By taking the local field at the electrons as due to the electronic dipoles on the other arsenics, a $T_2^{\mathrm{el}} \approx 4\times10^{-6}$ sec is found, yielding $T_{\mathrm{rf}}^{\mathrm{el}} \approx \frac{1}{2}\times10^{-4}$ from Eq. (2) (if one takes $H_1=10^{-2}$ oersted). The hyperfine splitting of 73 oersteds gives a value of the hyperfine parameter a equal to $\frac{3}{2}\times10^{-18}$ erg. Then, with an applied frequency of 9×10^9 cps and an rf field of 10^{-2} oersted, the value for the rf-induced nuclear transition time becomes, from Eq. (4),

$$T_{\mathrm{nuc}}=[(6\times10^{54})(2\times10^{-36})(4\times10^{-18}/3)]^{-1}\approx6\times10^{-2}\text{ sec.}$$

This is to be compared to the nuclear spin relaxation time of 16 sec.

I wish to acknowledge very helpful discussions with Mr. A. Kahn, Dr. R. D. Lawson, and Dr. A Honig.

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Results of a Phase Shift Calculation of High-Energy Electron Scattering*

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USING the phase shift analysis described previously,[1] an attempt has been made to fit the experimental data of Hofstadter *et al.*[2] on the elastic scattering of electrons on gold at energies of 84, 126, 154, and 183 Mev. Only scattering from a static spherically symmetric charge distribution is considered; all other interactions are neglected. The one-parameter charge distributions such as uniform, Gaussian, and exponential considered earlier[1] are clearly ruled out by the experimental data because of both the shape of the individual cross sections and their energy dependence. The present results are for "smoothed uniform" distributions, characterized by a central region of almost constant density and a surface region in which the density drops to zero. Of the two parameters required to identify a distribution of this type (a radius and a surface thickness), it turns out that the surface thickness is small enough compared with the electron's de Broglie wavelength λ that the detailed surface structure is unimportant; this is not true at higher energies, of course.

We define[3] a radius c by

$$c=\int_0^\infty \rho(r)dr/\rho(0), \tag{1}$$

and a surface thickness s by

$$s^2=-4\int_0^\infty (r-c)^2(d\rho/dr)dr/\rho(0). \tag{2}$$

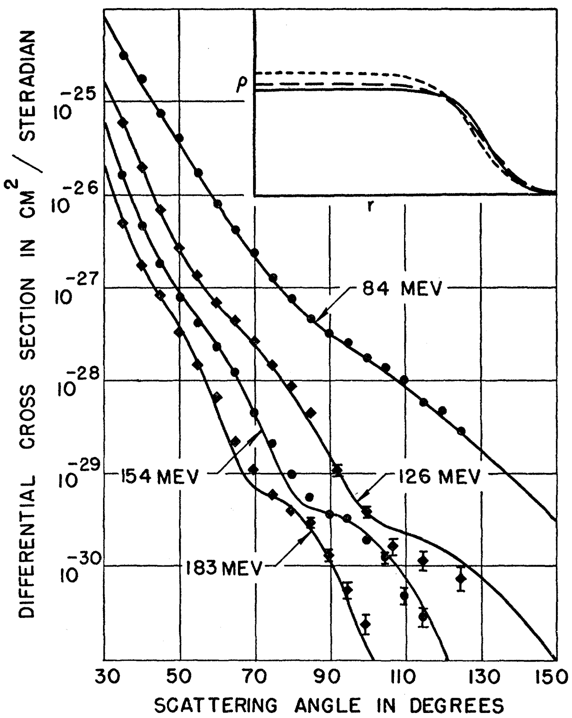

FIG. 1. Cross sections at 84, 126, 154, and 183 Mev for the elastic scattering of electrons by gold, using the charge distribution (4) with the parameters $K=2.20$, $c=6.63$ ($r_0=1.20$, $s=1.65$). (Distances are in units of 10^{-13} cm.) Inset is the charge distribution (full line), together with that for Fig. 2 (dashed line) and Fig. 3 (dotted line). The experimental values are of Hofstadter *et al.* (reference 2).

To relative order $(s/c)^4$, the root-mean-square radius is then given by

$$\langle r^2\rangle^{\frac{1}{2}}=\left(\frac{3}{5}\right)^{\frac{1}{2}}c\left(\frac{1+(5/2)(s/c)^2}{1+(3/4)(s/c)^2}\right)^{\frac{1}{2}}$$
$$=(3/5)^{\frac{1}{2}}r_0A^{\frac{1}{3}}\times10^{-13}\text{ cm.}$$

In the results presented here, we have used for the charge density the form

$$\rho=\rho_0[1+e^{K(r-c)}]^{-1}. \tag{4}$$

For $e^{Kc}\gg1$ the c of Eq. (4) is the same as that defined by Eq. (1). The surface thickness s is $2\pi/\sqrt{3}K(=3.63/K)$, which is slightly smaller than the previously defined "smoothing distance"[1] $(=4.40/K)$. To confirm theoretical arguments that the cross section depends only on c and s, and is independent of the surface shape,[3] calculations at 183 Mev have been carried out for several shapes having the same value of s and c as those of Fig. 1. The most extreme of these has a surface which varies linearly with r. For angles less than 105° the cross section for all of these shapes agreed to within 10 percent; by a slight alteration of parameters to allow for the terms in $(s/c)^4$ this agreement could be improved still further.

In Figs. 1–3 we compare the results of the phase shift calculations with the experimental data, which have

been arbitrarily normalized for each energy to give the best agreement with the theory. Perhaps the best fit is

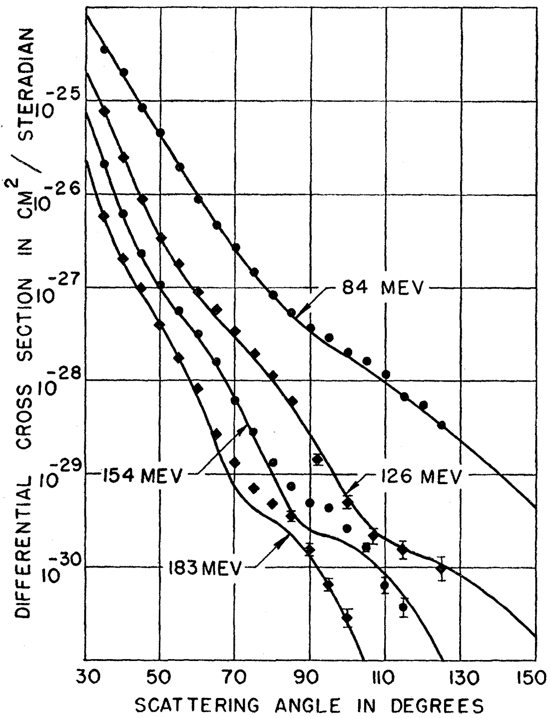

FIG. 2. Cross sections for the parameters $K=1.85$, $c=6.51$ ($r_0=1.20$, $s=1.96$).

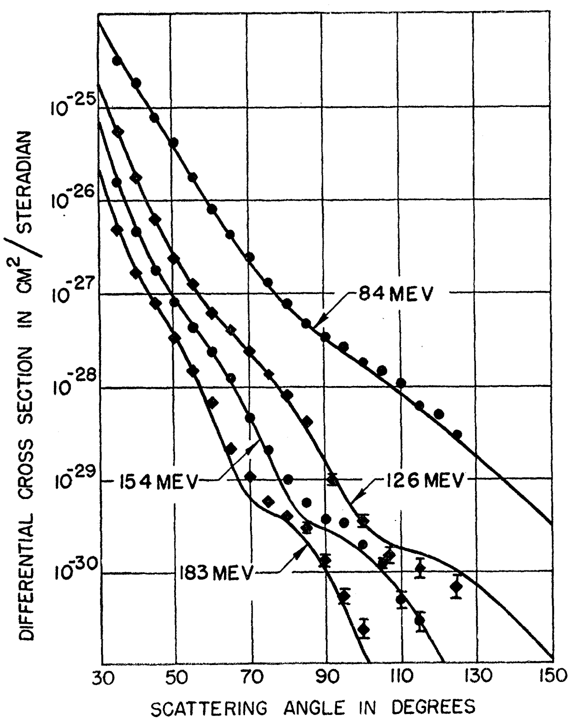

FIG. 3. Cross sections for the parameters $K=1.85$, $c=6.19$ ($r_0=1.16$, $s=1.96$).

that of Fig. 1, where $s=1.65\times10^{-13}$ cm, $r_0=1.20$ ($c=6.63\times10^{-13}$ cm).[4] The charge distributions of Figs. 2 and 3, which are for slightly different values of s and r_0, show that the cross section depends rather sensitively on these parameters.

The slight differences between the experiments and the results of Fig. 1, if significant, can be due to a number of different effects. Perhaps a more complicated charge distribution is required; preliminary calculations indicate that a decrease in the central charge density alters the cross sections in such a way as to improve the fit with the 183-Mev data.[5] There may also be appreciable contributions from the static quadrupole moment, nuclear excitations, and radiative corrections. L. I. Schiff and B. Downs[6] have considered the first of these, together with quadrupole excitations to low-lying levels, on the basis of a modified Born approximation.[3] They find that in gold these effects add at most three percent to the elastic cross section. The other effects have not yet been estimated.

For values of s and r_0 quoted above, the cross sections in Pb^{208} also agree very well with the data of Hofstadter *et al.*[2]

These calculations were made on the computer Univac at the University of California Radiation Laboratory at Livermore. We thank the authorities of this Laboratory, particularly Dr. S. Fernbach, for permission to use Univac, and Mr. H. Hanerfeld for instruction and advice in coding. We wish to thank Professor R. Hofstadter, Dr. B. Hahn, and Dr. J. A. McIntyre for discussions about their work and ours, and Professor L. I. Schiff and Professor G. C. Wick for helpful conversations. We also thank Dr. G. E. Brown for communicating his results and those of Drs. S. Brenner and L. R. B. Elton prior to their publication.

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[3] An elaboration of the following results will be presented later, together with some applications.
[4] This is slightly larger than the tentative value of r_0 ($r_0=1.1\pm0.1$) obtained in reference 2.
[5] Dr. G. E. Brown informs us that he and Drs. S. Brenner and L. R. B. Elton have come to a similar conclusion.
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Acquirement of Cosmic-Ray Energies by Electromagnetic Induction in Galaxies*

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IN 1933, the present writer applied to a special case[1] the principle of acceleration of charged particles to cosmic-ray energies through electromagnetic induction.