In^{116} Activation Ratios*

M. A. GREENFIELD
Department of Radiology, University of California, Los Angeles, California

AND

R. L. KOONTZ
Atomics International, Canoga Park, California

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The data of Domanic and Sailor regarding the ratio of the 54-min to the 13-sec activities of In^{116} produced by neutron capture in In^{115}, previously published, have been corrected with experimentally determined self-absorption factors for 54-min In^{116}. The results of these corrections have removed an anomaly observed between foils of different thicknesses, provided the foil is known to have been uniformly activated throughout its volume. The corrections appear to have removed a dependence of the ratio of activities on neutron energies from thermal to 2.66 ev. However, even after correction of the data there remains a substantial difference in the value of the ratio of activities at 3.86 ev. The corrected value of the ratio at 3.86 ev is about one half the value at the other energies investigated.

IN a recent paper,[1] Domanic and Sailor reported measurement of the ratio of the 54-min to the 13-sec activities of In^{116} produced by neutron capture in In^{115} to determine the relative probability for populating the ground or the isomeric state from the initial compound state. They used end-window proportional counters as detectors.

In order to eliminate the effects of self-absorption on the measured activation ratio they adopted the criterion that a foil was sufficiently thin providing that the counting rates from the two sides of the foil are practically identical.

Employing this criterion, they nevertheless found that foils of differing thicknesses (26.8 and 96 mg/cm^2) gave quite different values for the activation ratios for pile neutrons. We wish to point out that the criterion used only insures uniformity of neutron irradiation of the foil, but does not relate to the matter of self-absorption and self-scattering of the betas emitted by the 54-min activity.[2,3] These betas are sufficiently soft so that appreciable corrections are required for foil thicknesses greater than a few tenths of a mg/cm^2. We agree that no correction for this effect is needed for the relatively high energy betas from the 13-sec activity.

For pile neutrons they found that both the front and back counting rates of the thick and thin foils were the same to within a few percent. Nevertheless the ratios of activities for the foils studied were quite different as shown in column 2 of Table I.

Referring to Fig. 4 of reference 2 or Table B-III of reference 3, one finds the values of the correction factors for self-absorption and self-scattering that are listed in column 3 of Table I. By employing these corrections one now finds rather good agreement for the ratio of activities. This indicates that foil thickness is not a factor providing the foil is known to have been uniformly activated throughout its volume, as is the case with pile neutrons.

Domanic and Sailor also exposed the foils to other energies including 1.456, 2.66, and 3.86 ev with values for the ratio of activities as shown in columns 2 and 4, Table II. By applying the correction factor of 1.22 for the 26.8-mg/cm^2 foil, one obtains the corrected ratios shown in column 3, Table II.

They had observed a large ratio of front-back readings for the 96-mg/cm^2 foil exposed to 1.45-ev resonance neutrons, indicating inhomogeneous activation throughout the foil's volume. In this circumstance one cannot apply our correction for self-absorption and self-scattering. Thus the value of 1.98 measured by Domanic *et al.* is not valid. The value of 2.45 obtained as the corrected value of the 26.8-mg/cm^2 foil is applicable.

The data obtained by Domanic and Sailor for the 96-mg/cm^2 foil for pile neutrons and 2.66-ev neutrons are listed in column 4 of Table II. They found front-back ratios close to unity at these energies. Applying the correction factor of 0.71 from Table I for the thick foil yields the values of 2.40 and 2.23 listed in column 5 of Table II.

Table II shows that in the only case in which a valid comparison may be made of the results of the two foil thicknesses, that for pile neutrons, the values of the corrected ratio of activities are consistent well within the experimental error of the measured quantities.

The corrected values of the ratio of activities for the

TABLE I. Ratio of 54-min to 13-sec activities of In^{116} after irradiation by pile neutrons.

Foil thickness (mg/cm^2)	Ratio of activities[1]	Self-absorption[2,3] and self-scattering correction factors	Corrected ratio of activities
96	1.705	0.71±5%	2.40
26.8	3.02±0.18	1.22±5%	2.48

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TABLE II. Ratio of 54-min to 13-sec activities of In^{116} after irradiation by neutrons at various energies.

Neutron energy (ev)	26.8-mg/cm² foil Ratio of activities[1]	Corrected ratio of activities	96-mg/cm² foil Ratio of activities[1]	Corrected ratio of activities
3.86			0.85±0.05	1.20
2.66			1.57±0.15	2.23
1.45	2.99±0.15	2.45	1.98	
0.10	2.5 ±0.3	2.05		
Pile beam	3.02±0.18	2.48	1.705	2.40

various energies listed in Table II (excepting that at 3.86 ev) have a mean value of 2.32 with a standard deviation of 0.18 or 7.8%. The most different value from the mean, 2.05, differs from the mean by 12% or 1.5 standard deviations. However there is an uncertainty in the original data at this point of ±12%. On this basis there is no evidence that the ratio of activities is a function of the energy in the interval from pile neutrons to 2.66 ev.

The front-back counting ratio was also close to unity for the case of the thick foil at the 3.86-ev resonance energy. The ratio of activities for this case was 0.85; even after applying the correction factor, the resulting ratio of activities of 1.20 is approximately one-half of the other corrected values. This may indicate that the ratio of activities does depend on energy at 3.86 ev.

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Hyperfine Structure of the $(5p)^5(6s)\ ^3P_2$ State of $_{54}Xe^{129}$ and $_{54}Xe^{131}$†

W. L. FAUST* AND M. N. MCDERMOTT
Columbia Radiation Laboratory, Columbia University, New York, New York
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The hyperfine structures of the metastable $(5p)^5(6s)\ ^3P_2$ state of $_{54}Xe^{129}$ and $_{54}Xe^{131}$ have been measured by the atomic beam magnetic resonance method. The zero magnetic field intervals $f(F\leftrightarrow F')$ are: for Xe^{129}, $f(\frac{3}{2}\leftrightarrow\frac{5}{2})=5961.2577(9)$ Mc/sec; and for Xe^{131}, $f(\frac{5}{2}\leftrightarrow\frac{7}{2})=2693.6234(7)$ Mc/sec, $f(\frac{3}{2}\leftrightarrow\frac{5}{2})=1608.3475(8)$ Mc/sec, and $f(\frac{1}{2}\leftrightarrow\frac{3}{2})=838.7636(4)$ Mc/sec. The values of the quadrupole and octupole moments of Xe^{131}, without polarization corrections and without corrections for any effects of configuration mixing, are $Q=-0.120(12)$ b and $\Omega=+0.048(12)$ nmb. The hyperfine-structure anomaly for the two isotopes due to the $s_{\frac{1}{2}}$ electron alone is $\Delta(s_{\frac{1}{2}})=+0.0440(44)\%$, in disagreement with the prediction of the single-particle model.

I. INTRODUCTION

THE experiment to be described is one in a sequence to measure the hyperfine structure (hfs) of the metastable $^3P_2$ states of elements from Groups II and VIII of the periodic table by the atomic beam magnetic resonance method. The purpose is to measure hfs to a sufficiently high precision to determine the higher nuclear moments, and, where more than a single isotope of odd mass number exists in sufficient abundance, the hyperfine anomalies. For an electronic state of angular momentum J, there is no interaction higher than the 2^{2J} pole, and the ground states of elements from Groups II and VIII, which are $^1S_0$, have no hfs. However, all these atoms (excluding He) have excited states with $J\geq 2$ which can be expected to have lifetimes much greater than the transit time over the 30-cm length of a typical beam-resonance apparatus, so that they are stable for all observational purposes. The experiments performed to date have yielded data on the hfs of the metastable $^3P_2$ states of Group VIII atoms $_{10}Ne^{21}$, $_{54}Xe^{129,131}$ and Group II atoms $_{80}Hg^{199,201}$, $_{48}Cd^{111,113}$, $_{30}Zn^{67}$, $_{12}Mg^{25}$, and $_4Be^9$.[1–5] For the former set, the $^3P_2$ state belongs to a p^5s configuration, and for the latter to an sp, in each case the lowest excited configuration. Other atoms having metastable $^3P_2$ states are A, Kr (p^5s configurations), Ca and Sr (sp configurations). Ba and Ra have $^3P_2$ states which belong to similar sp configurations, but there are lower-lying sd levels to which decay is allowed. The lifetimes of the metastable $^3P_2$ states of xenon and the other inert gases (excluding He) may be expected to be quite long, probably greater than one second. For these atoms, the $^3P_2$ state is the first excited state. The lowest first order mode of decay from a pure $^3P_2$ state to a pure $^1S_0$ state, such as is the

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