Title
SUMMARY OF THE RESEARCH PROGRESS MEETING OF AUGUST 3, 1950

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of August 3, 1950

Henry P. Kramer

October 20, 1950

Berkeley, California

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Deflected Beam Energy by Cerenkov Radiation. R. Mather.

Cerenkov radiation, electromagnetic radiation in the range of visible light that is associated with the passage of a fast moving charged particle through matter, was first observed in 1934 and later explained as an electromagnetic shock wave formed whenever the speed of light in the medium is less than the speed of the charged particle. A velocity vector diagram, Fig. 1, yields the direction of motion of the shock front with respect to the direction of the charged particle: $\cos\theta = 1/n\beta$, where n is the index of refraction of the medium, and β is the speed of the charged particle relative to light.

The first observation of Cerenkov radiation produced by high energy protons was made at this laboratory about a year ago by means of a thin strip of film. The apparatus was then refined by the inclusion of a spherical mirror. The present apparatus, shown schematically in Fig. 2, consists of a sheet of glass inclined to the beam direction at an angle $\pi/2 + \theta$ whose aluminized rear surface reflects the Cerenkov radiation produced in it through a prism into a camera onto a film. The film is calibrated by means of markings originating from an illuminated scale. The optical system was carefully aligned by using the green mercury line as a standard and superimposing cross hairs on their twice reflected image in the plane of the photo plate. The index of refraction n of the glass was measured by observing the angle of minimum deviation. The prism was ground from the same batch of glass as the reflecting sheet.

The direction of the deflected proton beam was determined by the method of flexible, conducting wires. An exposure indicating a beam energy of 345±1.0 Mev is shown in Fig. 3. The uncertainty in Θ which brings about the uncertainty of 1 Mev. in the measurement is analyzed as follows:

Type of Uncertainty	ΔΘ
chromatic	± 3'
scattering	±19'
attenuation	± 3'
divergence of beam	± 7'
diffraction	± 3'
Beam Energy Spread	±21' ∼ 1 Mev.

Energy Levels of Pb^{207}. H. Neumann.

Some information has been obtained regarding the nuclear excitation levels of Pb^{207} by observing the electron radiation from a mixture of Bi^{207} and Bi^{208} produced by deuteron bombardment of lead. The following considerations lead to the conclusion that electron radiation from Bi^{208} does not contribute to the spectrum of the mixture and that, therefore, electron radiation from the mixture can be exclusively attributed to transitions between nuclear energy levels of Pb^{207}. The energy made available in the transition from Bi^{208} to Pb^{208} was estimated from other decay energies and neutron binding energies to be 2.5 ± .3 Mev. The lowest known excited level, and probably the lowest, of the Pb^{208} nucleus is 2.62 Mev. The energy released in the decay may therefore be sufficient at most to leave the Pb^{208} nucleus in its lowest excited state. Hence, the only γ-ray which may possibly come from Pb^{208} is one at 2.62 Mev. corresponding to the isomeric transition to the ground state. This hypothesis was tested by comparing the electron spectrum from the Bi^{207}-Bi^{208} mixture with that of a sample of Bi^{207} grown by α-decay from At^{211}. The spectra were found to be practically identical thus supporting the notion that the only radiation emitted by the Pb^{208} present in the mixture consists of soft x-rays whose conversion electrons are easily distinguished from those produced by γ-rays, and possibly of much harder γ-rays than those with which the measurements were concerned. The results of the β-spectroscopy are shown in Table 1 together with the corresponding γ-ray energies and relative intensities.

Further evidence about the energy levels of Pb^{207} was obtained by analyzing the α-radiation emitted by Po^{211} in decay to Pb^{207}. Four α-groups were observed:

α-energy (Mev)	Rel. Intensity (%)	Corresponding Pb^{207} Levels (Mev)
7.43	98.8	
6.90	0.6	0.54
6.57	0.5	0.88
6.34	0.08	1.11

The corresponding Pb^{207} levels above were calculated from the cycle shown in Fig. 4 where the decay energy At^{211}-Po^{211} was estimated by empirical correlation to be 0.8 Mev. Taking 5.9 Mev. for the energy of the At^{211} α-ray and 7.5 Mev. for the Po^{211} α-ray one arrives at an estimate of 2.4 Mev. for the energy of the transition Bi^{207}-Pb^{207}. Thus it appears that the highest state observed in these experiments corresponds to the highest state in which the Pb^{207} nucleus may be left by the decay of Bi^{207}. A tentative level diagram constructed on the present evidence is shown in Fig. 5. Workers at MIT have found two levels at .9 and 2.7 Mev.

Theory of π^- Absorption in Hydrogen. K. Brueckner.

On the basis of an experiment by W. Panofsky in which he observed competition between the two processes:

$$\pi^- + p^+ \longrightarrow n + \pi^0 \nearrow 2\gamma$$
$$\pi^- + p^+ \longrightarrow n + \gamma$$

and was able to arrive at the ratio of the relative probabilities of these processes, the speaker has constructed the transition matrix that specifies the final states of nucleons and mesons. The theory has yielded this ratio in better approximation than other existing theories. It will be subjected to a further test by an experiment on the capture of π^- mesons in deuterium. A complete discussion of the calculations is set forth in UCRL-856, "The Analysis of π-meson Production in Nucleon-Nucleon Collisions". K. M. Watson and K. A. Brueckner.

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e^- Energy (Mev)	Corresponding γ-ray Energy (Mev)	Corresponding γ-ray Rel. Intensity
0.049	0.137 or 0.064	0.106
0.062	Auger electrons	0.050
0.477	0.565 (K)	0.07
0.551	0.565 (L)	0.0084
0.975	1.063 (K)	0.37
1.050	1.063 (L)	0.084
1.37	1.46 (K)	0.0114
1.46	1.46 (L)	0.0044
1.96	2.05 (K)	0.0014
2.11	2.20(K)	0.0005
2.24	2.33 (K)	0.0014
2.40	2.91 (K)	0.0016

Table 1
(Rel. Intensities Normalized with Auger electron Intensity=0.05)

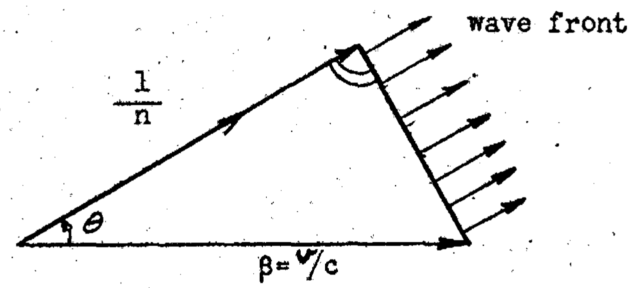
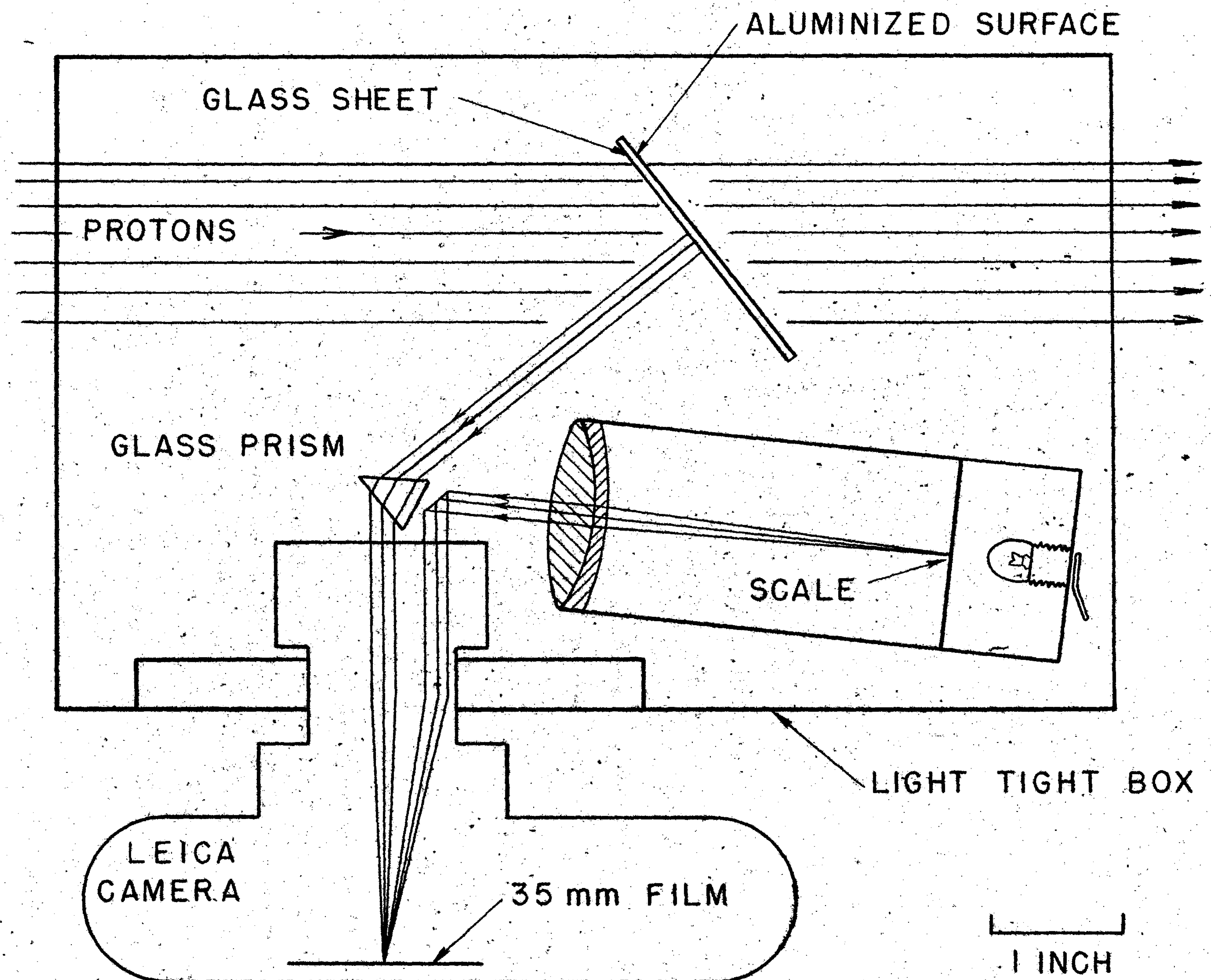


Fig. 1
Vector Diagram for Cerenkov Radiation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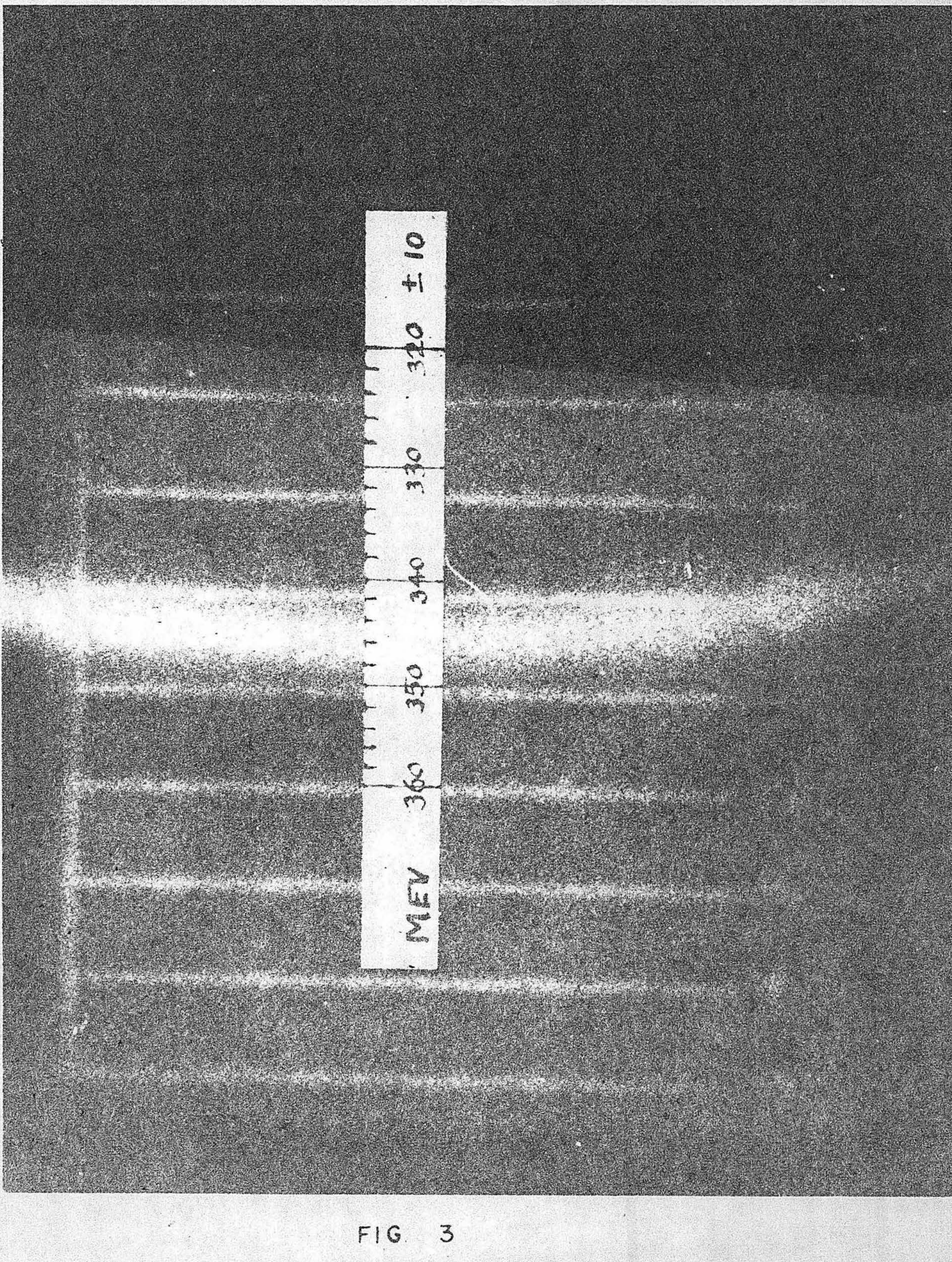

FIG. 3

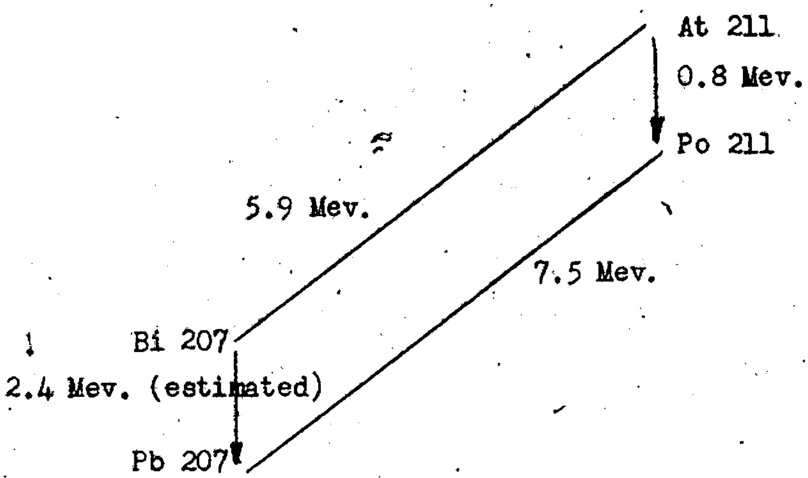

Fig. 4
Closed Energy Cycle

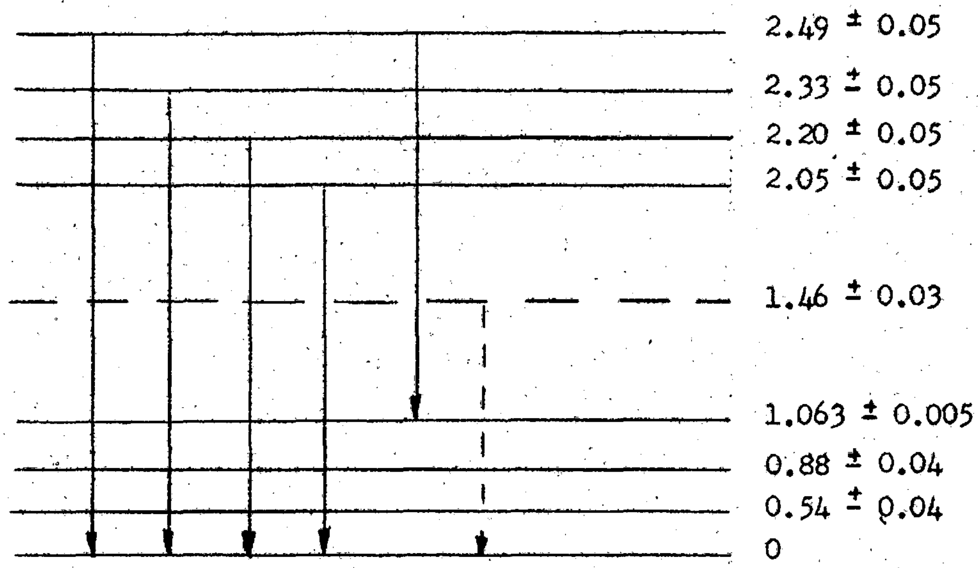

Fig. 5
Tentative Energy Level Diagram for the Pb^{207} Nucleus