the lead of the precipitate and not in the thallium of the filtrate. Neither of the activities was observed following bombardments of mercury targets. Thresholds for production were compared with the threshold for production of 8-hour Pb^{201}, and this comparison supported the proposed assignments. Comparison of the energy of the 5.6-second γ-ray with the energy of a γ-ray found in polonium extracted from a bismuth target indicated that the α-decay of Po^{206} probably goes to the 5.6-second excited level of Pb^{202}.

Intensity of the 0.67-Mev line of the 50-second activity appeared to be about four times that of the two lower energy lines on the basis of comparisons of the areas under the photoelectric capture peaks. Although definite transition types cannot be specified, it is interesting to note that the energies 0.42 and 0.25 Mev are in line with the energy spacings of $i_{13/2}$ to $f_{5/2}$ and $f_{5/2}$ to $p_{1/2}$ levels for adjacent isomers of odd neutron number as plotted by Hill.[3] The type of transition giving rise to the intense 0.67-Mev line is particularly puzzling since a crossover transition $i_{13/2}$ to $p_{1/2}$ is ruled out as being of type $M6$. Further data are required before this point can be clarified.

In the course of this investigation the period of the known Pb^{207} metastable state was redetermined as 0.80 ± 0.02 second.

Indebtedness is expressed to Dr. J. S. Foster, Director of the Radiation Laboratory, to Dr. S. W. Breckon and Dr. A. L. Thompson, and to the National Research Council of Canada for two studentships.

* Now at Atomic Energy of Canada, Limited, Commercial Products Division, Ottawa, Canada.

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Heat Pulses in He II Below 1°K

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THE fact that below 1°K the speed by which heat pulses travel in He II increases enormously[1] has generally been regarded as a confirmation of the Landau version of the two-fluid model.[2] According to that version the so-called normal fluid would essentially consist of rotons, the role of which would be taken over by phonons below 1°K.

In different laboratories it has been observed, however, that the width of the heat pulses increases greatly, and this might suggest that at the lowest temperatures one does not have to do with second sound proper but with the normal transmission of heat pulses in a medium of a certain specific heat and thermal conductivity. The formulas of Kronig and Thellung[3] might be appropriate to describe the transition to the phenomenon of second sound above 1°K. The magnitude of the speeds observed suggests that the mean free path of the phonons responsible for the thermal conductivity is determined by the width of the vessel.[4] The difference with Landau's picture would consist of his emphasis on the momentum of the phonons and of their large effective diameter for collisions.

Mr. H. C. Kramers in Leiden is preparing to investigate the expected influence of the length and the width of the vessel. The publication of the present letter was stimulated by a discussion with Dr. Pellam and Dr. De Klerk, who kindly showed me the recent results obtained at the Bureau of Standards.

Finally, it might be suggested that the increase of the second sound velocity[5] above 1°K upon dissolving He^3 also could be accompanied by an increase of damping and dispersion and so indicate an earlier transition to the very low temperature case.

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Mass Assignment and Gamma-Radiations of the Seven-Hour Molybdenum Isomer

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THE 7-hr isomer activity in molybdenum produced by proton[1–3] and by deuteron irradiation of niobium,[2,4] by alpha-particle bombardment of zirconium,[2,5,6] and in very low yield by fast neutron irradiation[6] of enriched Mo^{94} is of interest in that its assignment to mass 93 cannot be easily reconciled with predictions from shell theory.

Some doubt concerning this mass assignment has persisted, for, unexpectedly, it has not been possible to prepare 7-hr Mo^{93} by deuteron bombardment[6] of enriched Mo^{92}, or by a (γ, n) reaction when enriched Mo^{94} was irradiated with 23-Mev γ-rays.[7] In addition, despite numerous attempts, we have been unable to produce any detectable amounts by irradiating molybdenum enriched to 92.1 percent in mass 92 with slow neutrons in the Oak Ridge graphite pile, nor has this period been observed as a daughter from intense sources of 2.75-hr Tc^{93} produced by a (d, n) reaction on Mo^{92}. Again, in recent bombardments of molybdenum with 20-Mev protons no 7-hr molybdenum whatever from the energetically possible (p, pn) reaction could be detected, although easily measurable quantities of the well-known 67-hr Mo^{99} were formed.

To make quite certain that the 7-hr activity was correctly assigned chemically, a molybdenum fraction was separated from niobium irradiated with 20-Mev protons and exhaustively purified. The decay of gamma-radiations from this purified source was accurately exponential for more than 60 hours and gave a half-life value of 6.95 ± 0.05 hours. Measurements of the γ-ray spectrum were also made using a (Tl+Na)I crystal scintillation counter spectrometer. Energies of 290, 690, and 1464 kev for the photoelectric peaks (Fig. 1) which decayed with a 7-hr half-life were estimated to within 3 percent by comparison with the 141-kev C^{144}, the 661-kev Cs^{137}, and the 1175-kev and 1332-kev Co^{60} γ-rays, respectively. These values appear to be in good agreement with recent magnetic lens spectrometer measurements of conversion and photoelectron energies,[8] except for the lowest energy transition. The observed relative intensities of the (unconverted) γ-rays were as 11.2:4:1, which, when compared with the detection efficiency ratios of 18.3:4.1:1 for 290-, 690-, and 1464-kev quanta, respectively, indicate the latter two γ-rays to be equally abundant, and the lowest energy gamma to have a total conversion coefficient of 0.6 ± 0.2. Measurements on a portion of the original proton-

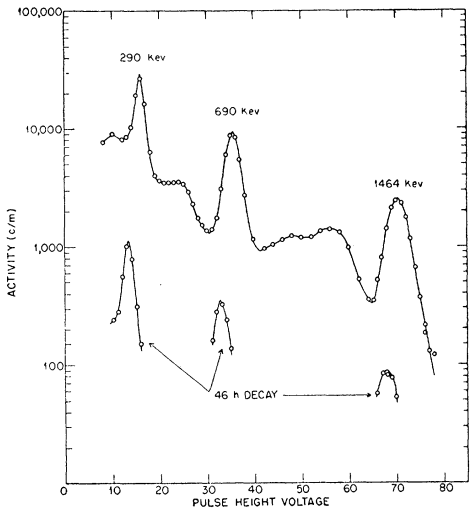

FIG. 1. Gamma-ray spectrum of 6.95-hr Mo^{93} (Tl+NaI scintillation counter spectrometer).

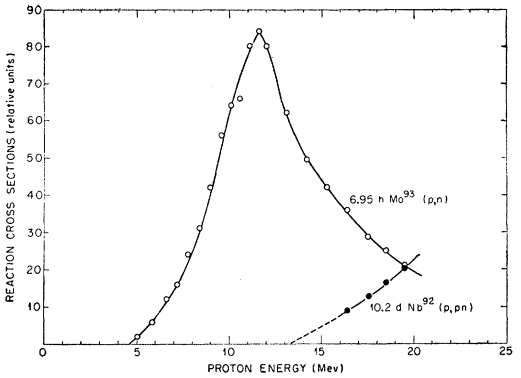

FIG. 2. Relative yields of Mo^{93} and Nb^{92} from Nb^{93}+20-Mev protons.

irradiated Nb showed the same 290-, 690-, and 1465-kev gammas from Mo as well as the 905-kev ray from 10.2-day Nb^{92} formed by a (p, pn) reaction.

The 7-hr Mo may be formed by either a (p, γ), a (p, n), or a $(p, 2n)$ reaction. The first of these alternatives seemed unlikely in view of the 3.7±0.2 Mev reaction threshold observed by Blaser *et al.*[3] However, the possibility of a $(p, 2n)$ reaction remained to be considered. Accordingly, an excitation curve was determined using a stacked foil technique in which one-mil Nb foils were bombarded for 90 minutes with a *ca* 10 μa beam of 20.1-Mev protons. The decay of the beta-activity produced in the Nb foils was resolvable into two periods only—the 6.95-hr Mo and the 10.2-day Nb^{92}. The yield of 6.95-hr Mo when plotted against the incident proton energy (Fig. 2) is seen to reach a maximum at about 11.5 Mev, after which it diminishes with increasing energy. The curve for the formation of 10.2-day Nb^{92} by a (p, pn) reaction shows a threshold at 13.3 Mev and has not reached a maximum at 19.5 Mev. The excitation curve for a $(p, 2n)$ reaction on Nb^{93} should resemble that for the (p, pn) reaction except that its threshold should be approximately 0.6 Mev lower. It seems necessary to conclude that the 6.95-hr Mo isomer is formed by a (p, n) reaction with Nb^{93} and hence must be assigned to mass 93.

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Soft Radiation from Pu^{239}†

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THE radiations from Pu^{239} have been studied in the region 5–25 kev. For this purpose, a proportional counter, filled with argon to a pressure of 53-cm Hg and with methane to a pressure of 6-cm Hg, was employed in combination with a single-channel pulse analyzer and associated amplifying and counting circuits.

Advantage was taken of the fact that the plutonium sources used were capable of causing detectable quantities of fluorescent x-radiation in thin foils of various materials. By using a thin absorber of suitable material, there was obtained the spectrum from plutonium on which was superposed the peak resulting from the characteristic K x-radiation of the absorber material. Such a peak could then be used for purposes of calibration.

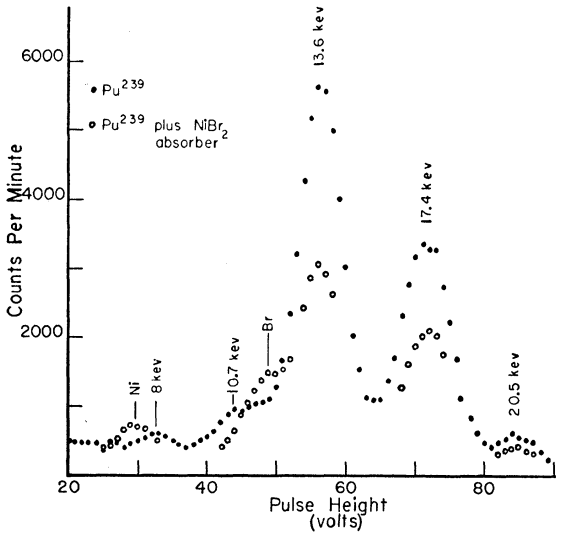

FIG. 1. Spectrum of soft radiation from Pu^{239}.

A typical result is shown in Fig. 1. The source, covered with sufficient Scotch tape to absorb all alpha-radiation, consisted of 0.164 mg PuO_2 on 2-mil Be and was approximately 2 cm^2 in area. The absorber used was a thin layer of $NiBr_2$ crystals put down on Scotch tape. The contribution of the absorber material to the spectrum can easily be noted.

The spectra obtained show peaks at 20.5±0.4, 17.4±0.3, and 13.6±0.3 kev. These values agree with the observed values for the L x-rays of uranium. The peak at 10.7 kev is assumed to be the escape peak for the 13.6-kev radiation, and the peak at 8 kev is considered to be the result of fluorescent radiation from a brass case in which the glass proportional counter was placed.

Using a collimated source, a determination of the L-photon yield was made. Calculations carried out in the usual way[1] gave the results shown in Table I. The total yield, 2.9×10^{-2} photons per alpha-particle, is in error by not more than 50 percent and is in agreement with that reported by Dawson and West.[2]

TABLE I. L-photon yield in Pu^{239} disintegration.

Photon energy (kev)	13.6	17.4	20.5
Photons/alpha-particle	1.2×10^{-2}	1.4×10^{-2}	0.3×10^{-2}

In all phases of the work, much valuable assistance was given by Simon Shlaer. The sources were supplied and prepared by John G. Povelites.

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Spherical Model of a Ferromagnet

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IN a paper having the above title[1] Berlin and Kac have presented a model for cooperative action in crystals to which statistical mechanics can be applied rigorously. We wish to point out that the mathematical manipulations of that paper can be reduced to almost nothing by the use of a grand rather than a canonical ensemble. We feel that this observation is of some consequence in a domain of research in which progress is largely impeded by mathematical difficulties.