1961
~
XV

NOTE BOOK

Manufactured with best ruled foolscap
Brings easier & cleaner writing

Sept 1961 Wiitaglum
~
May 1962, Wheeler
Vigner

VOL. XV

Yukawa

日章 SA 50

Sept. 11, 1961 RIFP

Informal Meeting with G. Wataghin

G. Wataghin: non-locality

$\langle p_\perp \rangle \sim \frac{1}{2} M$

$\langle p_\parallel \rangle \sim M$

$\Delta E \sim 100 M$

$G(|\vec{p}|_{CM})$

$|\vec{p}^{(\pi)}|_{aver} \sim 430$ MeV

$n = n_i + n_f$

$n_i \geq 2$

no. of invariant $3n-10$

causality: $G^+(\vec{k})$, $G^-(\vec{k})$

cut-off for incident particles?

unitarity: $S = \dfrac{1 - \frac{1}{2}iK}{1 + \frac{1}{2}iK}$

M. Ida: Wave-packet description

Sept 12
Yokoyama:

Munakata:

Sept. 27, 1961　基研

Indefinite metric についての Colloquium

午前

横山氏: unitarity, convergence

$$\mathcal{L}_1 = \sum f_{ij}(\bar{\chi}_i + \bar{\chi}_i')(\chi_j + \chi_j') + \ldots$$

$$\mathcal{L}_2 = \sum g_i(\bar{\chi}_i\chi_i - \bar{\chi}_i'\chi_i') +$$

$$\sum_i f_{ij} g_i = 0 \qquad f_{ij} = f_{ji}$$

regularization の条件.

$$\left.\begin{aligned} \chi_1 &= \phi_1 + \frac{g_1}{2g_2}(\phi_2 - \phi_2') \\ \chi_1' &= \phi_1' + \quad〃 \\ \chi_2 &= \phi_2 - \frac{g_1}{2g_2}(\phi_1 - \phi_1') \\ \chi_2' &= -\phi_2' + \quad〃 \end{aligned}\right\}$$

......

—— [illegible] —— [illegible] ——

宗像氏: scalar model.

unitarity の問題.

$A \to A^{ext}$.

particle image をはっきりさす diagonalization ができない.

complete set は eigenstate について はれない.

mass shift は δ_{μ}, δ_{3} ではずてこない。

$$\begin{cases} K_1 B_1 = 0 & B_1 = \Phi_1 - \Phi_1^c \\ K_2 A_2 = g'^2 B_1 \\ K \varphi = g^2 A_2 \\ K_2 B_2 = g^2 \varphi \\ K_1 A_1 = g'^2 B_2 \end{cases}$$

$$[A_i(x,t), \dot{B}_i(x',t)] = \cdots = i\delta(x-x')$$

$$[A_i(x,t), \cancel{A}\dot{A}_i(x',t)] = 0$$

etc.

$$\varphi = \varphi_0 + \frac{g^2}{\mu_2^2 - m^2} A_2^{(0)} + \frac{g^2 g'^2 B_1^{(0)}}{(\mu_1^2 - m^2)(\mu_2^2 - \mu_2^2)}$$

$$A_1 = A_1^{(0)} + (b_1 + \lambda_1 \frac{1 + x_\mu \partial_\mu}{2}) B_1^{(0)}$$
$$+ \cdots B_2^{(0)} + \cdots A_2^{(0)} + c\,\varphi_0$$

$$K\varphi_0 = K_1 A_1^{(0)} = K_1 B_1^{(0)} = 0$$

$$[P_\mu, Q] = i\partial_\mu Q$$

P_μ: total

φ_0 etc: in-field, out-field

divergence は残る。

$$\tilde{S}_1 \tilde{S}_1^\dagger + \hat{S}_2 + \hat{S}_2^\dagger \neq 0$$

regularization
& unitarization) の他の方法.
Feynman graph がどこまで使えるか?

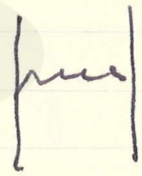
limitation of axioms.

Bogoliubov
macrocausality ?

大貫氏: Normal case. (no dipole ghost)
renormalized fields
perturbation
unphysical particle が出てくる!!!

午後.

田中正氏: Limited unitarity
S. N. Gupta, Conservation of energy (expectation value) Proc. Phys. Soc. 1952
どこまでが継続。



fictitious particles の $P_\mu^2 < M^2c^2$ でもよいが
of unstable にならないか?

梅沢氏: spin と statistics の連結
Gupta,
Pauli, P.T.P. 1950
Regularization
CPT theorem
free field eq. と C.R. とを invariant にし,

C: $\phi(x) \to \phi^H(x)$
P: $\phi(\vec{x}) \to \phi(-\vec{x})$ 積の逆する.
T: $\phi(t) \to \phi^H(-t)$
又は $\phi(t) \to \phi(-t)$ (c-number)→(c-number)*

inv.?
Heisenberg operator に対しては?

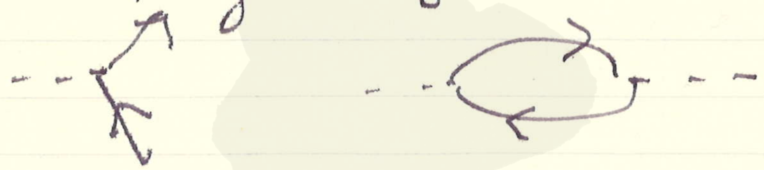
CPT-theorem.

L_{μ}^{+} に対して inv. な記述が
ある場合　T　　　　ついて対して
不変,

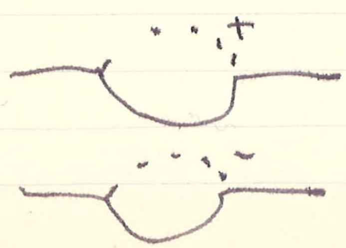
$T \quad \Phi(x) \to \Phi^H(-x) \qquad (c\text{-number}) \to (c\text{-nr})^*$
(const.)

Fermion anticommute の family?
条件?
CPT-theorem を信ずべきか?
spinor についての四つの可能性
Fermion　　　S_F, 或 $-S_F$?
Boson　　　$\epsilon(t)S_F$, 或 $-\epsilon(t)S_F$?

Pauli Regularization のむつかしい論点.



$\Delta N = 0$



 だの instability

中野董夫氏: Distribution in 5-th dimension.

Oct. 4. 1961

Okubo

$$G = R_3^{I} \times R_2^{N} \times R_2^{S} \subset U_3 \subset R_8,\ G_2;$$

kinematics or symmetry

$n = 3$: (Λ, n, p) B

$n = 4$: $\Lambda\ n\ p\ \mu$ Yamaguchi
$\mu\ e\ \nu\ \Lambda$

dynamics
$\psi \to \gamma_5 \psi$ strong
no
yes → mass term?

yes の立場
(1) Heisenberg $n = 2$ (isospin doublet)
$$L_1 = g(\bar\psi \gamma_\mu \gamma_5 \psi \cdot \bar\psi \gamma_\mu \gamma_5 \psi)\ (p)$$
(2) Nambu $n = 3$
$$L = g(\bar\psi\psi\bar\psi\psi - \bar\psi\gamma_5\psi \cdot \bar\psi\gamma_5\psi)$$
p

non-separable Hilbert space
Hilbert space の大きさが問題!!!
self-consistency → mass spectrum

R_8: triality principle

V_8
S_8 — $\bar S_8$

equivalence of vector and spinor

Solvay会議 1961

Oct. 9, Monday ~ Oct. 13, Friday
(Oct. 13. Yukawa, Extensions etc.)

Oct. 18, Wednesday, 1961

Lecture at Technical University of Trondheim on Elementary Particles

片山 及稿

Oct. 25, 1961

横山: $P\frac{1}{x}\delta(x)$

1st $T \to \infty$

2nd $\frac{1}{x - i\varepsilon}$ $\varepsilon \to 0$

$$\frac{1}{x - i\varepsilon_\varepsilon}\delta(x) = \left(\frac{x}{x^2 + \varepsilon_\varepsilon^2} + \frac{i\varepsilon}{x^2 + \varepsilon_\varepsilon^2}\right)\delta(x)$$

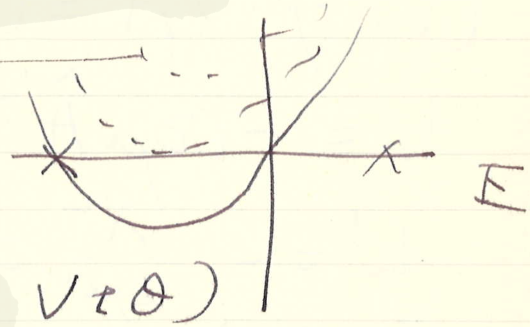
$$\downarrow \qquad\qquad\qquad \downarrow$$

$$\frac{P}{x} \qquad\qquad i\pi\delta(x)$$

田中: complex eigenvalue

$S_\nu^{\prime -1} = h^+(E)$

complex E, E^*



$(N + 2\theta) \to (N + 2\theta, V + \theta)$

$\int_0^\infty dt\, e^{st} s_\nu(t)$ Laplace 変換.

片山: $P_\mu = P_\mu^0 + P_\mu^1 \leftarrow L = L^0 + L^1$

$[P_\mu^0, P_\nu^1] = 0 \to \dot{P}_\mu^0 = \dot{P}_\mu^1 = 0$

$P_\mu \to \frac{\delta L^0}{\delta\phi} = 0 \to L^1$: 4-divergence

14 (1959)

Froissart model (N.C. suppl.)

$$L = -(\partial_\mu A \partial_\mu B + \mu^2 AB + \lambda^2 A^2)$$

$$[A, \dot{A}] = [B, \dot{B}] \qquad (\Box - \mu^2) A = 0$$

$$[A, \dot{B}] = i\delta \qquad (\Box - \mu^2) B = 2\lambda^2 A$$

$$A = \hat{A}$$

$$B = \hat{B} + \frac{\lambda^2}{\mu^2}(1 + x_\mu \partial_\mu)\hat{A} \qquad [\hat{A}, \hat{B}] = i\delta$$

$$(\Box - \mu^2)\hat{A} = (\Box - \mu^2)\hat{B} = 0$$

$$L = -(\partial_\mu \hat{A} \partial_\mu \hat{B} + \mu^2 \hat{A}\hat{B}) + L'$$

$$L' = -\frac{\lambda^2}{2\mu^2}\partial_\rho[x_\rho\{(\partial_\lambda \hat{A})^2 + \mu^2 \hat{A}^2\}]$$

$\to T_{\mu\nu} = \cdots$

$$P_\mu = i\int T_{\mu 4}\, d^3x = P_\mu^0 + P_\mu^1$$

$$[A, P_\mu] = i\frac{\partial A}{\partial x_\mu} \quad \text{etc.}$$

$$[\hat{A}, P_\mu^0] = i\frac{\partial A}{\partial x_\mu} \quad \text{etc}$$

$$[\hat{B}, P_\mu^1] = i\frac{\lambda^2}{\mu^2}\frac{\partial \hat{A}}{\partial x_\mu}$$

$[P_\mu^0, P_\nu^1] = 0$

KY 研究会　Nov. 6 ~ 9, 1961

Nov. 7, afternoon

下鍵田氏: KY 会議の Review.

	N	Λ	Σ	Ξ
p	938	1115	+ 1190	− 1319
n	940		− 1196	
			0 1191	0 1311 ± 8

π	K
± 140	± 494
0 135	0 498

Y_1^* 1385　　Y_0^* 1405

$\Gamma/2 \sim 15$　　$\Gamma/2 < 20$

K^* 880

$\Gamma/2 \sim 20$

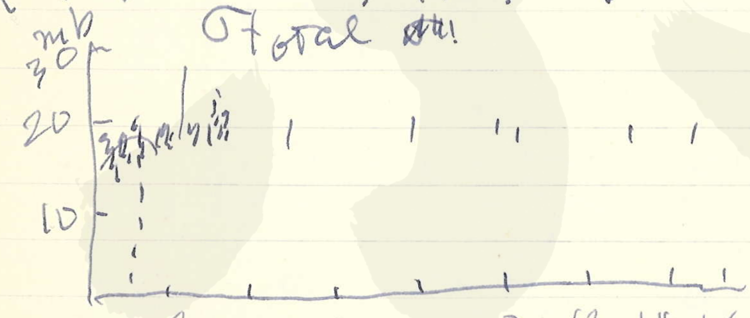
$K^\pm + p$

$K^\pm + d$

$K^+ + p$　15 BeV/c まで

$K^+ + n$　3 BeV/c まで

σ_{total}



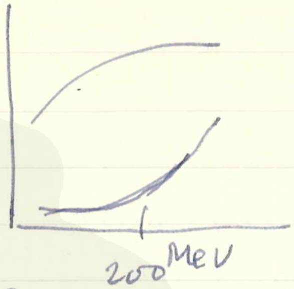
R.M.P. 33, 3

P.R.L. 7, 5

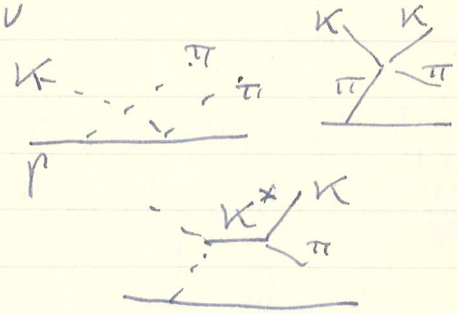
1 $K^+ + p$

3 $K^+ + n$

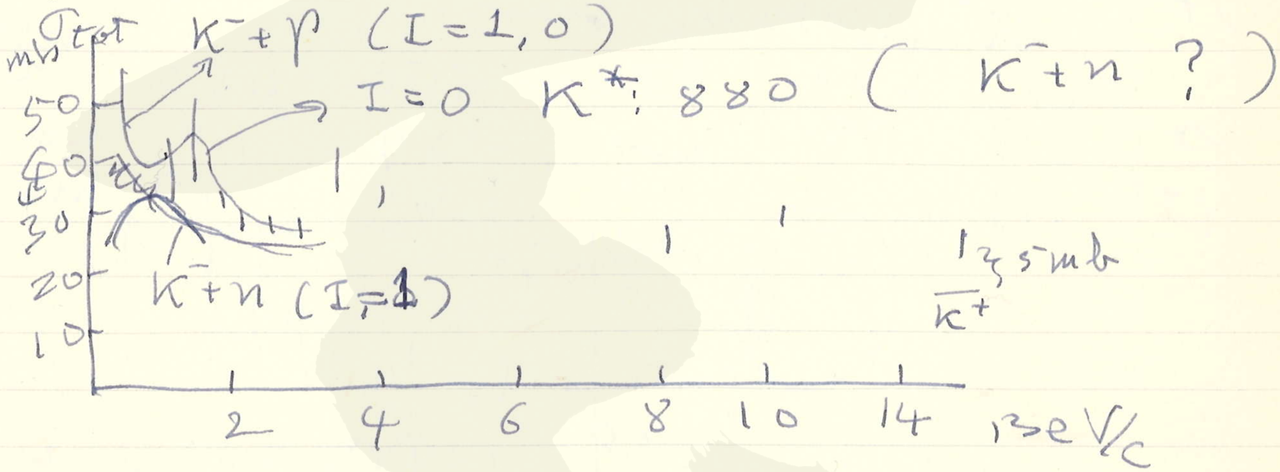
$K^+ + n \to K^0 + p$



$K^+ + p \to K^+ + p + \pi^0$
$\to K^0 + p + \pi^+$
$\to K^+ + n + \pi^+$



$K^- + p \to K^- + p,\ \bar{K}^0 + n,\ \Lambda + \pi^0,\ \Sigma^{\pm}_{0}\pi^{\mp}_{0}$
$K^- + n$

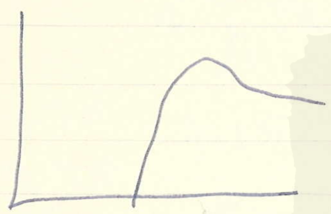


角分布
200 MeV/c 以下　S波
300 MeV/c　S だけでない
400 MeV/c　$\cos^2\theta$, P波

$K^- + p$: 引力, 斥力

at rest	H_2	D_2	n
Σ	82%	67%	16
Λ	18%	15%	14
		18%	16
		1%	

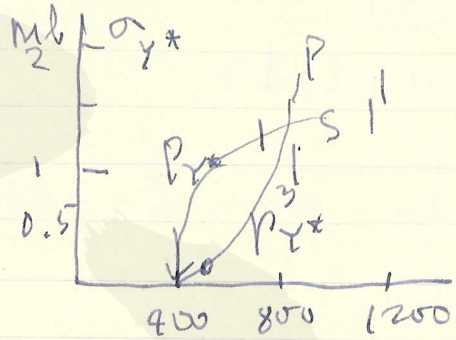
$K^- + p \to \bar{K}^0 + n$



Y_1^* - resonance (Dalitz resolution)
武田: 東大研 ↘ あまり信用できない。
R. R. Ross: 1170 MeV/c ~ 1175 MeV/c
σ_{el}, $\sigma_{c.e.}$

Y^*; K^- 1150 MeV/c beam

	510	620	760	850	1150	MeV/c
Y^{*-}	0.1	~~1.1~~	1.2	0.9	1.8	mb
Y^{*+}	0.1		1.2	1.0	1.3	mb



$Y_1^* \to \Lambda + \pi$
$\quad\;\; \Sigma + \pi$

$\frac{\Sigma+\pi}{\Lambda+\pi}$ = 1 ± 5% (760)　　850: 5 ± 5%　　1150: 1 ± 3%

Σ: 2倍 20%　　10%　　8%

$Y_0^* \to \Sigma + \pi$?

ΛΣ の parity odd の方がよい?

素粒子の構造研究会

11月11日
12日
13日
14日　放談会.

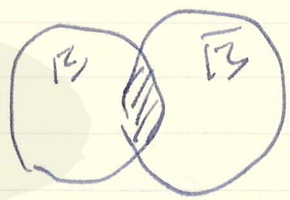
午前: Yukawa: contradiction
午後: 丹羽　β-matter　内容.
高林氏: 三次元の oscillator → U(3)
Elliot: 原子核 ('58, Roy. Soc.)

大槻氏: Lorentz 変換 → 非局所因子

$\frac{\delta S}{\delta \alpha} = -1$

$K^0 \to \pi^+ + e^- + \bar{\nu}$
$K^0 \to N\bar{\Lambda}$ → 2粒子
$\bar{\Lambda} \to \bar{p} + e^+ + \nu$

Nagoya model:
$\langle B e^- \rangle \langle \bar{B} \mu^+ \rangle$



片山氏: 閉包の話.
boson と fermion の逆の関係.

c033-685挟込

長谷川俊一: H-quantum

Nov. 22, '61

{ Bristol
Warsaw
Chicago 22 liter

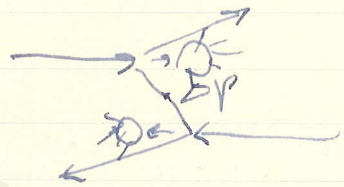
ICEF Koshiba 100 liter

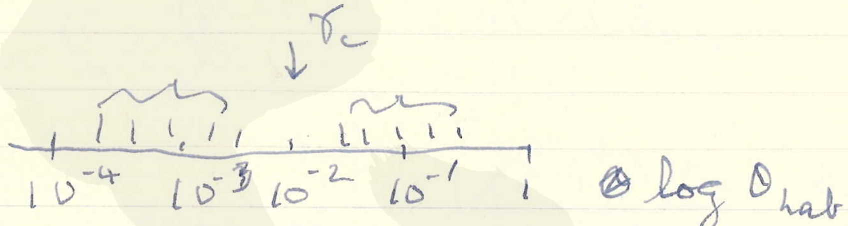
multiple production

実験: 飛跡をつかまえる困難
解析の困難
重心系 10^{-3} radian
Lab. 系 → E.C.C. $p_T \sim 3\mu$
→ 結論.

理論:

Niu model





F-plot

$$\log \gamma_c = \frac{1}{n_s} \sum_{n_s} \log \tan \theta_{lab}$$

α-family
非常に速い π^0 $\sim 8 \cdot 10^{13}$ eV p_T は大きい..
のこりは遅い $* \cdot 10^{12}$ eV

{ fireball - excited baryon?
H-quantum?

H-quantum : mass ~~2M~~ ~ $2Mc^2$

charged prong number $\langle n_H \rangle \simeq 4.3$

分布の形 $\bar{p}$-p に似ている

high number tail

decay mode : dipole type $\sin^2\theta\, d(\cos\theta)$

symmetrical emission

γ_H の quantization

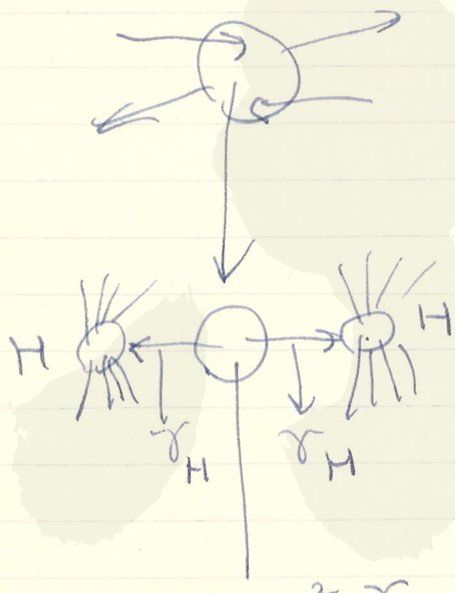
1.5   7.5

$\gamma_c \sim 5$ 20 ~

γ_H

100例以上   H-quanta   400個

energy 10^{11} eV 以上



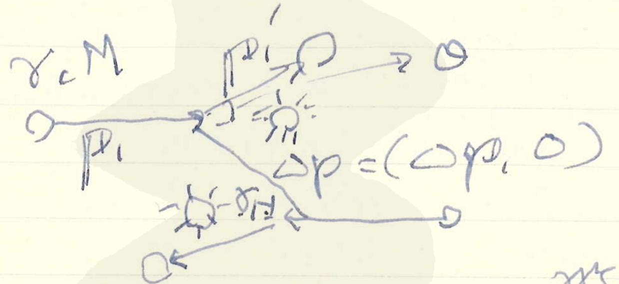
$E = 2 \times 2Mc^2 \cdot \gamma_H$ ε/ $2Mc^2$

$\gamma_H = 1.5 \rightarrow E = 6Mc^2$ 1.2   2.3

$\gamma_H = 7.5 \rightarrow E = 30Mc^2$ 5.6

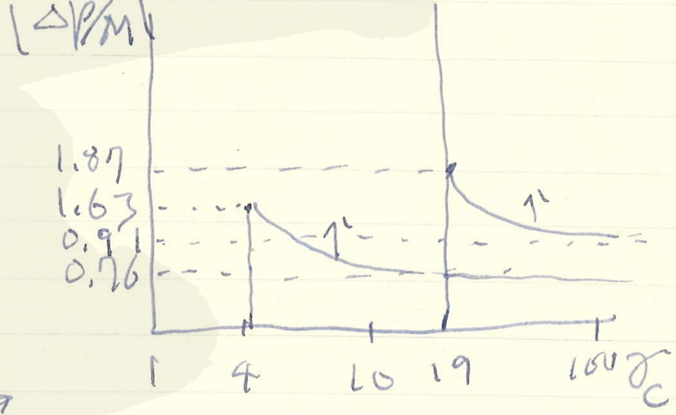
批判:
1) Kinematics
2) 流体モデル
3) K/π ratio

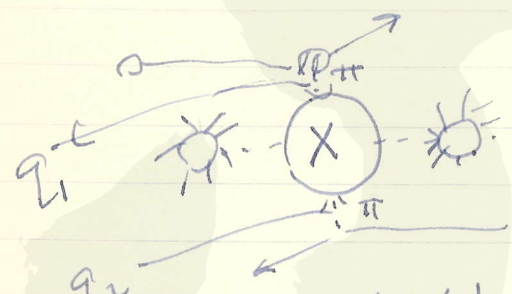
1)



$\gamma_H = 1.5$ $\qquad \gamma_c \geqq \gamma_H \frac{m}{M} + 1 = 4$

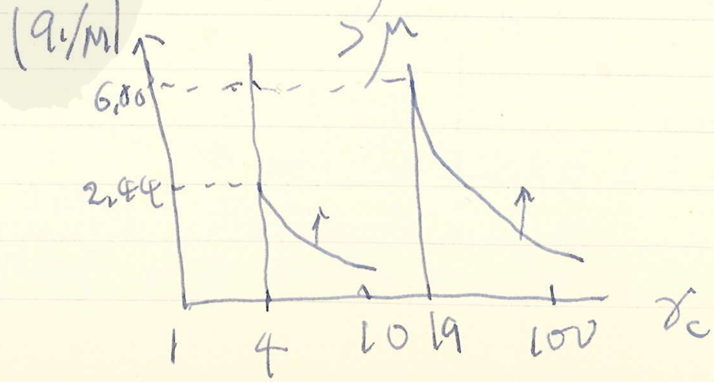
$\gamma_H = 2.5$ $\qquad \gamma_c \geqq (\gamma_{H_1} + \gamma_{H_2}) \frac{m}{M} + 1 = 19$



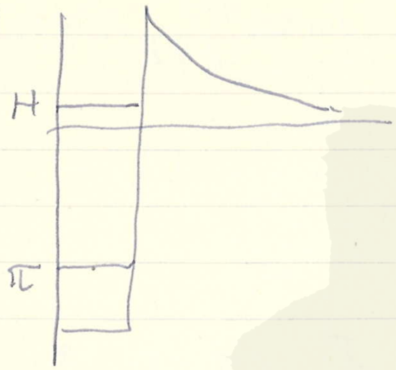


'59 Moscow
Bubelev

$|q_\perp|^2 \leqq \mu$



2)



3) $\Pi = \langle B \bar{B} \rangle$ $B = p, n, \Lambda$

$3 \times 3 = 8 + 1$ → $\pi^{0\prime\prime}$ (Π)

octet

$S=0$ $I=1$ $\{ \pi^+, \pi^0, \pi^- \}$ Ω^+, Ω^0, Ω^-

0 $\pi^{0\prime}$ → $\Omega^{0\prime}$ (Π)

$\frac{1}{2}\{ K^+, K^0 \}$ X^+, X^0

$S=1$ $\tilde{K}^0$ $\tilde{X}^0$

$S=-1$ $\frac{1}{2}\{ K^- \}$ X^-

[illegible] [illegible]

$S=0 \{$
Ω^+ Ω^-
Ω^- Ω^+
Ω^0 Ω^0
Ω^0 $\Omega^{0\prime}$
$\Omega^{0\prime}$ Ω^0
$\Omega^{0\prime}$ $\Omega^{0\prime}$

$|S|=1 \{$
X^+ X^-
X^0 $\bar{X}^0$
$\bar{X}^0$ X^0
X^- X^+

$\Omega \to 6\pi$
$\chi \to 3\pi + K$) $K/\pi \sim 4/48 \sim 8.2\%$

Casimirの法. 長谷川よりきいた.
~~[illegible]~~ Nov. 27 '61

談話会　Nov. 20 '61

田中さん: Complex Eigenvalue states
instability, auxiliary particles

$\hat{h}_I = g\bar{\psi}_l\psi_l(E_1 + E_2)^2$

$\oplus \quad \ominus$

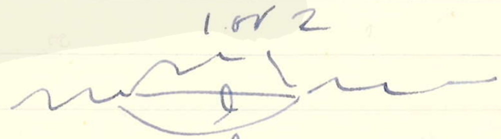
$\mu_1 \quad \mu_2$

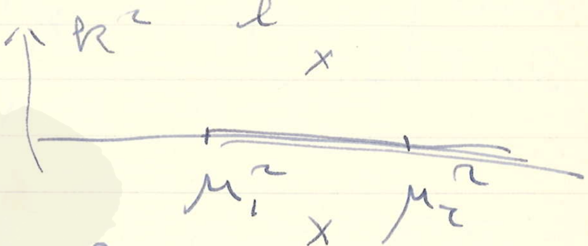
$F(x)$

$\Delta_c'(F) = \Delta_c(F) + \Delta_c(F)\sum\Delta_c'(F)$

$\Delta_c(F) = \dfrac{\mu_2^2 - \mu_1^2}{(k^2+\mu_1^2)(k^2+\mu_2^2)}$

1 or 2





$\Delta_c(k^2)$

$\Delta_c'(k^2)$

$\dfrac{(k^2+\mu_1^2)(k^2+\mu_2^2)}{\mu_2^2 - \mu_1^2} - i\Sigma(k^2) = 0$

Lee model

N-θ-system

$\Psi = \int \quad |N,\theta\rangle + \quad |V\rangle$

$\left\{\begin{array}{ll} m_0 & V \\ m_N & N \\ \mu & \theta \end{array}\right.$

$H\Psi = E\Psi$

$S_V'^{-1}(E) = h_V^+(E) = (m_0 - E) - \dfrac{g^2}{4\pi}\int \dfrac{f^2 d^3k}{2\omega} \times$

$\times \dfrac{1}{E - m_N - \omega}$

$\{\psi_\nu, \psi_\nu^\dagger\} = -1$

$\psi_\nu |0\rangle = 0$

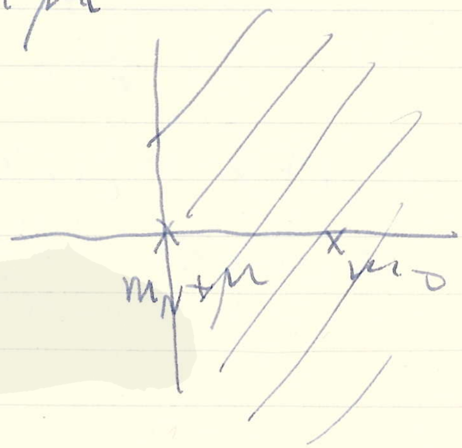
① 裸 m_0 が real であるときには $m_0 < m_N + \mu$

② 裸 m_0 が complex : $E = \alpha_1 + i\alpha_2$

$2\alpha_1 > m_0 + m_N + \mu$

$m_0 > m_N + \mu$

$\alpha_1 \geq m_N + \mu$



causality

$$S_\nu(E) = \frac{R}{E-\alpha} + \frac{R^*}{E-\alpha^*} + \int_{m_N+\mu}^{\infty} \frac{\rho(\kappa)\,d\kappa}{E-\kappa+i\epsilon}$$

$\rho(\kappa) \geq 0$

$R = R_1 + iR_2$; $R_2 \leq 0$

$g \to 0$: acausal

$N + 2\theta \to N + 2\theta$

$\to V^* + \theta$

real E } complete set
complex E

real E complete set

$$2N \varepsilon\, 3\theta \to V_c + V_c^* + \theta$$

$$E_c \quad E_c^* \quad \omega(k)$$

$$E = 2\,\mathrm{Re}\, E_c + \omega(k)$$

総研民: Pais, Octonion

Nov. 29, '61

$X = x_0 e_0 + x_\alpha e_\alpha \qquad \alpha = 1, 2, 3$

$\bar{X} = x_0 e_0 - x_\alpha e_\alpha$

$(X, Y) = \frac{1}{2}(\bar{X} Y + \bar{Y} X)$

$N(X) = (X, X) = x_0^2 + x_\alpha^2$

$N(SX) = N(XS) = N(X) N(S)$

$N(S^{-1} X S) = N(X) \qquad S^{-1} = \frac{\bar{S}}{N(S)}$

associative

四元数, 実数, 複素数 $\Big\}$ $X(YZ) = (XY)Z$

Octonion: $X(YZ) \neq (XY)Z$

$e_1(e_2 e_4) = e_1 e_6 = e_7$

$(e_1 e_2) e_4 = e_3 e_4 = -e_7$

$N(SX) = N(XS) = N(X) N(S)$

G_2

variant 1: $N(X) = x_0^2 + x_\alpha^2$

2: $N'(X^{(s)}) = x_0^2 + x_j^2 - x_\rho^2$

$\rho = 4, 5, 6, 7$

baryon octonion
meson ''

$B = B_0 - i e_\alpha B_\alpha$
$M = M_0 - i e_\alpha M_\alpha$

$B(\Lambda, \Sigma, N, \Xi)$
$M(\sigma, \pi, K, K^{(G)})$

$$(\gamma \partial + m) B + i G \gamma_5 B M = 0$$

$$BM \to [B + C_1 B^{(1)} + C_2 B^{(2)}] M$$

B : $8 = 1 + 3 + 2 + 2$
M : $8 = 1 + 3 + 4$

Hida: spurion 礎理研

素研談話会 Dec. 4, 1961

charge matter

I. charge quantal nature

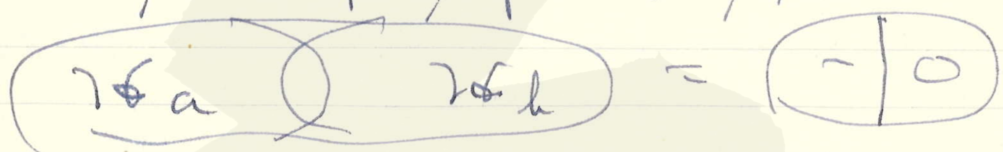
II. strong } charge は particle としては
electromag } あらわれない: 組がえがない.

III. weak } q-charge がくみかえられる.

super weak: b-charge 〃

na-charge 〃

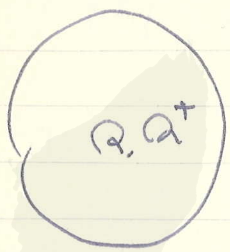
$$\bar n \gamma_\mu n + \bar p \gamma_\mu p + \bar\Lambda \gamma_\mu \Lambda$$



$$\langle n', a | n\, b\rangle = \langle n, b | n' a\rangle$$
$$= \delta_{nn'} p^{1/2}$$

$$|n, a\rangle = \cos\theta |n, -\rangle + \sin\theta |n, 0\rangle$$
$$|n, b\rangle = -\sin(\theta-\omega) |n, -\rangle + \cos(\theta-\omega) |n, 0\rangle$$

$$\omega = \sin^{-1} p^{1/2}$$



$$Q^+ |n, 0\rangle = |n, -\rangle$$
$$Q |n, -\rangle = |n, 0\rangle$$
$$\left.\begin{aligned} Q^{+2} &= Q^2 = 0 \\ QQ^+ + Q^+Q &= 1 \end{aligned}\right\} \text{spurion}$$

$$\phi = e + \sqrt{\frac{f}{g}}\, \frac{1+\gamma_5}{2} \nu Q$$
$$\bar\phi = \bar e + \sqrt{\frac{f}{g}}\, \bar\nu \frac{1-\gamma_5}{2} Q^+$$

spurion: integer spin
Fermi statistics

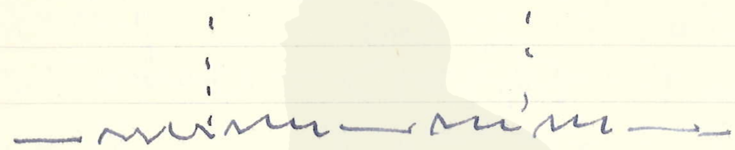
vacuum: $\langle \Omega | n \rangle = 0$

$$g\langle j_\mu j_\mu \rangle \to g\langle \bar{e}\gamma_\mu e \cdot \bar{e}\gamma_\mu e \rangle$$
$$+ f\langle \bar{e}\gamma_\mu \frac{1+\gamma_5}{2}\nu \cdot \bar{\nu}\gamma_\mu \frac{1+\gamma_5}{2} e \rangle$$

横山寛一 : Indefinite Metric

Dec. 5, 1961

Yokoyama
Munakata) → $\tilde{S}_1^* \tilde{S}_1 + \tilde{S}_2 + S_2 = 0$?



$\frac{P}{x}\delta(x) = 0$?

松田[illegible]一

Dec. 6, 1961

E.P.	m(MeV)	$m/\alpha^{-1}\cdot m_e$ (70.032)	n	$\alpha^{-1} m_e \cdot n$	δm
γ	0	0	0		0
ν	0	0	0		0
e	0.51098	~0	0		0.51
μ	105.66	1.509	1½		0.61
p	938.2	13.40	13½		−7.2
n	939.5	13.42	13½		−5.9
Λ	1115.4	15.93	16		−5.1
$\pi^{\pm}$	139.60	1.99	2		−0.46
π^{0}	135.50	1.93	2		−4.6 ~~−5.4~~
$K^{\pm}$	493.9	7.05	7		3.7
K^{0}	497.8	7.11	7		7.6
Σ^{+}	1189.4	16.99	17		−1.1
Σ^{0}	1191.5	17.01	17		1.0
Σ^{-}	1196.0	17.08	17		6.4
Ξ^{0}	1311. (8)	18.82	18½ } 19		
Ξ^{-}	1318. (1.2)	18.72	18½		
π_0'	550	7.85	8		
ρ	720~750		10½		
ω	780	11.14	11		
K^{*}	885	12.64	12½ (13)		
(33)	1233	17.60	17½		
N^{*}	1513	21.60	21½		
N^{**}	1688	24.10	24		
Σ^{*}	1385	19.78	20 (19½)		
Λ^{*}	1405	20.07	20		
Y_0^{**}	1525	21.79	21½ (22)		
$Y_{0\,or\,2}$	1565	22.35	22½		
Y_0^{***}	1813	25.90	26		

$$\frac{G^2}{4\pi} = \frac{2m_N}{m_\pi} \; (=13.5)$$

$$m_\pi = 2m_e \Big/ \frac{e^2}{4\pi}$$

$$\frac{G^2}{4\pi}\Big/\frac{e^2}{4\pi} = m_N/m_e$$

$$\frac{G^2}{4\pi}\Big/\frac{f^2}{4\pi} = \left(\frac{2m_N}{m_\pi}\right)^2 \qquad \frac{G^2}{4\pi}\cdot\frac{f^2}{4\pi} = 1$$

weak coupling

$$f_W\, \bar{e}\gamma_\mu(1+\gamma_5)\nu \cdot \bar{\nu}\gamma_\mu(1+\gamma_5)\mu$$

$$g\,[\bar{e}\gamma_\mu(1+\gamma_5)\nu]\,\phi_\mu \quad M_0$$

$$g^2 M_0^{-2} = f_W$$

$$m_N^2 f_W = 7.1\times10^{-6} \qquad \frac{e^2}{4\pi}\frac{m_e}{m_N} = 4.0\times10^{-6}$$

$$\frac{m_e}{m_N} = \frac{e^2/4\pi}{G^2/4\pi} = \frac{m_N^2 f_W}{e^2/4\pi}$$

$$(m_\Lambda - m_\mu) - (m_n - m_e) = \alpha^{-1} m_e$$

$$m_\Sigma = m_N + \tfrac{1}{2}m_K = m_\Lambda + \tfrac{1}{2}m_\pi$$

$$m_{\Sigma^*} = m_N + \tfrac{1}{2}m_{K^*}$$

$$m_{K^*} = m_K + \tfrac{1}{2}m_\omega$$

? $\begin{cases} m_{\Lambda^*} = m_\Lambda + \frac{1}{2} m_{\pi_0'} - 20 \text{ MeV} \\ m_{Y_0^{**}} = m_\Lambda + \frac{1}{2} m_\omega - 20 \text{ MeV} \end{cases}$

? $\begin{cases} m_{N^*} = m_N + m_{\pi_0'} + 20 \\ m_{N^{**}} = m_N + m_\omega - 30 \quad - m_N + m_\rho \end{cases}$

$m_{Y_0^{***}} = m_\Lambda + m_\omega + 20$

Katayama School Dec 20, '61

横山: Pauli 論文 1955

spinor - boson ?

$(\psi(x), \bar{\psi}(y)) = -iS(x-y)$

$\psi(x) = \sum (u_k a_r(k) e^{ikx} + \hat{v}_k b_r(k) e^{-ikx})$

$[u_k, \hat{u}_k] = 1$

$[v_k, \hat{v}_k] = -1$

$\hat{O} = \eta O^* \eta$

$\langle \Psi_\alpha | \eta O | \Psi_\beta \rangle$

$\bar{\psi} = \eta \psi^* \gamma_4 \eta$

charge conjugation

$u^c = v$ $\quad v^c = -u$

$\hat{u}^c = -\hat{v}$ $\quad \hat{v}^c = \hat{u}$

$\psi^c = C\bar{\psi}$

$(\bar{\psi})^c = -C^{-1}\psi$

$Q = e\sum(\hat{u}u + \hat{v}v) = e\sum(N^+ - N^-)$

$(\bar{\psi})^c \gamma_\mu \psi^c \to Q^c = -Q$ (1) ?

$\overline{\psi^c} \gamma_\mu \psi^c \to Q^c = Q$ (2) !

$\hat{u}^c = -\hat{u}^c$?

$$\eta \to \eta^c$$

$$\eta = (-1)^{\sum \hat{u}^c a^c} \to \eta^c = (-1)^{\sum \hat{v}^c v^c}$$

影津春男：非局所場　(素研 24(1961), ~~No.~~ 12月: No. 3, No. 4)
荒紙：　Jan. 24, 1962

統一描像
物認性
因果性
形状因子理論 { 非局所性 / 因果性

$(\Box - \kappa^2)\psi(x_\mu, \xi) = 0$　　$\xi = \xi_1 \cdots \xi$

$f_i\left(\frac{1}{i}\frac{\partial}{\partial x_\mu}, \xi, \frac{\partial}{\partial \xi}\right)\psi(x,\xi) = 0$

$$\psi(x,\xi) = \int \phi(k\xi)e^{ikx}(dk)$$

$$= \int \sum_\rho a(k,\rho)F(k,\rho,\xi)e^{ikx}(dk)$$

$$f_i\left(k, \xi, \frac{\partial}{\partial \xi}\right)F(k,\rho,\xi) = 0$$

$$\psi = \sum_{k,\rho}\frac{1}{\sqrt{Vk_0}}\left[a(k\rho)F(k\rho\xi)e^{ikx} + a^*(k\rho)F(-k\rho\xi)e^{-ikx}\right]dk$$

$k_0 = \sqrt{k^2+\kappa^2}$

$$F(-k,\rho,\xi) = F^*(k,\rho,\xi)$$

$$\psi = \sum_\rho F\left(\frac{1}{i}\frac{\partial}{\partial x}, \rho, \xi\right)\sum_k\left(a(k,\rho)e^{ikx} + a^*_{(k,\rho)}e^{-ikx}\right)$$

$$H = \int H\left(\psi\ \frac{\partial\psi}{\partial t}, A, \frac{\partial A}{\partial t}\right)dV$$

$$\to \int H(\psi(x\xi), \cdots)\,dV\,d\xi$$

$$\int d\xi = \int \rho(\xi)\prod_i d\xi_i$$

$$E_0 = \sum_{k,\rho} k_0\, a^*(k,\rho)\, a(k,\rho)$$

$$\int F^*(k\rho\xi)\, F(k\rho'\xi)(d\xi) = \delta_{\rho\rho'}$$

$$* \quad \sum_{\rho} F^*(k\rho\xi)\, F(k\rho\xi') = \delta(\xi-\xi')$$

Y^*について　植松(?)

Feb. 6, 1962　基研談話会

	m	$\Gamma/2$	T	J	P
Y_1^*	1385 MeV	~20	1	3/2	+ ?
Y_0^*	1405 MeV	~20	0	?	?
Y_0^{**}	1520	~8	0	3/2	K^-p even
$Y_{1\text{ or }2}^{**}$	1565	?	1 or 2	?	?
Y_0^{***}	1813	?	0	?	?

Y_1^*
$$K^- + p \to \Lambda + \pi^+ + \pi^- \quad (\to Y_1^* + \pi)$$
p_K : 405 MeV/c ~ 1150 MeV/c

$\Sigma/\Lambda < 10\%$ for 850 MeV/c

$< 20\%$ for 760 〃

$\Sigma/\Lambda = 0$ と consistent

Y_0^{**}

$K^- + p \to \begin{cases} K^- + p & \Lambda + 2\pi \quad I=0 \\ \bar{K}^0 + n & \Sigma\pi \quad I=0 \end{cases}$

p_K : 250 ~ 520 MeV

$\bar{K}N : \Sigma\pi : \Lambda 2\pi$

$= 3 : 5 : 1$

Y_0^{**} resonance で, Y_1^* はない

Y_0^*

$K^+ + p \to \Sigma + 3\pi$　1.1 BeV/c

$\to \Sigma + 2\pi$　0.8 BeV/c

single channel dynamics

a) 3-3 type　πY-channel $\begin{cases} \text{global symm.} \quad T=0 \quad \times \\ f_\Lambda^2 \gg f_\Sigma^2, \ T=0. \end{cases}$

b) $\bar{K}N$ bound state　$\bar{K}N$-channel

Multi-channel dynamics
a) cusp
b) Ball-Frazer
c) ———

Fubini　　Glashow $\xrightarrow{\text{isospin}}$ doublet
ρ_1, ω_0 → or charge indep or violation
Y_1^*, Y_0^*

[illegible]

片山氏

Feb. 12, 1962

Series					T	S
核子	N	N^*	N^{**}		$1/2$	0
励核	N_1	N_1^*	N_1^{**}		$3/2$	0
Λ	Λ	(Y_0^*)	Y_0^{**}	Y_0^{***}	0	-1
Σ	Σ	Y_1^*	$Y_{1(\mathrm{or}\,2)}^{**}$		1	-1
Ξ	Ξ				$1/2$	-2
π	π	ρ	ρ_2		1	0
π_0	(π_0)	η	ω		0	0
?	ϕ	ρ_1			0	0
K	K	K^*			$1/2$	1
?	$?^{**}$				2	0

π

K

π_0

$$M = M_1 + M_2 - \Delta M_{\sqrt{2}}$$

$$\left.\begin{array}{ll} \pi_0' & \frac{1}{\sqrt{3}}(N\bar{N} - \sqrt{2}\Lambda\bar{\Lambda}) \\ \pi & N\bar{N} \\ K & N\bar{\Lambda} \\ \pi_0'' & \frac{1}{\sqrt{3}}(\sqrt{2}N\bar{N} + \Lambda\bar{\Lambda}) \end{array}\right\} \text{full symmetry}$$

$$\frac{3+4\vec{J}_1\cdot\vec{J}_2}{4}\Delta M' = \frac{1}{2}J(J+1)\Delta M'$$

$$\Delta M' = 450\,\mathrm{MeV}$$

$$4\vec{T}_1\cdot\vec{T}_2\,\frac{3+4\vec{J}_1\cdot\vec{J}_2}{4}\Delta M''$$

$$\Delta M'' = 200\,\mathrm{MeV}$$

Σ $s_{1/2}$	Y_1^*	$\underline{p_{3/2}}$	Y_1^{**}	$d_{5/2}$
	Y_0^{**}	$\underline{d_{3/2}}$	Y_0^{***}	$f_{5/2}$
	N^*	$\underline{d_{3/2}}$	N^*	$\underline{f_{5/2}}$
	N_1	$\underline{p_{3/2}}$	N_1^*	$\underline{d_{5/2}}$

Σ : $(1-P_{N\bar{K}}^{\Sigma})^{1/2}\Lambda\pi + (P_{N\bar{K}}^{\Sigma})^{1/2} N\bar{K}$

$\cancel{\frac{1}{4}}\vec{\tau}_1\vec{\tau}_2 \left\{ \begin{array}{l} \cancel{\frac{3+4\vec{J}_1\vec{J}_2}{4}\Delta M' - \Delta M''} \\ \vec{J}_1\vec{J}_2\Delta M = \frac{1}{8}\left(J(J+1) - L(L+1) - \frac{3}{4}\right) \end{array}\right.$

$\times \vec{\tau}_1 \vec{\tau}_2 \Delta M$

$\Delta M = 400$ MeV

<u>or</u>

$\frac{1}{4}\left(J(J+1) - L(L+1) - \frac{3}{4}\right)$

$\times\left[T(T+1) + \frac{1}{4}S^2 - \frac{7}{4}\right)\Delta M$

$\Delta M \sim 400$ MeV

group

						MeV
0^+	ϕ	?	ρ_1			
0^-	π	(π_0)	K		$\pi \leftarrow 5 \rightarrow K$	] 450 ~ 500
1^-	η	ω	K^*			] 700 ~ 750
	ρ_1	ρ_2				
$1/2$	N	Λ	Σ	Ξ	$\leftarrow 5 \rightarrow$	1142
$3/2$	N_1	Y_1^*	(Y_0^*)	N^*	Y_0^{**} $\leftarrow 5 \rightarrow$	1400
$5/2$	Y_1^{***}	N_1^*	N^{**}	Y_0^{***}	$\leftarrow 3.5 \rightarrow$	1650

Okubo formula

$$M = a + b\,T(T+1) + cS^2 - dSN$$

$$c = -\frac{1}{4}b$$

$$M(K) = \frac{3M(\pi_0) + M(\eta)}{4}$$

$$\frac{M(N)+M(\Xi)}{2} = \frac{3M(\Lambda)+M(\Sigma)}{4}$$

d. w. G.:　　　　　　　　　　　　　　　　Feb. 14, 1962

(2体)

$$\frac{\Gamma}{2} \sim \frac{1}{2\pi}\overline{|R'|^2}\,\frac{q}{m_\alpha^2}$$

$$\overline{|R'|^2} = \frac{1}{2l_\alpha+1}\sum|R|^2(\pi\omega_f\cdots\omega_\alpha)$$

$$R = (2\pi)^4\delta(p_\alpha - p_f)S_{f\alpha}$$

$$S = g m \int \phi_{f_1}^* \phi_{f_2}^* \phi_\alpha \, dx$$

$$\frac{\Gamma}{2} \sim \frac{C' q^2}{4\pi}\left(\frac{m_\alpha}{(2l_\alpha+1)\cdot\cancel{4}}\right)\left(\frac{q}{m_\alpha}\right)^{2l_\alpha+1}\cancel{\left(\frac{m}{m_\alpha}\right)^{2}}^{-2l_\alpha}\cdot c$$

ζ　　~~+~~6 MeV

ρ_2　　8

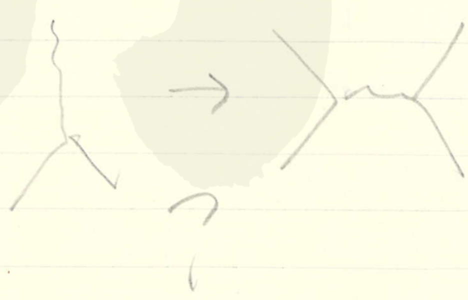
φ　　70

ρ_1　　150

(3体)

η　　1^-

ω



S.C. Frautschi, M. Gell-Mann
F. Zachariasen

Feb. 26
1962

Experimental conseq. of Hypothesis
of Regge poles (Preprint)

[illegible]

Pomeranchuk

素粒子の理論研究会.
March 19 ~ 22, 1962 基研.

small groups
(i) many body　　　　　　　　会議室
(ii) weak interaction
(iii) symmetry　　　　　　　　~~サロン~~ 小講義室
(iv) super high energy　　　　→ コロキウム室
(v) mass formula

Nakamura mass formula

(iv) new theory　　　　　　　サロン
(v) indefinite;

March 19 (月) 座長 山口
ii iii : Pais: Solvay, weak Int.
1) $H' = G\, \bar{j}_\mu j_\mu$　　$G = 10^{-5} \cdot M^{-2}$

$g^2 = G \cdot L^{-2}$

$\underline{pL \ll 1}$: $g^2 \ll e^2$

$e^- + \nu \to \mu^- + \nu$: $4G^2 p^2/\pi = \pi/2p^2$

$p = (\pi^2/8G^2)^{1/4} \approx 300\,\mathrm{GeV}$ s-scatt. maximum

$K_1^{(0)} - K_2^{(0)}$ mass difference
cut: $\frac{1}{L} \approx 30\,\mathrm{GeV}$

2) (I) $\Delta S = 0$, leptonic $\pi, \mu, \beta, \Sigma^+ \to \Lambda + e^+ + \nu$
(II) $\Delta S \neq 0$, leptonic K_{l_2}, K_{l_3} $\Sigma, \Lambda \to n + p$
(III) $|\Delta S| = 1$ non-leptonic

c033-686挟込

3) 一般的性質

a) P, C - violation

(I) maximum

(II) maximum $K_{\mu 2}$

(III) $\Lambda \to p + \pi^-$

$\Sigma^+ \to n + \pi^+$ (X)

max. viol. は一般的でない..

b) CP, T - invariance

(I) $\pi \to \mu \to e$ CP yes ; β-decay

(III) $\Sigma^+ \to p + \pi^0$, $\Lambda \to p + \pi^-$) α 大

(II)

c) CPT - invariance

$K^\pm$ decay lifetime

$\pi^\pm$ 〃

d) two component neutrino (mass 0, mag. mom. 0)

$\langle \beta | S | \alpha \rangle = \langle \alpha | S | \beta \rangle$

e) local action of lepton currents

$K \to \pi e \nu$ ← ~~(V-A current)~~

h.e. ν-physics

f) lepton conservation

n_l: +1 μ^-, e^-, ν

−1 $\mu^+, e^+, \bar{\nu}$

(II) ?

g) μ-e universality

(III) K_{e2}? $K_{\mu 3}$, K_{e3}

high energy?

4) class (I) V-A law. conserved vector currents.

$$G_V^{(\mu)} = G_V^{(e)} = G_F$$

$$\mathcal{J}_\lambda = J_\lambda + j_\lambda^{(e)} + j_\lambda^{(\mu)}$$

high energy ?

5) class (III) $|\Delta S| = 1$ and $|\Delta T| = 1/2$

$|\Delta S| \neq 2$ $K_1^0 - K_2^0$

$|\Delta T| = 3/2$?

asym.

$$\Delta T = 1/2 \left\{ \begin{array}{l} \Sigma^+ \begin{cases} \to p + \pi^0 & \text{O} \\ \to n + \pi^+ \text{ (s-wave)} & \times \end{cases} \\ \Sigma^- \to n + \pi^- \text{ (p-wave)} \quad \times \end{array} \right.$$

6) class (II) $\Delta S / \Delta Q$ and related rule.

$\Delta S / \Delta Q = +1$

$= -1 \to |\Delta T| = 3/2$

$$|\Delta T| = 1/2 \to \frac{K^0 \to \pi^- e^+ \nu}{K^+ \to \pi^0 e^+ \nu} = 2$$

$\Delta S / \Delta Q = -1$!!! Fry

7) Attempts toward synthesis

$$\mathcal{J}_\lambda = J_\lambda + S_\lambda + j_\lambda^{(e)} + j_\lambda^{(\mu)}$$

$\Delta S / \Delta Q = -1$ $\times$

$|\Delta T| = 1/2$ $\times$

$J_\lambda : S_\lambda$ $n_p : \Lambda_p$ $\times$

8) A crucial $K^0 \to$ experiment

$K^0 \to \pi^+ + e^- + \nu$

$\quad \to \pi^- + e^+ + \nu$

9) $W^\pm$, W^0, $W^{0'}$

$\nu + (Z) \to W^+ + e^- + (Z)$ } star

$\dfrac{\mu \to e + \gamma}{\mu \to e + \nu + \nu} \sim 10^{-5} \quad \leq 10^{-8}$

10) two-neutrino question

$\mu^0(\nu_1)$, $e^0(\nu_2)$ $\quad \bar{\nu}_1 + p \to n + e^+$?

11) conclusion

$\Delta S \neq 0$ では不明確.

近似的 conservation laws

大阪会議 : $\Delta S / \Delta Q$ Wisconsin

討論：
林（東大）：実験。

~~March~~ March 20 (火) 午後：山口。
宮沢：
大貫：Two Body — Octet

$^1S_0$　　　$^3S_1$

$\pi, K, \pi^{0\prime}$　　　$\rho\ K^*\ \omega$

$(\eta, (0^{-+}))$

$K^* \leftrightarrow \pi^{0\prime} + \pi$

η

大槻：(i) Binding Energy,

$$-V + T = B$$

$\hbar^2$
$\overline{2m}$

大　大　大

案外大

$$-\langle V\rangle_i + \langle T\rangle_i = B\int_0^R u^2 dr$$

強い大　案に大　案に大

(ii) Fundamental Force
野口：(1) hard core
(2) L·S

(3) ^1S, ^1D, ^1G の phase の相互関係

non-static

or $g^2 \xrightarrow[E\to\infty]{}$?

$N\bar{N}$ 引力

NN 斥力 → hard core $\sim \frac{2}{M}$

for $^1S_0$ (π)

+ α short range の斥力

1 BeV $^1S_0 = -1.1$

-0.7

LS. ^3P

T=1 : meson V (∼) : better $^3S_1$

pV (pV) $^3P_1$

$N\bar{N}$?

ρ, K^*, ω

$N\Lambda$: 斥力大.

上田(九大) : Bosonism

p-p 散乱における one boson exchange model

1. $\pi + B_1 + B_2 + \cdots$

2. one particle exchange

OBEP : S, V $m = 4m_\pi$

potential でなく perturbation

(non-static を入れる, くりかえしは考えない)

Schrödinger 方程式はすてる?

unitarity ? $S = \dfrac{1 + i\frac{T^{(1)}}{2}}{1 - i\frac{T^{(1)}}{2}}$

1, $\pi + S(m_s = 4m_\pi) + V(m_V \mp 4m_\pi)$
2, $\pi + S(m_s = 3m_\pi) + V(m_V \fallingdotseq 4m_\pi)$

	$(g_s)^2$	$(g_V^V)^2$	$(g_V^T)^2$
OBEC $m_s=4$	5.15	1.04	1.14
OBEP $m_s=4$ $m_V=4$	5.0	2.37	2.2

V : $m_V \gtrsim 4m_\pi$
S : $3m_\pi < m_s < 4m_\pi$

第12 small group (ii)
Nakamura : lepton theory

K. Fujii (北大) : C 導入 Fermi int.
Katayama : 第 { F 内

Sugano :

Matsumoto :

Katayama:
2体系:
$T=1$: $N\bar{N}$
$T=0$: $\frac{1}{\sqrt{3}}(N\bar{N} - \sqrt{2}\Lambda\bar{\Lambda})$
$T=\frac{1}{2}$: $N\bar{\Lambda}$

$$M = M_1 + M_{\bar 2} - M_{1\bar 2}$$

$$M_{N\bar\Lambda} = \frac{M_{N\bar N} + M_{\Lambda\bar\Lambda}}{2}$$

$$M = \frac{2K+L}{3} - \frac{K-L}{3}\left(T(T+1) - \frac{S^2}{4}\right)$$ basic formula

$$L = 2M_N - M_{N\bar N}$$

$$K = 2M_\Lambda - M_{\Lambda\bar\Lambda}$$

$$\Delta_0 M = b_0 \vec{T}_1 \vec{T}_2 = \frac{b_0}{4}\left[T(T+1) + \frac{S^2}{4} - 1\right]$$

0^- $\quad M + \Delta_0 M$

$$\Delta_1 M = a_1 + b_1 \vec{T}_1 \vec{T}_2 = a_1 + \frac{b_1}{4}\left[T(T+1) + \frac{S^2}{4} - 1\right]$$

1^- $\quad M + \Delta_1 M$

70 MeV:	π	K	η
	2	7	8
	ω	ρ	K^*
	11	11	12.5~13

$$M(\omega) = M(\rho)$$

$$M(K^*) = M(\rho) + 2$$

3体系

$T = 1/2$ $\quad \frac{1}{4}\left[N(N\bar N)_1 + \sqrt{3}\, N(N\bar N - \sqrt{2}\,\Lambda\bar\Lambda)_0 + \sqrt{6}\,\Lambda(N\bar\Lambda)_{1/2}\right]$

$T = 1$ $\quad$ - -

- - -

$$M = M_1 + M_2 + M_{\bar{3}} - M_{12} - M_{2\bar{3}} - M_{1\bar{3}}$$

$$M = \left(M_\Lambda + \frac{1}{2}(K+L)\right) - \frac{1}{4}(K-L)\left(T(T+1) - \frac{3}{4}(S+N)^2\right)$$

$$- \left(M_\Lambda - M_N - \frac{3}{8}(K-L)\right)(S+N)N$$

$K = L = 0$

$$M = M_\Lambda - (M_\Lambda - M_N)(S+N)N$$

$$M_\Lambda = M_\Sigma$$

$$M_\Xi = 2M_\Lambda - M_N = 18.5$$

$$\Delta_{1/2} M = b_{1/2} \vec{T}_1 \vec{T}_2$$

$$= \frac{b_{1/2}}{2}\left[T(T+1) - \frac{3}{4}(S+N)^2\right]$$

$$M_{1/2} = M + \Delta_{1/2} M$$

Y_1^* N_1 $\rho_{3/2}$

Y_0^* N^* $a_{3/2}$

$$M = a + bT(T+1) + c(S+N)^2 + d(S+N)N$$

$$M_{1/2} - M_{3/2} = \frac{3}{2}(M_0 - M_1)$$

N_2 N_1 Y_0^{**} Y_1^*

Sugawara:

$$\left.\begin{array}{l} f^2(NN\pi) = f^2(\Lambda\Sigma\pi) = 15 \\ f_2(\Sigma\Sigma\pi) = f(\Xi\Xi\pi) = 0 \\ g^2(\Lambda NK) = g^2(\Lambda\Xi K) \approx 1 \sim 3 \\ g(\Sigma NK) = g(\Sigma\Xi K) = 0 \end{array}\right\}$$

$\Sigma = (\Lambda\pi)$

$\Xi = (\Lambda\bar{K})$

$\bar{\mu} O \mu \chi$, $\bar{\Lambda} O \Lambda \chi$

μ or ν.

$f_\chi^2 \simeq e^2$ $\quad m_\chi \cong M_N$

Takabayashi: Oscillator model

baryon octet

meson octet

$$\left.\begin{array}{l} [a_\alpha, a_\beta^\dagger] = \delta_{\alpha\beta} \\ \{b_\alpha, b_\beta^\dagger\} = \delta_{\alpha\beta} \end{array}\right\} \quad \alpha, \beta = 1, 2$$

dichotomy

$T_i = \frac{1}{2} a^\dagger \tau_i a$

$Y = b^\dagger \tau_3 b$

$V_i = \frac{1}{2} b^\dagger \tau_i b$

$a_\alpha^\dagger a_\alpha - b_\alpha^\dagger b_\alpha = 0$

$[V_i, V_j] = i \varepsilon_{ijk} V_k$

$V_i V_j = \frac{1}{2} i \varepsilon_{ijk} V_k \qquad i \neq j$

$W_i = T_i + V_i$

$W_3 = Q = \frac{1}{2}(N_1 - N_2 + M_1 - M_2)$

$= n_1 - m_2 = m_1 - n_2$

physical operator: $a^+a - b^+b$ と commutable なもの.

$$\begin{array}{ccc} a & - & a^+ \\ | & & | \\ b & - & b^+ \end{array}$$

$$T^+ = \begin{pmatrix} 0 & & & \\ & 1 & & \\ & & 1 & \\ & & & \sqrt{2}\ \sqrt{2} \end{pmatrix} \quad \begin{array}{ll} \Lambda & \pi^0 \\ N & K^+ \\ \Xi & K^0 \\ \Sigma & \pi \end{array}$$

a^+a

b^+b

$a\ b$

a^+b^+

$\psi_p(n, m, x_\mu)$

$\psi^* A \psi$

$\langle A \rangle_B = \int \psi^* A \psi \, d^3x$

$[\langle A \rangle_B, \psi] = -(A\psi)$

$e^{-i\theta\langle T_i \rangle} \psi_{nm} e^{i\theta\langle T_i \rangle} = (e^{i\theta T_i}\psi)_{nm}$

$\varphi_{nm}(x_\mu)$

$\varphi_{nm} \to \tilde{\varphi}_{nm} = (-1)^{q} \varphi_{\underset{\sim}{n}\underset{\sim}{m}}$

$\varphi^* = \tilde{\varphi}$

$\rho_A = \frac{1}{2i}(\dot{\varphi}^* A \varphi - \varphi^* A \dot{\varphi})$

$\hat{A}_{nm,n'm'} = (-1)^{q-q'} A_{\underset{\sim}{n}'\underset{\sim}{m}', \underset{\sim}{n}\underset{\sim}{m}}$

$\hat{A} = -A$

$\hat{a} = \zeta a^\dagger$ $\qquad \zeta = \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix} = i\tau_2$

T_i, V_i : odd

$1, N_1 + N_2$: even

$S = \langle Y + 1 \rangle_M = \langle Y \rangle_M$

$\langle T_i \rangle_M = \int \rho_{T_i} \, d^3x$

$K = \begin{pmatrix} K^+ \\ K^0 \end{pmatrix} = \begin{pmatrix} (b_1 a_1 \varphi)_0 \\ (b_1 a_2 \varphi)_0 \end{pmatrix}$

March 21 (木):
田中君: Indefinite
gupta
unitarity O.K. ?
convergence O.K. ?

$$G\,\bar{\Psi}_e \psi_e (B_\mu + B_{\mu'})^2$$
$$\qquad\qquad\quad (-)\qquad (+)$$

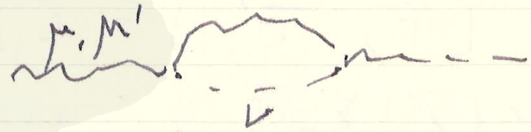
$$\psi_e \to \psi_e + \cdots + \cdots + \cdots = \Phi_\nu$$

$$B_\mu + B_{\mu'} = F$$

$$\mu \to \mu' + \nu$$
$$(-)\quad (+)\quad (+)$$

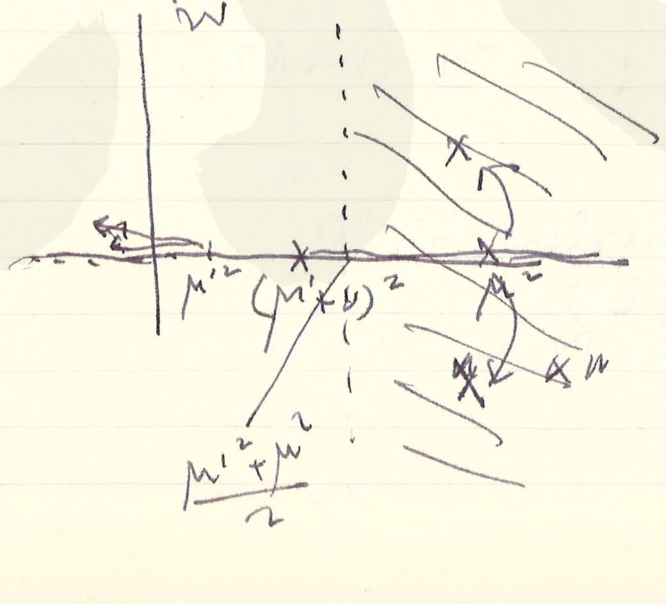
不安定性

$$\Delta_F^{c'}(x) = \Delta_F^{c}(x) + \iint \Delta_F^{c}(x-x')\Sigma(x'x'') \times \Delta_F^{c'}(x'')\,dx'dx''$$



$\Delta_F^c(\underbrace{-p^2}_{w})$　　$-p^2 = w$

complex pair



$|\alpha\rangle \qquad |\alpha^*\rangle$

$E_\alpha \qquad E_\alpha^*$

real energy → real + $E_\alpha = E_\alpha^*$

Lee model : yes

rel. field theory : no

$(\Box - \mu^2)(\Box - \mu^{*2})F(x) = 0$

$[F, F'] = iD$

$\psi(x, \xi_\mu) \qquad x_\mu \xi_\mu = \mathrm{const.}$

causality : 近似にwo

Takano : Finsler 空間.

$g_{\mu\nu}(x, l)$

Horvath, N.C.

Imoto;

$p \mid n$ $pe\nu$ Λ $pe\nu\eta$

$B \Uparrow$

$\nu \overset{\Rightarrow}{\Sigma} e \to \mu : e\eta$

$\Sigma : \Sigma : \eta$

α- decay $\longleftrightarrow$ $n - \Lambda$

$p\ e$ 斥力

$p\ \bar{\nu}$ 引力

Miyatake, geon

全12: Small group の討論の報告.

報告者: [illegible]エネルギー

H-quantum

1) mass $2Mc^2$

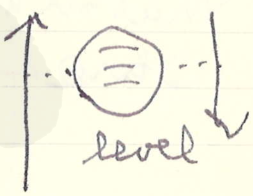
2) Lorentz factor の[illegible]

3) decay dipole type

4) [illegible]がない

5) $+, -, 0$ がある.

$\sigma_{jet} \sim \frac{1}{\mu^2}$

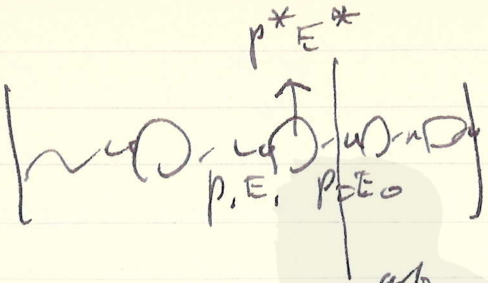


FNYH log tan θ

$\langle \Delta p^2 - \Delta E^2 \rangle$ $\sum \tan \theta_{i1} \sum \frac{1}{\tan \theta_{i2}} \cdot p_T^2$

$\langle \Delta p^2 - \Delta E^2 \rangle^{1/2} \sim 1$ BeV

virtuality const.



対数

$$2p_0p^* = m_H^2 \qquad p_0 = \frac{m_H^2}{2p^*} \sim 1\,\mathrm{BeV}$$

$p^* \to \tilde{\gamma}_H \to 1.5$

$\to 7$

$\to 4.0$

荘野([illegible])：[illegible]
normal mode

Yamazaki : Tamm-Dancoff

$$H = \frac{1}{2}(p^2 + \omega_0^2 q^2) + \frac{\lambda}{4} q^4$$

$\omega_0 = 0$

Ohnuki
(i) Gell-Mann
(ii) Matsumoto
(iii) Obarada

March 22 (木)

宇多

碇: Regge pole

analyticity
unitarity) 4体で Mandelstam

potential scattering : $\int dt\, v(t) \frac{e^{-\sqrt{t}\, r}}{r}$ (acausal)

bound state

Regge:

$$\left(\frac{d^2}{dx^2} + E - \frac{l(l+1)}{x^2} - V(x)\right)\psi(E, l, x) = 0$$

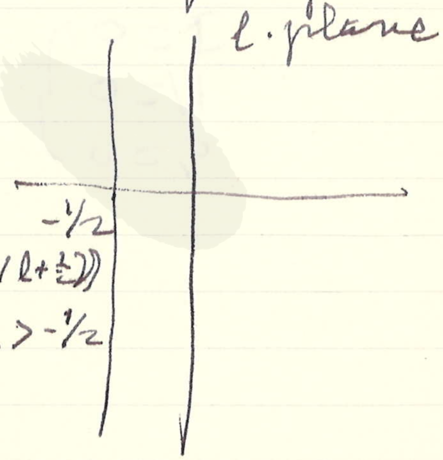
Y_l^m $\quad \psi(E, l) \xrightarrow[x\to 0]{} c\, x^{l+1} \quad l > -\frac{1}{2}$

x^{-l}

$\xrightarrow[x\to\infty]{} \sin\left(k r - \frac{\pi l}{2} + \delta(l)\right)$

$S_E(l) = e^{2i\delta(l)}$

(1) $S(l)$: $\mathrm{Re}\, l > -\frac{1}{2}$ simple pole を除いて regular analytic



(2) 下半平面に pole なし.

(3) $S(l) - 1 = O\left(\exp(-a|l+\frac{1}{2}|)\right)$

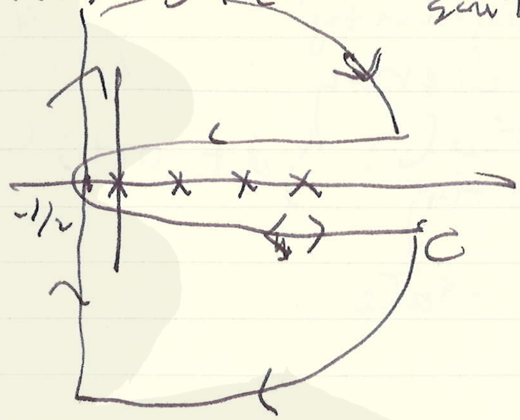
$|l| \to \infty \quad \mathrm{Re}\, l > -\frac{1}{2}$

$\cosh \alpha = 1 + \frac{\mu^2}{2E} > 1$

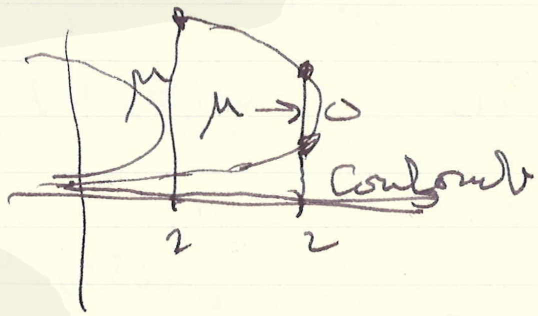
μ: min. mass appearing in $v(t)$

$$T(s, \overset{z}{\overset{\shortparallel}{\cos\theta}}) = \frac{1}{2i\sqrt{E}} \sum_{l=0}^{\infty} (S(l)-1)\, P_l(z)(2l+1)$$

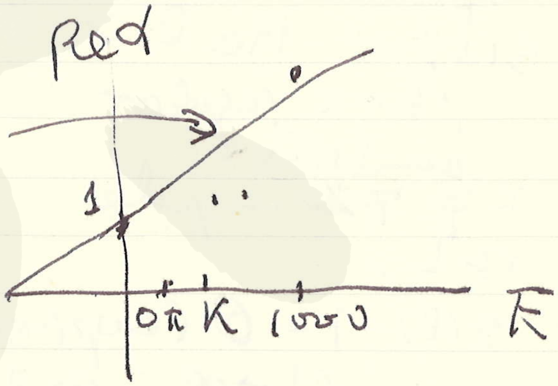
$$= \frac{1}{4\sqrt{E}} \int_C dl\, [S(l)-1]\, P_l(-z)\, \frac{2l+1}{\sin \pi l}$$



$$P_l(z) \xrightarrow[z\to\infty]{} z^l$$



$$\left.\begin{array}{l} I=0 \\ N=0 \\ q=0 \end{array}\right\}$$



それは　前の討論会.
[illegible]:
Janossy ; Lorentz 変換.
Ann. d. Phys.
場の　space-time description

小川

第[illegible]回 [illegible]研究会

[illegible]・山田・[illegible]・[illegible]
中野・[illegible]・[illegible]
京大 田中 [illegible]（[illegible]）

March 28, 1962

午後

[illegible]氏：最近の実験の報告

1) $\mu^+ \to e^+ + \gamma$ +1 Berkeley, Columbia

2) $\mu^- + N \to N + e^-$ +1

3) $K_0 \to \pi^+ + e^- + \bar\nu$ } $\Delta S/\Delta Q = -1$
$K_0 \to \pi^- + e^+ + \nu$ } Fry

4) $\pi \to \mu + \nu'$ $\nu' + N \to N' + \mu$ 10^5
(12~15 BeV) $\not\to N' + e$ 0^5

1) $\mu^+ \to e^+ + \gamma$ $\mu^+ \to e^+ + \nu + \bar\nu + \gamma$

spark chamber

$$R = \frac{\mu^+ \to e^+ + \gamma}{\mu^+ \to e^+ + \nu + \bar\nu} = 0.8 \times 10^{-8}$$

$R < 6 \times 10^{-8}$ 90% confidence

(P.R.L. Feb. 1, 1962)

2) $\mu^- + N \to N + e^-$ (P.R.L. ibid.)

$$R = \frac{\mu^- + (A, Z) \to \overset{103.8\,\mathrm{MeV}}{e^-} + (A, Z)}{\mu^- + (A, Z) \to \nu + (A, Z-1)} = (1.6 \pm 0.8) \times 10^{-7}$$

$R < 2.4 \times 10^{-7}$ 90% conf.

3) $\Delta S/\Delta Q = -1$ (P.R.L. ibid.)

790 MeV/c $K^+ \to K^0$ Bubble Chamber

2894

$K_1^0 \to 2\pi$ 5613

$x = 0.55 {+0.08 \atop -0.12}$

4) Iso letter

30 BeV　$\pi \to \mu + \nu \to \frac{12\sim15}{2}$ BeV ?

12~15 BeV

$\nu + \mathfrak{N} \to \mathfrak{N} + \mu^+$　10 事件

$\to \mathfrak{N} + e^+$　0 事件

坂田Q: Numerology

η　V, T $\to 3\pi$

$\left.\begin{matrix} I=0 \\ G=0 \end{matrix}\right\}$　Ps $\to 2\gamma$

$\to 2\pi + \gamma$

March 29, 1962

講　深谷Q　Lie group と symmetry

(R.M.P. Jan. 1962)

$GL(n, C)$

SU_n, O_n

simple group

| $\not\ni$　discrete) inv. ~~subgroup~~

semi-simple group

$\not\ni$　discrete) abelian ~~inv.~~ subgroup

simple Lie group

$A_n \equiv SU_{n+1}$

$B_n \equiv O_{2n+1}$

$C_n \equiv O_{2n}$　$n \geq 3$

$D_n = Sp_n$ (simplectic)

classical group

exceptional	G_2	14
	F_4	52
	E_6	78
	E_7	133
	E_8	248

root

weight　　g. r. a set

i) $SO_3(A_2)$

$$N = \left(1 + \frac{\lambda_1+\lambda_2}{2}\right)(1+\lambda_1)(1+\lambda_2)$$

$D^3(1,0)$

$D^3(0,1)$

$D^8(1,1)$

⋮

$D^N(\lambda_1,\lambda_2)$

λ_1, λ_2: 整数・[illegible]

ii) G_2

$N = (1+\lambda_1)(1+\lambda_2) \cdots\cdots$

$D^7(1,0)$ }

$D^4(0,1)$

$D^1(0,0)$

iii) $B_2 = C_2$

$N = (1+\lambda_1)(1+\lambda_2) \cdots\cdots$

Sp_2　$D^4(1,0)$

O_5　$D^5(0,1)$

$D^{10}(2,0)$

談話. 中野氏: 同位体.

$\omega_{IJ} = a_{KI} a_{LJ} \omega_{KL} \rightarrow T_{IJ}$

$\omega_{KL} \rightarrow M_{KL}$ $\qquad M_{KL} M_{KL} = T_{IJ} T_{IJ}$

O_5: $\Sigma_2 = C_2$

March 30: 午前

片山氏: neutrinos

[1]: e^0 left

$\pi^- \rightarrow e^- + \bar{e}^0$ $\qquad n \rightarrow p + e^- + \bar{e}^0$

$m(e^0) \leq$ few eV

μ^0 ~~left~~

$\pi^- \rightarrow \mu^- + \bar{\mu}^0$ $\qquad \mu^0 + n \rightarrow p + \mu^-$

$m(\mu^0) \leq$ few eV

[2] Q.N.

$-Q = N(e^-) + N(\mu^-)$

$n_\mu = N(\mu^-) + N(\mu^0)$

$n_e = N(e^-) + N(e^0)$

lepton number $\left\{ \begin{array}{l} L_+ = n_e + n_\mu \quad (e^- e^0 \mu^- \mu^0) \\ \text{or } L_- = n_e - n_\mu \quad (e^- e^0 \mu^+ \bar{\mu}^0) \end{array} \right.$

$\left. \begin{array}{l} e^0 = \frac{1+\gamma_5}{2}\nu \\ \bar{\mu}^0 = \frac{1-\gamma_5}{2}\nu \end{array} \right)$ only if $m(e^0) = m(\mu^0) = 0$

$\mu \nrightarrow 3e$ $\times$ L_-

$\mu \to e + \gamma$ λ (L_+) + charged current
$(L_-,)$

L_+: $\hat{j}_\mu = \bar{e}^0 O_\mu^+ e + \bar{\mu}^0 O_\mu^+ \mu$

L_-: $\hat{j}_\mu = \bar{e}^0 O_\mu^+ e + \bar{\mu}^+ O_\mu^- \mu_{\bar{0}}$

1. Nagoya model の修正が可能か.
2. $|\Delta I| = 1/2$ rule をいかに出すか.
3. $\Delta Q/\Delta S = \pm 1$ がどうでるか.

Model I. T-M

$$\begin{array}{ccccc} & e^- & e^0 & \mu^0 & \mu^- \\ & & \nu_1 & \nu_2 & \\ B^+ & \downarrow & \downarrow & \downarrow & \downarrow \\ & n & p & V^+ & \Lambda \end{array}$$

$\frac{\Delta Q}{\Delta S} = +1$

$\Delta I = 1/2$ appr. ← neutral current

Model II. Yamada

$$\begin{array}{ccccc} & e^+ & e_{\bar{0}} & \mu_{\bar{0}} & \mu^+ \\ B^0 & \downarrow & \downarrow & \downarrow & \downarrow \\ & p & n & \Lambda & V \end{array}$$

Model III.

e^- e^0 $\mu_{\bar{0}}$ μ^+

B^+

n p Y^0 Σ^+ Σ^- Σ^0 Ξ^- Ξ^0

$\frac{\Delta S}{\Delta Q} = \pm 1$

$$\begin{array}{ccccc} & \Omega & \Sigma^0 & \Xi^0 & \Xi^- \\ B^0 & \uparrow & \uparrow & \uparrow & \uparrow \end{array}$$

Model IV.

$$\begin{array}{ccccc} & e^- & \nu_1 & \nu_2 & \mu^- \\ B^+ & \downarrow & \downarrow & \downarrow & \downarrow \\ & n & p & Y^0 & Y^0 \end{array}$$

記：
中野氏

五次元
$D(L_1, L_2)$

H_1　H_2

$\frac{1}{2}\gamma_4$　$\frac{1}{2}\sigma_3$

$L_1 \geq L_2$

四次元
$\vec{M}_\pm = \frac{1}{2}(\vec{m} \pm \vec{n})$

$D(L_+, L_-)$

回転に對稱又は不對稱

L_+, L_-　反転に對稱、不對稱

4次元	Degree	5次元	Degree
$\{D(1/2, 0)$	2	$D(1/2, 1/2)$	4
$D(0, 1/2)$	2	$D(1, 0)$	5
$D(1/2, 1/2)$	4	$D(1, 1)$	10
$D(1/2, 1)$	6	$D(3/2, 1/2)$	16
$D(1, 0)$	3 self-dual tensor	$D(3/2, 3/2)$	20
$D(1, 1)$	9	$D(2, 0)$	14

$$D^5(3/2, 1/2) = D^4(1, 1/2) \oplus D(1/2, 1) \oplus D^4(1/2, 0)$$
$$+ D(0, 1/2)$$

$$a + bY_3 + cY_3^2 + dT(T+1) + eY(Y+1)$$

$b = 3$　　$a = 13$

$c = -12$　　$d = \frac{1}{2}$

$e = 10$

c033-688挟込

基研　4月8日, 1962

中村氏：
現象論的整理

素粒子の構造

1. 相互作用 2種類あり
strong: baryon ⟷ spin 0 meson

weak: lepton, baryon ⟷ spin 1 meson

2. angular momentum coupling
内部自由度
3. 剛体モデル

4. gauge transformation
fundamental field (0 mass)

chirality invariance
reflection 〃

素粒子 ⟷ 原子　　① 原子核力 ⟷ yukawa type,
isobar ⟷ 分子　　② isobar = $\left(\frac{H}{\omega}\right) + \left(\frac{H}{2\omega}\right)$

③ mass spectrum ← (ω)　(ω) ~~(ω)~~

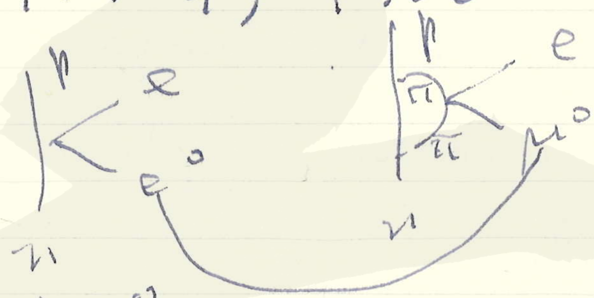
(τ, ξ)　ε　　　τ_3　λ_3

$$\left(\begin{array}{l} p = p\ n\ \Sigma^0\ \Xi^- \\ q = \Sigma^+\ Y^0\ Z^0\ \Sigma^- \end{array}\right. \quad \begin{array}{c} \frac{1}{2} \\ -\frac{1}{2} \end{array} \Big\} \ \frac{1}{2}$$

$$\left(\begin{array}{l} \nu = \boxed{e^+ e^0}\ \delta^0\ \delta^- \\ s = \mu_1^+ \mu_1^0\ \boxed{\mu_2^0\ \mu_2^-} \end{array}\right. \quad \begin{array}{c} \frac{1}{2} \\ -\frac{1}{2} \end{array} \Big\} \ -\frac{1}{2}$$

c033-689挟込

β-ray spectrum
hauger effect (1961)
$1 + b\,\overline{W}^2$
V−A からのずれ
Rehovoth Conf.
P.R. 112, 6, 2004, 2010
3, 945
119 4, 1308



$\delta K_3 = 0$

Gamow-Teller !!!

Resonance level

實驗式		T		
940	3	3/2	N_4^*	
740	2	1/2	N_3^*	
580		1/2	N_2^*	
300	3	3/2	N_1^*	

MeV
$N_4^* - N_1^* = 640$
$N_3^* - N_2^* = 160$
$\frac{N_4^* + N_1^*}{2} = \frac{N_3^* + N_2^*}{2}$

	(π)	(N)
τ	1	1/2
ζ	0	1/2

$\tau_3 + \zeta_3 = T_3 = Q$
$\tau + \tau' = T$
$\zeta + \zeta' = Z$
$\vec{T} + \vec{Z} = \vec{I}$

$x = T \cdot Z$
$y = T^2 + Z^2$
$F(x, y) = ax + by$ X

$$F(x,y) = a'x^2 + b'xy + c'y^2$$

$$M_{\Xi^-} - M_{\Xi^0} = M_{\Sigma^-} - M_{\Sigma^0}$$

$$M_{\Sigma^0} - M_{\Sigma^+} = M_N - M_p$$

岡林氏：

川口氏： High Energy limit

1) Pomeranchuk

$\sigma(A + B \text{ total}) = \sigma(\bar{A} + B \text{ total})$

(1) ~~const~~ analyticity (2) const.

$\bar{p} + p,\ p + p \to \sigma_\infty \sim 40\,\mathrm{mb}$

$\pi^- + p,\ \pi^+ + p \to \sigma_\infty \sim 30\,\mathrm{mb}$

$K^- + p,\ K^+ + p \to \sigma_\infty \sim 25\,\mathrm{mb}$

$\sigma(I = \frac{3}{2}) = \sigma(I = \frac{1}{2})$

2) I-independence

$\sigma(p + p) = \sigma(n + p)$

$\sigma(K^- + p) = \sigma(K^0 + p)$

- - -

S-matrix が high energy で I-ind.

となるか？

3) Λ, p, n

$\sigma(p + p) = \sigma(n + p) = \sigma(\Lambda + p)$

4) $\sigma(\pi^- + p) > \sigma(\pi^+ + p)$

$\sigma(\bar{p} + p) > \sigma(p + p)$

$\sigma(K^- + p) > \sigma(K^+ + p)$

谷川氏：Massとは何か.

spin　　　　mass

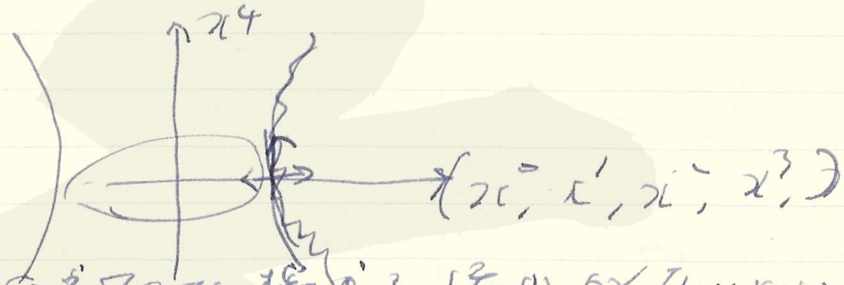
$\boxed{\text{inhomogeneous Lorentz group}}$ → discrete

↓ conti.

$\boxed{\text{de Sitter group}}$

conti.

de Sitter space



(i) 時空点の概念を捨てる[illegible]ということ
制限を置く.

(ii) x^μ, p^μ に関する交換関係を仮定.

$H_\lambda^{(1)}(r_{\underset{R}{\shortparallel}})$　　　$H_\lambda^{(1)}(r_{\underset{R}{\shortparallel}}) = 0$

↓ imag.

<u>spin 0, 1</u>

$M = m_0(2n+1)$　　$n = 0, 1, 2, \cdots$

$x^{\mu 2} = R^2$　　$p^{\mu 2} = -M^2$　$\longrightarrow \lambda \to m$

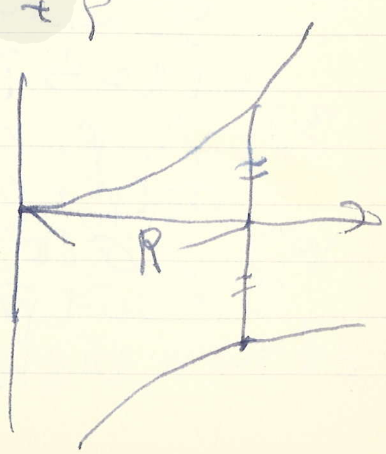
$p_\mu^2 + x^{\mu 2} \longrightarrow \frac{M^{\alpha\beta} M_{\alpha\beta}}{R} + \rho^2$

isospin
de Sitter 空間が拡がる!!!

spin 1/2:

$\alpha^\mu(\tau_1 p_\mu + i \tau_2 x_\mu)$

$+ x_\mu^2 + \tau_3(\cdot\cdot)$



(baryon
lepton

牧氏: 2-neutrinos
$\nu - \nu'$ particle mixture

$j_\mu = (\bar{e}\nu) + (\bar{\mu}\nu')$ → [illegible] $\begin{pmatrix} \nu_2 \\ \nu_1 \end{pmatrix}$ $\begin{matrix} \rightarrow \text{nothing} \\ \rightarrow p \end{matrix}$

$\gamma_\mu(1+\gamma_5)$

完全[illegible]可能 !!!

田中正氏: majorana neutrinos

Iso symmetry

$\mu^+ \leftrightarrow \Lambda$
$e^- \leftrightarrow n$
$\begin{pmatrix} \nu \\ \nu^c \end{pmatrix} = \tilde{\nu} \leftrightarrow p$

国枝氏: Two neutrinos
1961: P.T.P. 25, 4

$$Q = I_3 + \frac{S-L}{2}$$

	μ	νe	ω
S	-1	0	$+1$
I	0	$1/2$	0
I_3	0	$+\frac{1}{2}, -\frac{1}{2}$	0

$\mu^+ \rightarrow e^+ + \nu + \tilde{\nu}$
$\rightarrow e^+ + \omega + \tilde{\omega}$

基研：

Existence of $\Delta S = -\Delta Q$ leptonic Decays and a model of Weak Interaction on the Intermediate Boson Basis

by G. Takeda

April 16 '62

Exp.
1. V and/or A
2. $\Delta I = 1/2$ approx.
3. $\Delta S = \Delta Q$
4. $|\Delta S| \ngtr 1$
5. CP inv.
6. $G (\approx 10^{-5})$ の universality.

$$H_W = \sum_{\lambda=1}^{n} J_\mu^{(\lambda)} B_\mu^{(\lambda)} + h.c.$$

$\cancel{n=6}$ $\cancel{x}$ $\underline{\underline{n=3}} \rightarrow \underline{\underline{n=6}}$

basic baryon field の数: $\underline{4}$
$(p\ n\ Y_+\ Y_0)$
$(\Sigma_0\ \Sigma_-\ \Xi^0\ \Xi^-)$

basic lepton field
(ν, e^-, ν', μ^-)

Interaction of Elementary Particles with Internal Degrees of Freedom
H. Shimazu
(受稿 April 23, 1962)

一種の non-local field
$\psi(x, \xi)$

空蓋不足

Rotator Model of Elementary Particles I,
J. P. Vigier
April 25, 1962

$x_\mu(\tau)$ and $\xi_a^3(\tau)$

→ bilocal theory
simplified model
→ relativistic rotator

a_μ^{ξ} b_μ^{ξ}
L T

$x_\mu(\tau)$

bilat. group $C \to C' = ACB^{-1}$

Souriau Analytic continuation

internal kinetical gyroscope (Fukutome)

4-dimensional case
Einstein und Mayer 1932
$SL_4 \leftrightarrow SO_3^*$
$B_k^{r\pm} = b_k^r b_4^4 - b_4^r b_k^4 \pm \varepsilon_{ijk} b_i^r b_j^4$
$A_k^{r\pm} =$
two sets of complex Euler angles ω^+, ω^-
$B^+ = \Lambda(\omega^+) A^+$
$B^- = \Lambda(\omega^-) A^-$

m^+ J_3^+ i_3

m^- J_3^- $\frac{s}{2}$

m' $S_3 = J_3'^+ + J_3'^-$ $-\frac{B}{2}$

$l^+(l^++1)$ J^{+2}

$l^-(l^-+1)$ J^{-2}

$s(s+1)$ $S^2 = S_k S_k$ $s = |l^+ - l^-| \cdots l^+ + l^-$

$$Q = i_3 + \frac{s}{2} + \frac{B}{2} = -i\hbar\left(\frac{d}{d\varphi_1} + \frac{d}{d\psi_1}\right)$$

$D(l^+, l^-)$ table

quantization

proper time τ clock inside

$$a_\mu = m\dot{x}_\mu + \alpha^r b_\mu^r$$

Vigier (continued)

II. Interaction

April 20, 1962

Prectiké d'apparia

M space

$O_4 = SO_3 \times SO_3'$

$J^+ \quad J^-$

$S_k = J_k^+ + J_k^-$

Feynman's ~~diagrams~~ objection

Yang-Mills field

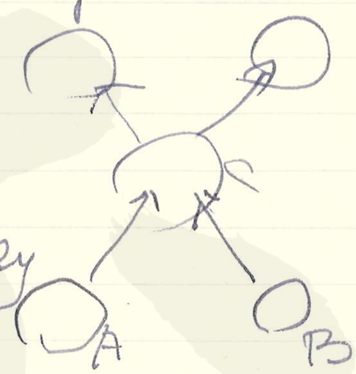
Sakurai

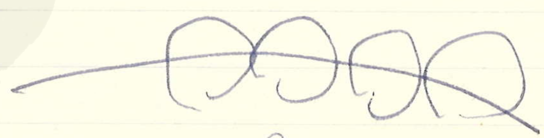
Utiyama

1) Meaning of $\alpha(x_\mu)$

2) Meaning of charge

internal variables change continuously with x_μ $\omega^\pm(-x_\mu)$ ether





3) Mass of vector meson?

$$Q = J_3^{+} + J_3^{-} - S_3'$$

$$Q\varphi = \varphi(x_\mu) q Z$$

$$Q\begin{pmatrix}\nu_e\\ e\end{pmatrix} = \begin{pmatrix}0\\ -1\end{pmatrix}$$

strong interaction ≡ invariant under total group $G = SO_3^{+} \times SO_3^{-} \times SO_3'$

J_k^{+} J_k^{-} S_k'

A_μ^{T} A_μ^{S} A_μ^{B}

$f^{T} \ll f^{S} \ll f^{B}$

Mass of Yang-Mills field

$$\vec{F}^{a}_{\mu\nu} = \partial_\mu \vec{A}^{a}_\nu - \partial_\nu \vec{A}^{a}_\mu - \frac{1}{2}\varepsilon\,\varepsilon^{a}_{bc}(A_\mu^{b} A_\nu^{c} - A_\nu^{b} A_\mu^{c})$$

Ikeda-Miyachi

$$\Box^{a}_{\mu}\vec{A}_\mu + 2\vec{A} \times \{2(\partial_\nu \vec{A}_\mu \partial_\nu \vec{A}_\mu) - 2\vec{A}_\mu \times \vec{A}_\nu\} = 0$$

effective mass?

{ Schwinger,
{ Vigier. Nuovo Cimento

$$\vec{A}_\mu = \overset{0}{\vec{A}}_\mu + \vec{A}_\mu$$

vacuum part　regular part

$$\overline{\overset{0}{A}_\mu} = 0 \qquad \overline{\vec{A}_\mu} = \vec{A}_\mu$$

$$\overline{\mathring{A}^a_\mu \mathring{A}^b_\nu} = a^{ab}_{\mu\nu}$$
$$\overline{\mathring{A}^a_\mu \mathring{A}^a_\mu} = \mu^2$$
} const.

Symposium on Gravitation
May 10 ~ May 12, 1962

May 10. (absent)
Quantization of Gravitational Fields and Geometrodynamics
(Narlikar, Hayakawa, Wheeler)

May 11:
Yukawa, Remarks

Takabayashi, N. C. 23 (1962), 222, 1155

$\{b_\alpha, b_\beta^\dagger\} = \delta_{\alpha\beta}$ $\quad \alpha, \beta = 1, 2$

n_1	n_2	
0	0	ν_e
1	0	$-\nu_\mu$
0	1	e^-
1	1	μ^-

$Q = -N_2$ $\quad m_L = \frac{3}{2} n_1 n_2$

$$\left.\begin{array}{l} b_2 = \omega_2^{(1)} + i\omega_2^{(2)} \\ \omega_2^{(3)} = -b_2^\dagger b_2 + \frac{1}{2} \end{array}\right\}$$

$$l^{(+)} = \bar{\chi}\gamma_\mu(1+\gamma_5) b_2 \chi = \bar{\nu} e + \bar{\nu}_\mu \mu$$

$[a_\alpha, a_\beta^\dagger] = \delta_{\alpha\beta}$ $\quad M_\alpha = a_\alpha^\dagger a_\alpha$

$(a^\dagger a - b^\dagger b)\,|\,\rangle = 0 \to n_1 + n_2 = m_1 + m_2$

$m_B = n_\Lambda + \mu\left(-\frac{5}{2}Y + n_1 n_2\right)$

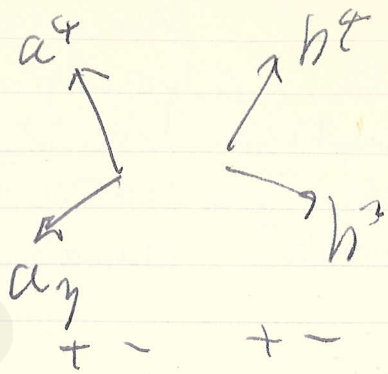
$Y = n_1 - n_2$

$= m_0 + \frac{\mu}{2}\left(t(t+1) - 5s\right)$

+ + − −

$L_3 \times L_3'$

surface wave



Vigier:

extended structure from

a) bunched solution

b) topology (e.g. worm hole)

consequence:

1) $v_\mu \nearrow a_\mu$

2) $\varphi(x_\mu, \eta)$ must be continuous!!

→ $\eta(x_\mu)$ continuous

gage group

weak interaction:

$SO_3^+ \times SO_3^- \times SO_3'$

$\underbrace{i_3 \quad S/2}_{i_3 + \frac{S}{2}}$ $\quad B/2$

$\begin{pmatrix} \nu_e \\ \mu \end{pmatrix}$ $\quad \begin{pmatrix} \nu_\mu \\ e \end{pmatrix}$

$(\Lambda)^+$ $\quad (\Lambda)^-$

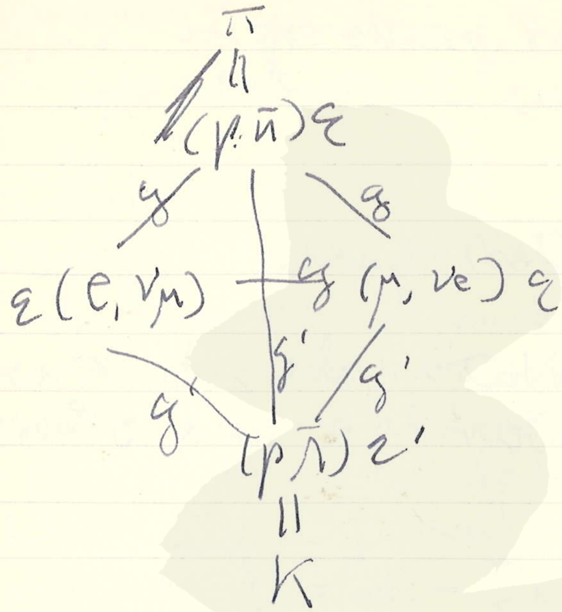
$(p, \bar{n})$ $\quad (p, \bar{n})$

$\Delta Q = -1, 0 \quad \Delta S = 1, 0$

$\Delta Q = -1, 0 \quad \Delta S = -1, 0$

Sakurai

Takeda



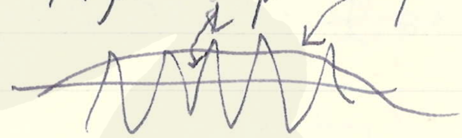
$$\left(\frac{g}{g'}\right)^2 = 10$$

$$\varepsilon\varepsilon' = g'$$

$$\varepsilon^2 = g$$

mass of YM field

$$\vec{A}_\mu = \vec{A}_\mu + \vec{a}_\mu$$



Schwinger

Nakano: Generalized Gauge Transformation

phase Trans: $\partial_\mu\psi \to \partial_\mu\psi + \frac{1}{2}(\bar{\psi}_\mu\psi - \bar{\psi}\psi_\mu)\psi$

1) Lorentz Transf.

i) $x^\mu \to x^\mu + \varepsilon^\mu(x)$ $\qquad \psi \to \psi'(x')$

$$D_k\psi = b_k{}^\mu \partial_\mu \psi$$

$$b_k{}^\mu = \delta_k{}^\mu + \varphi_k{}^\mu$$

ii) $x^\mu \to x^\mu$ $\quad \psi \to (1 + \frac{i}{4}\omega_{\mu\nu}\sigma_{\mu\nu})\psi$

$j_k \sim j_k + 4\alpha\,\partial_l f f_{kl}$

Fukutome : Ether with spin

Tanikawa : de Sitter space
1935 : Dirac
C. Møller, S. Watanabe, K. Husimi,
K. Goto, Davidson and others
Wigner
problem of mass

$$x_0^2 + x_1^2 + x_2^2 + x_3^2 - x_4^2 = R^2$$

$$S = \int p^\alpha dx_\alpha \quad (\alpha = 0, 1, 2, 3, 4)$$

$$p^\alpha \to p^\alpha + x_\alpha \Phi \quad \text{or } x^\alpha x_\alpha = R^2$$

$$p^\alpha p_\alpha = -M^2$$

$$x^\alpha p_\alpha = 0$$

$$M^2 = \frac{\Omega^2}{R^2} = m^2$$ continuous values classically

$$\frac{m_\nu}{m_e} = \frac{10^{-11}}{R} = 10^{-39}$$

antiparticle (Stückelberg)
quantum : additional condition

$$\left(p^\alpha p_\alpha + \frac{M^2}{R^2} x^\alpha x_\alpha\right) \varphi = 0$$

Schrödinger eq. :

$$-\frac{1}{2} m^{\alpha\beta} m_{\alpha\beta} \varphi + m^2 \varphi = 0$$

$$m = \frac{1}{2} M (2n+1) \quad n = 0, 1, 2, \cdots$$

May 12. Morning (absent)
Gravitational wave (Takeno, Taniuti)

Afternoon
Murai. Gravitation theory based only on the ~~bas~~ equivalence principle
no difference between inertial system and the system moving with a constant acceleration
Six dimensional formulation is necessary for linearization.
non-vanishing torsion without curvature
spherical surface

15-parameters of rotation
Nuovo Cimento

Utiyama:
(1) Quantization of G.R.
(2) Rewrite G.R. theory in a covariant form

$$\psi' = \psi + \frac{i}{2} \epsilon^{kl}(z) R_{kl} \psi$$

$$D_\mu \psi \equiv \frac{\partial \psi}{\partial \xi_\mu} - \frac{i}{2} A_\mu^{kl}(\xi) R_{kl} \psi'$$

田中正君: Indefinite metric

基研談話会　May 14, 1962

$G\,\Phi^2\phi_\nu$

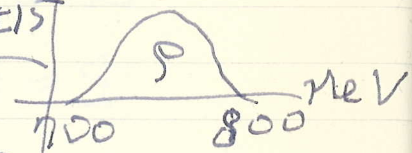
$\Phi = \phi_\mu + \phi_\mu^{*}$

ρ, Maglic, Omega etc. May 16 1962

May 1, 1961 ~ May 1, 1962

T \ J	0^-	1^-	0^+	1^+	2^+
1	π	ρ	(ζ 560)	α 625±15	
1/2	K	K^* 883	K^* 883		
0	η ↓ 550	{ω}	(ABC)		X → 1050

M 730



0	1	11

~2 BeV $\bar{p} + p \to N\pi$ $N = 2, 3, \ldots$

expects $\langle N \rangle = 3$ (stat. model)

obs. $\langle N \rangle = 5 \pm .3$

$\bar{p} + p \to (\pi\pi\pi) + \pi + \pi$

$\to (\pi\pi) + (\pi\pi) + \pi$

$\omega \to \pi^0 + \gamma$ neg. result.

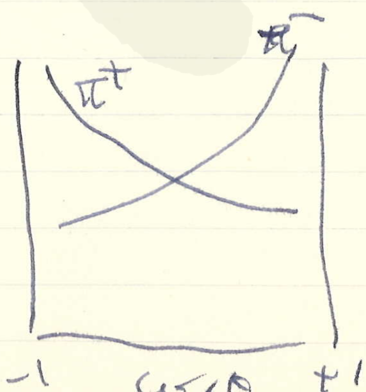
if 400 ~ 500 MeV

if larger :

$\omega \to \pi^+ \pi^- \pi^0$

$\to \pi^+ \pi^- + \gamma$

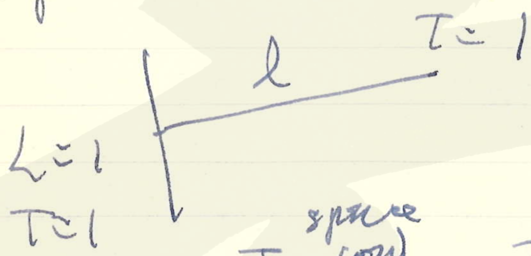
Koba and Takeda



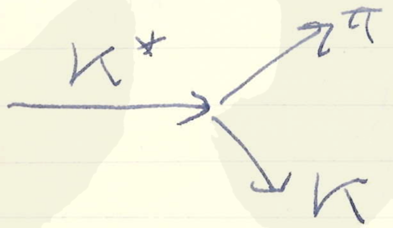
ρ-meson $\quad m_{\rho^0} \approx 725$ MeV ± 30
$m_{\rho^\pm} \approx 750$ MeV ± 50

ω-meson
$I_\omega = 0$
$M_\omega = 787$
$\Gamma \le 24$ MeV
$10^{-23} \le \tau \le 10^{-16}$ sec

spin



	space conf. J	"meson" J	
$l=0$	1^-	1^+	$\vec{p}_i - \vec{p}_j$
$l=1$	0^+ →	0^-	$E_i - E_j$
	1^+	1^-	$\vec{p}_i \times \vec{p}_j$
	$\cancel{2^+}$	$\cancel{2^-}$	



M Miller at al.
730 ± 10 MeV

ζ $\quad \pi^+ p \to p + \pi^+ \pi^0$
560 MeV

$p\,\Sigma K \pi$
$\pi^- + p \to \Lambda \pi^- K^+$
$\to \Lambda \pi^0 K^0$

α: $pp \to pp + \pi^+\pi^-\pi^0$
$\to np + \pi^+\pi^+\pi^-$
625 ± 15 MeV

780 $\omega \to 3\pi$ $G=-1$ 100
$\to 2\pi$ $G=+1$ 1–10

1780 ρ_2

$\eta \to$ neutrals $G=+1$
$\to \pi^+\pi^-\pi^0$

hyperons:
Y_0^* 1.409 MeV
$\Gamma < 40$ MeV

$$\frac{\Delta S}{\Delta Q} = +0.5 \pm 0.2$$

$$\tau_{K_2} = 3.6 \begin{matrix} +1.4 \\ -1.0 \end{matrix}$$ on the basis of $\Delta I = 1/2$

$$\tau = 6.8 \begin{matrix} +2.7 \\ -1.5 \end{matrix}$$

Rules for weak interactions
May, 1962

1. R. E. Behrends and A. Sirlin,
Phys. Rev. Letter 8 (1962), 221
(March 1)

weak int. satisfying
(i) $|\Delta I| = \frac{1}{2}$ for nonleptonic decays
of strange particles
(ii) $|\Delta S| \leq 1$ rule ~~for an~~
can be consistent with $\Delta Q = -\Delta S$.

2. G. Takeda (preprint) 1962

3. J. P. Vigier.

4. Katayama, Matsumoto, Tanaka and Yamada
preprint May 1962
Unified Models with Two Neutrinos

Possible resonance levels
with $S=+1$, $B=+1$

1. M. Ferro-Luzzi, R. D. Tripp and M. B. Watson, P. R. L. 8 (1962), 28 (Jan. 1.)

$K^- + p \to \Lambda + \pi^+ + \pi^-$

mass 1520 ± 3 MeV　　($p_K \sim 400$ MeV)

$\Gamma/2 = 8$ MeV

$I = 0$

$J = 3/2$

parity even with respect to $\bar{K} p$ ($D_{3/2}$)

branching ~~ra~~ ratio $\bar{K}N : \Sigma\pi : \Lambda 2\pi$
$= 3 : 5 : 1$