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SUMMARY OF THE RESEARCH PROGRESS MEETING OF MAY 31, 1951

Bonnie E. Cushman

September 12, 1951

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Berkeley, California

SUMMARY OF THE RESEARCH PROGRESS MEETING OF MAY 31, 1951

Bonnie E. Cushman

Radiation Laboratory, Department of Physics
University of California, Berkeley, California

September 12, 1951

I. Scattering and Absorption of Mesons. K. N. Watson.

Work at Cornell, Columbia and Berkeley on meson scattering and absorption was compared.

Identical results were obtained at Cornell for both π^- and π^+ scattering by carbon. 45 ± 10 Mev mesons were studied. 13,000 traversals yielded data which was divided into two groups: (1). 85 nuclear events (n) including absorption, all scatterings at $\theta > 75^\circ$ and inelastic scatterings at $\theta < 75$; and (2) 25 diffraction scatterings (d) - elastic scattering with $25^\circ > \theta > 75^\circ$. The results, analyzed with the theory of Fernbach, Serber and Taylor, are

$$\sigma_n = (0.66 \pm 0.06)\pi R^2; \qquad \lambda = (2.6 \pm 0.06)a_o$$

$$\sigma_d = (0.26 \pm 0.06)\pi R^2; \qquad \lambda = (2.2 \pm 0.05)a_o$$

$$\lambda_{ave} = 2.4a_o$$

a_o, the mean spacing in the nucleus, is taken as 1.37×10^{-13}cm.

At Columbia 85 Mev π^- mesons from a number of elements from Li to Pb were studied. Results were as follows:

$$\sigma_H = 1.33 \times 10^{-26}\text{cm}^2$$

$$\lambda_s = v_A/A\sigma_H = 6.3a_o \qquad \text{leading to}$$

$$\sigma_n = 0.38\pi R^2 \qquad \text{and}$$

$$\sigma_d = 0.04\pi R^2 \qquad \text{if the events defining } \sigma_n \text{ and } \sigma_d$$

are the only things happening. With the heavier elements $\sigma_n + f\sigma_d$ should be measured. Furthermore $1/\lambda = 1/\lambda_s + 1/\lambda_a$ and $\lambda_a = 4a_o$.

The data of Richman and Skinner give $d\sigma/d\Omega = 0.6\pi R^2/4\pi$ and on the basis of the above half would be diffraction and half scattering.

Cornell $\lambda = 2.4a$

Columbia $\lambda_s = 6.3a$

U.C. $\lambda_a = \sim 4a$

The work done by Panofsky et al when compared with Steinberger's value suggests that σ increases with energy:

$$\pi^- + p \rightarrow n + \gamma$$
$$\searrow n + \pi^0$$

$$\frac{T_p^{\gamma}}{T_p^{\pi^0}} \sim 1 \text{ and } \sigma_{\pi^- \rightarrow \pi^0} \simeq 1.4 \times 10^{-27} cm^2$$

$$\sigma \sim 1.3 \times 10^{-26} cm^2 \quad \text{(Steinberger)}$$

Other work by this group gives probably an upper limit for λ_a by looking for the gamma ray produced when $\pi^- + C \rightarrow$ star and deducing

$$\lambda_a = V_a/Z(\sigma/Z)(\pi^- + A \rightarrow \text{star}) \leq 5.5a$$

The lower limit is $\lambda_z > a_o - Za_o$ from work by Steinberger and Mozley.

II. <u>Structure and Mass Spectral Patterns of Molecules. A. Newton.</u>

Mass spectrographic work on organic compounds has been developed along two lines: (I). Analysis of organic mixtures and more recently, (2). the correlation of what happens in a mass spectrograph (where the material is ionized by electrons) with what happens when compounds are bombarded with high energy particles.

The instrument used in the current investigations is a Consolidated Engineering Corporation 180° focusing spectrometer with a 5-inch radius; the ion source is a 70 volt electron beam; The material is scanned with the voltage and heavy ions are not collected as efficiently as the lighter ones.

Discrimination curves were run to determine the voltage effect with the result that all molecules appear on one or the other of the bands (indicated by lines in Fig. 1), depending apparently on the molecule and source of the ion. The initial kinetic energy might have some influence on such a distribution but the absence of intermediate curves tends to discredit this.

Recombination on such a large scale is precluded since the pressure is 10^{-5} mm. Previous work by the Consolidated Engineering Corporation has found no recombinations except H_3^+ from H_2, H_3O^+ from water and CH_3CNH^+ from the nitrile. This effect is always proportional to the square of the gas pressure. They found also that rearrangement peaks occur (e.g. butane to isobutane), but these too are small.

As large molecules are ionized the parent peaks become smaller and there is less probability of losing a hydrogen atom; i.e. C - C bonds are broken in prefernece to C - H. Parent peaks from branched molecules are smaller than those from straight chains. Hydrogen atoms evidently prefer to leave in pairs. There are exceptions to these general rules however; e.g. a molecule with an isopropyl group will lose the hydrogen from the tertiary carbon: $R - C\begin{matrix}CH_2\\ \oplus\\ CH_2\end{matrix}$. The CEC people concluded that the effects were too subtle to predict.

These investigations have been continued here with oxygenated compounds, where the polarity provided by the oxygen makes the results more easily analyzed. Double bonds also have a polarizing influence. Figs. 2-6 show the principle peaks for various types of oxygen compounds, calling the largest peak 100 and evaluating the rest of the series in percent of the largest. R denotes a rearrangement peak. General results are as follows:

1. Groups adjacent to the polarizing influence are the most reactive.
2. The smallest group containing the oxygen usually carries the charge.
3. When competition occurs between polarizing groups one must look at the spectrum to draw conclusions. At present no quantitative measurements can be made.

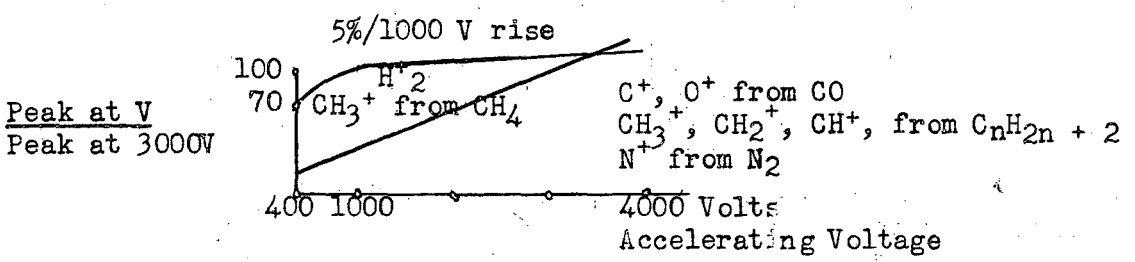

FIG. I

III. Ten Atmosphere Expansion Cloud Chamber. J. DePangher.

Small cross sections for high energy particles necessitated the use of higher pressure in the cloud chamber in order to increase the number of events (190 Mev neutrons on hydrogen and deuterium). A new chamber, 2-1/2 inches high and 12 inches in diameter, is being built for use with the existing magnet. Fig. 7 shows a vertical section of the chamber. Wood's metal is used between the stainless steel and glass to make uniform contact; the force at 10 atm. is 9 tons. The force of the door, $P(A_1 - A_2)$, is about 500 lbs. Fig. 8 is a horizontal section; the 3/4 inch lucite cylinder is backed with a stainless steel ring perforated to permit passage of light for picture taking. The copper entrance windows are as thin as possible within the safety limit - 2 and 5 mils. There are no projections in the chamber so that turbulence may be avoided. Fig. 9 is an overall view of the chamber. Tests with water at 20 atm. show no deterioration. See also UCRL-1257 Abstract.

Errata: In Fig. 3, alcohol of mass 45 should read CH_3CHOH^+.

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DI KETONES

Mass	Ion	Bi acetyl	Acetyl Acetone	Acetonyl Acetone
15	CH_3^+	33.9	18.3	16.8
16	O^+	0.5	0.3	0.3
27	$C_2H_3^+$	1.4	9.1	7.1
28	$C_2H_4^+, CO^+$	1.0	1.7	3.1
29	$C_2H_5^+, CHO^+$	2.0(R)	7.9(R)	2.1(R)
39	$C_3H_3^+$	0.4	5.4	2.6
41	$C_3H_5^+, CHCO^+$	1.8	6.0	1.9
43	$C_3H_7^+, CH_3CO^+$	100	100	100
56	$C^{=O}-C=O^+$	0.3		
57	$CH_3COCH_2^+$			4.1
58	$CH_3COCH_3^+$		3.5(R)	
69	$COCHCO^+$		0.8	
71	$COCH_2CO^+$	0.01	0.1(R)	8.4
72	$HCOCH_2CO^+$		3.3(R)	1.8(R)
85	$COCH_2COCH_3^+$	0	27.2	0.1
86	$CH_3COCOCH_3^+$	11.1(p)		
99	$COCH_2CH_2COCH_3^+$		0	14.7
100	$CH_3COCH_2COCH_3^+$		18.2(p)	1.0(1)
114	$CH_3COCH_2CH_2COCH_3^+$			2.7(p)

Fig. 2

METHYL KETONES

Mass	Ion	Me-Me	Me-Et	Me-nPr	Me-iPr	Me-nBu
15	CH_3^+	36.7	16.6			
16	O^+	0.6	0.3			
27	$C_2H_3^+$	8.0	18.5	14.1	13.0	15.1
28	$C_2H_4^+, CO^+$	1.8	3.6	2.0	1.8	4.3
29	$C_2H_5^+, CHO^+$	4.2(R)	24.3	2.7	1.2	20.9
39	$C_3H_3^+$	3.8	3.0	6.1	6.6	7.2
41	$CHCO^+, C_3H_5^+$	2.1	2.0	9.3	13.0	14.3
43	$CH_3CO^+, C_3H_7^+$	100	100	100	100	100
57	$CH_3COCH_2^+, C_4H_9^+$	0.8	6.4	0.4	0.2	13.6
58	$CH_3COCH_3^+$	26.0(p)	0.2	6.9(R)	0.1	42.2(R)
71	$CH_3COC_2H_4^+$		0.8	5.8	3.8	4.3
72	$MeCOEt^+$		16.8(p)	0.3	0.2	0.8
85	$CH_3COC_3H^+$			0.1	.06	4.2
86				10.5(p)	9.8(p)	0.3
100						6.5(p)

Fig. 3

ALDEHYDES

Mass	Ion	HCHO	MeCHO	EtCHO	Acrolein	n-PrCHO	i-PrCHO
15	CH_3^+	--	48.1		0.6		
16	O^+	1.7	10.4		1.1		
27	$C_2H_3^+$	--	4.5	58.2	100	100	69.3
28	$C_2H_4^+, CO^+$	30.9	10.3	69.0	44.3	26.5	14.8
29	$C_2H_5^+, CHO^+$	100	100	100	43.9	95.6	45.1
30	$HCHO^+$	88.5(p)		5.7	--		0.9
39	$C_3H_3^+$		0.2	4.1	4.8	35.4	25.7
41	$C_3H_5^+, C_2H_2O^+$		4.4	2.0	1.0	62.2	69.0
43	$C_3H_7^+, C_2H_4O^+$		28.7	11.2	0.5	80.8	100
44	CH_3CHO^+		50.[illegible]	3.1	0.1	87.7(R)	4.4
55	$C_2H_2CHO^+$			1.7	33.5	2.3	1.5
56	$C_2H_3CHO^+$			0.8	43.4(p)	0.3	0.4
57	$C_2H_4CHO^+$			10.8		18.8	2.5
[illegible]	$C_2H_5CHO^+$			37.4(p)			0.2
[illegible]	$C_3H_6CHO^+$					4.5	0.7
[illegible]	$C_3H_7CHO^+$					44.8([illegible])	35.5(p)

Fig. 4

ETHYL KETONES

Mass	Ion	Et-Me	Et-Et	Et-Pr	Et-Bu
15	CH_3^+	16.6	5.9		
16	O^+	0.3	0.2		
27	$C_2H_3^+$	18.5	41.1	49.4	28.0
28	$C_2H_4^+, CO^+$	3.6	11.6	10.9	9.9
29	$C_2H_5^+, COH^+$	24.3	97.2	68.3	68.3
39	$C_3H_3^+$	3.0	3.9	12.8	7.5
41	$C_3H_5^+, CHCO^+$	2.0	1.1	23.0	21.8
43	$C_3H_7^+, CH_3CO^+$	100	5.7(R)	100	10.1
56	$C_2H_4CO^+$		3.9	1.8	2.8
57	$C_2H_5CO^+$	6.4	100	76.1	100
58		0.2(i)	3.6(i)	2.5(i)	3.7(i)
71	$C_3H_7CO^+, C_2H_5COCH_2^+$	0.8	0.1	45.6	0.9
72	$EtCOCH_3^+$	16.8(p)	0.1	4.4	17.6(R)
85	$CH_2COPr, COBu^+$		0.5	2.0	23.5
86	$EtCOEt^+$		17.4(p)		
100	$EtCOPr^+$			19.9(p)	
114	$EtCOBu^+$				7.8(p)

Fig. 5

ALCOHOLS

Mass	Ion	MeOH	EtOH	n-PrOH	i-PrOH	Allyl	n-BuOH	i-BuOH	Sec BuOH	t-BuOH
15	CH_3^+	42.5	9.7	3.9	11.8	6.0	9.2	8.7	7.82	15.5
16	O^+	1.0	0.5	0.2	0.5	0.3	0.3	0.3	0.4	0.5
27	$C_2H_3^+$	0.2	22.0	15.6	16.4	45.2	51.9	44.3	17.6	11.2
28	$CO^+C_2H_4^+$	6.5	5.7	5.4	1.2	25.7	17.1	7.1	3.5	2.7
29	$C_2H_5^+CHOH^+$	62.1	21.6	14.7	10.0	8.0	31.4	23.0	15.2	14.0
31	CH_2OH^+	100	100	100	5.7	60.3	100	63.7	21.3	37.1
32	CH_3OH^+	69.1(p)	1.7(i)	2.8		1.1	1.7(i)	1.5	0.3	
39	$C_3H_3^+$		0	4.0	5.7	39.8	17.0	20.6	3.8	9.8
43	$C_3H_7^+, C_2H_2OH^+$		7.8	3.2	17.0	6.05	60.9	100	10.9	15.7
45	$CH_2CH_2OH^+$		37.5	3.5	100	0.4	6.8	6.25	100	1.0
46	$C_2H_5OH^+$		15.9(p)	0.1	2.2	--	--	--	2.3	0.02
57	$C_4H_9^+, C_3H_4OH^+$			1.3	0.3	100	7.13	3.5	2.9	9.5
58	$C_3H_5OH^+$			0.4	0.2	26.7(p)	0.3	0.5	0.5	0.9
59	$C_3H_6OH^+$			9.5	3.5	1.1	--	4.4	18.7	100
60	$C_3H_7OH^+$			5.5(p)	0.3(p)	0.1	--		0.6	3.5
73	$C_4H_8OH^+$						1.36	1.8	1.2	0.0
74	$C_4H_9OH^+$						0.5(p)	7.2(p)	0.2(p)	0.0(p)
C+d peaks							56 (83.6)	33 (52.4)		

Fig. 6

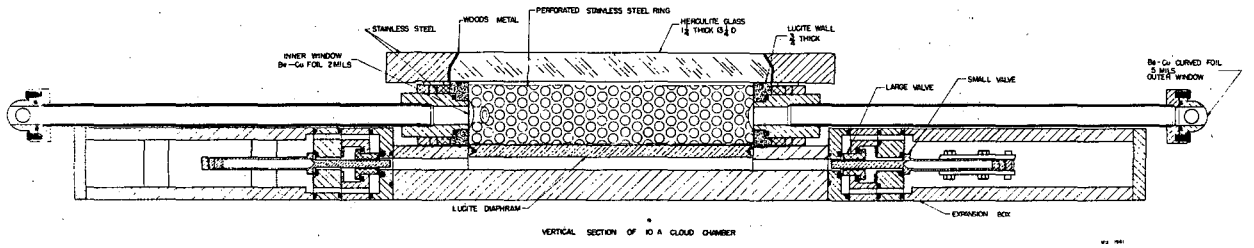
STAINLESS STEEL
WOODS METAL
PERFORATED STAINLESS STEEL RING
HERCULITE GLASS
LUCITE WALL
INNER WINDOW
Be-Cu FOIL 2 MILS
LARGE VALVE
SMALL VALVE
Be-Cu CURVED FOIL
5 MILS
OUTER WINDOW
LUCITE DIAPHRAM
EXPANSION BOX
VERTICAL SECTION OF 10 A CLOUD CHAMBER

Fig. 7

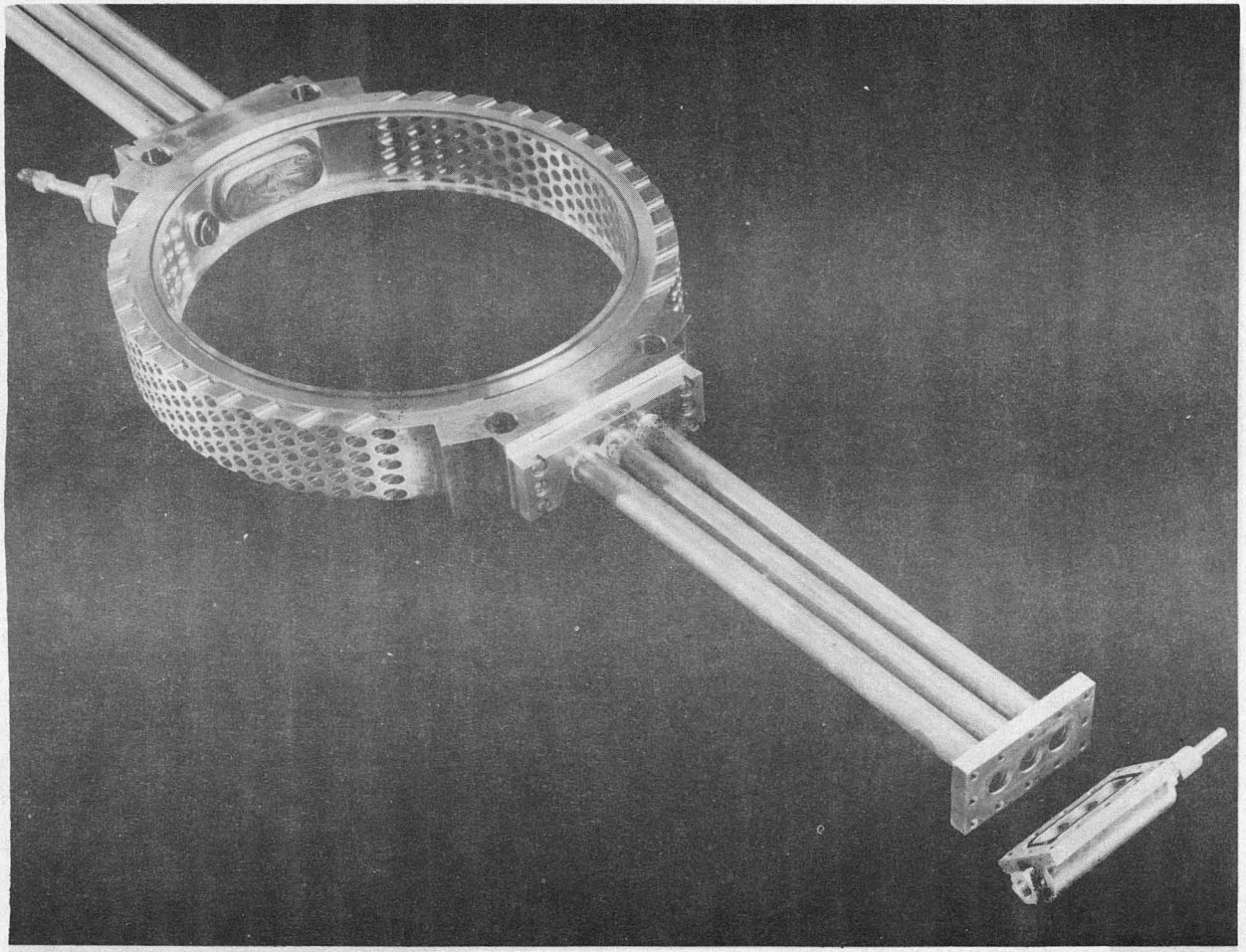

Fig. 8

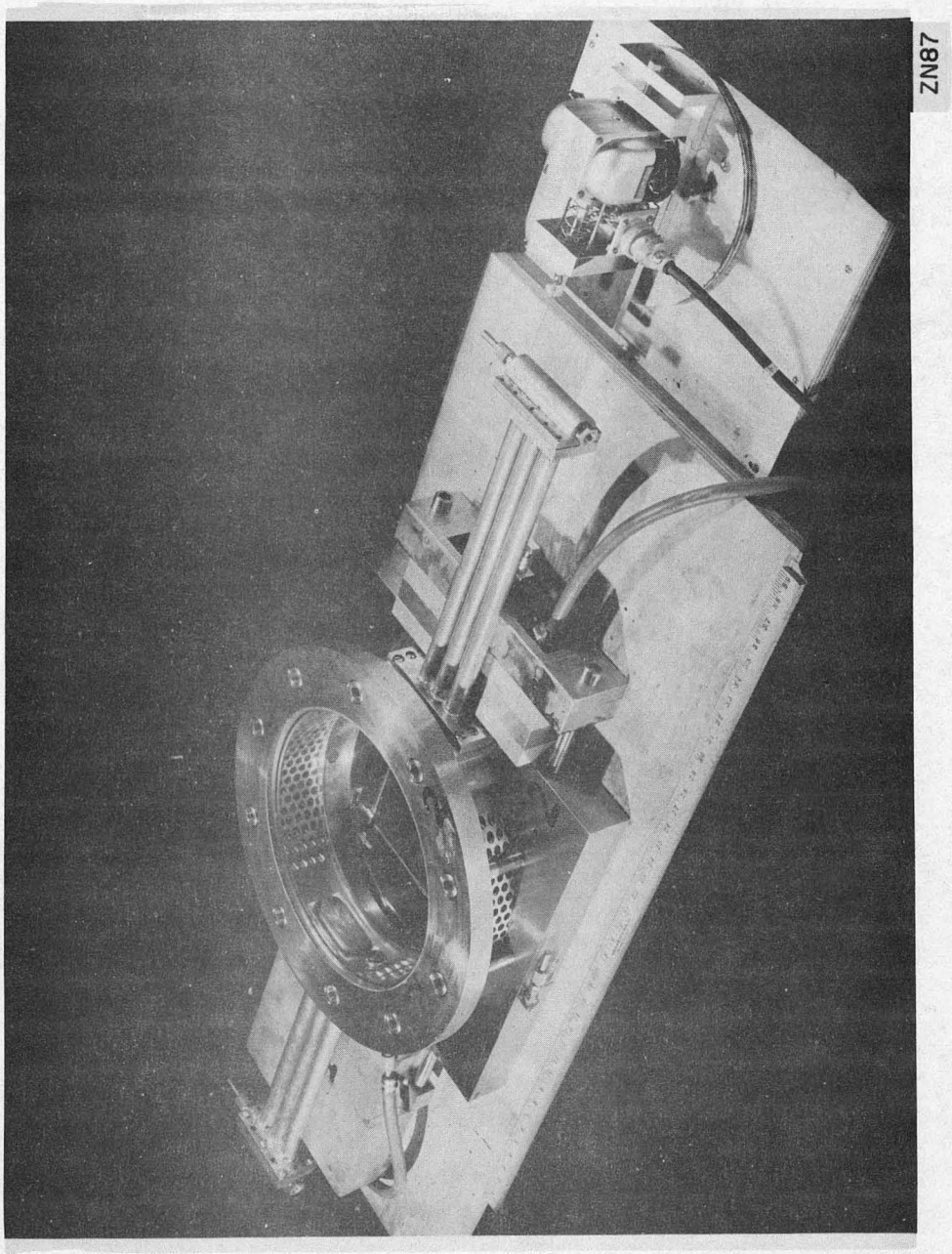

Fig. 9