In the case of invariance under charge conjugation, this effect does not arise.

I would like to express my gratitude to B. L. Ioffe for a useful discussion.

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Translated by G. E. Brown
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Nuclear Photoeffect in Be⁹ at High Energies

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(Submitted to JETP editor January 30, 1957)
J. Exptl. Theoret Phys. (U.S.S.R.) **32**, 1249-1250 (May, 1957)

ÜBERALL[1] HAS INVESTIGATED the $Be^9(\gamma_1 n)Be^8$ reaction on the basis of the one particle model in the γ-energy interval 20–200 Mev. The interaction energy curve of the (Be^8, n) system is taken in the form of a potential well having spherical symmetry. He studies both the electric and magnetic transitions of the system taking account of retardation.

The Born approximation gives a photoneutron angular distribution proportional to $\sin^2\theta$ as well as the energy dependence of the total effective cross section. The cross section curve, generally falling with increasing energy, has zeros at several energy values (curve *1* of the figure), which do not correspond with the experimental data.

Überall shows that such an oscillation of the total cross section curve is possibly due to the special choice of the potential in the form of a square well. One can expect that with a different choice of the interaction potential the total cross section may not oscillate. To test this idea we investigated the same reaction taking as the interaction potential of the (Be^8, n) system the potential of an oscillator, terminated at some point $r = r_0$.

Our work[2] showed that with this choice of potential the wave function of the (Be^8, n) system can be represented with satisfactory approximation in the form

$$R(r) = \sqrt{2/3}\,(2\pi)^{-1/4}(r_0')^{-3/2}\exp\{-1/4\,(r/r_0')^2\}\,r/r_0', \qquad (1)$$

where r_0' is a parameter proportional, on one hand, to the most probable distance between the nuclear core of B^8 and the neutron, and on the other hand, to the nuclear radius. The parameter r_0' may be regarded as the quantity which characterizes the behavior of the wave function inside the nucleus and hence in some measure takes into account the structure of the nucleus.

The differential cross section, found from Eq. (1), is likewise proportional to $\sin^2\theta$. The total effective cross section, as found by us, takes the form:

$$\sigma = 4.82\cdot 10^{-29}\delta^5\,[\hbar\omega]^{3/2}\exp[-0.094\delta^2\hbar\omega], \qquad (2)$$

where $\delta = r_0' \times 10^{13}$ cm^{-1}, and $\hbar\omega$ is in Mev. Equation (2) shows the total effective cross section falling off exponentially with increasing γ-energy, while the damping coefficient depends upon r_0'.

It is easily seen that to get quantitative agreement between theory and experiment it is sufficient to set

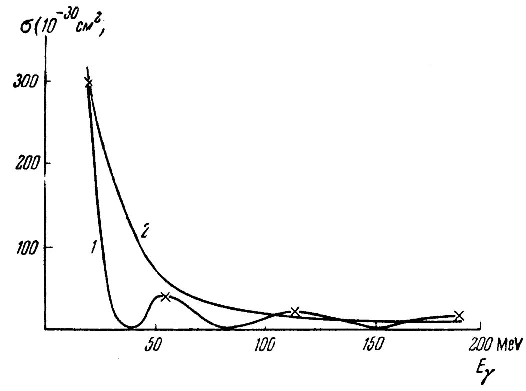
$$\delta = 1.6\,(20/\hbar\omega)^{2/5}. \qquad (3)$$

In this case we will have for the total effective cross section

$$\sigma = 2.36\cdot 10^{-25}\exp[-5.15\,(\hbar\omega/20)^{1/5}]\,(\hbar\omega)^{-1/2}. \qquad (4)$$

The energy dependence of the effective cross section obtained from Eq. (4) is shown by Curve *2* of the figure. The experimental points, shown by crosses, fit the theoretical curve well.

The energy dependence of the parameter r_0', expressed by Eq. (3), can be determined approximately from the wave function (1). The point is that at high γ-energies the excitation of the nucleus is so large that it is not legitimate to assume that the liberated neutron leaves the nucleus in the definite stationary state given by the wave function (1). The energy dependence of r_0', apparently, in some measure takes account of the change in state of the (Be^8, n) system under the influence of radiation. As Eq. (3) shows, an increase in the γ-energy reduces r_0', which is natural, since with increasing excitation of the nucleus the role of the smaller distances should become more and more important in releasing the neutron.



At $\hbar\omega$ = 5–8 Mev Eq. (3) gives $r_0' \approx 2.6 \times 10^{-13}$ cm. This particular value agrees with the experiment on the collision of the deuteron with the beryllium nucleus, treated in Ref. (2).

If we consider that in the energy range 20–200 Mev, where there is a satisfactory agreement between theory and experiment, r_0' changes only by a factor 2.5, we can conclude that the assumption of a slow energy dependence of r_0' will explain the experimental data over a wide range of γ-energies.

In conclusion I wish to thank Prof. V. I. Mamasakhlisov for helpful discussions.

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Translated by C. V. Larrick
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Distribution of the Electron-Photon Component on the Periphery of Extensive Air Showers of Cosmic Rays

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(Submitted to JETP editor February 4, 1957)
J. Exptl. Theoret. Phys. (U.S.S.R.) **32**, 1250-1252 (May, 1957)

INVESTIGATIONS of the lateral distribution function of the electron-photon component of extensive air showers at 3860 m were carried out by means of an experimental set-up[1] consisting of a large number of hodoscoped counters placed at various distances from each other. Counters intended for the measurement of the flux density of all charged particles in the shower were placed under thin covers made of aluminum and wood ($\sim$ 2g/cm^2). The particle flux density at a given distance from the axis of the shower was determined according to the formula

$$\rho(r) = \frac{1}{\sigma} \ln \frac{n}{n-m}$$

This formula makes it possible to determine the most probable value of the flux density of charged particles that discharge m out of the total number of n counters, each of area σ, situated in the given place of observation.

In the case when $\rho\sigma n \lesssim 1$ the determination of the particle flux density in an individual case of shower detection is impossible. In such cases the particle flux density was determined for a group of showers identical with respect to the total number of particles and the position of the shower axes. It was assumed that n equals the product of the total number of counters by the number of showers of a given group and m is the total number of counter discharges during the passage of all showers of the group. Test computation showed that the probable value of the particle flux density in a given group of showers is, within the limits of statistical accuracy, the same as the mean weighted value of the probable values of the particle flux density determined for each separate shower of the group.

We considered three groups of extensive air showers with definite axis positions. The first group comprised showers with a total number of particles between 5×10^4 and 1×10^5. The energy of primary particles producing these showers can be estimated[2] as $\bar{E}_0 = 1.6 \times 10^{14}$ ev. The limits of the total number of shower particles and the corresponding mean energy of primaries for the second and third group were $1.5 \times 10^5 - 2.6 \times 10^5$ ($\bar{E}_0 = 5 \times 10^{14}$ ev) and $5 \times 10^5 - 13 \times 10^5$ ($\bar{E}_0 = 16 \times 10^{14}$ ev). The lateral distribution functions of all charged particles obtained for the three groups of showers are shown in Fig. 1. The plotted lateral distributions for distances from the axis smaller than 40 m are based on previously published results[3].

The experimental data given in Fig. 1 characterize the lateral distribution of the electron-photon component of the shower only at distances from the axis smaller than $\sim$ 100 m, where the relative contribution of penetrating particles is not appreciable.