bath temperature was deliberately varied periodically, the resulting pressures (and temperatures) being read on differential oil manometers. A trend of the solid curve toward increasing pressures means superflow *out of*, and toward decreasing pressures superflow *into*, the adsorption system.

The observed flow behavior is presumably due to the inability of the adsorption system to stay in phase with the fluctuations of the bath temperature, so that a temperature gradient is set up across the leak. It is indeed almost impossible to thermostat the bath sufficiently well to prevent the effect. The phenomenon is completely analogous to the fountain effect in bulk liquid HeII, and these preliminary measurements show that the thermomechanical effect here observed is of the same order of magnitude as in the bulk liquid.

Measurements are being continued to establish, if possible, the order of the transition HeII—HeI in adsorbed films, and in particular to measure accurately the thermomechanical effect in adsorbed layers in order to determine $\Delta P/\Delta T$ for comparison with the theory of the fountain effect in liquid HeII.

[1] E. Long and L. Meyer, Phys. Rev. **76**, 440 (1949).
[2] Giauque, Stout, and Barieau, J. Am. Chem. Soc. **61**, 654 (1939); Osborne, Weinstock, and Abraham, Phys. Rev. **75**, 988 (1949).
[3] However, with vacuum initially at the exit of the leak, superflow is detected only at temperatures lower than the normal λ-point, the "onset" temperature being a function of P/P_0, and ranging from 1.40°K at $P/P_0=0.50$ to 2.03°K for $P/P_0=0.95$. This result is probably related to the fact that under these conditions the pressure near the exit of the leak is far lower than the equilibrium pressure for 1½ layers. However, all the leaks gave, with a given saturation, exactly the same sharp "onset" temperature, with or without the presence of adsorbent at the inlet of the leak.
[4] This is not inconsistent with the specific heat data of H. P. R. Frederikse, Physica **XV**, 860 (1949). Frederikse evidently measured the specific heat at substantially constant amount adsorbed, due to the use of a closed vessel of small dead-space volume, whereas the present experiments are performed at constant pressure.

Gamma-Spectrum of Ta^{182}

F. E. O'Meara
NEPA Division, Fairchild Engine and Airplane Corporation, Oak Ridge, Tennessee
July 3, 1950

THE gamma-spectrum of Ta^{182} has been examined in a thin lens beta-spectrometer. A preliminary survey in 1949 using the Oak Ridge National Laboratory spectrometer indicated that there were numerous gamma-rays in the interval from 0.325 to 1.13 Mev where none had previously been reported.[1] The spectrum has now been examined again on the NEPA spectrometer and 27 electron lines have been found.

The tantalum was prepared by irradiation in the Oak Ridge pile and then allowed to decay for six months. A piece of uranium approximately 100 mg/cm² thick was used as a radiator. The counter had a conventional mica end window.

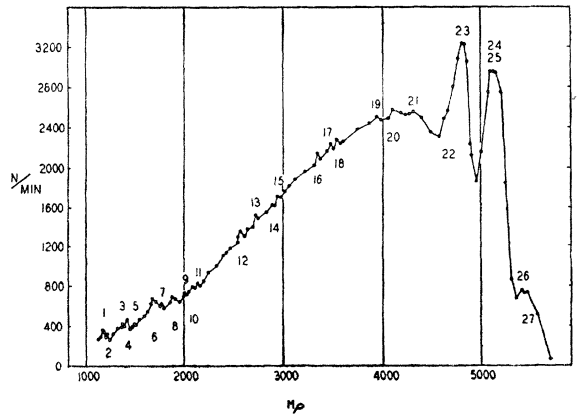

FIG. 1. Gamma-ray spectrum of Ta^{182}.

TABLE I. Electron lines from Ta^{182}.

Line No.	Energy (kev)	Identification
1	109	K_1
2	117	K_2
3	145	K_3
4	153	K_4
5	165	K_5
6	205	K_6 and L_1
7	227	K_7
8	247	K_8
9	277	K_9
10	297	K_{10} and L_6
11	306	K_{11}
12	411	K_{12}
13	450	K_{13}
14	492	K_{14}
15	509	K_{15}
16	613	K_{16}
17	648	K_{17}
18	665	K_{18}
19	777	K_{19}
20	820	K_{20}
21	878	K_{21}
22	971	L_{21}
23	1018	K_{22}
24	1100	K_{23}
25	1116	K_{24} and L_{22}
26	1189	L_{23}
27	1204	L_{24}

Figure 1 shows the electron spectrum obtained. Table I lists the electron lines, their energies, and identification. Table II lists the gamma-rays and their energy. It is quite possible that some of the low energy lines may be L shell lines from gamma-rays whose K shell lines were too low in energy to be observed.

TABLE II. Observed gamma-rays.

Gamma-ray No.	Energy from K	L (Mev)
1	0.224	0.227
2	0.232	
3	0.260	
4	0.268	
5	0.280	
6	0.320	0.319
7	0.342	
8	0.362	
9	0.392	
10	0.412	
11	0.421	
12	0.526	
13	0.565	
14	0.607	
15	0.624	
16	0.728	
17	0.763	
18	0.780	
19	0.892	
20	0.935	
21	0.993	0.993
22	1.133	1.138
23	1.215	1.211
24	1.231	1.226

[1] Beach, Peacock, and Wilkinson, Phys. Rev. **76**, 1585 (1949).

Radioactivity of Ni^{59} and Ni^{63}

H. W. Wilson
Department of Natural Philosophy, University of Glasgow, Scotland
July 6, 1950

A PREVIOUS communication[1] described an investigation by the proportional counter technique of the long-lived activity of nickel after pile irradiation. This was first undertaken to examine the positron activity ascribed to Ni^{59} by Segrè,[2] Rosenfeld[3] and others. Our experiments failed to reveal this activity but a soft negative β^--activity of upper energy limit 63±2 kev was shown to belong to Ni^{63}. The form of the spectrum was compared with Fermi theory.

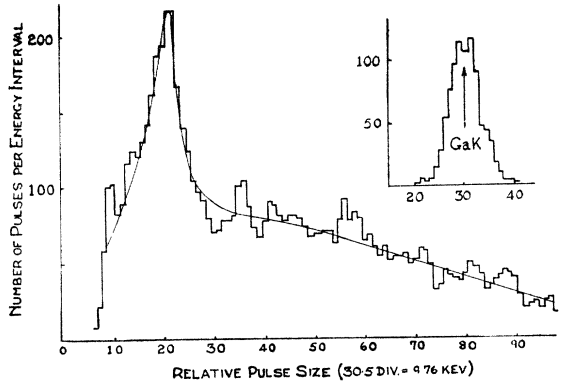

FIG. 1. Pulse-height spectrum for particles to about 30.5 kev.

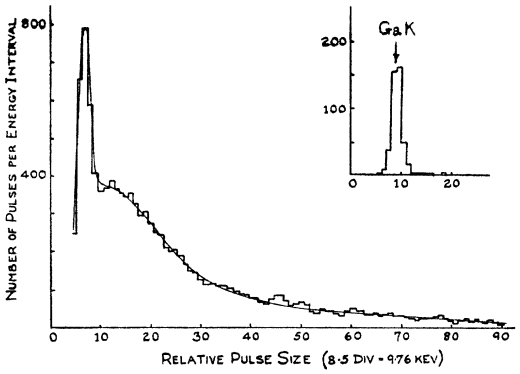

FIG. 2. Pulse-height spectrum for particles to about 100 kev.

In the paper referred to above it was noted that no evidence of positrons, K x-radiations or Auger electrons could be detected. Since the isotope Ni^{59} is expected to decay by K-capture and/or emission of positrons the failure of the very sensitive search led to the conclusion that the lifetime of Ni^{59} was very long. The alternative possibility that the neutron capture cross section of Ni^{58} was very small did not seem to be likely.[4]

To extend the investigations, a sample of pure nickel oxide (free of iron and cobalt) was irradiated for two months in the thermal region of a pile and then a portion was carefully purified as described previously;[1] i.e., by precipitating any active cobalt, with non-active carrier, using α-nitroso-β-naphthol; precipitating nickel with dimethylglyoxime and finally by converting the nickel to nickel carbonyl. The nickel from the carbonyl vapor was then deposited on a hot aluminum foil which was thereafter inserted into the central region of a proportional counter, pressed against the cathode. (The diameter of the counter was 6 cm and the active length 15 cm. It was filled with 2 atmospheres of argon and 10 cm of methane.) The counting rate was 34,000/min. and it was quickly shown by the examination of the β-spectrum emitted from this source, that this rate was almost entirely due to Ni^{63}. Next the source was covered with an aluminum foil, of thickness 1 mil, sufficient to absorb all the β-radiation of Ni^{63}. The counting rate of the counter was now reduced, within the statistical fluctuations, to the background value ($\sim$350/min.) but nevertheless it was thought desirable that the energy spectrum of the pulses should be examined carefully. The results for two different energy ranges, are shown in Fig. 1 and Fig. 2. The first extends to $\sim$30 kev and the second to $\sim$100 kev. A peak is clearly seen in both histograms. It is superposed on the spectrum of the counter background. The K-capture radiation of Ge^{71} giving rise to the x-rays of Ga^{71}, was used as a calibrator (inset figures). The radiation was filtered with Perspex of a thickness sufficient to equalize the intensities of the K_α and K_β x-rays (slightly resolved in Fig. 1). Taking the mean value of these radiations as 9.76 kev, the energy corresponding to the peak observed on the spectra is calculated to be 6.9 ± 0.3 kev. Now the energy of the K_α x-ray of cobalt is 6.93 kev. The nearly perfect agreement between these values strongly supports the view that this radiation is due to Ni^{59}, decaying by K-capture to Co^{59} and emitting the x-radiations of cobalt.

This radiation from Ni^{59} is of very low intensity. The counting rate (corresponding to the integral under the peak of Fig. 1 not including background) was 22/min. Allowing for the efficiency of the counter and its solid angle of 2π, this corresponds to 49 disintegrations/min. in a source weighing approximately 17.3 mg. This low activity is, no doubt, one of the reasons why the radiation has escaped detection hitherto. The proportional counter technique is possibly unique in its ability to reveal and give accurately the energy of a radiation of such low intensity and energy.

The extremely long life calculated for this isotope is of interest. If the cross section of Ni^{58} from which Ni^{59} is formed by slow neutron irradiation, is taken as 1 barn, the half-life is calculated to be 1.8×10^5 years. The main uncertainty is in the cross-section value. Ross and Story[4] state that the absorption cross section for nickel is between 4.2 and 4.6 barns for thermal neutrons and is mainly due to Ni^{58}. If this is so the half-life is $\sim8\times10^5$ years.

Our estimate of the life of Ni^{63} is much less than that given by Seaborg and Perlman;[5] i.e., 300 years. On the basis of a cross section of 0.51 barn[2] for Ni^{62}, a life of 2.1 years is obtained. The cross section of Ni^{62} may be doubtful and no figures for its cross section could be found elsewhere in the literature. In fact, very little work appears to have been done on the cross sections of the nickel isotopes although Seren *et al.*[6] give the cross section of Ni^{64}, leading to the 2.6-hour isotope Ni^{65} on slow neutron bombardment, as 1.96 barns.

In a recent letter, Thomas and Kurbatov[7] described a search for photons emitted by long-lived nickel isotopes and also, by cloud chamber, for the continuous spectrum of Ni^{63}. They found evidence of the former but not of the latter activity. On the other hand, our experiments with carefully purified nickel show that a relatively intense β-emission of Ni^{63} is accompanied by a weak K-capture emission of Ni^{59}, the ratio of the disintegration rates being $\sim$1200:1. It is difficult to understand their failure to observe the relatively much stronger activity of Ni^{63}. We have ourselves observed no γ-rays corresponding to their values (either for Ni^{59} or Ni^{63}) but our work showed that very thorough chemical purification is necessary to eliminate spurious radiations. Further work is proceeding on the lifetimes and activities of the nickel isotopes with a source of higher activity.

I should like to take this opportunity of thanking Dr. S. C. Curran for his continued interest and help in these investigations, and also to record my indebtedness to Sir J. D. Cockcroft and the Ministry of Supply, A.E.R.E., Harwell, England for the preparation of radioactive nickel.

[1] H. W. Wilson and S. C. Curran, Phil. Mag. **40**, 631 (1949).
[2] Segrè Isotope Chart, 1947.
[3] L. Rosenfeld, *Nuclear Forces* (North-Holland Publishing Company, Amsterdam, 1948), Vol. 1, p. 506.
[4] M. Ross and J. S. Story, Reports on Progress in Physics, **12**, 296 (1948–1949).
[5] G. T. Seaborg and I. Perlman, Rev. Mod. Phys. **20**, 596 (1948).
[6] Seren, Friedlander, and Turkel, Phys. Rev. **72**, 894 (1947).
[7] D. G. Thomas and J. D. Kurbatov, Phys. Rev. **77**, 151 (1950).