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SUMMARY OF THE RESEARCH PROGRESS MEETING OF MAY 10, 1951

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September 11, 1951

Berkeley, California

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I. Investigation of Some Nuclear Reactions. H. D. Sharma.

The reactions (d, γ), (α, γ), (α, 2p), (d, 2p), (α, α2p) and (p,4p) have been studied in the 60- and 84-inch cyclotrons. A theoretical derivation for their cross sections, based on a statistical model and experimentally found cross section values, is presented in UCRL-1265.

II. Excitation Functions of Deuterons and Protons on Mg. S. D. Softky.

Two years ago the spallation products from deuteron bombardment of Cu were studied (see UCRL-757), but the bombardment energies were so high that one could not say definitely what reactions were occurring. Therefore, the aim in more recent work has been to investigate reactions with thresholds so low that only one reaction was highly probable. Mg isotopes were chosen for this study and they were bombarded with deuterons in the 60-inch cyclotron and protons in the linear accelerator. Greatest attention was given to the Mg^{24} (d, 2α)F^{18} reactions. Threshold values are given in Table I. The target form made no difference in the results since it was found that the excitation curves were the same for thin foils and powder pellets. Details and curves for several of the reactions are shown in UCRL-1357. Since the Mg was quite pure, the results are not due to contaminants.

III. New Measurements on Meson Decay Energetics and Developments in Emulsion Techniques. W. H. Barkas.

New experiments have been made on the π/μ mass ratio and the absolute momentum of the μ from the decay of a π at rest. The μ mass was determined by comparison with the π mass with a method like that shown in Fig. 1 where the proton is used as the comparison particle. According to this theory the range is linearly dependent on the momentum (Fig. 2) and if the range ratio of the two particles is equal to their momentum ratio, their velocities must be equal and therefore the ratio must be also the mass ratio. Fig. 3 shows the curve for π/μ vs $P_o/\mu C$. On this basis the following values have been calculated:

$$\pi = 276.1 \pm 2.3 \text{ electron masses}$$

$$\mu = 209.6 \pm 2.4 \text{ electron masses}$$

$$\pi - \mu = 66.46 \pm 0.16 \text{ electron masses.}$$

See UCRL-1285 for further discussion and also UCRL-1275 (Abstract)

The law of grain density has been studied the last few years in order to determine n (= No. of grains per micron) and its relationship to ionization and rate of energy loss. Results to date indicate that n is a function of ionization only ($n = f(e)$) and when the grain density is small it is proportional to the energy loss ($n = \lambda e$). Furthermore n approaches saturation as the rate of energy loss increases. Therefore one expects that $dn = 1(n_o - n)de$ and $n = n_o(1 - \epsilon)^{\lambda e}$, where n_o is the number of grains threaded by the particle per unit path $\simeq 3$ grains/μ, and λ is expressed in grains/Kev. This law agrees quite well with observed characteristics.

Fig. 5 illustrates the grain density-energy loss relationship. Alpha particles and protons define essentially the same locus in the emulsion. The grain density is proportional to the rate of energy loss when the grain density is low.

Another problem studied by the Film Group has been the peeling of the plates caused by humidity changes. One solution would be to imbed the plates in polystyrene, thus keeping the humidity presumably constant. At Columbia this problem is dealt with by washing and fixing the plates in cold water, gradually diluting the fixer. The plates are then placed in a 2 percent glycerine bath and dried slowly, surrounded by other plates.

In order to make accurate measurements, it is necessary to know the shrinkage factor of the emulsion. This was found by casting the shadow of a uranium strip on the plate with x-rays (Fig. 4). The emulsion thickness can then be measured with a microscope.

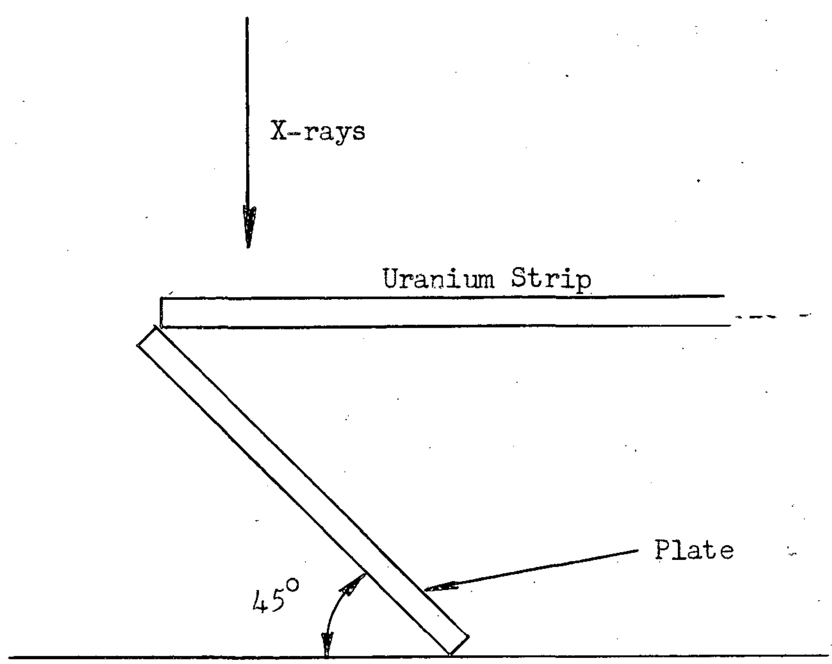


Fig. 4

MESON TO PROTON MASS RATIO CALCULATION

R, P	Range and Momentum of Particle of Calculated Mass M (Proton Mass = Unity)
R_P, P_P	Proton Range and Momentum

A. $R/M = f\left(P/M\right)$

(General relation)

B. $R/M = C\left(P/M\right)^q$

(An approximate relation with $q \approx 3.44$ and C a constant of the emulsion - valid for large range of R and P)

C. $C = RP/P_P{}^q$ (for average proton)

D. $M^{1-q} = \left(\frac{P}{P_P}\right)^{-q}\left(\frac{R}{R_P}\right) = C\,R/P^q$

E. ERROR IN METHOD:

If momentum ratio, P/P_P, is $M_o + \delta$ rather than the true mass ratio, M_o, and if q is $q_o + \epsilon$ rather than the correct exponent q_o, then the apparent mass ratio M will be in error as follows:

$$\frac{M - M_o}{M_o} = \frac{\epsilon}{q_o - 1}\ \frac{\delta}{M_o}\ \left(1 - \frac{\epsilon}{q_o - 1} - \frac{\delta}{2M_o} + \ldots \text{ terms of higher order}\right)$$

For $\frac{\delta}{M_o} \leq .05$, $\overline{\delta/M_o} \leq .01$, $\overline{\left(\delta/M_o\right)^2} \leq .001$, $\epsilon \lesssim .1$:

$$\frac{M - M_o}{M_o} \leq .002 \pm .0001 \pm .00005,$$

and the average error will be :

$$\overline{\frac{M - M_o}{M_o}} \leq .0004 \pm .00002 \pm .00002$$

Fig. 1

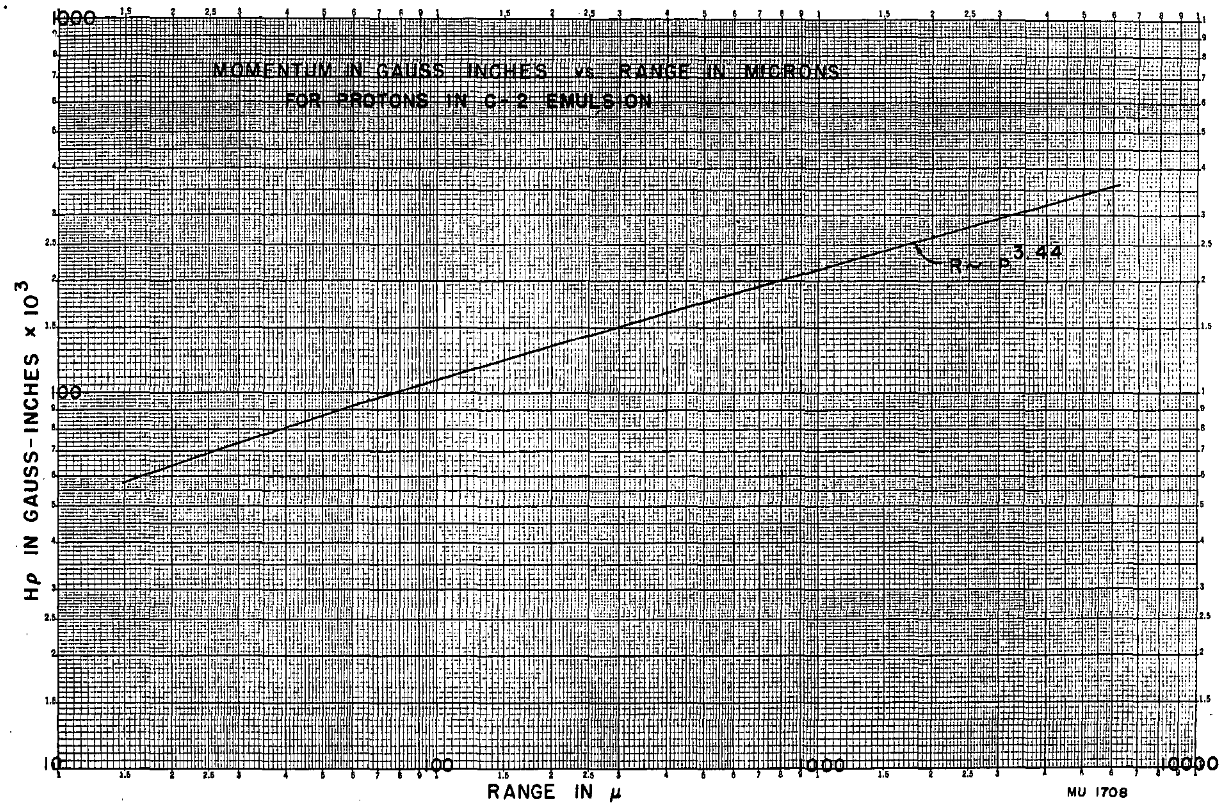
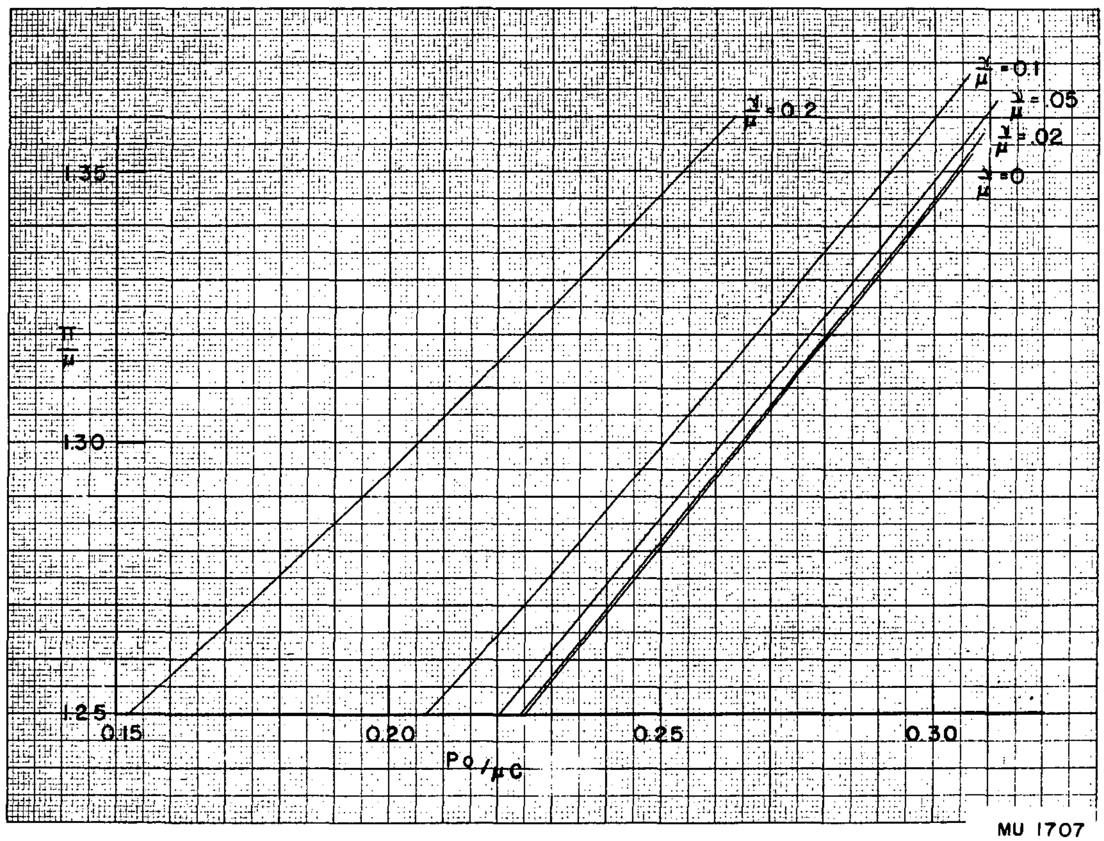
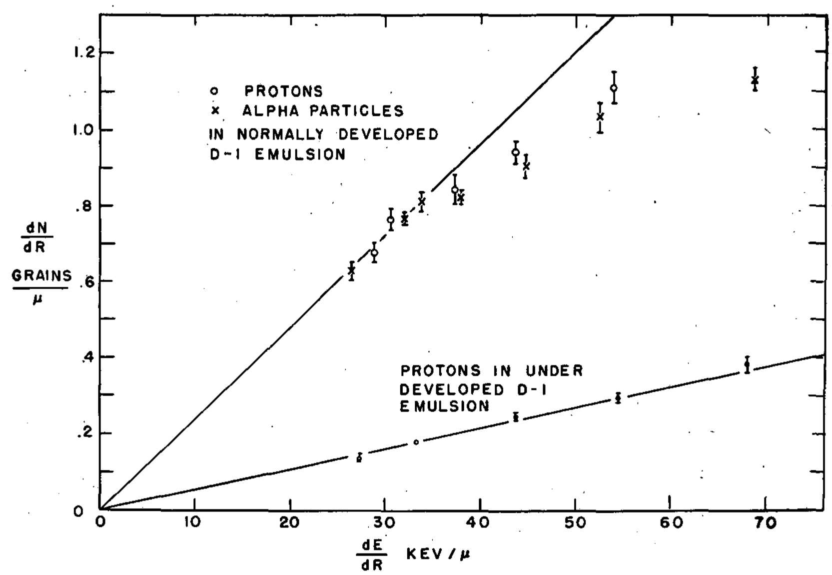

MOMENTUM IN GAUSS INCHES vs RANGE IN MICRONS
FOR PROTONS IN C-2 EMULSION
R ~ P^3.44
Hρ IN GAUSS-INCHES × 10^3
RANGE IN μ
MU 1708

Fig. 2



$\frac{\nu}{\mu}$ = 0.1
$\frac{\nu}{\mu}$ = .05
$\frac{\nu}{\mu}$ = .02
$\frac{\nu}{\mu}$ = 0
$\frac{\nu}{\mu}$ = 0.2
1.35
$\frac{\pi}{\mu}$
1.30
1.25
0.15
0.20
0.25
0.30
Po / μc
MU 1707

Fig. 3



PROTONS
ALPHA PARTICLES
IN NORMALLY DEVELOPED
D-1 EMULSION
PROTONS IN UNDER
DEVELOPED D-1
EMULSION
dN/dR
GRAINS/μ
dE/dR KEV/μ
0
.2
.4
.6
.8
1.0
1.2
10
20
30
40
50
60
70

Fig. 5