Title

Summary of the Research Progress Meeting

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SUMMARY OF THE RESEARCH PROGRESS MEETING

of June 15, 1950

Henry P. Kramer

October 26, 1950

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Berkeley, California

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Meson Detection by Decay. M. Jakobson.

π^+ -mesons decay in two steps. First a μ^+ -meson results. Then, the decay of the μ^+ -meson gives rise to a positively charged electron. The mean life of the heavy meson is known to be 2.6×10^{-8} sec. whereas that of the μ^+ -meson is 2.1×10^{-6} sec. The decay property affords a unique means for the detection of positively charged heavy mesons which was employed in the past by J. Steinberger et al. Previous investigators employed crystals viewed by photomultiplier tubes and identified a positive heavy meson by the delayed coincidence between two pulses separated in time by about 10^{-6} sec. Their electronic counting circuit lacked the necessary resolving power to distinguish with precision between two pulses separated by only 10^{-8} sec. such as those from the π^+ and the μ^+ mesons. The speaker has been sucessful in devising means whereby the resolution of the circuit was improved so that now all three pulses arising from the decay of a π^+ -meson can be detected in delayed coincidence.

This improvement in the overall resolution of the circuit was effectuated by causing a pulse to initiate a fixed delay in the opening of an electronic gate that allows a second pulse to pass by means of a delay line consisting of a cable approximately thirty meters in length. The shortest delay that has been achieved is 1.8×10^{-8}.

The innovation has increased the experimental usefulness of the equipment manyfold by reducing the background of random coincidences. The counting rate of random triple coincidences has been found to be 1/2 per hour for a total counting rate of 350 counts per hour.

Dynamics of the Human Circulation. N. Pace.

Radio-active isotopes provide the first effective instruments for the study of the circulation of blood in the body without necessitating a profound alteration of the system under investigation. Experiments are being carried out to the end of learning the manner of distribution of various materials by the blood and the circulation of the proper components of the blood. The distribution of the following materials is being studied by means of radioisotopes: Na^+, SO_4^{--}, H_2O, and K^+. It is seen that for obvious reasons the simplest and most common ions and molecules are being considered first. The circulation of the blood proper is being studied by labelling erythrocytes with P^{32} or with C^{14}. In order to avoid contamination of the blood by foreign material, about 10cc of blood are withdrawn, incubated with P^{32}, and reinjected into the principal vein of the arm. Samples of blood are withdrawn at frequent intervals from the main artery of the arm which did not receive the injection. The method by which the blood cells are labelled with C^{14} consists of allowing the subject to breathe minute amounts of labelled carbon monoxide.

The graph of Fig. 1 indicates variation of the logarithm of the counting rate with time for blood that was labelled with P^{32}. When this curve is analyzed for rectilinear components to the right of the maximum, it appears that in addition to the long-lived component with a 12 hour half-life, which represents the rate of elimination of P^{32} from the erythrocytes (since the serum contains only 1/1000 of the total P^{32} activity, the remainder lodging in the erythrocytes), there are two components with half-lives 2.5 min. and 30 sec. These components represent the metabolism of P^{32} carried in the blood by as yet undetermined organic systems. It is worthy of note that extrapolation to zero time of the long-lived component gives a measure of the concentration without decay of P^{32} in the sample withdrawn.

The total volume of the blood in the body is then equal to the ratio between the initial concentration of P^{32} and the dilute concentration. When the same calculation is carried out on the basis of the concentration of C^{14} in blood samples one obtains a value that is between 15 and 20 percent higher than the previous one. This discrepancy is explained by the absorption of the hemoglobin in which the radioactive carbon is carried by muscle tissue.

With Na^{+} a half-time of 11 days was found. This agrees with previously determined elimination rates from the blood. Na^{+} and SO_4^{--} (half-time=3.5 hrs.) are taken up into all body cells from the blood. By placing counters over various parts of the body, the absorption rates of these ions in bony tissue were measured. The uptake in bone tallies reasonably well with the loss from the blood. Since water penetrates all cells one does not get decay curves for labelled water that seem to be analyzable into a finite number of components.

By means of the techniques described it will be possible to measure the volume of extra-cellular fluid in the body which varies independently of the intra-cellular fluid volume.

Patients who have circulatory disorders exhibit decay curves that vary markedly from the normal. This may prove to be an important criterion for the diagnosis of circulatory disorders.

High Energy γ-ray Line from π^- Capture in Hydrogen. W. Panofsky.

The curve of Fig. 2 gives the intensity distribution of γ-rays observed when π^- mesons are captured in a hydrogen target. It had been surmised that the two peaks of the curve are due to two separate processes for the production of γ-rays by π^- mesons:

$$\pi^- + p^+ \rightarrow \mu^- + \gamma \qquad 1)$$
$$\pi^- + p^+ \rightarrow \mu^- + \pi^0 \searrow 2\gamma \qquad 2)$$

The first peak was thought to be due to a distribution of γ-rays with a mean energy of 70 Mev arising from the decay of neutral mesons. This would have a spread due to the Doppler effect. The second peak was thought to be caused by mono-energetic γ-rays of energy 130 Mev arising from 2) above, which should have virtually no spread.

By an improvement in the resolving power of the apparatus, the spread of the second peak has been narrowed down considerably so that it now appears that one is actually dealing with a single line at 130 Mev.

The new design of the pair spectrometer that made this improvement in resolution possible is shown in Fig. 3. Sixteen Geiger counters are ranged on each side of the evacuated tank. These counters are viewed by a pair of proportional counters each of which is divided into two measuring volume. A fourfold coincidence in the proportional counters opens an electronic gate that allows a record by means of pens to be made of the firing of the G.M.

tubes. If marks are recorded by two pens actuated by G.M. tubes on opposite sides of the spectrometer, it is possible to calculate the energy of the initiating γ-ray within limits that are due only to radiation losses of the electrons. The technique is applicable with ease only to the high energy region of the spectrum. Here however, a definite peak has been established. By means of it, it was possible incidentally to fix the mass of the π^- meson at $268 \pm 13\ m_e$.

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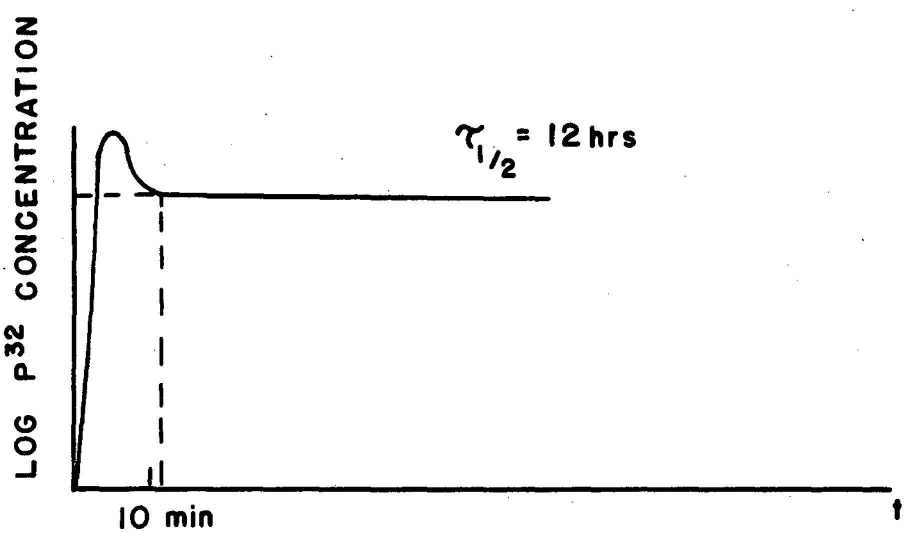
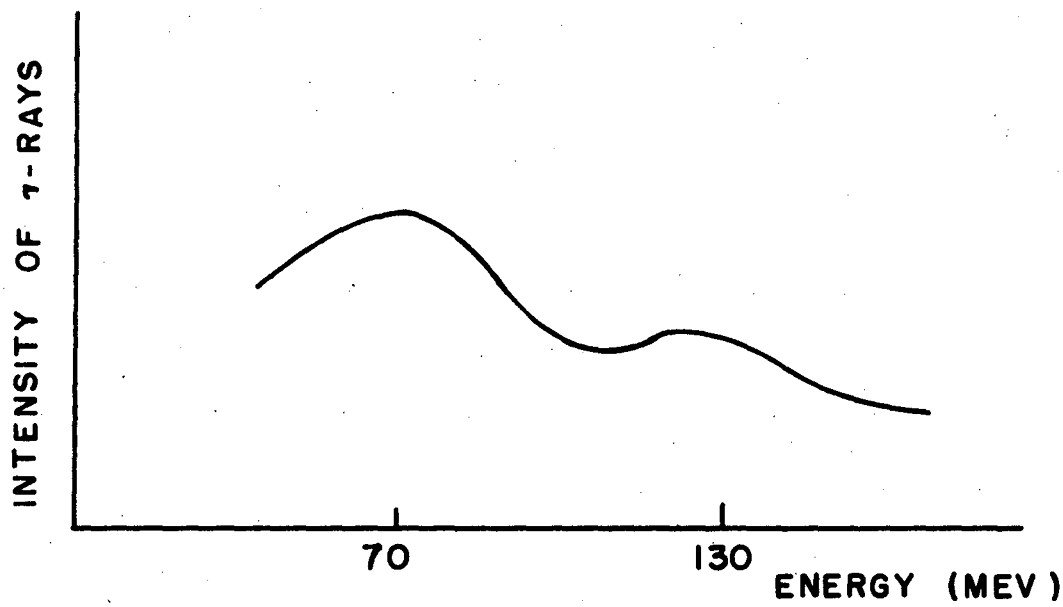


VARIATION OF P^{32} CONCENTRATION IN RED BLOOD CELLS

FIG. 1

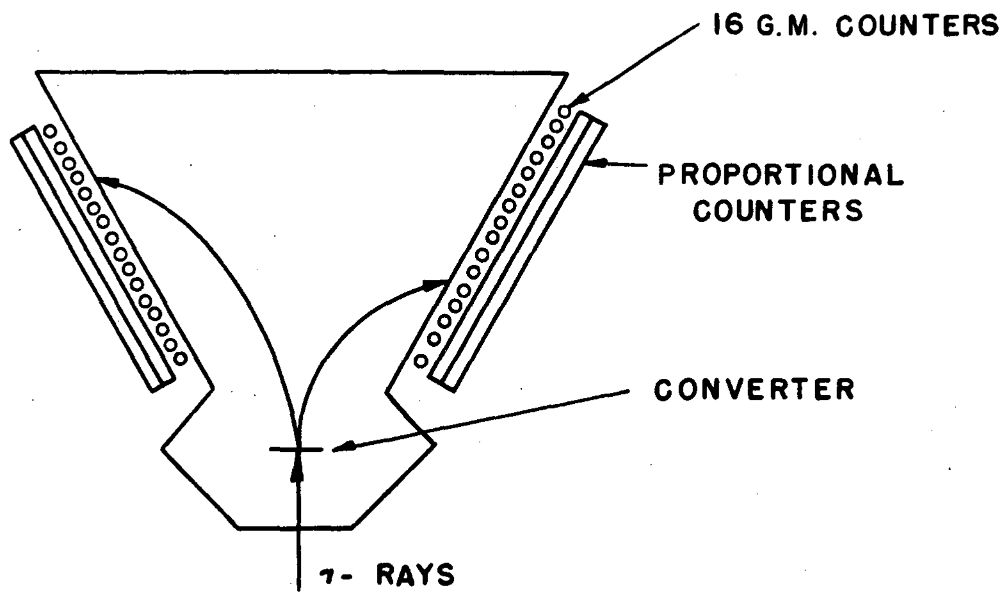
MU 965



VARIATION OF INTENSITY OF γ-RAYS WITH ENERGY

FIG. 2

MU 966



SCHEME OF NEW HIGH RESOLUTION PAIR SPECTROMETER

FIG. 3

MU 967