formation is obtained about the spin values of the excited states in oxygen.

The present investigation indicates that this method gives considerable information about the levels in an energy interval, several Mev wide, above the (γ,p) threshold. It should be possible to increase the resolution by a factor of 2 or 3. It would then be possible to resolve the peaks with great certainty, especially if the statistics is improved by measuring a great number of tracks.

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Size Distribution of Neutron Widths*

D. J. HUGHES AND J. A. HARVEY
Brookhaven National Laboratory, Upton, Long Island, New York
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IN the program of work carried out with the Brookhaven fast chopper[1] on total cross sections of heavy elements, various regularities have been observed[2] with regard to the widths and spacings of energy levels. In contrast to the near-constancy of Γ_γ (~20 percent variation from level to level in a given nuclide), the neutron widths were found to have an extremely large variation in size; the reduced neutron widths, Γ_n^0 (given by $\Gamma_n/E_0^{\frac{1}{2}}$ with E_0 the neutron energy at resonance), differed by factors as high as several hundred.

In the work of Harvey *et al.*,[2] in which several hundred neutron widths were measured, it was found that within experimental error the neutron widths had an exponential distribution in size for each nuclide that was investigated. When the number of resonances in a given energy range with widths larger than a given value were plotted as a function of the latter, the resulting distribution was consistent with an exponential distribution, implying that the differential distribution, that is, the number of levels as a function of neutron width, was also exponential. It was difficult to draw any definite conclusion, however, from individual nuclides because the number of levels observed in each case was rather small, of the order of ten levels. In order to investigate the distribution in more detail it is obviously desirable to combine the data from many nuclides to attain greater statistical accuracy.

The combination of data from various nuclides has been accomplished by plotting the reduced neutron widths relative to the average value for each nuclide rather than in terms of actual widths. This process normalizes the distributions for different nuclides so they can be plotted together, but some distortion of the final distribution results because the average neutron widths are not accurately known for individual nuclides.

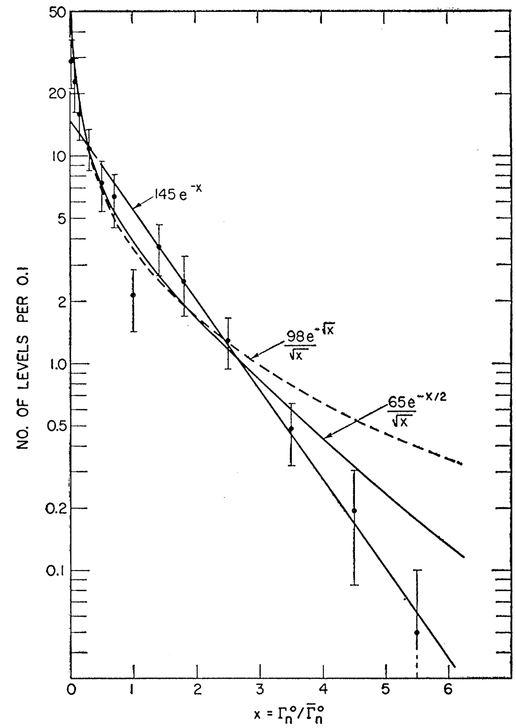

FIG. 1. Distribution (per 0.1 in Δx) of 145 reduced neutron widths relative to the average value for each nuclide. The curves are various suggested distribution laws described in the text.

Fortunately, it is possible to compute the distorting effect rather easily and the experimental points were corrected for it before plotting.

The distortion just described would of course add to a similar one already present in the distribution for the individual nuclides, which is a result of the presence of levels of two spin values. In computing the neutron widths from experimental transmission data the statistical factor, g, was assumed to be $\frac{1}{2}$, except for zero-spin target nuclei, where it is known to be unity. As a result, the distribution obtained for a given nuclide actually consists of two sets of levels, each with a different g value.[3] The spurious curvature in the distribution arising from the uncertainties in $\bar{\Gamma}_n^0$ and in g was computed and the experimental points were corrected before being plotted in Fig. 1. The distortion arising from the error in the average widths is much larger than that arising from the g uncertainty; the total correction is less than 10 percent for $x<3$ but reaches a factor of one half for the highest x value.

In plotting the points of Fig. 1, a careful attempt was also made to investigate other possible experimental distortions of the distribution, particularly the loss of very small levels simply because of their small size, as well as the loss of levels by failure to resolve them at high energy. One method that was used to investigate the failure to observe levels was to determine for each nuclide a neutron energy below which it was felt that

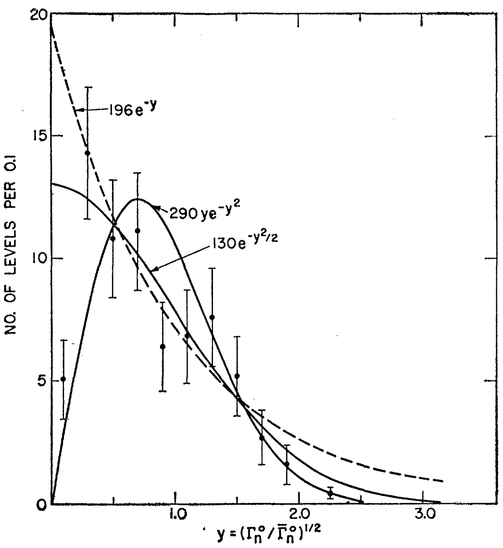

FIG. 2. The data and curves of Fig. 1 plotted as distributions (per 0.1 in Δy) of $y=(\Gamma_n^0/\bar{\Gamma}_n^0)^{\frac{1}{2}}$.

essentially no levels were lost by insufficient resolution, this process involving the plotting of location of levels as a function of energy. The average neutron width was then determined as an arithmetical average for the levels below this limiting energy, and the size distribution of these levels plotted. The process just described was then repeated with an energy limit one half of the value first used and again with an energy limit $1\frac{1}{2}$ times that limit. It was felt that this method would reveal experimental failure to locate levels because the rapid change of resolving power with energy would give in that case distributions that would differ in shape as the energy region covered was varied. The resulting distributions, however, show no significant difference in shape, providing a strong indication that the observed distribution is not strongly affected by missed levels. In addition, direct estimates based on examination of the experimental transmission curves lead to the conclusion that the distribution shape, especially at the small-size limit, is not affected greatly by failure to find levels, the correction being less than the statistical error shown.

Since the neutron width distribution was first found, several theoretical treatments have been made on the possibility of correlating it with nuclear theory. In addition to the exponential distribution,[4] the curved solid line shown in Fig. 1 has been suggested by Porter and Thomas,[5] and the dotted line by Bethe.[6] At large widths, the exponential gives the best fit, whereas at small widths, the other suggestions provide better agreement. Actually, as the square root of the neutron width is a property more closely related to nuclear structure theory[7,8] than the width itself,[9] it is instructive to consider the distribution in size of $(\Gamma_n^0)^{\frac{1}{2}}$. For example, a Gaussian distribution in $(\Gamma_n^0)^{\frac{1}{2}}$ was assumed by Porter and Thomas, whereas the exponential distribution of widths requires a $y\exp(-y^2)$ distribution, where $y=(\Gamma_n^0/\bar{\Gamma}_n^0)^{\frac{1}{2}}$. The experimental points and suggested distributions of Fig. 1 are shown as functions of y, on a linear scale, in Fig. 2. The points of Fig. 2, which can be considered to give more fundamental nuclear data than the width of Fig. 1, do not decide in favor of one distribution definitely but the e^{-y} curve (leading to Bethe's suggested curve of Fig. 1) seems to predict too many small and large values of y. The $y\exp(-y^2)$ curve, corresponding to the simple exponential distribution of neutron widths of Fig. 1, seems as satisfactory as $\exp(-y^2/2)$, although it does not seem to have as firm a theoretical basis (for it implies[4] complex y's).

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[7] J. M. Blatt and V. F. Weisskopf, *Theoretical Nuclear Physics* (John Wiley and Sons, Inc., New York, 1952), Chap. 8.
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[9] The quantities that are proportional to $(\Gamma_n^0)^{\frac{1}{2}}$ determine the decay probability into different channels, and are variously titled (references 7 and 8) most recently (reference 8) as "reduced-width amplitudes." We prefer not to use this terminology because of possible confusion with the usual use of amplitude as (cross section/4π)$^{\frac{1}{2}}$.

Inelastic Polarization and Nucleon Momentum Distribution*

L. MARSHALL

Institute for Nuclear Studies, The University of Chicago, Chicago, Illinois

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INELASTIC $p-p$ polarization is similar in angular dependence, but smaller in magnitude than free $p-p$ polarization. In particular, at 310 Mev it is about 65 percent[1] of the latter.[2] It may be represented as being the free polarization distorted by the effect of the momentum distribution of the target protons in the nucleus.

We assume here that an incoming 310-Mev proton hits a 20-Mev proton in a 30-Mev potential well. The effective kinetic energies of the colliding protons are, therefore, 340 Mev and 20 Mev. We consider five types of collisions classified in terms of the resultant B of the momenta, $P_1=869$ Mev and $P_2=193$ Mev, of the two colliding protons, and listed in Fig. 1. These are assumed to occur with equal probability in the plane of the two emitted protons.

For each case, the barycentral momentum p and energy w are calculated. To demonstrate the range of