UCRL- 1069

UNCLASSIFIED

UNIVERSITY OF CALIFORNIA — BERKELEY

RADIATION LABORATORY

DISCLAIMER

Copy 2

UCRL-1069
Unclassified-Physics Distribution

UNIVERSITY OF CALIFORNIA

Radiation Laboratory

Contract No. W-7405-eng-48

UNCLASSIFIED

ON THE HARD SPHERE MODEL OF THE NUCLEON

Robert Jastrow

December 28, 1950

Berkeley, California

UCRL-1069
Unclassified-Physics Distribution

ON THE HARD SPHERE MODEL OF THE NUCLEON

Robert Jastrow

Radiation Laboratory, Department of Physics
University of California, Berkeley, California

December 28, 1950

It has been suggested that the evidence from P-P scattering experiments at 340 Mev[1] for large momentum transfers in nucleon-nucleon collisions may be explained by the assumption of a strong short-range repulsion between nucleons.[2] Since the completion of calculations based on this assumption additional experimental results have been reported at 340 Mev and at lower energies.

The experiments at intermediate energies are of special interest because the assumption of a repulsion in the nucleon-nucleon interaction results in the apparance of a pronounced minimum in the singlet cross section at energies in the neighborhood of 170 Mev, as a result of interference between the repulsion and the surrounding attractive well. This minimum is partially masked by a maximum in the tensor contribution to the complete cross section at corresponding energies, but, nevertheless, its effect becomes appreciable for sufficiently large radii of repulsion. In Fig. 1, values of the P-P cross section at 90° for energies between 100 Mev[3] and 340 Mev[4] are compared with calculations in which the repulsion is represented by a hard sphere, using radii of 0.50 and 0.60×10^{-13} cm. From Fig. 1, one may conclude that a radius greater than 0.60×10^{-13} cm would lead to a minimum in the P-P cross section incompatible with present experimental values.

The angular dependence of the P-P cross section at intermediate energies has also been measured recently and is compared in Fig. 2 at 100 Mev[3] and

---

1 O. Chamberlain and C. Wiegand, Phys. Rev. 79, 81 (1950).
2 R. Jastrow, Phys. Rev. 79, 389 (1950); detailed account in press.
3 O. Chamberlain, E. Segrè and C. Wiegand, Phys. Rev. (in press).
4 R. Birge, Phys. Rev. 80, 490 (1950).

250 Mev[4] with curves calculated on the assumption of a hard sphere repulsion of radius 0.60 x 10^{-13} cm. Previously published values at 30 Mev are also shown.[5]

Revised values at 340 Mev are shown in Fig. 3 on a plot of the P-P cross section calculated from the same model.

The indicated experimental uncertainties include both statistical and estimated systematic errors, with the exception of the 100 Mev values in Fig. 2, where only the estimated 10 percent uncertainty in the relative values at various angles is shown. The absolute value of the 100 Mev cross section values is subject to an uncertainty of 20 percent.

This work was carried out under the sponsorship of the Atomic Energy Commission.

---

5. W.K.H. Panofsky and F. L. Fillmore, Phys. Rev. 79, 57 (1950).

Information Division
1-8-51 cg

250 Mev[4] with curves calculated on the assumption of a hard sphere repulsion of radius 0.60×10^{-13} cm. Previously published values at 30 Mev are also shown.[5]

Revised values at 340 Mev are shown in Fig. 3 on a plot of the P-P cross section calculated from the same model.

The indicated experimental uncertainties include both statistical and estimated systematic errors, with the exception of the 100 Mev values in Fig. 2, where only the estimated 10 percent uncertainty in the relative values at various angles is shown. The absolute value of the 100 Mev cross section values is subject to an uncertainty of 20 percent.

This work was carried out under the sponsorship of the Atomic Energy Commission.

---

[5] W.K.H. Panofsky and F. L. Fillmore, Phys. Rev. 79, 57 (1950).

Information Division
1-8-51 cg

FIGURE CAPTIONS

Figure 1: P-P cross sections at 90°. The experimental values at 100 Mev are taken from ref. 3; the remainder from ref. 4.

Figure 2: P-P cross sections at 30 Mev[5], 100 Mev[3] and 250 Mev[4] compared with calculations assuming a radius of repulsion 0.60×10^{-13} cm.

Figure 3: P-P cross sections at 340 Mev[4] compared with the same model.

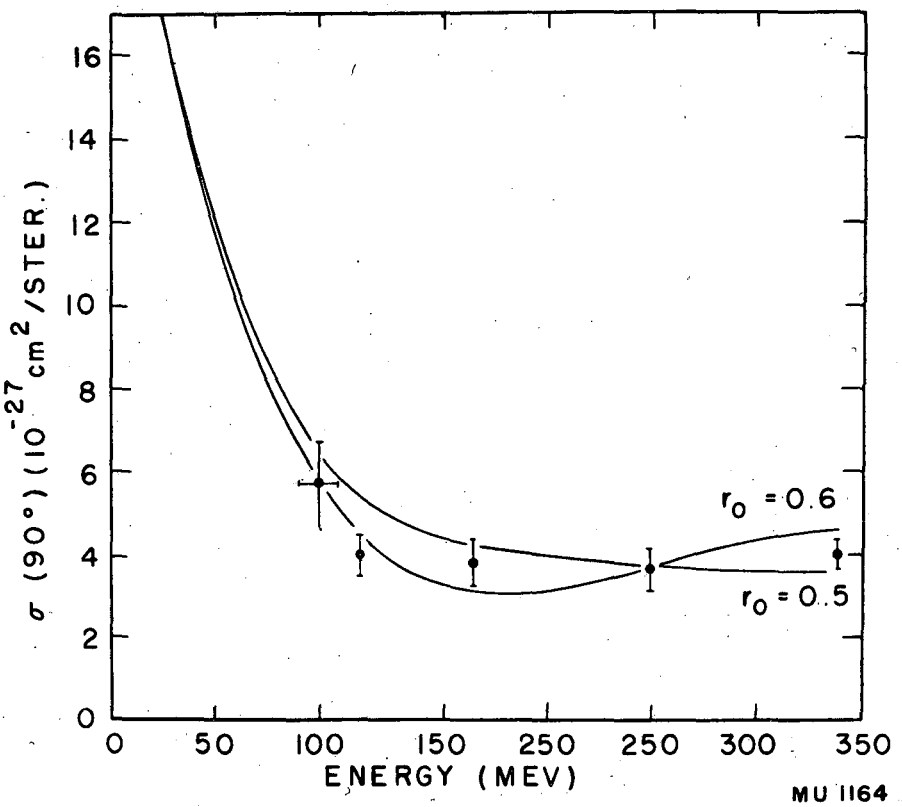
16
14
12
10
8
6
4
2
0
0
50
100
150
250
250
300
350
σ (90°) (10^-27 cm^2/STER.)
ENERGY (MEV)
r0 = 0.6
r0 = 0.5
MU 1164

FIG. 1

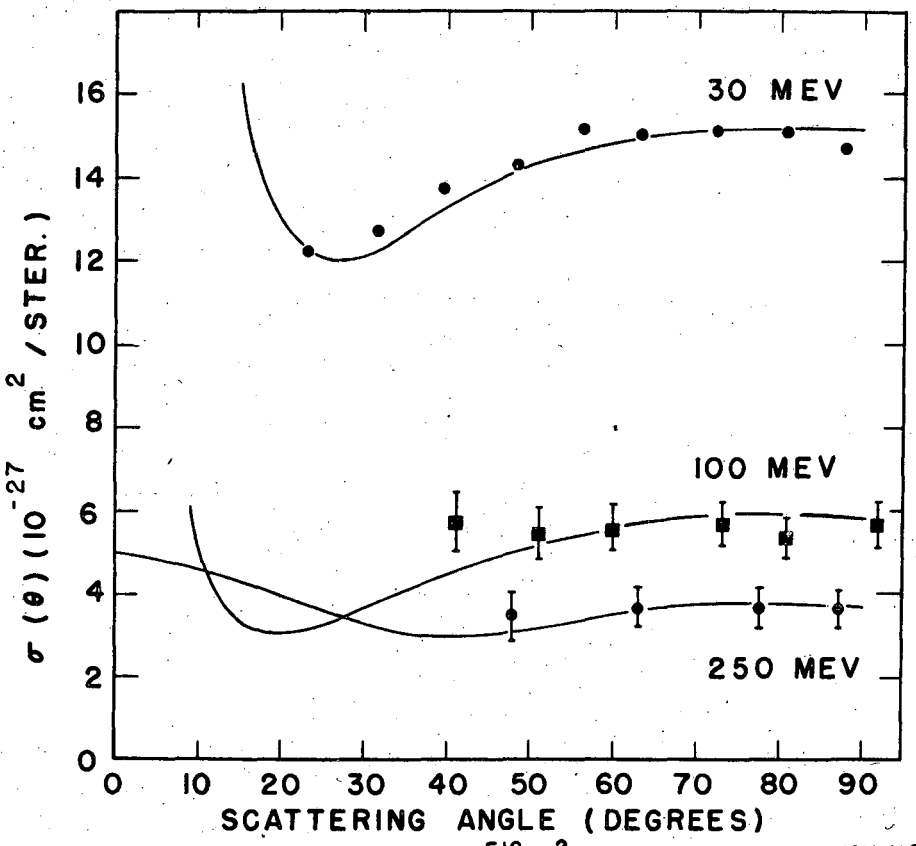
30 MEV
100 MEV
250 MEV
σ (θ) (10^-27 cm^2 / STER.)
SCATTERING ANGLE (DEGREES)
0
2
4
6
8
10
12
14
16
0
10
20
30
40
50
60
70
80
90

FIG. 2

MU 1165

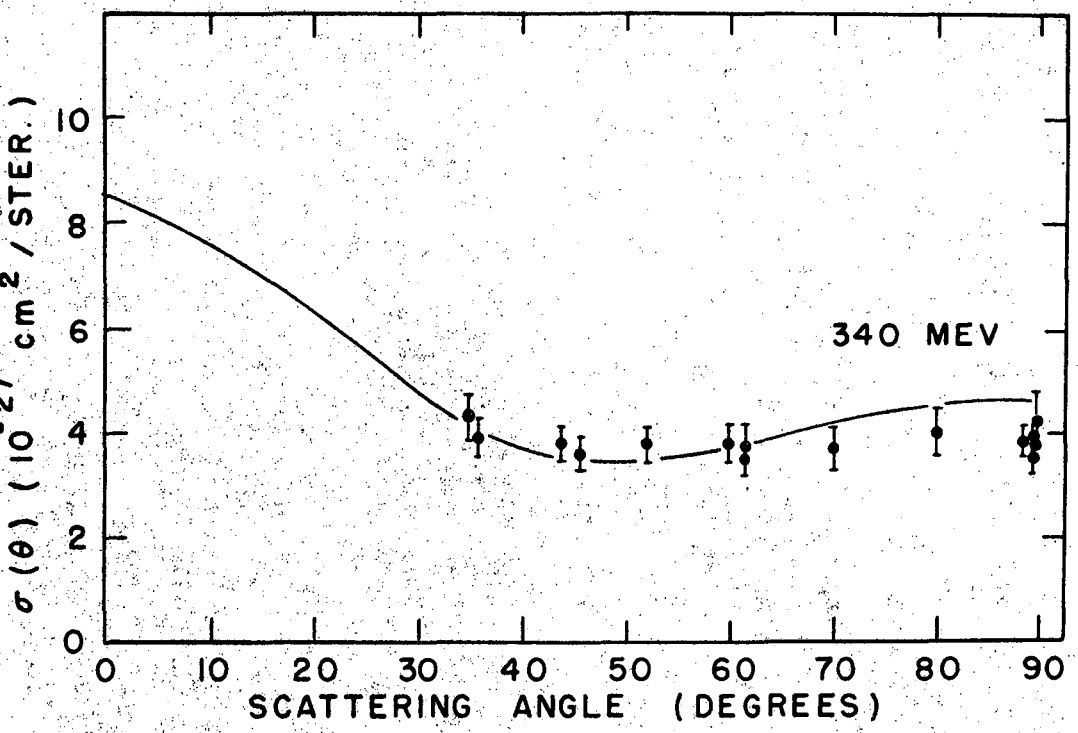
σ (θ) (10^-27 cm^2 / STER.)
0
2
4
6
8
10
340 MEV
0
10
20
30
40
50
60
70
80
90
SCATTERING ANGLE (DEGREES)

FIG. 3

MU 1166