ed in the original Hamiltonian.

For a point charge Ze the total screening charge is correctly obtained from the limit as $q \to 0$ of our susceptibility: $-4\pi Zeq^{-2}\chi_{ee}(q) = -Ze$, independent of the magnetization.

Although $\chi_{me} = \chi_{em} = 0$ for the paramagnetic state, in the ferromagnetic case these nondiagonal susceptibilities are as important as the usual diagonal susceptibilities. If we assume that the effect of adding an impurity can be represented typically by a charge Ze and spin S interacting with the conduction electrons via an exchange interaction $J(s\text{-}d$ interaction), then the total spin polarization induced in the medium due to the charge and the spin are given, respectively, by $-Z\mu_B[N_+(0)-N_-(0)][N_+(0)+N_-(0)-2U(0)N_+(0) \times N_-(0)]^{-1}$ and $4(JS/N)\mu_B[1/N_+(0)+1/N_-(0)-2U(0)]^{-1}$, where for typical values of Z and S these two contributions are on the same order of magnitude. Recently neutron-diffraction experiments[12] and Mössbauer experiments[13] revealed a rather complicated behavior for the spin and charge polarization around impurities in ferromagnetic metals and some attempts were made to analyze this behavior theoretically.[2] We believe our results offer a sound basis for this kind of analysis.

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$$[\theta_{k\sigma}(q), \mathcal{H}_c] = V(q)(n_{k+q,\sigma} - n_{k\sigma}) \sum_{l,\sigma'} \theta_{l\sigma'}(q) - U(q)(n_{k+q,\sigma} - n_{k\sigma}) \sum_{l} \theta_{l\sigma}(q).$$

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CHEMICAL EFFECT ON THE HALF-LIFE OF U^{235m}

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The half-life of the low-energy isomeric state of U^{235} produced by α decay of Pu^{239} was measured as a function of various metallic environments. The results show a correlation between the half-life and the average electronegativity of the host metal. In addition, effects due to impurity diffusion of U in metals at room temperature are observed.

The transition rate between two nuclear states is usually independent of the chemical or physical state of the sample. This behavior can eventually be violated,[1] e.g., when the transition energy between two nuclear levels of a given nucleus is exceptionally low: In this case, the transition proceeds by conversion in the outer electron shells of the atom, and a perturbation of these shells by chemical or physical means can alter the transition rate in a measurable way. This is

the case for the $\frac{1}{2}^+$, 26-min isomeric state of U^{235}, whose energy above the $\frac{7}{2}^-$ ground state is less than 100 eV.[2,3] Some conflicting results concerning this isomer were reported by Mazaki and Shimizu[4] and by ourselves.[5] We report here a larger number of results confirming those we published previously,[5] i.e., that the chemical effect on the half-life is large and controllable and that in addition penetration and diffusion phenomena of U recoils in metals are observed.

A U^{235m} source is easily obtained by collecting the recoil atoms from the α decay of a thin Pu^{239} layer. The experimental conditions were essentially the same as reported previously,[5] except for the counter. We have used a special proportional flow counter (90% Ar, 10% CH_4, 1 atm) with two source positions, which allows us to follow simultaneously the radioactive decay of two U^{235m} sources, and thus to measure accurately the ratio of the half-lives and of the initial activities. For all the measurements reported here, a Pt collector was always used as a reference. During collection, it was located above the Pu^{239} layer together with another metallic collector, and both were afterwards measured with the double counter.

The space between the Pu^{239} layer and the collectors was either filled with argon at 1-atm pressure, or kept under a vacuum of a few times 10^{-5} Torr (a cryogenic sorption pump was used to avoid oil contamination). When collected under vacuum, the recoils keep their initial kinetic energy of 90 keV (except for losses in the Pu layer) and are implanted in the metal disk (some sputtering may also occur). On the other hand, when collected under argon, they are slowed down by collisions with the gas atoms and pulled to the surface of the metal by the polarization voltage of 600 V applied between collector and Pu layer (the range of U^{235m} recoils in Ar is about 0.1 mm, and the distance between collector and Pu layer was 1 mm). These surface U atoms can further diffuse into the metal during the remaining collection time.

Regarding the counting equipment, a low-noise, high-gain amplifier was used. The output pulses were sent to five single-channel analyzers, selecting a given range of the pulse spectrum. Each decay was recorded and analyzed separately.

More details about the experimental conditions will be published elsewhere.

The main results are shown in Table I. The errors quoted are external, i.e., they are the standard errors of the average of all measurements of a given type (which was repeated at least five times). The internal (i.e., statistical) error of an individual measurement was always smaller. The overall reproducibility was good: The results relative to Pt used as a reference, as explained above, agreed with the average absolute values within better than the errors quoted in Table I.

When collecting under vacuum, the relative initial intensity (column 3 of Table I) shows that indeed the implantation phenomenon is dominant (the range of a given projectile atom is inversely proportional to the atomic number of the target material). The most striking result is the correlation between the average electronegativity and

Table I. Relative initial intensities I_0 and half-lives $T_{1/2}$ of U^{235m} collected on various metallic disks, and with either vacuum or argon between the collector and the Pu^{239} layer. The columns labelled "Low V" (columns 4 and 7) and "High V" (columns 5 and 8) give the half-lives deduced from the lower 2.5-12.5 V) and higher (50-75 V) ranges, respectively, of the output pulse-height spectrum. In each case, the half-lives deduced from intermediate-voltage ranges had intermediate values.

		Vacuum			Argon		
			$T_{1/2}$ (min)			$T_{1/2}$ (min)	
Collector	Average Electronegativity[a]	I_0[b]	Low V	High V	I_0[b]	Low V	High V
Au	2.54	1.09 ± 0.04	26.98 ± 0.22	26.89 ± 0.30	0.74 ± 0.10	26.59 ± 0.11	27.03 ± 0.16
Pt	2.28	1.00	26.51 ± 0.10	26.86 ± 0.11	1.00	26.25 ± 0.03	26.98 ± 0.06
Ni	1.91	0.62 ± 0.04	25.66 ± 0.14	26.43 ± 0.40	0.98 ± 0.08	26.22 ± 0.08	26.82 ± 0.20
Cu	1.90	0.61 ± 0.05	25.82 ± 0.28	26.08 ± 0.31	0.76 ± 0.04	25.88 ± 0.06	26.66 ± 0.17
V	1.63	0.51 ± 0.04	25.52 ± 0.23	25.87 ± 0.44	0.74 ± 0.03	26.07 ± 0.06	26.90 ± 0.13

[a]A. L. Allred. J. Inorg. Nucl. Chem. 17, 215 (1961) (in this compilation, the average electronegativity of U is given as 1.38).

[b]Relative to Pt.

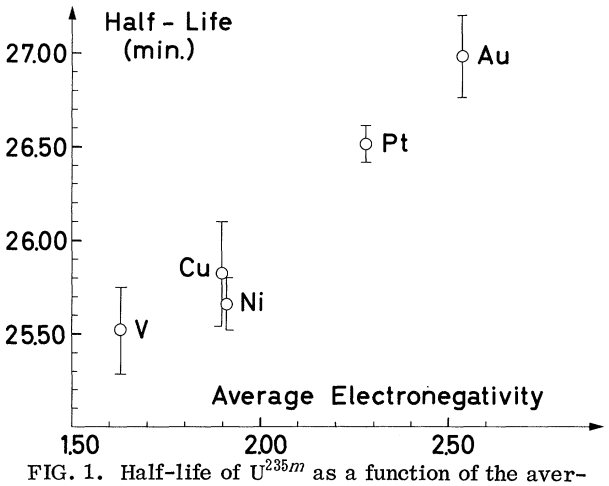

FIG. 1. Half-life of U^{235m} as a function of the average electronegativity of the metal into which the U atoms are implanted.

the half-lives associated with the low-voltage part of the pulse spectrum (columns 2 and 4, respectively, and Fig. 1): The half-life of U^{235m} in V is $(5.7 \pm 1.2)\%$ lower than the half-life of U^{235m} in Au, the other values falling between these limits.

In the case of collection under argon (column 7), this correlation is partly lost and the half-life is either unchanged (Cu), increased (Ni and V) or slightly decreased (Au and Pt) with respect to the values obtained under vacuum. These changes are probably due to diffusion phenomena occuring during collection. The range of the U^{235m} conversion electrons in a metal being probably of the order of 10 to 100 Å, the detection probability of the U nuclei should be markedly decreased if they diffuse to distances of that order below the metal surface. No data on U impurity diffusion in the five metals studied here are available, but a rough calculation with the data available for some other metals[6] shows that the hypothesis proposed above is reasonable. This would explain why the half-life with Cu, under either vacuum or argon, does not change. The relative initial intensities given in column 6 indicate that U impurity atoms diffuse readily in Cu, so in both cases the U^{235m} atoms are similarly embedded in the metal when they are counted some time after the end of the collection. The case of Ni, column 6, shows that diffusion is much slower, thus most U^{235m} nuclei will stay on the metal surface; the environment being different from that in the case of collection under vacuum, the half-life is changed by $(2.2 \pm 0.6)\%$. However, the results obtained with Au, Pt, and V are not so clear and indicate that the phenomena are probably more complex (e.g., formation of intermetallic compounds).

As regards the half-life found for the various parts of the pulse spectrum, a nearly constant value is observed in the case of collection under vacuum (columns 4 and 5), but clear differences are found with argon (columns 7 and 8), the values always increasing with the pulse-height level. To explain the latter case, the argument given above can be used, namely, the U^{235m} nuclei are roughly divided into two classes, with very different electronic environments or configurations (and, consequently, different half-lives), one group of nearly free atoms on the surface and another group bound to the metal either by diffusion or following the formation of an intermetallic compound. For this second group, the average energy of the conversion electrons escaping from the metal surface should be lower than that of the quasifree atoms of the first group. If the proportional counter used here is sensitive to this change (this might be the case if a variable fraction of the electrons have energies below the ionization potentials of the Ar-CH_4 mixture, i.e., 15.7 and 14.5 eV, respectively), then the higher pulse range (and longer half-lives) would be mainly associated with the surface atoms, and the lower pulse range (and shorter half-lives) with the bound atoms.

The overall results presented here are consistent with this explanation. Additional experiments are currently being performed to obtain more direct evidence.

Electron conversion of the isomeric transition can take place in the $6s_{1/2}{}^2$, $6p_{1/2}{}^2$ or $7s_{1/2}{}^2$ subshells of U, whose binding energies are 71, 43, and some fraction of an eV, respectively.[7] Mazaki and Shimizu[3] have measured the conversion electron spectrum of U^{235m} deposited on Au using an electron multiplier as detector, and found a small peak at about 25 eV and a much larger one at 1.2 eV. Taking into account the results reported here, one would conclude that the 1-eV electrons are due both to conversion electrons, emitted by embedded U^{235m} nuclei and losing energy on their way to the metal surface, and to conversion electrons from U^{235m} nuclei on the surface, while the 25-eV peak is due only to the latter class of nuclei. Considering the experimental errors, it is possible to attribute these two peaks to conversion in the $6s$ and $6p_{1/2}$ subshells, respectively, the isomeric-transition energy being just larger than 71 eV, instead of 30 ± 2 eV (implying conversion in the $6p$ and $7s$ subshells) as proposed by Mazaki and Shimizu.[3] A calculation of

the conversion probabilities in these subshells should be made to check this interpretation. Uranium has six valence electrons,[8] namely $5f^36d7s^2$. The chemical effect on the half-life would be due to changes of the screening produced by the valence electrons on the conversion subshells.

The author is indebted to J. Colard for suggesting the double counter, P. del Marmol for useful criticism, Miss H. Depuydt and Mrs. G. DeCorte for help in computing the results, and E. Mies, L. Vansteelandt, and their colleagues for technical contribution.

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MEASUREMENTS OF THE BRANCHING RATIO AND FORM OF INTERACTION FOR THE BETA DECAY OF THE Λ HYPERON*

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In a stopping-K^- exposure of the Brookhaven National Laboratory 30-in. hydrogen bubble chamber, we have found 204 Λ β decays, $\Lambda \to p + e^- + \bar{\nu}_e$, with a scanning efficiency of 0.97 ± 0.02. We obtain a branching ratio of $(0.80 \pm 0.08) \times 10^{-3}$. Using SU(3) and conservation of vector current to determine the weak-magnetism to vector form-factor ratio in the baryon current, we find an axial-vector–to–vector ratio of $0.72^{+0.19}_{-0.14}$. The results are in good agreement with Cabibbo theory and are insensitive to the relative strength of weak magnetism.

In a scan of 109 000 pictures of the Brookhaven National Laboratory 30-in. hydrogen bubble chamber exposed to a stopping K^- beam,[1] we have found 204 beta decays of the Λ hyperon, $\Lambda^0 \to p + e^- + \bar{\nu}_e$.

To insure a satisfying scanning efficiency we instructed the scanners to examine all Λ events and only Λ events. At intervals of 100 pictures, all Λ events were recorded. Elsewhere, only those events considered as leptonic decays were recorded. The signatures by which the events are identified are the curvature and the ionization of the negatively charged decay track. 95% of our expected events have an electron lab momentum less than or equal to 140 MeV/c. The track of a π meson with this momentum has twice minimum ionization and its distinction from the minimum ionization of an electron track is not difficult in our film.

To negate the effect on our branching ratio of any bias, we required our events to satisfy the criteria shown in Table I. Events for which the lambda or proton projected length was obviously less than 1 mm were cut on the scanning table. After the measurement of an event, length and dip cuts were applied and the identity of the event was established by means of a microscopic measurement of gap-length distribution. We accepted 143 events in a total of 130 500 charged Λ decays. Based on a rescan of 24 000 pictures, our scanning efficiency for Λ beta decays is 0.97 ± 0.02. The energy limit in our criteria eliminates 5.5% of the electron spectrum in the leptonic decay.

Table I. Acceptance criteria for the branching ratio.

(1)	$D_\Lambda \geq 4$ cm, D_Λ = distance from production vertex to the nearest chamber wall
(2)	$l_\Lambda \geq 1$ mm, l_Λ = length of Λ track projected onto the scanning plane
(3)	$l_p \geq 1$ mm, l_p = length of p track projected onto the scanning plane
(4)	$\lvert\sin\delta_p\rvert \leq 0.94$, δ_p = dip of p track
(5)	$\lvert\sin\delta_-\rvert \leq 0.94$, δ_- = dip of negative decay track
(6)	$T_e^{\rm cm} \leq 133$ MeV, $T_e^{\rm cm}$ = c.m. kinetic energy of e^- in the leptonic decay