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10-MEV PROTON REACTION CROSS SECTIONS COMPARED WITH SURFACE AND VOLUME ABSORPTION OPTICAL MODELS OF THE NUCLEUS

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10-MEV PROTON REACTION CROSS SECTIONS COMPARED WITH SURFACE AND VOLUME ABSORPTION OPTICAL MODELS OF THE NUCLEUS

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(p, n) cross sections were measured at 9.85 Mev and added to (p, p') and (p, α) cross sections previously measured[1] in order to obtain approximate reaction cross sections for the nuclei, Al, Ti, Fe, Co, Ni, Cu^{63}, Cu^{65}, Rh, Ag, Sn, Ta, and Au. The Rh, Ta, Ag, and Au reaction cross sections were corrected for (p, 2n) contributions using the statistical model of the nucleus.[2] Charged particle emission was assumed to be negligible in the latter two heavy elements because of the large Coulomb barrier.

The results were compared with predictions of the optical model of the nucleus for the volume absorption Woods-Saxon[3] well and the surface absorption well of Bjorklund and Fernbach.[4] Reaction cross sections had been predicted previous to our measurements on the basis of both models[5, 6] using parameters obtained from fitting elastic scattering and polarization data at 10 Mev. It has been previously pointed out that reaction cross section measurements obtained for several nuclei[1,7] are larger than those predicted by the optical model with a uniform nuclear volume absorption. Results were previously obtained by us for the copper isotopes which agree within experimental error with surface absorption optical model calculations.[8]

Our present results extended to other nuclei are plotted against atomic weight in Fig. 1 where they are compared with surface absorption reaction cross sections previously calculated by Bjorklund and Fernbach[6] using parameters that fit elastic scattering and polarization measurements obtained by others. The parameters are the following:

$r_0 = 1.25$ $b = 1.2$ $V = 43 + Z/A^{1/3}$

$a = 0.65$ $W = 11$.

The spin orbit potential is 20 times the Thomas term. Also plotted are reaction cross sections obtained using the volume absorption model for a nuclear radius of 1.2 fermis.[5] Our results are much higher than those predicted by the volume absorption calculations, and show much better agreement with the surface absorption calculations.

Better agreement with the volume absorption model for copper could be obtained using a nuclear radius parameter of 1.33 fermis and would agree almost as well with elastic scattering and polarization data[5] due to the ambiguity between V and r_0 parameters. However, in the case of argon and tin this large a nuclear radius gives poor agreement with elastic scattering and polarization data.[5]

Reaction cross section measurements may be a crucial test of which model is correct since the higher orbital partial waves localized at the nuclear surface are weighted by the $(2\ell + 1)$ factor in the reaction cross section calculation. Thus one expects to get a larger reaction cross section from a surface absorption optical model calculation.[9] It has also been pointed out that an even larger value may be obtained by assuming a radius for the imaginary well larger than that of the real well.[1] It is felt that the precision of the present experimental results does not warrant investigation of the validity of this point. However, it appears that the present results do constitute strong support in favor of surface absorption over volume absorption for the optical model of the nucleus.

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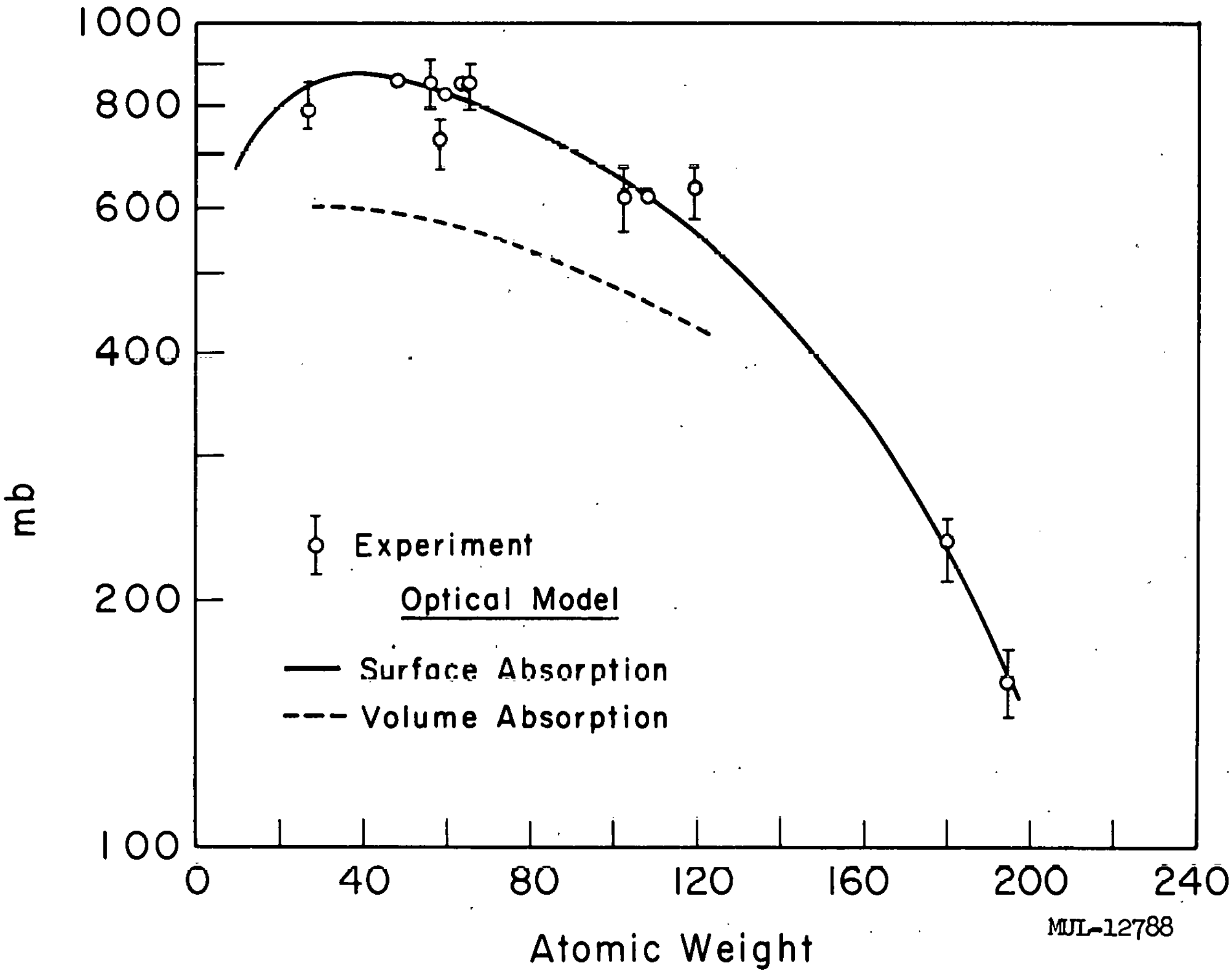

Fig. 1. Proton reaction cross section at 10 Mev.