Relations between Electromagnetic Form Factors and the Wave Functions of the Deuteron (*) (**).

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Summary. — We have calculated the deuteron form factor with some local and separable potentials. The last ones are treated directly in momentum space. We have found a relation between the dip in the charge form factor and the dip in the momentum-space wave functions \( |\phi_0(p)| \). The second maximum of this form factor can be understood with the help of the «high-energy component» of the deuteron. In the course of our discussions we found it useful to change the notation connected with the softness of the nucleon-nucleon interaction.

1. — Introduction.

In recent years the question has been revived about how soft is the nucleon-nucleon interaction for small distances (1,2). In sect. 2 we review the situation in the case of the deuteron wave functions and define a degree of softness and a corresponding high-energy component of the S-wave.

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Then we apply these different wave functions in the calculation of the electromagnetic form factors of the deuteron and discuss the relations between the structures in the charge form factors and in the wave functions.

Polarization experiments have been proposed to separate this form factor. However, the knowledge of the tensor polarization by itself can be a powerful tool in the understanding of the nucleon-nucleon interaction. Therefore we discuss this quantity in sect. 4.

2. – Properties of the deuteron wave functions.

In this section we discuss the properties of various wave functions. For this purpose we chose functions for some important or typical potentials given either in momentum or in co-ordinate space. In order to compare these functions in a consistent way and to see connections between these representations we have drawn all wave functions in both representations.

The two representations are connected by the Hankel transformation

\[
\begin{align*}
\psi_i(p) &= i^l \sqrt{\frac{2}{\pi}} \int_0^\infty r^2 j_l(pr) \psi_i(r) \, dr, \\
\psi_i(r) &= i^l \sqrt{\frac{2}{\pi}} \int_0^\infty p^2 j_l(pr) \psi_i(p) \, dp,
\end{align*}
\]

(1)

where \( l \) is the orbital angular momentum and \( j_l \) the corresponding spherical Bessel function.

The normalization of these wave functions is given by

\[
\int_0^\infty r^2 (\psi_0^2(r) + \psi_2^2(r)) \, dr = \int_0^\infty u^2(r) \, dr + \int_0^\infty w^2(r) \, dr = \int_0^\infty p^2 (\psi_0^2(p) + \psi_2^2(p)) \, dp = \int_0^\infty u^2(p) \, dp + \int_0^\infty w^2(p) \, dp = p_s + p_d = 1
\]

(2)

with the definitions

\[
\begin{align*}
u(r) &= r\psi_0(r), & w(r) &= r\psi_2(r), \\
u(p) &= p\psi_0(p), & w(p) &= p\psi_2(p).
\end{align*}
\]

(3)

Because it is also informative to discuss the «probability functions» \( u \) and \( w \) we have drawn these functions. The importance will be demonstrated later in this paper.