under ordinary conditions transitions between these states, and if they are formed at all, this occurs somewhere in "singular points" of the universe, for example in galactic nuclei or in the case of gravitational collapse of stars.

It follows from all the foregoing that the asymptotic saturation conditions are not always an unconditional test in the search for NN potentials.

In conclusion, I am grateful to A.I. Baz' for discussions.

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SOFT-PION THEOREMS AND DIRECT NUCLEAR PROCESSES

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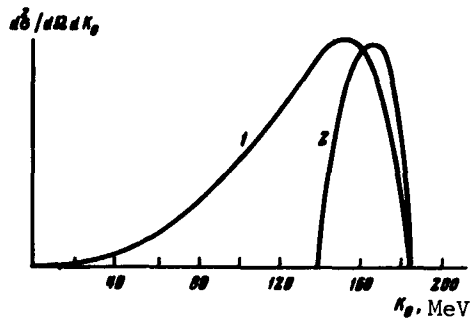
We have obtained the spectra of soft pions emitted in direct stripping and pickup nuclear reactions. It is shown that the pion spectra are not sensitive to the mechanism of the direct nuclear reactions.

We investigate here the applicability of the so-called soft-pion theorems (see [1, 2]) against direct nuclear stripping and pickup reactions. In this connection, we consider two processes: the possibility of extrapolating nuclear amplitudes with respect to the momentum transfer q^2 to a point corresponding to the mass of the physical pion, and the possibility of obtaining information concerning the mechanism of the direct nuclear processes by investigating reactions with emission of soft pions.

Of greatest importance in the question of the feasibility of the extrapolation procedure is a determination of the rate of change of the nuclear amplitudes with respect to the momentum transfer q^2 when $q^2 \lesssim \mu^2$ (μ is the pion mass).

To this end we have considered a broad class of diagrams with pion emission by one of the nucleons of the nucleus. This class of diagrams has a singularity in the momentum transfer to the nucleus at $q^2 = M\varepsilon$ (M is the nucleon mass and ε its binding energy in the nucleus). In the particular case of a deuteron, this singularity corresponds numerically to $q^2 \simeq 1.2\mu^2$. It follows therefore intuitively that extrapolation of the amplitude to the physical pion over a distance on the order of $q^2 \lesssim \mu^2$ may turn out, generally speaking, not valid. This situation differs significantly from that in elementary-particle theory where one can hope the ratio of the pion mass to the characteristic mass of the process to be $\mu/m_{char} < 1$ [2]. For this reason, the extrapolation procedure turns out to be valid here. On the other hand, in the case of direct nuclear processes, the characteristic-mass is of the order of $m_{char} \sim \sqrt{M\varepsilon}$ [3]. Taking this result into account, we can conclude that the process of the validity of the extrapolation procedure in nuclear processes should be considered separately in each concrete case. In this connection, it is apparently necessary to approach the results obtained without such a special investigation with some caution (see, e.g., [4]).



The foregoing conclusion drawn concerning the extrapolation procedure is confirmed by experimental data on pion-nucleus scattering length [5], which do not agree with the theoretical calculations [6]. The reason for these discrepancies lies precisely in the fact that an energy equal to the pion mass is so high an excitation energy for nuclei, that the pion at the threshold cannot be regarded as "soft."

Within the framework of the soft-pion technique [1], the contribution of the diagrams corresponding to emission of a pion from the internal lines is suppressed compared with the contribution of the diagrams corresponding to emission from the free lines. However, it is precisely the emission of the pions from the internal lines which is of greatest interest, being the principal source of information on the mechanism of the direct nuclear processes. For this reason, in calculating the spectra of the soft pions we took into account not only diagrams with emission of pions from external lines, but also from internal lines.

The figure shows by way of illustration the differential spectra of the pions in the pickup reaction $C^{12}(p, d\pi)C^{11}$ for the case z = 0, where z is the cosine of the angle between the momenta of the proton and the deuteron, obtained under the assumption of the pole mechanism of the reaction. The abscissas in this figure represent the total pion energy K_0. The ordinates represent the pion spectrum in arbitrary units. Curve 1 in the figure corresponds to an "unphysical" pion with mass $\mu = 0$. Curve 2 corresponds to a physical pion with mass $\mu = 140$ MeV. The obvious difference between curves 1 and 2 emphasizes the importance of a correct execution of the extrapolation of the nuclear amplitude with respective q^2 to the point corresponding to the mass of the physical pion. In addition, it is seen from the curves that in the pion energy region $K_0 > \mu$ there are no characteristic singularities in the soft-pion spectrum that are sensitive to the mechanism of the considered direct process. In this sense, the spectrum of the soft photons gives more critical information concerning the mechanism of the direct nuclear process [7]. The reason for this difference lies in the fact that diagrams corresponding to emission of a pion from the internal lines are suppressed compared with the corresponding diagrams in the case of photon emission. Results analogous to those given above are obtained also with respect to the direct stripping process. The values z = 0 lead to analogous spectra. The results reported here will be discussed in greater detail in a separate paper.

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