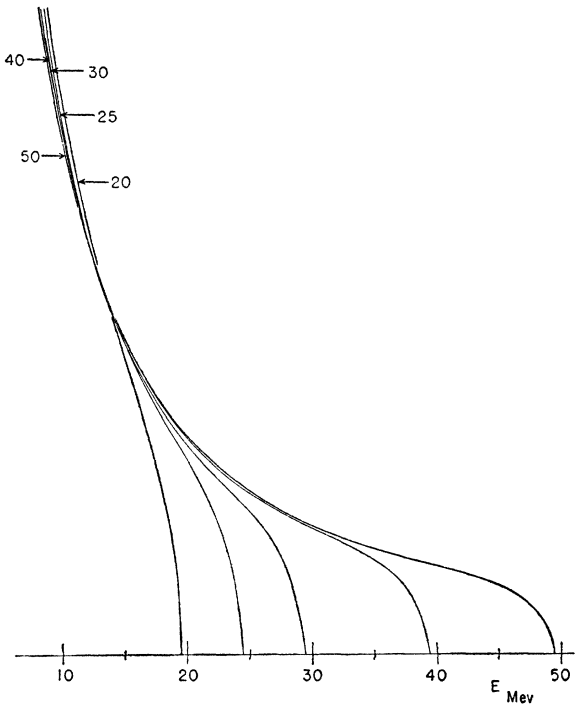

FIG. 1. Relative number of quanta, corresponding to several E_{max} settings, calculated by Schiff's formula ($C=111$) and normalized for constant activity of tantalum monitor. The resonance curve for Ta assumed to be as reported (see reference 5).

a change of E_{max} is proportional to the integral of σ times the difference between the appropriate normalized spectra. The character of this second factor is illustrated by the curve bounding the shaded area in Fig. 2. The desired cross section first may be roughly estimated by differentiation of the activation curve and then revised, by successive trials, so that the incremental relative yield ΔI is closely proportional to the integral of $\sigma \times \Delta n_{h\nu}$. This procedure is illustrated graphically in Fig. 2 for the reaction $C^{12}(\gamma, n)C^{11}$, monitored by the radioactivity induced in copper. It is estimated that if the accuracy of the activation curve is of the order of 1 or 2 percent, the shape of the resonance curves may be computed in this way with an accuracy of 3 to 5 percent. Subsequent recomputation in the light of new data can be readily performed.

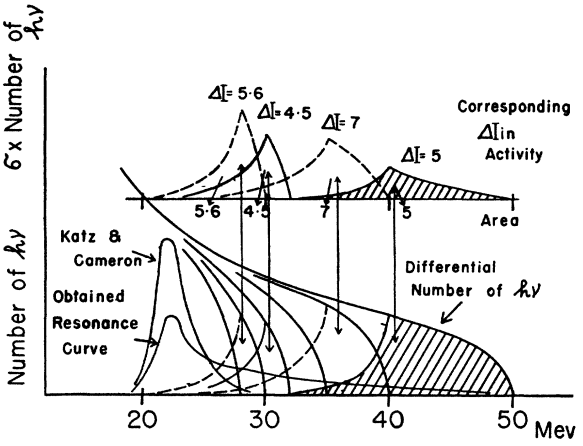

FIG. 2. Examples of procedure on how to adjust the area for

$$\int_{Em}^{Em+\Delta} \sigma \times N_{h\nu} dE \propto \Delta I.$$

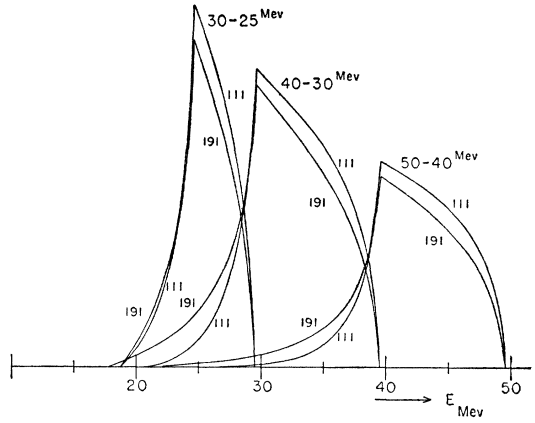

FIG. 3. Comparison of differential number of photons between Schiff curves corresponding to $C=191$ and $C=111$. Normalization was made with C^{62} activity.

The foregoing method is quite insensitive to the assumed shapes of the bremsstrahlung spectra and of the monitor resonance, if no prominent high energy "tail" is present. In Fig. 3 are given differential numbers of photons between Schiff's curves for constant activation of Cu corresponding to constant $C=191$ and $C=111$. The effects due to the difference of assumed value for the constant C are not very large. The necessity for detailed computations of ion-chamber response, differential absorption in the donut wall (because the monitor samples are usually insensitive to low energy quanta), and similar somewhat complicated phenomena is, of course, avoided. Special care should be taken in the use of monitor substances which are particularly sensitive to neutrons or to scattered x-rays. Errors from spurious induced activities may be kept to less than 5 percent, and commonly less than 2 percent, if suitable precautions are taken and the effects of geometrical changes (sample location, relative position, and thickness) are explored, enabling one to obtain a little better accuracy than with the usual Victoreen chamber.

The author wishes to express his heartiest gratitude to Dr. L. J. Laslett and Dr. D. J. Zaffarano for their continuous interest and help given during the course of the experiment. Thanks are also due Mr. D. V. Steward for the help given in numerical calculations.

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Unusual Broad Resonances in $C^{12}(\gamma,n)C^{11}$ and $O^{16}(\gamma,n)O^{15}$

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THE study of photonuclear resonances has been continued with the use of induced radioactivity as a monitor.[1,2] Use has been made of high energy x-radiation, with an upper limit adjustable to 70 Mev, obtained from the Iowa State College synchrotron.

The samples and monitors used were all of the same area ($\frac{3}{4}'' \times \frac{3}{4}''$) and with thicknesses usually from 1 mil to 10 mil. Lucite was used as a sample for carbon and oxygen. The targets were irradiated at fixed positions, either 10″ or 20″ from the x-ray source, and were so oriented that the beam struck a stack of

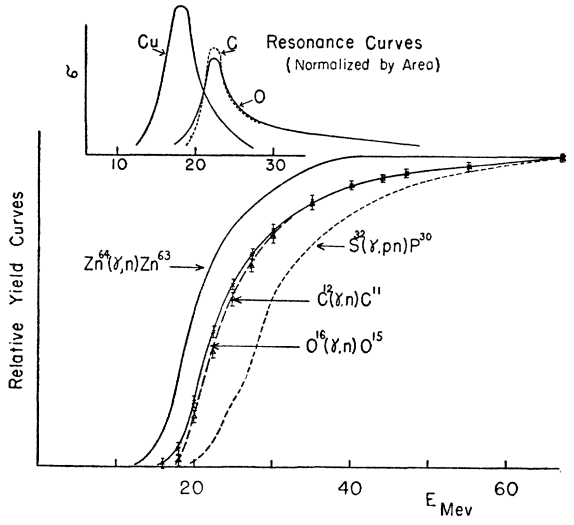

FIG. 1. Relative yield curves for C^{12} and O^{16}. Curves for S^{32} and Zn^{64} are also given for comparison.

several samples and monitors at normal incidence. The relative activity induced in the samples was thus independent of the dependence of geometrical beam-width upon energy.

The relative yield curves[3] for C^{11} and O^{15}, with C^{62} as a monitor, are given in Fig. 1. (In constructing these curves a correction has been made for the appreciable cross section possessed by copper at energies as high as the carbon and oxygen thresholds.)[4] The corresponding cross-section curves, computed by the method previously reported,[2] are also shown in Fig. 1. It is noteworthy that these resonances are quite similar, each being markedly asymmetrical and exhibiting a prominent high energy "tail" which extends to over 60 Mev. The carbon and oxygen resonances may be contrasted with the more common type illustrated by the copper curve reproduced in Fig. 1.

The high energy cross sections for carbon and oxygen are roughly proportional to E^{-3}, which suggests that this portion of the curve may be interpreted in terms of the nuclear photoeffect.[5] Additional evidence for this process is found in the reported[6] 90° excess of neutrons from carbon. Similar high energy tails have been found and are now under further investigation for the reactions $S(\gamma, pn)$, $Pb(\gamma, p$ or $\gamma, pn)$, $Al(\gamma, 2p)$, $Zn(\gamma, n)$, $Mg(\gamma, p$ or $\gamma, pn)$, and $Fe(\gamma, n)$.

The resonance curves for the reaction $C^{12}(\gamma, n)C^{11}$ as determined in the present work and as reported by other workers,[7-9] may be compared in Fig. 2. The main peak of the resonance found here agrees well with that given in the recent report of Katz and Cameron[7] if the energy scale of the synchrotron is adjusted to an 18.8-Mev C^{12} threshold. The author wishes, however, to draw attention to the existence of the long tail appearing at high energies

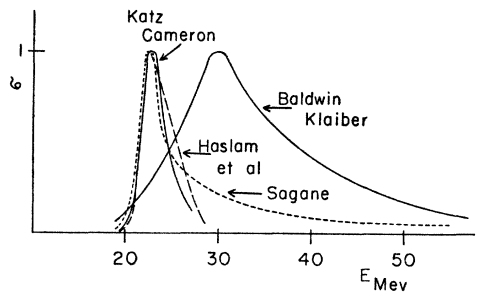

FIG. 2. Comparison of the resonance curves for $C^{12}(\gamma, n)C^{11}$ reported by different workers.

and to the support which this may provide for the nuclear photoeffect.

The author wishes to express his heartiest gratitude to Dr. L. J. Laslett and Dr. D. J. Zaffarano for their continued interest and help given during the course of the experiment.

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The Decay of Fe^{52}*

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A 7.8-HOUR iron activity emitting ~0.55 Mev positrons was found by Miller, Thompson, and Cunningham[1] as a product of the bombardment of copper with high energy deuterons. They identified this iron isotope as Fe^{52} through the growth of the well-known 21-minute Mn^{52}.

In order to measure yields of Fe^{52} in various spallation reactions, it is necessary to know what fraction of the Fe^{52} decays occur by electron capture. A search for manganese K x-rays resulting from electron capture in Fe^{52} was therefore undertaken by means of a proportional counter and pulse height analyzer.[2] Samples of Fe^{52} were prepared by bombardment of copper with 370-Mev protons in the circulating beam of the Columbia University Cyclotron at Nevis. The iron activity, with a fraction of a milligram of carrier, was purified by a procedure which involved carrying on $Al(OH)_3$, isopropyl ether extractions, and a separation from gallium by $Fe(OH)_3$ precipitation in $3M$ NaOH. The final samples were precipitated as $Fe(OH)_3$ from neutral solution on 0.1 mg/cm² Nylon.

Manganese K x-rays were found with a pulse height analyzer in conjunction with a proportional counter filled to one atmosphere with argon and methane. The decay of these x-rays could be analyzed into an 8-hour half-life and a very long-lived component, presumably due to Fe^{55}. The samples were rather weak and it was therefore not practical to obtain the total x-ray counting rate from the area under a pulse height distribution curve as previously described.[3] Instead, the peak counting rate was compared with that of an Fe^{55} standard sample whose total x-ray counting rate in turn was determined from the area under its pulse height distribution curve. With appropriate corrections[3] for geometry, counter efficiency, air and window absorption, fluorescence yield (0.27),[4] and L capture contribution (8.5 percent),[5] the absolute electron capture decay rate of Fe^{52} in the sample was calculated.

To determine the absolute positron disintegration rate of the Fe^{52} sample, counts were taken with an end-window GM tube, provided with a geometry-defining opening in front of the window. By means of beryllium and aluminum absorption measurements, the contributions of x- and γ-rays to the GM counting rate, and the attenuation of positrons by the air and mica window were determined. Small corrections were also made for long-lived activities (Fe^{59} and Fe^{55}). From the corrected counting rate and the calculated solid angle the sum of the absolute positron disintegration rates of Fe^{52} and of 21-minute Mn^{52} in equilibrium with it was determined. Decay curves of Fe^{52} showed no tail attributable to 5.8-day Mn^{52}. It was thus established that at least 95 percent of the Fe^{52} decays go to the 21-minute Mn^{52} isomer. From the electron capture and positron decay rates of the sample and the fact that