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December 7, 1951

Berkeley, California

SUMMARY OF RESEARCH PROGRESS MEETING OF OCTOBER 11, 1951

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I. Cerenkov Counters. By R. Birge.

This Cerenkov counter is similar to the one developed by Gedding in 1947. The main objective is to be able to reduce the error due to the background of stray scintillations caused by the incident particle and so to measure only the Cerenkov radiations. Fig. 1 shows schematically the characteristics of Cerenkov radiation.

If the counter is in the shape of a clindrical pipe and the value of particle β is close to one, the Cerenkov angle is close to the critical angle, which fact then causes the Cerenkov radiation to fall outside the pipe: as shown in Fig. 1.

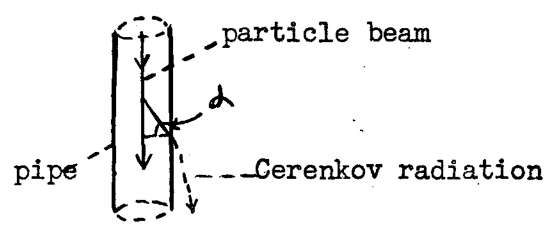
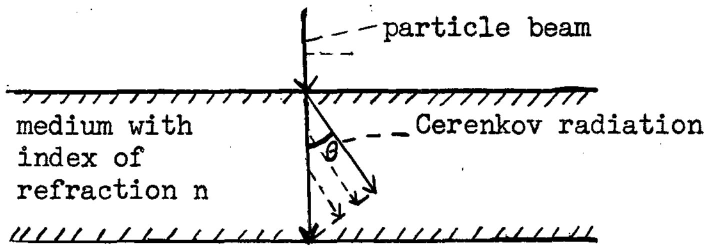


Fig. 1

In this case $\sin \alpha = \frac{1}{p}$ which is equal to $\cos \Theta$ in Fig. 2 where Θ is the Cerenkov angle and β equals one. The solution is to use a conical pipe whose sides are at an angle equal to the critical angle so as to reflect all of the Cerenkov radiation. Fig. 3 shows the shape of such a cone and the path of the Cerenkov radiation. It is to be noted that a cone shaped like this would also focus much of the scintillations produced by the particle in the lucite obscuring the weaker Cerenkov radiation. Since the major part of the scintillations pass through the central portion of the lens, it was decided to cut out the central portion as shown in Fig. 4 and to run an experiment. An experiment was made using an e⁻ particle beam from a .020" Ta film strip which gave a 7 percent conversion of its α particles into e⁻. The counter was calibrated against a known standard and the results indicated a fairly high efficiency.



$$\cos\theta = \frac{1}{n\beta}$$

if $\beta = 1$,

$$\cos\theta = \frac{1}{n}$$

Figure 2.

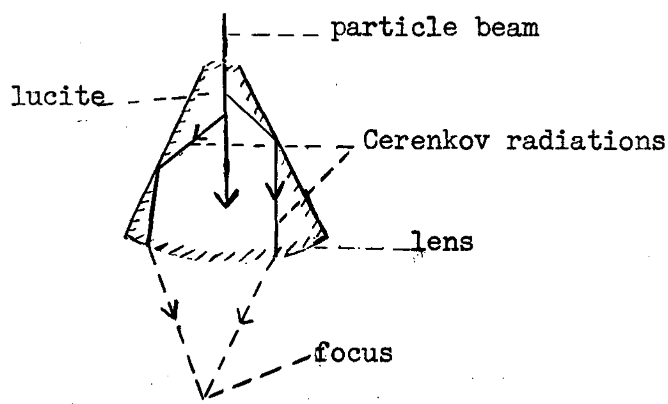


Figure 3.

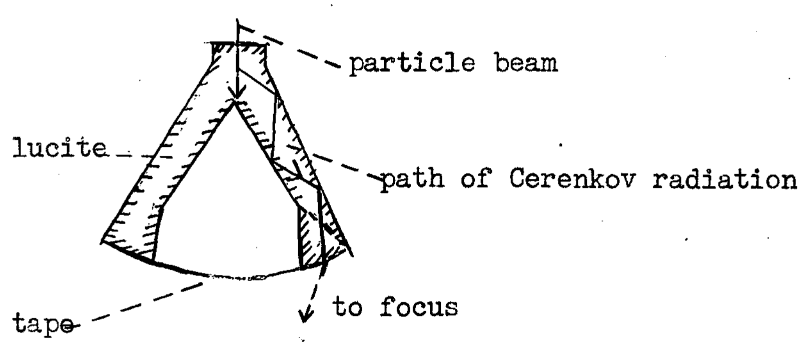


Figure 4.

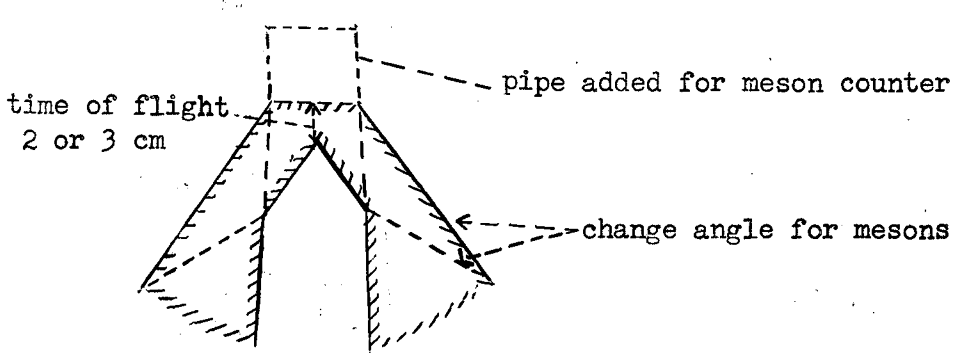


Figure 5.

Fig. 5 shows another shape that was tried. Here it was hoped to reduce scintillation in the lucite by limiting the time of flight of the particle in the central portion. However, the resulting aberrations were considerable. This shape it is suggested could be altered to count mesons by including a cylindrical portion as indicated and changing the angles of the cone so that electrons would be permitted to fall outside and thus escape being counted together with the mesons.

II. <u>New Results in European Laboratories</u>. By W. H. Barkas.

The Imperial College, Birkbeck College of the University of London, and the university at Bristol were visited and the work principally with nuclear emulsions was discussed. Some rare and interesting events were seen relative to tau and kappa mesons. At Bristol the tau meson is believed to be certain.

At the Imperial College an event was found where a heavy particle produced a star with three coplanar tracks. See Fig. 6. The direction of the track made by the heavy particle was not known for certain but assumed to be forward as indicated. The momenta of the three resulting particles in the plane appeared to be balanced provided they were of same mass. If the three particles are π mesons, then they give a mass of 960 for the heavy particle. In earlier work at Bristol one event had been seen where one of the secondary particles itself decayed into a star, as Fig. 7 shows. Powell obtained the value of 966 ± 8 for all such heavy particles. Only five cases have been found, all at high altitudes.

Another event at Bristol showed a heavy particle apparently decaying into a μ meson. See Fig. 8. The heavy particle track had a range of 6150 microns and resembled that of a proton. The μ meson track had a range of 1098 microns and decayed to that of an electron. This track looks a little like a π meson decay in flight except that it is going in a wrong direction. Another event with about the same mass particle gives a minimum ionization track of 250 Mev, if interpreted as an electron. O'Ceallaigh estimated the mass in this case to be 1320 $\pm$ 170. All these events seem to be going upward in space. They have a short life span of about 10^{-9} seconds. It was argued that those going down decay in flight and that there is a much better probability of their stopping and being caught in the emulsions when going upward. The emulsions used were G - 5.

O'Ceallaigh also studied spectra of $e^{\pm}$ from μ decay. They are like those of Sagane and Hubbard here, but have a high energy tail running up to 100 Mev. This could be explained through direct decay of π mesons into electrons but this is doubtful. There are less than 1% like this. Perhaps negative mesons give a tail and positives do not.

At Bristol they also studied charges on cosmic ray primaries. In the U. S. no primaries between He and C have been found. Fowler's results are at variance with this. In England these have been measured by small angle scattering techniques. There is increasing use being made of small angle scattering and δ ray techniques in Europe.

At Lund, Von Friessen and Kristiansson have photometered the tracks and separated the background to make grain density measurement strictly objective. They didn't get the results expected from a comparison of the π and μ tracks of the same velocities. According to theory, tracks should look the same for the same charge and velocity. They do not find this to be true. Barkas has exposed some proton and other charged particle tracks for them to study this.

A few new things in nuclear emulsions have been devised by Ilford and Occhialini. These are cloud chamber-like emulsions with fine Pt wires stretched and embedded in them. There is remarkably little absorption by the Pt wire. There is no appreciable distortion 30 microns away from the wires. One can see pairs produced and other nuclear events when particles strike the wires.

They have improved on eradication of emulsions by subjecting them to rougher treatment than we do. The temperature is run up higher and the heating is for a longer time. The emulsion still clings and apparently the grain density is not affected.

Some aspects of the Guerney-Mott theory of latent image formation have been undermined concerning the mobility of Ag ions in a lattice. By using an electric current it has been shown that the Ag conductivity must go via surfaces of crystal planes, producing beautiful "Xmas tree" deposit patterns of Ag in certain planes. Hence, the photographic process is now believed to be almost entirely a surface phenomenon, wherein the conditions are determined by the interface between gelatin and crystal face.

Figures not included in this report:

Figure 6.

Photograph taken of illustration on page 1061, "The Philosophical Magazine", Vol. 42, Seventh Series, No. 332, Sept. 1951, printed and published by Taylor & Francis Ltd., Red Lion Court, Fleet St., London, E.C.4. Article: "The τ-Meson". By P. E. Hodgson, pp 1060-61.

Figure 7.

Reproduction taken of photograph facing page 1048, "The Philosophical Magazine", Vol. 42, Seventh Series, No. 332, Sept. 1951, printed and published by Taylor & Francis Ltd., Red Lion Court, Fleet St., London, E.C.4. Article: "Masses and Modes of Decay of Heavy Mesons.- Part II. τ-Particles." By P. H. Fowler, M. G. K. Menon, C. F. Powell and O. Rochat. pp 1040-49.

Figure 8.

Reproduction taken of photograph facing page 1039, "The Philosophical Magazine", Vol. 42, Seventh Series, No. 332, Sept. 1951, printed and published by Taylor & Francis Ltd., Red Lion Court, Fleet St., London, E.C.4. Article: "Masses and Modes of Decay of Heavy Mesons.- Part I. K-Particles." By C. O'Ceallaigh. pp 1032 -39.

III. Meson Production in Nuclei by Protons. By E. Henley.

The details for this talk are to be found in UCRL-1467 by Ernest M. Henley, September 11, 1951. An abstract of this report is as follows:

"The meson production cross section for protons incident on nuclei is formulated in terms of two particle transition rates and the struck nucleon momentum distribution in the nucleus. Three different momentum densities are assumed. They are a modified Chew-Goldberger, a Gaussian, and a Fermi distribution. With these, it is attempted to fit the experimental π^+ and π^- meson spectra obtained by bombarding C^{12} with 345 Mev protons. The effect of the exclusion principle is estimated on the basis of a single particle model for the nucleus. Meson reabsorption and scattering, after production, are also taken into account, but only roughly. The calculations show that the Gaussian distribution approximates nuclear conditions best, and that the fundamental proton-neutron and proton-proton production transition matrices are most probably not equal."

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