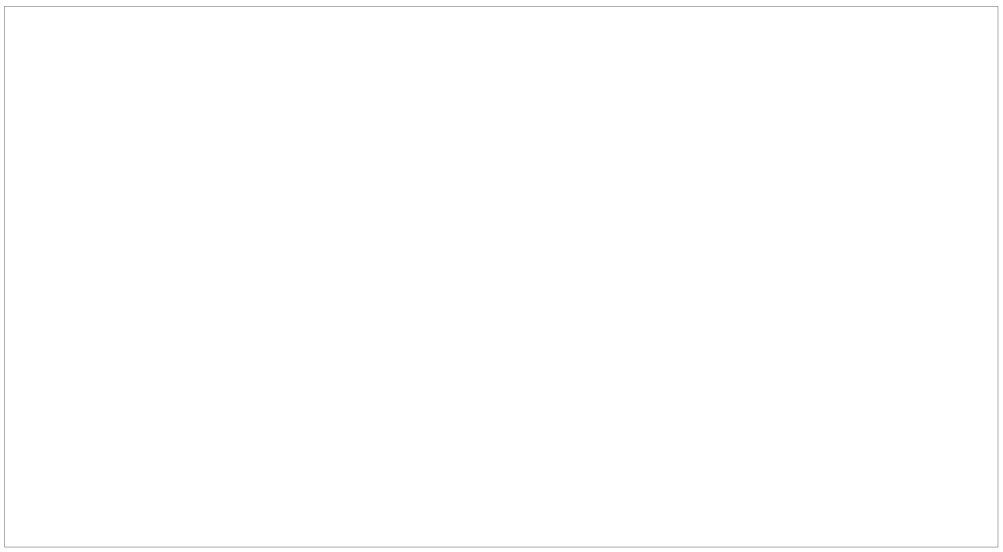

Title: CONCERNING THE THEORY OF SCATTERING OF NEUTRONS BY PROTONS
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CONCERNING THE THEORY OF SCATTERING OF NEUTRONS BY PROTONS.

by Ya. Smorodinskiy

It was shown in the previous work ([1] is quoted below as I) that the usual formula by Wigner of effective cross section of neutron scattering by protons should be corrected. The constants belonging to this formula in reality depend linearly on neutron energy. As a result the formula contains four constants instead of two.

In order to determine the values of these constants we used the magnitude of bond energy of the deuteron and the measured values of effective cross section of scattering for various energies. However, due to the scarcity of experimental data and their low accuracy, the obtained values of constants could be very rough.

Recently two works on research of scattering of neutrons by protons in a wide energy range [2,3] were published. In the experiments of Bailey et al [2] the neutron energy was varied from 350 keV to 6 MeV. Frisch [3] additionally investigated the scattering of neutrons of energies of 35, 95, 165 and 490 keV.

The obtained data permit to verify the derived formula and to obtain a more accurate value of constants. The formula even with the old values of constants appeared in good agreement with the experimental data. The experimental points appeared only in the case of low energies somewhat above the computed ones. This discrepancy may be explained by the fact that we were unable to utilize data corresponding to low neutron energies (except the case of thermal neutrons, see I).

In order to still improve the agreement it suffices to change only slightly one coefficient. Namely instead of the constant 0.29 in the second term, we should take 0.27. Finally, the formula for the effective cross section takes the form:

$$\sigma = 1{,}50 \cdot 10^{-24} \frac{5}{(1{,}22 - 0{,}06E)^2 + \frac{E}{2}} + \frac{1}{(0{,}27 + 0{,}06E)^2 + \frac{E}{2}} \text{ cm}^2 \qquad (1)$$

where E is measured in MeV (in the laboratory system of coordinates). Formula (1) appears to be in excellent agreement with the experimental data (fig 1).

As was shown in I the root of the denominator of the second term equals $\frac{\varepsilon}{2}$, where ε is the energy of the virtual (singlet) deuteron level. Making use of the new values of constants, we obtain the following value for this energy

$$\varepsilon = 0{,}066$$

instead of the value 0,15 given in I. The accuracy of the value is around 10%.

It is necessary to notice that formula (1) differs very little by [illegible] the second coefficient in the denominator of the second term. Therefore actually only two constants are determined from data on scattering (the third constant is determined by the bond energy of the deuteron).

The obtained agreement between the two-parameter formula and the experimental data confirms our point of view, that it is impossible to obtain from available data some information on the shape of the potential well, except the values of some two parameters(or in the best case of three) defining the interaction of proton and neutron in two states (singlet and triplet).

It is of interest to apply formula (1) to the case of neutrons with an energy of 25MeV, investigated by Sherr [4]. Sherr obtained for the cross section the value $0{,}39 \cdot 10^{-24}$ cm^2. According to formula (1) in this case the value $0{,}60 \cdot 10^{-24}$ cm^2 is obtained. Here we should take under consideration the p-scattering, the cross section of which at these energies should be around $0{,}01 \cdot 10^{-24}$ cm^2 (see I); therefore the computed value of the cross section will be approximately $0{,}41 \cdot 10^{-24}$ cm^2, and this value agrees well with experiment. (let us recall that at 14 MeV the agreement was also very good, as seen from I).

Hence formula (1) gives the values of scattering cross sections in a wide range of neutron energies.

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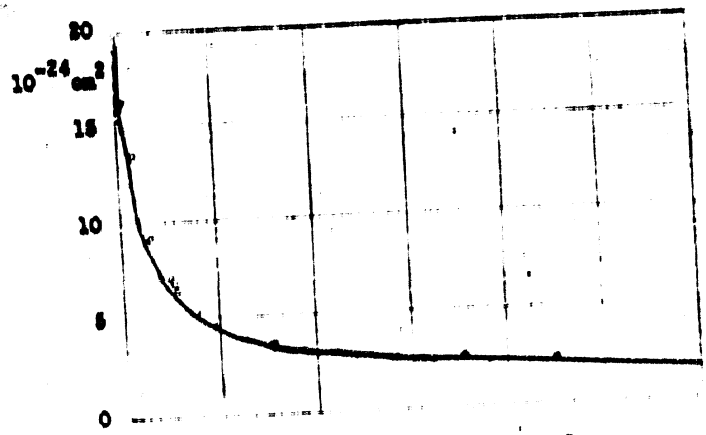

Figure 1. ○ - Frisch, ● - Bailey et al.

Continuous line is the result of computation.