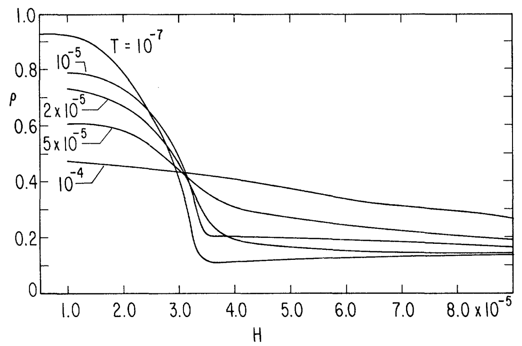

FIG. 3. Resistivity versus field at various temperatures for the same conditions as Fig. 1. Below $H = 0.5 \times 10^{-5}$, the resistance is only weakly field dependent.

evaluated at $x = \mp H$.

Curves of the resistivity versus T for various H are given in Fig. 2. For sufficiently large H, there are two well-separated peaks; the first one occurs at temperatures above T_K, whereas the second (lower temperature) peak is dependent in size and position primarily upon V.

The experiments of Monod[11] on copper manganese agree qualitatively with these calculations insofar as they overlap in the temperature range. (The temperature was low enough, and the fields high enough to check the upper peak in Fig. 2.) On the other hand, Daybell and Steyert[12] working with Cr in Cu, observe no peaks, only a low-temperature plateau region.

In Fig. 3, we show the resistance as function of H for fixed T.

The drop in electrical resistance must be ascribed to four causes: the "freeze out" of the local moment exhibited in Eq. (5); the evaluation of the amplitudes at $x = \pm H$, which for $H > T_K$ is outside the resonance region; the change in $\bar{\tau}$ from its zero-field value; and the appearance of the new amplitude U.

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INVERSION IN THE DEFORMATION EFFECT FOR NEUTRON TRANSMISSION THROUGH ORIENTED Ho^{165}†

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We report measurements of the "deformation effect" in the total cross section for neutrons on oriented Ho^{165} over the energy range 0.330-5.60 MeV. They are in good qualitative agreement with the prediction of a previous theoretical calculation, and the predicted inversion or sign change in the energy range 3-7 MeV is verified.

Measurements of the "deformation effect" in the total cross section for fast neutrons incident on oriented Ho^{165} have been reported at neutron energies of 8, 15, 0.350, and 14 MeV.[1-3] The "deformation effect" is defined by $\Delta\sigma_{\mathrm{def}} = \sigma(\text{oriented}) - \sigma(\text{unoriented})$, where σ(oriented) and σ(unoriented) are the total cross sections for the oriented and unoriented cases, respectively. The experiments have shown that $\Delta\sigma_{\mathrm{def}}$ varies in magnitude with neutron energy, but in all measurements the sign of $\Delta\sigma_{\mathrm{def}}$ has corresponded to the change in the geometrical cross section of the Ho^{165} nucleus. A recent calculation,[1] using the coupled-channel formalism in the adiabatic approximation, predicted that $\Delta\sigma_{\mathrm{def}}$ would undergo a sign change in the neutron energy range from 2.5 to 7 MeV and the verification of this prediction formed the basic motivation for the present experimental work.

Most of the essential features of the experimental arrangement are described in Ref. 1. Only one minor change was made in the SCONT-polarized[1] holmium target: The holmium sample was shortened to 7.4 cm by unsoldering the two end sections. This change resulted in a slightly higher average magnetization of the sample ($M/M_\infty = 0.71 \pm 0.03$) and a slightly lower average temperature for the cold runs (0.33°K). The data presented, however, have been appropriately scaled to correspond to the nuclear alignment described by the orientation parameters in Ref. 1 [$B_2/B_2(\max) = +0.25 \pm 0.05$].

The neutron detection system of Ref. 1 could not be used in the present experiment since Si(Li) detectors are ineffective as neutron detectors below about 7 MeV. A monitor counter consisting of a paraffin-moderated BF_3 proportional counter was installed at an angle of 105° and a distance of 25 cm from the neutron source. The fast-neutron detector was a 1.9 cm diam × 2.5 cm long stilbene crystal mounted on a 6810 photomultiplier tube, and was positioned 50 cm from the holmium sample. Gamma-ray discrimination was provided by a NE 5553 preamplifier obtained from Nuclear Enterprises, Ltd. Neutron energies of 0.330, 0.570, 0.935, and 1.85 MeV were obtained with the reaction $H^3(p,n)He^3$; the reaction $H^2(d,n)He^3$ was used for neutron energies of 4.50 and 5.60 MeV. The neutron collimation system is described in Ref. 1.

The procedure followed in the measurements was identical to that in Ref. 1, warm cycles (4.2°K) being alternated with cold cycles (0.33°K).

The results of the measurements of $\Delta\sigma_{\text{def}}$, as well as measurements of the total cross section for neutrons on unoriented Ho^{165}, are presented in Table I. The results have been corrected for background; corrections for inscattering are completely negligible in the present geometry. The background corrections amounted to 18 and 13% at 0.300 and 0.570 MeV, respectively, where effective gamma-ray discrimination was not possible; at other energies, these corrections were less than 3%.

The comparison between the experimental data and the calculated curve taken from Ref. 1 is shown in Fig. 1. The points from the present experiment, as well as the points at 8 and 15 MeV taken from Ref. 1, are all measured with the same nuclear orientation. The uncertainties in these points are statistical only, but the points may be scaled by ±20% due to uncertainty in the nuclear orientation parameters.[1] The points at 0.350 and 14 MeV from Refs. 2 and 3 were measured in a different nuclear orientation [$B_2/B_2(\max) \approx -0.25$] with negligible uncertainty in the nuclear-orientation parameters. The apparent discrepancy between the present results and the results of Wagner et al.[2] at 0.350 MeV is not understood. The application of the permissible 20% scale change to the present data, as discussed above, is not sufficient to resolve the discrepancy. However, since the uncertainties are primarily due to counting statistics and therefore represent actual standard deviations, it is not impossible to reconcile the two results statisti-

Table I. Summary of data on σ_T and $\Delta\sigma_{\text{def}}$ from Ref. 1 and the present experiment. The nuclear orientation is described by the parameters given in Ref. 1, with $B_2/B_2(\max) = +0.25$.

$\bar{E}_n$[a] (MeV)	ΔE_n[b] (keV)	σ_T (b)	$\Delta\sigma_{\text{def}}$ (mb)	Source
0.330	85	7.80 ± 0.15	−146 ± 18	Present experiment
0.570	70		−173 ± 18	Present experiment
0.935	60	7.65 ± 0.15	−251 ± 11	Present experiment
1.85	45	7.10 ± 0.15	−104 ± 10	Present experiment
4.50	200	5.76 ± 0.12	+86 ± 12	Present experiment
5.60	120	5.21 ± 0.12	+67 ± 10	Present experiment
8.0	450	4.97 ± 0.11	−38 ± 10	Ref. 1
15.0	500	5.27 ± 0.09	−139 ± 16	Ref. 1

[a] Average neutron energy.

[b] Total neutron energy spread.

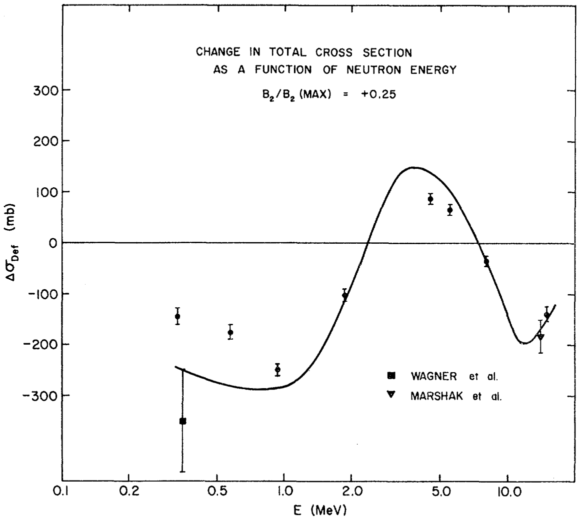

FIG. 1. Deformation effect in the Ho^{165} total cross section as a function of neutron energy. The 8- and 15-MeV points are taken from Ref. 1. The calculated curve from Ref. 1 is based on optical parameters obtained by smooth interpolation between parameters giving the best fit to then available data at 0.350, 8, and 15 MeV.

cally.

Thus far, the rotational optical model with the coupled-channel formalism[4-6] has adequately explained all data on the direct interaction of fast neutrons with Ho^{165}. The data at 0.350 MeV have been fitted by an exact coupling calculation,[2] and the higher energy data by calculations[1,3] using the adiabatic approximation. The addition of the present data should provide a much stricter test of the theoretical formalism. As can be seen, the present data are in qualitative although not quantitative agreement with the calculated curve of Ref. 1, and an attempt is being made to see if the existing data can still be explained within the framework of the coupled-channel formalism using reasonable and smoothly varying optical parameters. Should the theory prove adequate to this task, the interpretation of future experiments in the light of the theory will contribute greatly to the knowledge of nuclei in the rare-earth region. The performance of much more sophisticated experiments involving fast neutrons and polarized targets appears possible in the very near future.

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