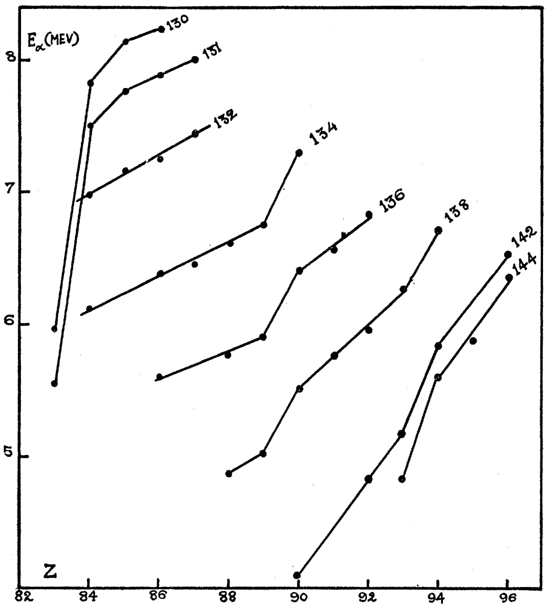

FIG. 1. Variation of E_α with Z. Constant neutron number is shown at the end of each curve.

In Fig. 1 we get a very sharp fall of E_α of about 2 Mev at $Z=84$, which obviously is due to the well-known proton shell at $Z=82$. In addition to this, however, we get two other less marked falls of about 0.7 and 0.5 Mev at $Z=94$ and 90, respectively. These probably correspond to proton subshells at $Z=92$ and 88. It may be noted that Stahelin and Preiswerk's[7] analysis of the energy of the first excited states of even-even nuclei has also revealed a magic number at $Z=92$.

According to Mayer's scheme[8] there ought to be a proton subshell at 92 due to the completion of the $1h_{9/2}$ level. However, this is not corroborated by the spin data, as has been shown by Dube and Jha.[9] According to the above scheme both ${}_{89}Ac^{227}$ and ${}_{91}Pa^{231}$ should have spin 9/2. Actually both are found to have a spin 3/2. These experimental values clearly indicate that from $Z=89$ to 92 the four protons must be filled in the $3p_{3/2}$ level. This at once gives us two subshells at $Z=88$ and 92, in agreement with what is found from our present investigation. The level order after $Z=82$ seems to be $2f_{5/2}$, $3p_{3/2}$, rather than $1h_{9/2}$, $2f_{7/2}$, as is given by the square well potential. But then the spin 9/2 of ${}_{83}Bi^{209}$ turns out to be anomalous.

A more detailed discussion of these and other related points will soon be published in a separate paper.

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Superconductivity below 1°K

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IN their study of superconductivity below 1°K, Daunt and Heer[1] observed an excess "paramagnetism" as the specimen of paramagnetic salt and superconducting metal warmed up in the presence of a finite applied magnetic field (Fig. 1).

The extrapolated dashed curve in Fig. 1 represents the paramagnetism of the salt alone. That portion (from C to B) of the full curve which lies below the dashed curve represents the situation when the metal has a diamagnetic susceptibility (in the superconducting state). From B to A the system exhibits a paramagnetic susceptibility in excess of that due to the salt alone.

It is the purpose of this note to suggest an explanation for the shape of this warm-up curve which is not restricted to multiply-connected superconductors.[1] Figure 2 shows typical isothermal (dashed lines, with $T_1<T_2<T_3\cdots$) and isentropic (solid lines, with $S_1<S_2<S_3\cdots$) magnetization curves for a large ideal super-

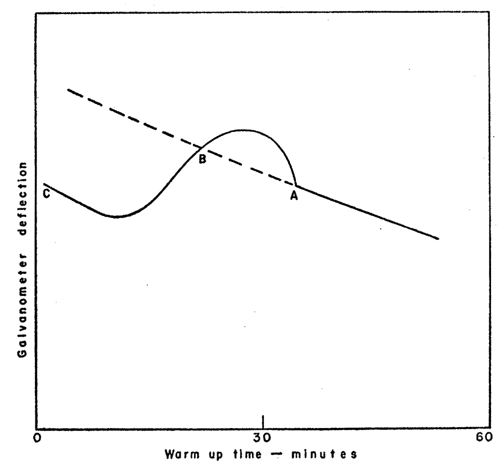

FIG. 1. Typical curve showing change of susceptibility with warm-up time in the presence of a small applied magnet field.

conducting sphere. The isentropic lines were obtained from the critical field and entropy data for tin. The other superconductors should give similar curves. The curves are plotted on a dimensionless basis with H_0, the critical field at $T=0°K$, as the normalizing factor. The vertical line in Fig. 2 represents the field h_1 in which the warm-up curve was observed. We seek the derivative $\partial\mu/\partial h$ (the differential susceptibility) of the magnetization curves at $h=h_1$. At this point we must distinguish between the isothermal and isentropic situations. In experiments such as carried out by Daunt

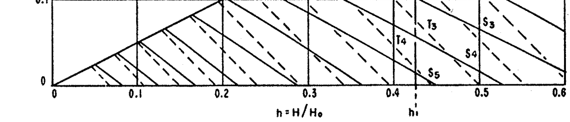

FIG. 2. Typical magnetization curves for an ideal large superconducting sphere.

and Heer[1] the process would be more nearly isentropic than isothermal. Hence, a plot of $(\partial\mu/\partial h)_S$ as a function of reduced temperature ($t=T/T_c$, T_c is the zero field transition temperature) is shown as the solid line in Fig. 3. For a real sphere the discontinuities shown in Fig. 3 would be replaced by smoothed curves.

Since increasing time in Fig. 1 corresponds to increasing temperature, it is clear that the essential features of the observed full curve can be obtained from a superposition of the dashed curve in Fig. 1 and a curve having the general shape shown in Fig. 3. If the

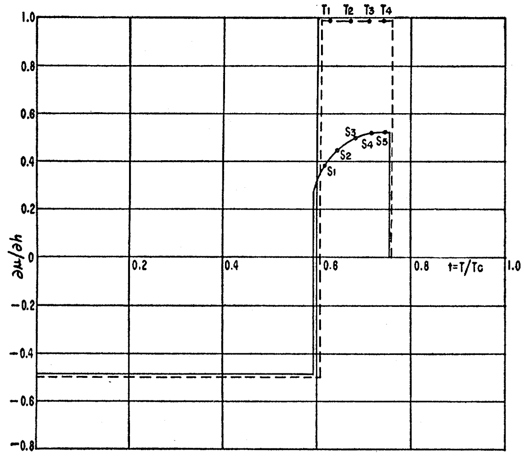

FIG. 3. Differential susceptibility as a function of temperature.

process were isothermal one would get a differential susceptibility given by the dashed line in Fig. 3. It is noted that the shape of the solid curve in Fig. 3 is a function of the applied field h. This should reflect itself in a change in the warm-up curves (Fig. 1) as the fields are varied.

Preliminary experiments performed at this laboratory in studying the critical magnetic field curves for ruthenium and cadmium have revealed warm-up curves which are considerably different from that shown in Fig. 1. Since the metal particles used for these experiments were much smaller than those of previous workers, the difference in warm-up curves may be associated with size effects in the superconductors. This supposition is made plausible in terms of the suggested explanation given above when one examines the isothermal magnetization curves of small superconducting spheres.[2] In fact one can utilize the warm-up curves obtained for small particles to construct the magnetization curves. Such data would be useful in the study of penetration depths for those elements having transition points below 1°K. Such a program is now in progress at this laboratory.

The author wishes to thank M. F. M. Osborne for profitable discussions relating to this problem.

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Cross Section for the Reaction $Br^{81}(\gamma,\alpha)As^{77}$

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THE cross section for the (γ,α) reaction in Br^{81} has been found by counting forty-hour As^{77}. Arsenic was separated from sodium bromide which had been irradiated with the University of Saskatchewan betatron. Ten ninety-gram samples of reagent NaBr were irradiated at betatron energies from 16.0 to 25.4 Mev. Arsenic was precipitated from solutions $3N$ in HCl and obtained for counting as As_2S_3. The usual counting corrections were applied. The chemical yield determined gravimetrically was 100 percent. It was assumed that exchange of active and carrier ions was complete.

X-ray doses were recorded by tantalum monitors mounted at the front of each sample, appropriate corrections being made for inverse square attenuation and x-ray absorption in the sample.

The yield curve is shown in Fig. 1. No attempt was made to determine yields at energies lower than 16 Mev on account of the very long irradiations that would have been necessary. From the yield curve the cross section, Fig. 2, was computed by the photon difference method.[1] This cross section has a peak value of 270 microbarns at 21.5 Mev. The integrated cross section is about

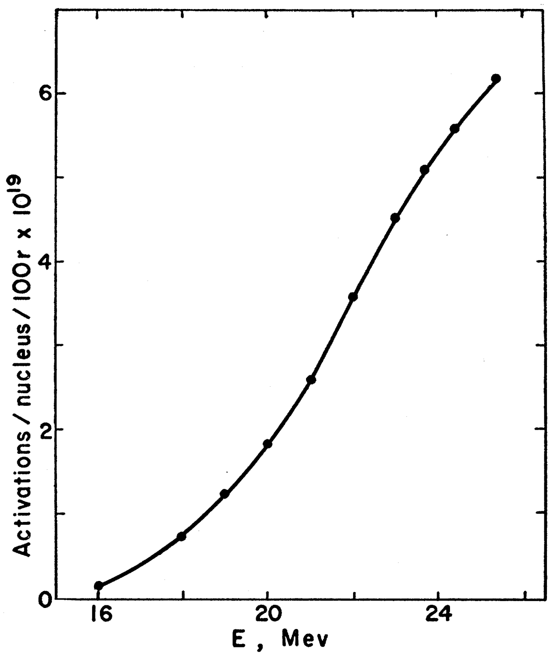

FIG. 1. Yield curve for $Br^{81}(\gamma,\alpha)As^{77}$. The number of activations/Br^{81} nucleus/100 roentgens is plotted against the maximum betatron energy in Mev.

1.5 Mev-millibarns. In shape this cross section is quite similar to those found for $Cu^{65}(\gamma,\alpha)Co^{61}$,[2] and $Rb^{87}(\gamma,\alpha)Br^{83}$,[3] while in magnitude it lies between them, the cross sections declining with increasing atomic number. This trend is similar to that observed for photoproton yields from middle-weight nuclei.[4]

It is of interest to compare our result with measurements of alpha-tracks arising from the photodisintegration of bromine and silver in nuclear emulsions.[5–7]

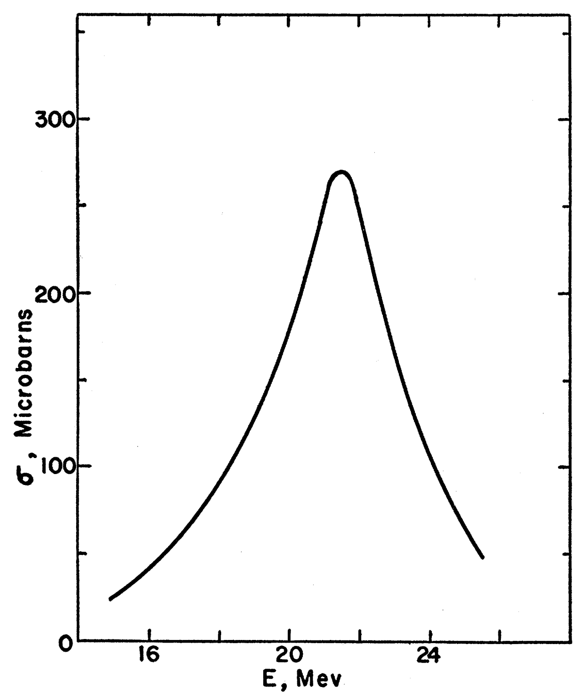

FIG. 2. Cross section for $Br^{81}(\gamma,\alpha)As^{77}$. The cross section in microbarns is plotted against photon energy.