleon and a photon in the expansion of the antihermitian part of the scattering amplitude in terms of a complete system of functions does not fully account for the electromagnetic interaction. In the case of π^--p scattering we have to consider the π mesonic atom. For this purpose the forward scattering amplitude $f_-(\omega)$ for the process $\pi^- + p \rightarrow \pi^- + p$ has to be investigated more carefully. It can be represented as the sum of three terms: (1) the Rutherford amplitude, (2) a purely nuclear term, and (3) an interference term of the preceding two. The last term is small for energies of some 10 Mev, since it is proportional to α/η (α is the fine-structure constant, $\eta = p/m_\pi c$). But in the dispersion relations it is important to know the scattering amplitude for small $\omega - m_\pi > 0$, in which case the interference term is not small. We note that the dispersion relations are strictly proven[3] only for the nuclear part of the scattering amplitude. Therefore we have to regard the interference term as a correction to the usual dispersion relations for the processes $\pi^\pm + p \rightarrow \pi^\pm + p$.

The interference term contains poles corresponding to the bound states of the system π^-, p. The correction to the dispersion relations due to these states is equal to

$$\Delta\left(\frac{D_\mp^b}{r_0}\right) = \pm \frac{\eta\eta^b}{\omega - 1}\left[\frac{8\pi^2\alpha}{9}(4a_1^2 + a_3^2 + 4a_1a_3) \times \sum \frac{(-1)^n}{n!\,(n+1)!} + O(\alpha)\right],$$

where $D_\pm = \mathrm{Re}\, f_\pm(\omega)$, $r_0 = h/m_\pi c$, and the index b implies taking the value in the center-of-mass system. The sum arises from the inclusion of all bound states. These states are considered stable, the finite level width effecting only the terms $0(\alpha)$. The quantities a_1, a_2 are equal to α_1/η, α_3/η and are taken from the paper of Orear.[4] Numerical calculations show that the correction coming from the π mesonic atom is a small effect and accounts for only 4% of the deviation of the coupling constant f^2 in the region of 120 Mev.

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[1] A. Agodi and M. Cini, Nuovo cimento **5**, 1256 (1957); **6**, 686 (1957). Agodi, Cini, and Vitale, Phys. Rev. **107**, 630 (1957). V. K. Fedianin, J. Exptl. Theoret. Phys. (U.S.S.R.) **33**, 1301 (1957); Soviet Phys. JETP **6**, 1001 (1958).

[2] G. Puppi and A. Stanghellini, Nuovo cimento **5**, 1305 (1957).

[3] N. N. Bogoliubov and D. V. Shirkov, Введение в теорию квантованных полей (Introduction into the Quantum Theory of Fields), Gostekhizdat, M. 1957.

[4] J. Orear, Phys. Rev. **96**, 176 (1954).

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EFFECT OF UNIAXIAL ELASTIC DEFORMATIONS ON THE MAGNETIC PROPERTIES OF ZINC CRYSTALS AT LOW TEMPERATURES

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UNIFORM compression of zinc crystal at an approximate pressure of 700 kg/cm^2 increases the period of oscillations of its magnetic susceptibility by 40 to 50%, and reduces correspondingly the