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Radiation Laboratory

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SUMMARY OF THE RESEARCH PROGRESS MEETING OF APRIL 12, 1951

Bonnie E. Cushman

September 11, 1951

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Berkeley, California

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I. <u>α Decay Rates for Rare Earth α Emitters - J. Rasmussen.</u>

Investigation of the rare earth α emitters has continued (see UCRL 863). The decay constants have been calculated by several theoretical methods using $\lambda = \lambda_o P$ and compared with experimental values (Table I; λ_o is the hypothetical decay constant, P the probability of penetration through the potential barrier, r_o the nuclear radius ($R = (r_o A^{1/3} + a)10^{-13}$ cm), a the width of the potential well for α decay). Even-even nuclei were used in the calculations because of more regularity in decay. Odd-odd isotopes should have a longer half-life then is calculated, but this prediction is not borne out in the case of Sm^{147}; the Gd and Eu results are fairly good, however. Apparently the energy dependence assumed is wrong; for Sm^{147} the rapid decay rate might be explained by considering its quadrupole moment. Bethe's theory gives a longer decay time because of the probability factor of forming the α particle. It can be improved by putting in a proportionality factor relating to the variation in level spacing from light to heavy elements. The experimental radius values were determined independently of α cross sections in separate α decay experiments; a was chosen to give the best fit in the heavy elements and then extrapolated to the rare earth region. The Perlman values are in best agreement with the observed data.

II. <u>Production of π^+ Mesons in C^{12} - E. Henley.</u>

Huddlestone and Henley have applied the Watson-Breuckner analysis of meson production in free nucleon-nucleon collisions to cross section data obtained by Richman and Wilcox. This analysis indicates that the majority

of the mesons produced exist in p-states; therefore in the present work s-state mesons were not considered because of lack of knowledge, and contributions to the corss section from deuteron formation were neglected. Results indicate that the spectra of high energy mesons are dependent quite sensitively upon the assumed momentum distribution. See UCRL-1219 for a complete report.

III. Photomesons from Beryllium - H. Medicus.

Photomesons from Be have been studied with the same method used by Peterson with carbon, but whereas the C nucleus is symmetrical, that of Be is not with the result that neutrons are easily obtained from this element. Mesons were detected at 90° with photographic emulsions (see Fig. 1 for arrangement) and the ratio π^-/π^+ was determined by observing the number of stars (π^-) and $\pi^+ - \mu$ decays in the same region of the plate; only emulsions with a high density of mesons were scanned. Assuming a 10 percent loss from $\pi^+ - \mu$ decay, the results for three energy regions are as follows:

E	π^-/π^+
30-40 Mev	2.5 ± 0.6
40-55	2.0 ± 0.3
55-70	2.2 ± 0.3

The ratio seems to be independent of the energy. See also UCRL-1154.

Table I

Treatment (for 6 Mev α)	One Body Perlman Ypsilantis	One Body Kaplan	Many Body Experimental Radius	Many Body Bethe
λ_o (sec^{-1})	$\sim 10^{21}$	$\sim 10^{20}$	$\sim 10^{19}$	$\sim 10^{15}$
r_o	1.48	1.57	1.43	2.05
a	0	0	1.48	0
$T_{1/2}(Exp)/T_{1/2}(Theo)$				
Gd^{148}	2		0.9	1/23
Eu^{147}	1/2.5		1/3.7	1/68
Sm^{147}	1/12		1/2.7	1/1100

Element	Experimental Half-Life	α Energy	Partial α Half-life
Gd^{148}	> 30 Years	3.21 ± 0.03 Mev	~140 Years
Eu^{147}	26 Days	2.92 ± 0.05	~6000 Years
Sm^{147}	$\sim 1.35 \times 10^{11}$ Years	2.18	$\sim 1.35 \times 10^{11}$ Years

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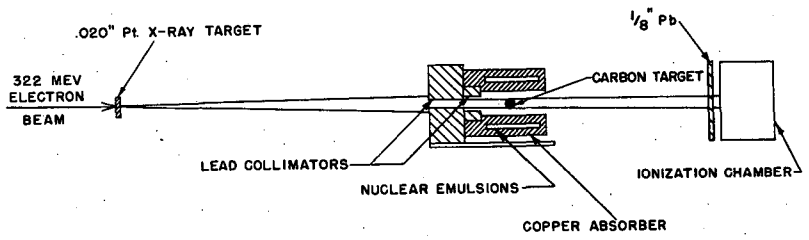

EXPERIMENTAL ARRANGEMENT

Fig. 1