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# Summary of the Research Progress Meeting

March 3, 1949

Henry P. Kramer

**Special Review of Declassified Reports**
Authorized by USDOE JK Bratton
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| Bureau of Ships | 21 |
| Carbide & Carbon Chemicals Corporation (K-25 Plant) | 22-25 |
| Carbide & Carbon Chemicals Corporation (Y-12 Plant) | 26-29 |
| Columbia University (Dunning) | 30 |
| General Electric Company, Richland | 31-34 |
| Hanford Operations Office | 35 |
| Iowa State College | 36 |
| Knolls Atomic Power Laboratory | 37-40 |
| Los Alamos | 41-43 |
| Mound Laboratory | 44-45 |
| National Bureau of Standards | 46-47 |
| Naval Radiological Defense Laboratory | 48 |
| NEPA Project | 49 |
| New York Operations Office | 50-51 |
| North American Aviation, Inc. | 52 |
| Oak Ridge National Laboratory | 53-60 |
| Patent Branch, Washington | 61 |
| Sandia Base | 62-63 |
| Technical Information Division, OROO | 64-78 |
| UCLA Medical Research Laboratory (Warren) | 79 |
| University of California Radiation Laboratory | 80-84 |
| University of Rochester | 85-86 |
| Total | 86 |

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Summary of the Research Progress Meeting

March 3, 1949

Henry P. Kramer

Radiation Laboratory
University of California

Isotopes of Polonium. D. Karraker.

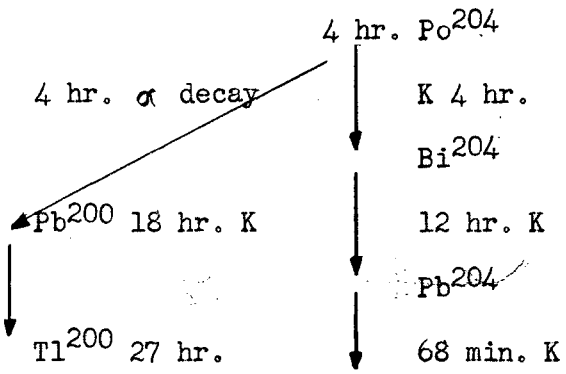
Although polonium was one of the first of the radioactive elements to be investigated, it is still one of the most interesting: to wit, two new isotopes of polonium have been found in recent research. The isotopes were produced by 80 Mev deuteron and 380 Mev proton bombardment of Bi and 380 Mev $\alpha$ bombardment of Pb. The following spallation products were observed and chemically separated from the target material: Po, Bi, Pb, Tl, Hg, and Au. Since yields of the other elements were quite large, the separation of the Po fraction was difficult. This separation was accomplished by a series of alternate reduction and oxidation of the Te carrier solution. Finally the carrier was precipitated out of the solution and the polonium was electroplated on Ag electrodes.

The $\alpha$ decay curve (Fig. 1) was clearly resolvable into two unknown activities and a number of activities which have already been assigned. The four hour activity which was discovered had an energy of 5.4 Mev and the 1 hour activity had an energy of 5.6 Mev. Energy determinations were accurate to within $\pm$ .1 Mev.

In order to make assignments of these newly found activities, the polonium fraction was milked: 2 hour and 12 hour Bi were found. This result suggested a parent-daughter relationship between the unknown Po activities and the Bi isotopes. Periodic milking of the Po fraction for the 12 hour $Bi^{204}$ showed that the log yield decreased linearly. From the slope of this curve, the half-life of the parent was calculated and was found to be 4 hours. On this basis a definite assignment was made of the four hour activity to $Po^{204}$, the K-capture parent of

$Bi^{204}$.

In order to fix the decay scheme of the 4 hour Po isotope it was decided to milk its 18 hour daughter by alpha decay, $Pb^{200}$, from the Po fraction. This milking was not successful. However it was possible to count the 27 hr. Tl daughter of $Pb^{200}$ by alpha decay. The yield was found to be initially 3240 counts/min., four hours later, 1740 counts/min., and after an additional four hours, 845 counts/min. This rate of decay affirms the 4 hr. half-life of the grandparent and thus assures the correctness of the following scheme.




The K to alpha branching ratio was found to be $10^3$, that is, for every count of Bi, 1000 counts from Pb were observed. Although the above scheme is correct, its place in the isotope table is less well known since there is some uncertainty regarding the position of the 27 hour Tl activity and since the arrangement of the scheme into the table hinges on the assignment of this activity.

The assignment of the 1 hour Po activity has not been completed. Its placement in Table I has been made on insufficient evidence.

Recent Progress in Meson Studies with the Cloud Chamber. E. Hayward.

The most successful run which has been made thus far yielded 220 tracks that had the appearance of meson tracks. These tracks were produced by both $\pi$ and $\mu$ mesons although some of them must probably be ascribed to electrons. The tracks were produced in the cloud chamber when the neutron beam was intercepted by a piece of lead and a sheet of lucite as shown in Fig. 2. Uncertainty in the identification of some of the tracks is due to the fact that for positive recognition it is necessary to see at least one end of the track, but some of the

tracks started on one side of the illuminated area, passed through, and stopped out of view. All tracks were given their particle assignation on the basis of their radii of curvature and density of ionization.

Fig. 3 shows a track which is thought to demonstrate the decay in flight of a $\pi$ into a $\mu$ meson. It is impossible to judge from the appearance of the track which branch was produced by the $\pi$ meson and which by the $\mu$ meson. To make the identification, a method was used which may appear somewhat awkward, but it was the only one which would furnish the answer. It was first assumed that one branch of the track was produced by the $\pi$ meson. On the basis of this assumption, the energy of the $\mu$ meson was calculated from the data furnished by its supposed track. Then the calculation was reversed with the assumption that the $\pi$ meson had produced the other branch. The following pairs of values for the energy in Mev were calculated in this fashion:

| | | | | | | |
|---|---|---|---|---|---|---|
| 3.5 | 3.8 | 2.3 | 4.0 | 4.0 | 3.1 | 2.4 |
| 7 | 9 | 0.7 | 0.0 | 0.0 | 1 | 0.2 |

The expected energy of $\mu$ mesons is Eu = 4 Mev. Therefore, the assumptions which yielded the values in the top row were considered to be correct. The energy of the $\pi$ mesons was between 10 and 20 Mev. The charge of $\mu$ mesons which were seen in the decay tracks was always positive.

The question was raised from the audience whether it might not be possible that the tracks which seem to be consistent with the hypothesis of decay in flight might not have been caused by inelastic scattering. Although the possibility was admitted, it was thought to be unlikely for two reasons. The average change in curvature from one branch of a track to the other is too large to be ascribed to scattering with a great deal of likelihood. The angle $\theta$ with which the two branches intersect is usually too large to be ascribed to scattering since one would expect a high frequency of small angles $\theta$ from scattering and small $\theta$ is very rarely encountered on meson tracks.

Eight tracks have been observed in which the particles came to a stop. Seven of these were among the 220 tracks produced in the run that has been des-

cribed and one was seen in a previous run. All the tracks which stopped must be ascribed to negatively charged mesotrons. One $\mu$ meson was observed to stop. From the range and $H\rho$ its mass was calculated to be 220 electron masses. Four of the tracks end in stars. The masses of the particles as computed from $H\rho$ and range were between 275 and 285 electron masses.

On the basis of $H\rho$ measurements and the assumption that all observed tracks were made by $\pi$ mesons, the energy distribution curves of Fig. 4 were drawn. Fig. 4(a) represents the raw data. Fig. 4(b) shows the corrected continuous distribution which these data imply.

Ten Channel Pulse Analyzer. C. Wiegand.

A modified version of the ten channel pulse analyzer that was designed at Los Alamos by E. W. Dexter and M. L. Sands has been constructed at this laboratory. In spite of its name, the analyzer consists of eleven channels. The first nine channels group the incoming pulses into approximately equal finite voltage height intervals. The tenth channel receives all of the pulses which are too high to fall below a fixed maximum. Finally, the supernumerary channel registers every incoming pulse and thus furnishes the total count. The first nine channels can be adjusted to equal widths of 2, 5, and 10 volts with an uncertainty of 10 percent for the 2 volt interval and 2 percent for the 10 volt interval.

Two notable attempts at designing an apparatus to count pulses with regard to their heights have been made in the past. One of these consisted in having a discriminator triggered and released by the voltage peak itself. Since the duration in time of this peak is very short (for example, the maximum of a sinusoidal variation) it was not possible to avoid extreme instability in the circuit. In order to overcome this difficulty, workers at Chalk River, Canada passed the incoming pulses through a preshaper which formed them into rectangles with altitude equal to the pulse height and base approximately 80 $\mu$ sec. With this arrangment instability was avoided, but it became necessary to adapt the pulse shaper to each separate sequence of measurements that were to be made with

the analyzer.

The instrument that was developed at Los Alamos, on the other hand, is quite flexible since it dispenses with pulse shaping. Every incoming pulse imposes its range of voltages on the grid of the discriminator vacuum tube of each channel. If the pulse in the course of its variation passes through a voltage which is sufficient to release the flow of electrons through this discriminator tube, the channel is activated. The channel remains in a steady state operation, it is "locked," until it is released by an anticoincidence circuit. The anticoincidence circuit releases a certain channel if both this one and the subsequent one are activated. Only the final channel which is activated by the pulse and thus contains the pulse peak remains stable and gives a count. After a fixed dead time of 60 $\mu$ sec. it furnishes a small pip to bring the entire apparatus to a stable state in which it can receive the next pulse.

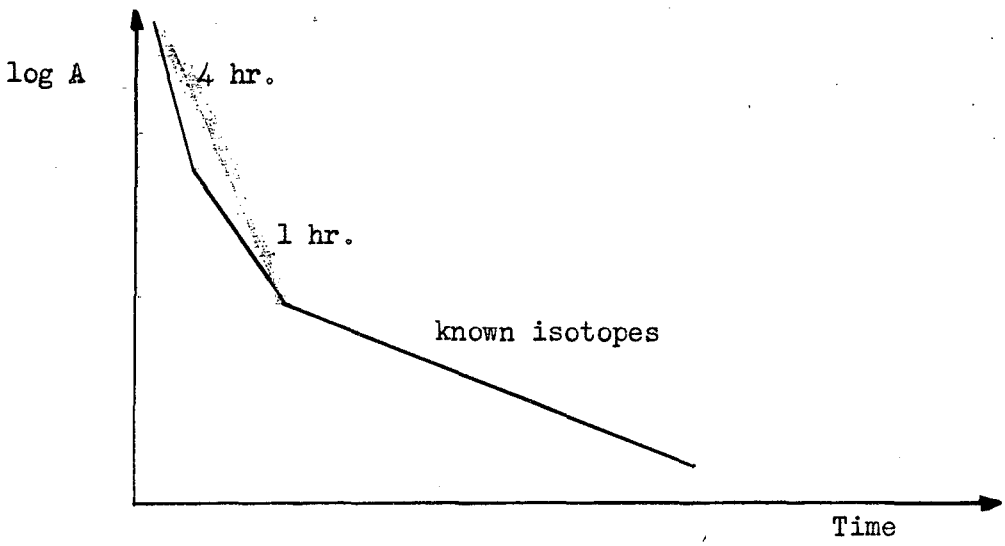
The practical usefulness of the analyzer is enhanced by the fact that pulses can be selected as to shape and kind before they are admitted for counting. But its foremost advantage is the high speed with which it can receive and analyze a large mass of data. The time interval between consecutive measurements is 10-12 $\mu$ sec. and each measurement requires 60 $\mu$ sec.

The bias on the discriminator tubes is obtained by tapping a series of resistors atequal intervals. The voltage drop across the resistor determines the voltage interval of the discriminator. The intervals are calibrated by using a sliding pulse generator and thus imposing known pulses on the system. Each discriminator is connected to a scale of eight and each channel is capable of registering about 100 counts/sec.

Drift is not a serious problem. One month after adjustment, only two channels were found to have changed their voltage intervals by as much as 1 volt, 10 percent.

The details of operation and construction of this fast and accurate analyzer are contained in "A Ten Channel Pulse-Height Analyzer" by E. W. Dexter and M. L.

Sands, LAMS-573, May 28, 1947.

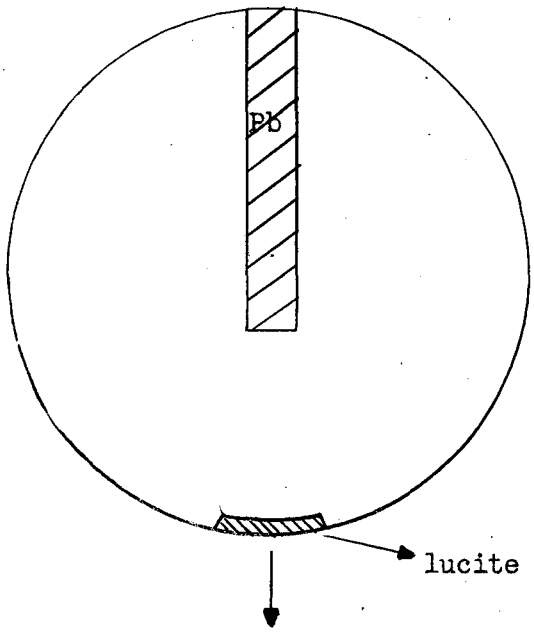



Decay Curve

Fig. 1

| | 200 | | 202 | | 204 | | 206 | | 208 | | 210 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Po | | | 1 hr? | | 4 hr. K | | 9 d. 10% | 5.7 hr. K | .3 yr. | 30-100 y. | 140 hr. |
| Bi | | 1-5 hr. | 2 hr? | | 12 hr. K | | 6.4 d. K | | | | |
| Pb | 18 hr. K | 8 hr. K | | | 68 min. | | | | | | |
| Tl | 27 hr. | 3 d. | 12 d. | | | | | | | | |

Table 1



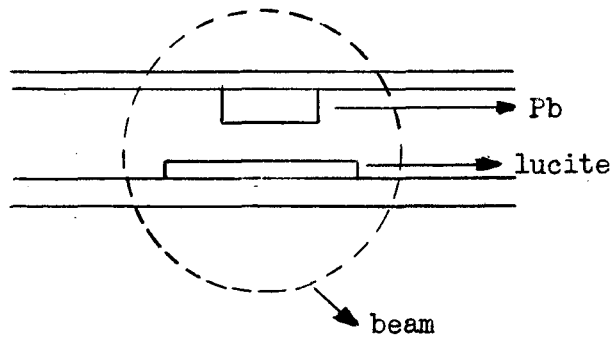




Fig. 2

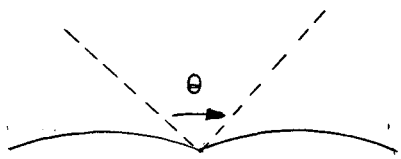



Fig. 3

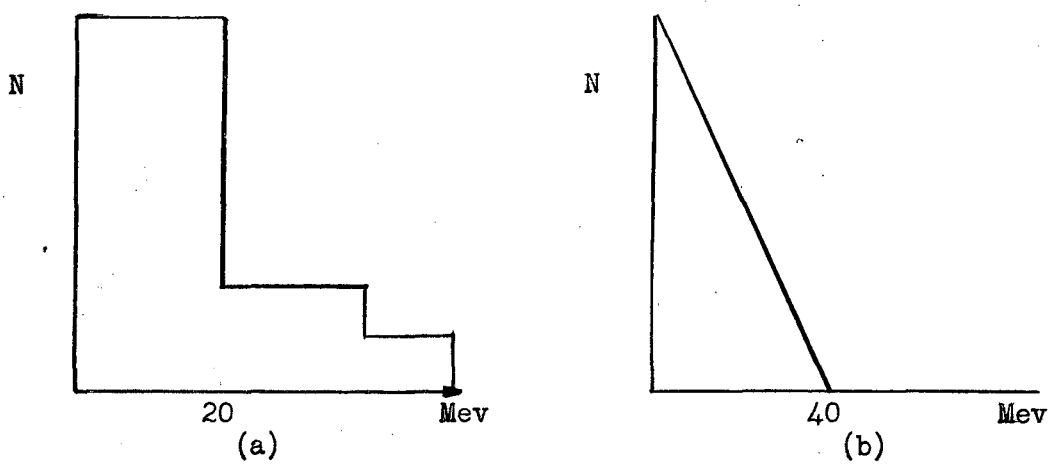



Fig. 4

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