TABLE I. Electronic mobilities in Ge at 300°K.

Nature of samples	Mobility in cm²/volt-sec.
Polycrystalline	3200±750
Single crystals	3370±550
Resistivity above 1.0 ohm-cm	3330±230
Resistivity below 0.1 ohm-cm	3250±790
All	3270±700

low temperatures, but impurity scattering is primarily Rutherford scattering with the mean free path proportional to the fourth power of the velocity. If the Hall coefficient is represented by $R=-r/(ne)$, the quantity r depends upon ρ_I/ρ in the manner shown in Fig. 1 of reference 5. The mobility is now calculated from $b_L=|R|/(r\rho_L)$. Table I shows the room temperature electron mobility, associated with lattice scattering, as obtained in the manner just described. The measure of error for the averages in Table I is given by the standard deviations of the respective data. The large deviations are due primarily to the uncertainty in the determination of the probe separations used in the resistivity measurements. In conclusion, it should be noted that, (1) the average mobility calculated in the manner described is in agreement with the "drift" and "conductivity" mobilities measured by Pearson *et al.*, (2) there is no significant difference in mobility between polycrystalline and single crystal samples, and (3) there is no significant difference in mobility between high and low resistivity samples.

* Work assisted in part by Signal Corps contract.

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[2] E. Conwell and V. F. Weisskopf, Phys. Rev. **69**, 258 (1946); **77**, 388 (1950).
[3] G. L. Pearson, Phys. Rev. **76**, 179 (1949); R. E. Davis and K. Lark-Horovitz, Progress Report of Purdue University Department of Physics to Signal Corps (August 1, 1948), p. 77; R. Bray, Progress Report (August 1, 1948), p. 86; C. S. Hung and J. R. Gliessman, Progress Report (December 1, 1949), p. 36.
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Spectrometer and Coincidence Studies on Np^{238}

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THE Np^{238} used in these experiments was prepared by pile irradiation of Np^{237}, and subsequently separated from other activities and foreign salts. Spectrometer samples (~0.03 mg/cm²) were mounted on conducting LC-600 films. An anthracene scintillation detector was used, and the double-lens spectrometer resolution was three percent.

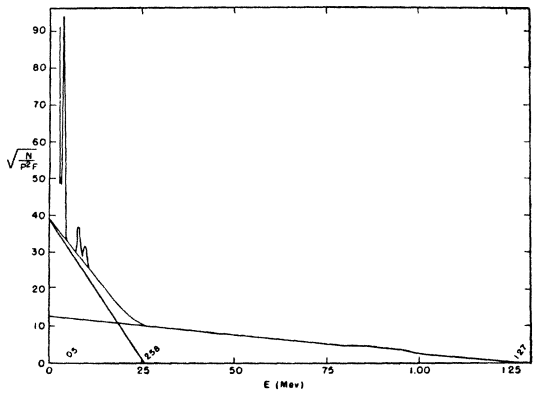

FIG. 1. Kurie plot of Np^{238} beta-spectrum. The Kurie plot of the low energy beta-component ($E_0=0.258$ Mev) can be seen at the left.

TABLE I. Radiations of Np^{238}.

Radiation	Energy[a] (Mev)	Binding energy of conversion electron (Mev)	Gamma-energy (Mev)	Abundance of conv. electron (rel. to weak β) (percent)	Conv. coef.[b] (percent)
β	0.258			100	
β	1.272			89	
Conv. elec.	0.913	0.124(K)	1.04	0.6	1.2
Conv. elec.	0.859	0.124(K)	0.98	0.6	1.2
Conv. elec.	0.0979	0.0048(M)	0.1028	2.2	4.7
Conv. elec.	0.0802	0.0222(L)	0.1029	3.5	7.5
Conv. elec.	0.0419	0.0048(M)	0.0467	6.0	12
Conv. elec.	0.0374	0.0048(M)	0.0422	27	27
Conv. elec.	0.0247	0.0222(L)	0.0469	37	74
Conv. elec.	0.0208	0.0222(L)	0.0430	71	71
Numerous conversion lines below 20 kev are also observed.					
Photo-electron	1.010	0.020(L)	1.030		
Photo-electron	0.966	0.020(L)	0.986		
Photo-electron	0.914	0.116(K)	1.030[c]		
Photo-electron	0.867	0.116(K)	0.983[c]		

[a] Calibration based on K conversion line of Au^{198}.
[b] According to decay scheme of Fig. 2.
[c] Gamma-energy taken from these values.

Table I summarizes the radiations observed. Photo-electron peak shift corrections were negligible for the 3.7-mg/cm² uranium radiator.[1] We estimate the 1.030 gamma to have 1.02 times the intensity of the 0.983 gamma. L and M binding energies for plutonium were obtained from a Moseley law extrapolation from the heavy element region. The Kurie plot, calculated with a relativistic Coulomb function, and by neglecting shielding, appears in Fig. 1. The transitions are seen to be both of the allowed shape, though the higher energy beta is empirically second forbidden ($ft=2.26\times10^8$). The lower beta is empirically allowed ($ft=1.03\times10^6$). The relative beta-intensities are consistent with these ft-values and with the relative beta-energies. For similarly high Z (79) the linear shape has been observed even for second-forbidden transitions.[2]

Gammas of low energy were sought with 30-mg/cm² uranium radiators and 5-mg/cm² gold radiators without success. By using a spiral baffle in the spectrometer together with an intense (100μC) beta-source, positrons were looked for, and an upper limit on the ratio of $\beta^+/\beta^-=0.001$ in the energy range above 50 kev was established. No x-ray or conversion line corresponding to K-capture was observed, contrary to predictions.[3] Using proportional counters, coincidences were found between (1) soft beta and L x-rays, (2) hard beta and L x-rays, (3) L x-rays and L x-rays, (4) soft beta and hard gamma, and (5) L x-rays and hard gamma. Measurements by D. Engelkemeir of this laboratory with anthracene scintillation counters showed coincidences between the hard beta and a quantum radiation of about 100 kev. A more precise half-life value, 2.10±0.01 days, was determined.

A tenatative decay scheme is suggested in Fig. 2.

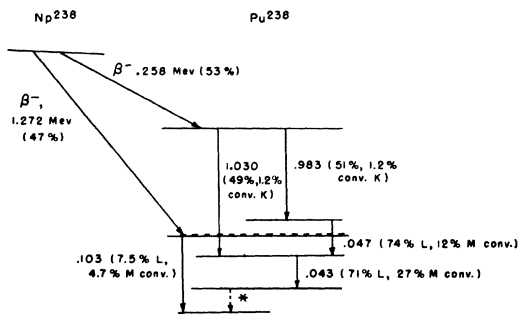

FIG. 2. Suggested decay scheme for Np^{238}. The transition marked * may be a 44-kev gamma whose conversion lines are unresolved from those of the 43-kev gamma; a 13-kev gamma if the dotted level is identical with that about it; or a 60-kev gamma (unlikely) if the dotted level is identical with that immediately below it.

We are indebted to Mary Novick, Robert Keyes, Jerome Lerner, and Jack May for assistance in various phases of these experiments. A final report on this work will be submitted to this Journal.

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A 1.0-Mev Energy Level in C^{13}

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THERE has been some discussion recently in the literature[1–3] as to whether C^{13} has a 1.0-Mev energy level as obtained from the reaction $C^{12}(dp)C^{13}$. A carbon target[4] was bombarded by 10-Mev deuterons from the Washington University cyclotron. The recoil particles were recorded in Ilford E-1 nuclear emulsion plates which were placed at various angles to the cyclotron beam. At 90° there was a homogeneous group of particles which was attributed to the reaction $C^{12}(dp)C^{13}$. There were no recoil particles from the reaction in which C^{13} would be left in the 1.0-Mev excited state. However at 115° and 155° there were two prominent groups of proton tracks, the first of which was analyzed as being due to the above reaction where C^{13} was left in the ground state, and the second as being due to the reaction where C^{13} was left in the 1.0-Mev excited state. These results indicate that there is an angular dependence for the second group of tracks.

To prove that there was no oxygen in the carbon target as a contaminant which would be producing these proton groups due to the ground state of O^{17} and the well-known 0.88-Mev level, a second target composed of Li_2O was bombarded with 10-Mev deuterons and the recoil particles were recorded at 90° to the beam. In this case there were two homogeneous proton groups from the reactions $O^{16}(dp)O^{17}$ and $O^{16}(dp)O^{17*}$. If oxygen were a contaminant of the carbon targets causing the observed groups at 115 and 155° one would also expect the two groups of particles at 90°.

The reason that Buechner[1] and Heydenburg[2] did not find the 1.0-Mev level in C^{13} may be the fact that they used lower bombarding energies.

I wish to thank Dr. R. N. Varney for his constant interest, encouragement, and assistance.

* Assisted by the joint program of the ONR and AEC.
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[4] To be published in greater detail later.

Gamma-Gamma-Correlation Experiments*

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THE correlation of successive gamma-rays has been reported previously for a number of radioactive substances.[1] We have also investigated the gamma-gamma-correlation for several of these activities and for a few other isotopes. The apparatus consisted of two scintillation gamma-counters with 931-A photomultipliers and stilbene crystals. Figure 1, curve A, shows the observed function for Co^{60} and Fig. 2 that of Rh^{106}. These are essentially in agreement with the observations of Deutsch and Brady. The significance of the function for Co^{60} has been discussed by Brady and Deutsch[1] and by Segrè and Helmholtz.[2] The explanation of the Rh^{106} data is still a matter for speculation.

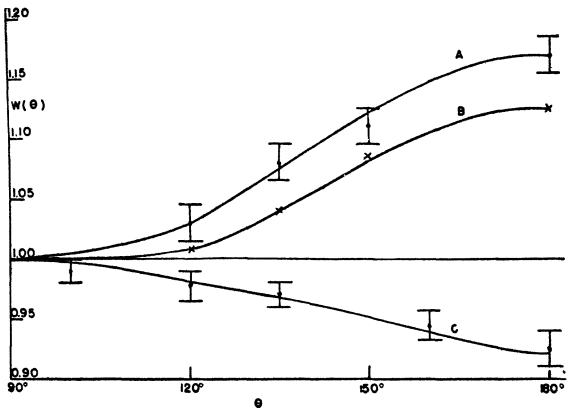

FIG. 1. Gamma-gamma-correlation functions of Co^{60} (curve A), Cs^{134} (curve B), and Ag^{110} (curve C).

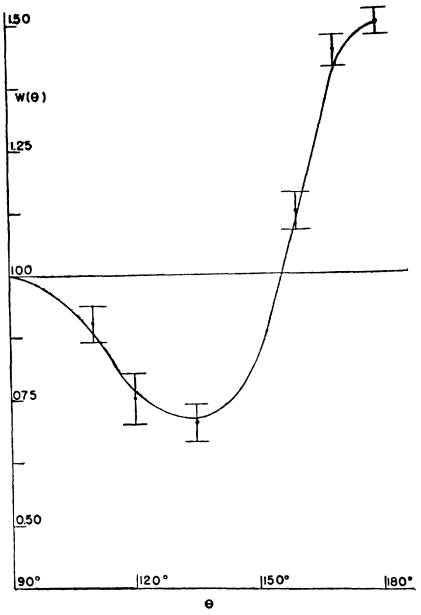

FIG. 2. Gamma-gamma-correlation function of Rh^{106}.

Figure 1, curve B, is the observed function for Cs^{134}. It will be recalled that Cs^{134} has essentially three gamma-rays in cascade, the upper gamma occurring about 25 percent of the time.[3] It is possible to explain the experimental data with the assumptions that the two lower transitions are quadrupole between states possessing angular momenta $J=4$, 2, and 0, and that the upper transition is quadrupole with $J=4$, 5, or 6 for the uppermost state. The polarization correlation experiments[4] and the measurements of the total absolute conversion coefficient[5] for Cs^{134} indicate that one of the lower transitions may be magnetic quadrupole.

Curve C is the observed correlation function for Ag^{110}. An interpretation of this function is difficult because of the large number of gamma-rays present in the structure.[6]

We have also observed that the correlation function for Na^{24} is the same as that of Co^{60}, and have found some evidence of gamma-gamma-correlation in Hf^{181} and Tb^{160}.

* This research was supported in part by the AEC.
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