Crocker Laboratory cyclotron for their cooperation in making bombardments; we also wish to thank Professors G. T. Seaborg, I. Perlman, and B. B. Cunningham for their continued interest and advice.

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[1] We are indebted to Mr. J. G. Conway of this laboratory for spectroscopic analyses.

The Penetration of μ-Meson Decay Electrons and Their Bremsstrahlung Radiation

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MEASUREMENTS of the penetration of the charged particles from the 2.2-μsec. meson decay using the arrangement of counters and delayed coincidence circuits previously described[1] have been extended with absorbers of lead and aluminum, in addition to carbon. The results confirm our previous conclusion that at least a substantial number of particles have an energy >25 Mev. Although detailed analysis of the absorption curves does not seem justified, a soft and a hard component are evident. In lead, for example, the "soft" component is essentially absorbed by about 20 g/cm², and the "hard" one is easily detected after 38 g/cm², where its intensity (~1 count/day) is about ten times the casual rate.

While our results will be published in full later, we report here an investigation of the "hard component." First, the arrangement of Fig. 1 was used to determine whether or not the "hard component" is composed of penetrating charged particles. Mesons stopped in 8.5 g/cm² of graphite are detected by the anticoincidence (*AB–C*). If a decay particle traverses trays *C*, *D*, or *E*, between 1 and 6 μsec. after a meson stops, a delayed coincidence is registered which we designate as $(C)_{del}$, $(D)_{del}$, or $(E)_{del}$. Ordinary coincidence mixers detect the events* $(CD)_{del}$, $(CE)_{del}$, while delayed coincidences of greater complexity are observed by recording all delayed pulses with a ten-pen recorder.

By this technique we have observed that in a run of 103 hr. with 16.4 g/cm² of lead between both *C* and *D*, and *D* and *E*, there were 9 events of the type $(CDE–B)_{del}$, and 10 of the type $(CE–D–B)_{del}$. We expect in the same time about 8 casual $(CDE–B)_{del}$ events, but only about 0.5 casual $(CE–D–B)_{del}$ events. The experiment when repeated using a similar arrangement with 13.6 g/cm² of graphite between *C* and *D* (but lead still between *D* and *E*), gave similar results.** This demonstrates the production of a neutral radiation in the lead or carbon absorbers and indicates that most or all of the "hard component" consists, in fact, of photons from bremsstrahlung by the particles of the "soft component."

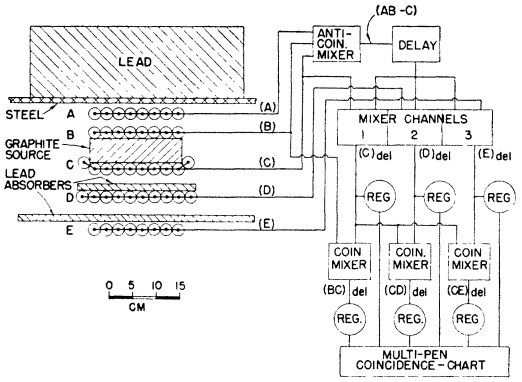

FIG. 1. Experimental arrangement for the detection of bremsstrahlung. Length of counters = 40 cm.

To test further this interpretation, we have compared the intensities of production of the "hard component" in elements of different *Z*, *viz.* carbon and lead. The counter arrangement is shown in Fig. 2, and the circuits are as in Fig. 1. A constant thickness of lead (8.2 g/cm²) is kept above tray *E*, while an 8.2-g/cm² lead absorber and an 11.0-g/cm² graphite absorber are alternated in the two arrangements: (I), *C*–graphite–*D*–lead, and (II), *C*–lead–*D*–graphite, as shown. The rates $(CE–D–B)_{del}$, taken as a measure of the intensity of the "hard component," are given in Table I. The ratio (2.8±0.9) of the number of $(CE–D–B)_{del}$ counts in Case II to that in Case I is consistent with the ratio 2 to 3 to be expected*** if the effect is due to radiation from electrons. In Table I we have also given the $(CD–B)_{del}$ rates, which show that the "soft component" is, in fact, more strongly absorbed by 8.2-g/cm² lead than by 11.0-g/cm² carbon.

Our conclusion that the "hard component" is bremsstrahlung radiation produced by the charged particles of the "soft component" has the following consequences:

(1) The charged particles are indeed electrons, for if they were heavier (2 m_e or more) it would be difficult to account quantitatively for the absolute intensity of the bremsstrahlung radiation, and for the ratio of the intensities of such radiation produced in lead and carbon.

(2) Comparison of measured with calculated intensities of bremsstrahlung indicates that the *average* electron energy is >25 Mev;

TABLE I. Results obtained with the two arrangements of Fig. 2 (corrected for casual events).

Absorber between trays *C* and *D*	Absorber between trays *D* and *E*	Hours of observation	$(CE–D–B)_{del}$/hr.	$(CDE–B)_{del}$/hr.	$(CD–B)_{del}$/hr.
None	None	47	0.11 ±0.05	1.8 ±0.2	5.7 ±0.4
I.—Carbon (11.0 g/cm²)	Lead (8.2+8.2 g/cm²)	392	0.046±0.013	0.02±0.02	1.50±0.07
II.—Lead (8.2 g/cm²)	Carbon (11.0 g/cm²) +lead (8.2 g/cm²)	392	0.13±0.02	0.01±0.02	1.02±0.06

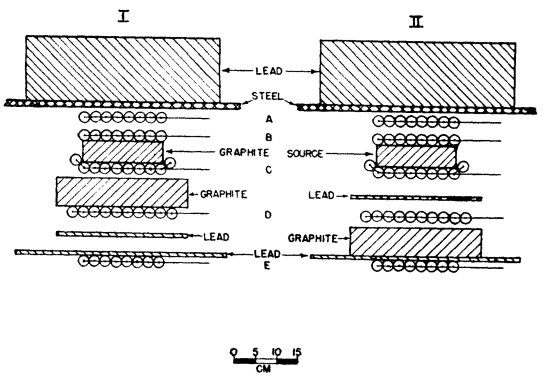

FIG. 2. Two arrangements which were alternated to compare production of bremsstrahlung in carbon (I) and lead (II). For the circuits see Fig. 1.

(3) The presence of bremsstrahlung adds to the difficulties of determining the *maximum* electron energy from absorption measurements;[1] it is clear, however, that to interpret our absorption curves, as well as Steinberger's, there is no need to invoke the presence of electrons of energy >50 Mev.

* The events $(BC)_{del}$ are also recorded and used to cancel some of the *chance* delayed events. Thus if $(CD)_{del}$, $(CE)_{del}$, etc., are accompanied by a discharge of B, they are disregarded: hence the appearance of $-B$ in all the significant rates.

** See also the rates $(CE-D-B)_{del}$ and $(CED-B)_{del}$ in the next experiment (Table I).

*** We have computed the total energy loss by radiation of electrons in the lead and carbon absorbers, as well as the "background" value (constant in both arrangements) of the energy radiated in the brass counter walls of tray C and in the carbon source itself. Assuming that the efficiency of tray E (together with the lead above it) for detecting a photon is proportional to the energy of the photon, the ratio of the $(CE-D-B)_{del}$ rates will be approximately equal to the ratio of the total energies radiated in the two cases.

[1] E. P. Hincks and B. Pontecorvo, Phys. Rev. **74**, 697 (1948); for a similar experiment see J. Steinberger, Phys. Rev. **74**, 500 (1948).

Nuclear Gyromagnetic Ratios of Be^9, Rb^{85}, Rb^{87}, and Cs^{133}

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USING the super-regenerative oscillator techniques described in recent notes,[1] we have observed magnetic resonance absorption by the nuclei Be^9, Rb^{85}, Rb^{87}, and Cs^{133} in aqueous solutions of salts. Preliminary results for the gyromagnetic ratios and magnetic moments of these nuclei are listed in Table I and within our present limits of accuracy are in fair agreement with previous results obtained by molecular beam methods.[2-4] It should be pointed out that our preliminary values are based on flux meter measurements of the magnetic fields; the flux meter was calibrated in terms of the proton resonance and we believe the values listed in Table I are accurate to one part in 300. In every case the observed resonance peak was considerably narrower than the corresponding peak obtained in molecular beam experiments. We plan to attempt to improve the accuracy of our results by making simultaneous measurements of the resonance frequency for each nuclear species and the resonance frequency for the proton in the same magnetic field.

One or two remarks about the observed resonance peaks may be in order. The Be^9 peak as observed for a solution of $BeCl_2$ is quite strong, and no difficulties are anticipated in making the proposed direct comparison with the proton peak. An interesting result of our studies of rubidium is that the intensity of the peak observed for the less abundant isotope Rb^{87} is greater than that of the peak observed for the more abundant isotope Rb^{85}. The peak observed for Cs^{133} was weak, and considerable difficulty is anticipated in making the direct comparison with the proton peak.

TABLE I. Preliminary results for gyromagnetic ratios and magnetic moments.

Nucleus	Gyromagnetic ratio g	Spin	Magnetic moment μ
Be^9	0.783	—	—
Rb^{85}	0.536	5/2	1.34
Rb^{87}	1.83	3/2	2.74
Cs^{133}	0.734	7/2	2.57

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[2] P. Kusch, S. Millman, and I. I. Rabi, Phys. Rev. **55**, 666 (1939).
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The Chain $_{56}Ba^{130}(n,\gamma)_{56}Ba^{131}\rightarrow_{55}Cs^{131}\rightarrow_{54}Xe^{131}$

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THE above chain was studied by Katcoff[1] who made the mass assignment of the chain, determined the half-lives, and studied some of the radiation characteristics of the members. Fu-Chun Yu, Gideon, and Kurbatov[2] examined the disintegration schemes of the members of the decay chain. Katcoff gives the decay of Cs^{131} (10.2-day half-life) as occurring by orbital capture, without γ-ray emission. Kurbatov *et al.* find a half-life of 10 ± 0.3 days in fundamental agreement with that of Katcoff. However, they also find an intense radiation of electrons of 112 kev which were identified as conversion electrons of a 145-kev γ-ray emitted by Cs^{131} and estimate its conversion to be about 97 percent. Finkle[3] found that neither Ba^{131} nor Cs^{131} emits positrons.

During the course of irradiation of natural barium we had occasion to examine the above chain. The barium was removed from the cesium by five carbonate precipitations