N92

XXI

NOTE BOOK

Manufactured with best ruled foolscap
Brings easier & cleaner writing

January, 1966 ~ (Tomonaga Symposium等)
July, 1966 (素領域の考え) (Charge conj の violation?)

VOL. XXI

日章 G △50

H. Y.

Nissho Note

A. Schild, Einstein 方程式
の新しい解
Jan. 6, 1966　[illegible]

Electromagnetic Mass Difference

colloq. 乾研 Jan. 19, 1966
宮城研究所.

1. cut-off or form factor + perturbation

2. symmetry

3. S-matrix 

1. Cini, 1959
Hofstadter $p - n = 0.66\,\mathrm{MeV}$
$\pi^+ - \pi^0 > 0$
$r_\pi \sim 0.46 \times 10^{-13}\,\mathrm{cm}$

Mathews, 1959
$K^+ - K^0$ Hall
$K^+ - K^0 < 0$ experimentally

$\frac{\mu}{\lambda} = 8, 9$
$K^0 - K^+ = 2.7$ $\quad$ 4.5

2. S. Coleman & L. Glashow, PRL 6 ('61), 423
Marshak

Exper.
$$\left.\begin{aligned}
\pi^+ - \pi^0 &= 4.6 \\
K^+ - K^0 &= -3.9 \\
p - n &= -1.3 \\
\Sigma^+ - \Sigma^0 &= -2.9 \\
\Sigma^0 - \Sigma^- &= -4.9 \\
\Xi^0 - \Xi^- &= -6.5
\end{aligned}\right\}$$

A. $(\Sigma^+ - \Sigma^-) - (p-n) - (\Xi^0 - \Xi^-) = 0$

B. $\dfrac{\Sigma^+ + \Sigma^- - 2\Sigma^0}{(p-n) - (\Xi^0 - \Xi^-)} = \dfrac{2.0}{5.2} > 0$

$\dfrac{(\pi^+)^2 - (\pi^0)^2}{(K^+)^2 - (K^0)^2} = -\dfrac{1}{4} < 0$

T_3^3

$$\hat{M} = M_0 - \frac{3}{2}\Delta_F Y + [I^2 - \frac{1}{4}Y^2]\Delta_D - \frac{3}{2}\delta_F Q + [\hat{K}^2 - \frac{1}{4}Q^2]\delta_D$$

T_1^1 $\quad (\pi^0, \eta)$

symmetry からは
A はよい
B はだめ

perturbation からは
B がでるのではないか

FD ration: $\dfrac{N - \Xi}{\Sigma - \Lambda} = -\dfrac{3}{2}\dfrac{\Delta_D}{\Delta_F}$, $\dfrac{\Delta_D}{\Delta_F} = 1/3$

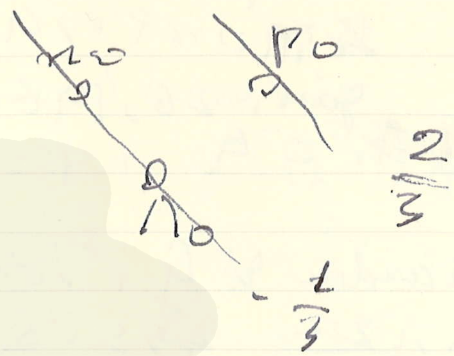
$\dfrac{\delta_D}{\delta_F} \sim \dfrac{2}{3}$

SU(6): D/F = 0 (mass)

1+2: Tadpole　scalar meson

Socolow

宮島氏:



Goldstone ~~particle~~ boson

基研コロキウム

Jan. 26, 1966

山田栄二 q

(I) 1) Y. Nambu & G. Jona-Lasinio
PR 122 235 ('61)
124 246 ('61)

(II) 1) J. Goldstone N. C. 19 154 ('61)

(III) 1) M. Yamada, PTP 32 406 ('64)

[I] 17 Nambu and Lasinio

$$L = \bar{\psi}(\gamma\partial)\psi + g(\rho_s^2 + \rho_p^2)$$

$$\rho_s = \frac{1}{2}(\psi, \bar{\psi}), \quad \rho_p = \frac{1}{2}[i\gamma_5\psi, \bar{\psi}]$$

$$\psi \to e^{i\frac{\alpha}{2}\gamma_5}\psi \qquad \bar{\psi} \to \bar{\psi}e^{i\frac{\alpha}{2}\gamma_5}$$

$$\rho_s \to \rho_s\cos\alpha + \rho_p\sin\alpha$$

$$\rho_p \to -\rho_s\sin\alpha + \rho_p\cos\alpha$$

$$\langle\rho_s\rangle_0 \neq 0 \qquad \langle\rho_p\rangle_0 = 0$$

PS: boson

(II) $$L = -\frac{1}{2}\sum_{i=1}^{2}(\partial_\mu\phi_i\partial_\mu\phi_i + \mu_0^2\phi_i^2) - \frac{\lambda}{4}\left(\sum_i\phi_i^2\right)^2$$

$\Phi = (\phi_1, \phi_2)$ $\qquad \langle\Phi\rangle_0 = 0$ ならあたり前

$\langle\Phi\rangle_0 = \varphi \neq 0 \qquad \varphi_1 \neq 0, \ \varphi_2 = 0$

$$\left.\begin{aligned}\phi_1 &= \phi_1' + \varphi_1 \\ \phi_2 &= \phi_2'\end{aligned}\right\}$$

森田正人

原子核によるμ中間子の捕獲

Feb. 1, 1966

基研談話会

V-112A　　hydrogen

Cp の前后

片山泰久: Mass Formula
基研コロキウム　Feb. 2, 1966

A Space-Time Approach to the Internal Symmetry of Elementary Particles

1. spin → ½-spin　rigid ← (?)†
2. isospin → dilatation　elastic body
hypercharge
baryonic (leptonic) charge
charge conjugation property

† (自由度を
　(運動の制限

$$\frac{1}{2} M_{\mu\nu} M^{\mu\nu} = 2\{ j_1(j_1+1) + j_2(j_2+1) \}$$

$$j = j_1 + j_2$$

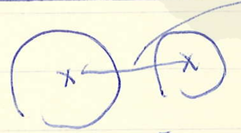
$$D(j_1, j_2)$$

$$\epsilon_{\mu\nu\rho\sigma} M_{\mu\nu} M^{\rho\sigma} = 2\{ j_1(j_1+1) - j_2(j_2+1) \}$$

charge conjugation

γ_μ^{α}　$\alpha = 1, \cdots 6$

7種類　　重心が異なる



$\left\{ \begin{array}{l} \gamma_\mu^{i} : \text{complex} \\ \gamma^{*}_{i}{}_{\mu} \end{array} \right.$　$i = 1, 2, 3$

$$a^i_\mu = \sqrt{\frac{\omega}{2}}\, r^i_\mu + i\sqrt{\frac{1}{2\omega}}\, p^{*i}_\mu$$

$$b^\mu_i = \sqrt{\frac{\omega}{2}}\, r^{*\mu}_i + i\sqrt{\frac{1}{2\omega}}\, p^\mu_i$$

$$a^{*\mu}_i = \cdots$$

$$b^{*i}_\mu = \cdots$$

boson:
8次元 (4+4次元)
particle　anti-particle

$$\frac{1}{2} M_{\mu\nu} M^{\mu\nu} = L + S + 36$$

8次元 inv.　~~4~~次元 inv

M = 8次元 inv + 4次元 inv

i, j, k - symmetry　$\frac{1}{2I} M_{\mu\nu} M^{\mu\nu}$

$e^{-i\alpha} a^\dagger,\ e^{i\alpha} a$ - inv.

$$\frac{1}{2I}\left(j_1(j_1+1) + j_2(j_2+1)\right)$$

	1	$L = 0, 2$
$\Phi^{l}_{i,\alpha\beta}$	8	$L = 0, 1, 2$

baryon

classical → boson
real

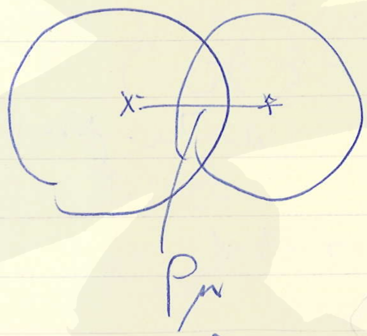
$N = 0$

$N \neq 0$

fermion

$\Psi^{lmn\cdots}$

$\Psi_{ijk\cdots}$



$$x_\mu \left\langle \begin{array}{l} X_\mu + \frac{\rho_\mu}{2} \\ X_\mu - \frac{\rho_\mu}{2} \end{array} \right.$$

$$x^i_\mu + \frac{\rho^i_\mu}{2}$$

$$x^i_\mu - \frac{\rho^i_\mu}{2}$$

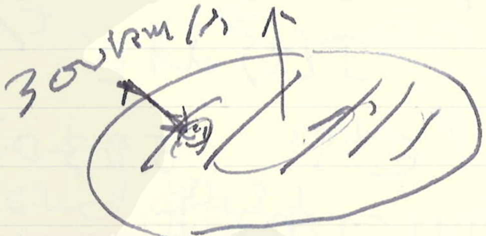
$$x^{(a)}_\mu \left\langle \begin{array}{l} x^{(a)}_\mu + \frac{\varepsilon^{(a)}_\mu}{2} \\ x^{(a)}_\mu - \frac{\varepsilon^{(a)}_\mu}{2} \end{array} \right.$$

長谷川博一　　学術講演会

宇宙線の永年変化　Feb. 15, 1966

1912年 宇宙線発見

Compton-Getting
銀河回転　周期　9×10^4 y
0.3%



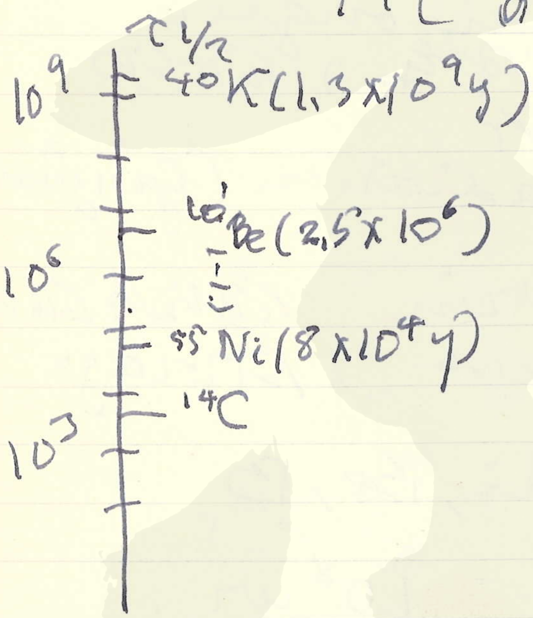
1942 solar origin
Teller, Alfven
1949 extra-solar origin
Fermi　銀河系の磁場
1950 電波天文学
synchrotron radiation (Ginzburg)
1953
Davis, Greenstein　銀河の磁場
3×10^{-6} gauss　storage
宇宙線の組成
heavy primary → Li, Be, B
C + H
storage time　10^8 yr.
anisotropy < 0.3%

Crab nebula　super nova remnant
super nova origin (Ginzburg)

interplanetary space

地球環境
大気
化石としてのこる
核破砕　spallation → 放射能
t年前　$I(t)\,dt$
現在量　$I(t)\,dt\,e^{-t/\tau}$

Libby　C^{14}　5730年(半減期)
$^{14}N(n,p)^{14}C$　年輪
エジプト遺跡　~6000年まで
^{14}C の量は constant



インド:
大気中:
岩石　^{26}Al　$^{28}Si(p,2n)^{26}Al$
海底の泥　$<2\times10^5 y$ Th.Io 法
$>2\times10^5 y$ 年代不明

$10^3 \sim 10^4$ y.
S.N. $10^3 \sim 10^4$ y.
近くで爆発したか？　$R \sim \sqrt{t}$
250 l.y.　10万年まえ
600 l.y.　1万年まえ

solar activity　700年 周期説
earth magnetic field　10^3 y

14C　年輪
1820年　屋久島の杉（木越）
1% 程度の real な変動

1949 熱残留磁気
Thellier（フランス）
永田武

和田
セコイヤの年輪　3000年前 ～ 6000年前

$\lesssim 10^6$ y　く～Tu
Arnold, Honda

$10^7 \sim 10^9$ y

galaxyの爆発　数
radio galaxy
M 82
starlike　10^{-6}
ふつうの galaxy　1

M31 アンドロメダ星雲
爆発したか？ (会津)

own galaxy の構造
石田説 東北説

0.63×10^8 y 中生代 白亜紀

2.3×10^8 y 古生代終 二畳紀

3.5×10^8 y デボン紀 石炭紀

[illegible]指導
[illegible] [illegible]現象

せりた : C. R. for Quarks
基研コロキウム (Preprint 51)
Feb. 16, 1966

SU(6)

$56 = (10, \frac{3}{2}) + (8, \frac{1}{2})$

$H = \frac{1}{2m} \sum_{i=1}^{3} p_i^2 + V(\underline{r}_1, \underline{r}_2)$

$V(\underline{r}_1, \underline{r}_2) = \frac{k}{2}(\underline{r}_1^2 + \underline{r}_2^2)$

$6 \times 6 \times 6 = 56 + 70 + 70 + 20$

excitonの数

				10	8	1
$n=0$	□□□	$L=0$	$\underline{56}$	$\frac{3}{2}$	$\frac{1}{2}$	
$n=1$	⊞	$L=1$	70, $\underline{70}$	$(\frac{3}{2})^2(\frac{1}{2})^2$	$(\frac{5}{2})^2(\frac{3}{2})^4(\frac{1}{2})^4$	$(\frac{3}{2})^2(\frac{1}{2})^2$

$[R, P] = i$

$[R, r_i] = 0$

$[R, p_i] = 0$

$[r_{1\alpha}, r_{2\beta}] = i f \delta_{\alpha\beta}$

$[p_{1\alpha}, p_{2\alpha}] = i g \delta_{\alpha\beta}$

$[r_{i\alpha}, p_{j\beta}] = i \eta \delta_{ij} \delta_{\alpha\beta}$

中西襄：B-S 方程式

基研講演会 1966. 2. 22

ladder

κ, n, l, m

$\rho = \overline{p}$

$\kappa = 0$: normal solutions

$\kappa \neq 0$: abnormal solution

non-rel. の limit で 0

[illegible]

normalization : κ : odd negative norm

(B. S. angle or p_0 の odd 部 " ")

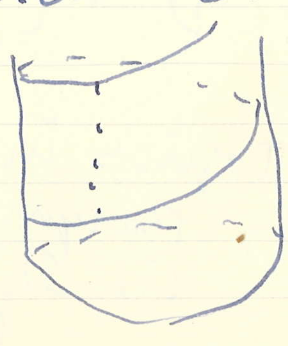
little group : k_μ を不変にする Lorentz transf.

$$\frac{\partial^2}{\partial p_\mu^2} \chi_l(p) = 0$$

$$k_\mu \frac{\partial}{\partial p_\mu} \chi_l(p) = 0$$

討論会：素粒子のperiodic table?
基研コロキウム 1966.2.23

1. (a) 化学史から
原子量の測定 (J. S. Stas (1813〜1917))
が 1860〜65 …行なわれた
W. Prout　Fe Co Ni　数値 28
1839: J. Döbereiner　Triad
Cl　Br　I　arith. mean
35.47　79.916　126.92　81.9
1850: M. J. v. Pettenkofer　8の法則
Li　7
Na　$23 = 7 + 16$
K　$39 = 23 + 16$
1852: J. B. A. Dumas
$C_nH_{2n+2} = 16 + (n-1) \times 14$
1853: J. H. Gladstone
(i) 原子量等しく　Co, Ni
(ii) 原子量近い　Pd　Pt
(iii) 等差級数
1854: J. P. Cooke　16 等多り
59　W. Odling　13 〃
64　〃　48, 16, 40, 44
4の?
(1868: He の発見)
1863: A. E. B. de Chancourtois
"Vis tellurique
16 個
$a + 16b$　$a = 7 \sim 16$



1865: J. A. R. Newlands "law of octaves"

Li Na Ka (7)

2 9 16

1869: D. J. Mendelejeff

→ 71p (J. L. Meyer: 原子容曲線)

eka B eka Al eka Si

Sc Ga Ge

(7) Rosenfeld - Glashow R. M. P. Oct. 1965

(8) SU(6)

baryon $56 = (8,2)+(10,4)$

meson $35 = (8,1)+(8,3)+(1,3)$

baryon - meson

$35 \otimes 56 = 56 + \underline{70} + 700 + 1134$

$70 = (1,2)+(8,4)+(10,2)+(8,2)$

Λ(1405) γ

baryon - 2 meson

$35 \otimes 20 = \underline{20} + 56 + \cdots$

baryon - baryon

$56 \times 56 = \underline{462+490} + \underline{1050} + 1134$

D^{+++} $(pp\pi^+)$ $M = 2520 \pm 20$ MeV

$\Gamma \sim 120$

2. Topics in 1965

1. Baryon

(i) Ω^- 3番目のevent PL 19 ('65), 152

(Birmingham, Glasgow, Imp. Coll., Munich

Oxford, Rutherford 51名)

$K^- p \to K^0 K^+ \Omega^-$

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

$\Omega^- \to \Xi^0 \pi^-$

$\Xi^0 \to \Lambda^0 \pi^0$

$\Lambda^0 \to p \pi^-$

$M_{\Omega^-} = 1666 \pm 8$ MeV

$\tau_{\Omega^-} = 1.85 \times 10^{-10}$ sec

(ii) $\Sigma(1660)$ $J^P \to 3/2^-$ 이 옳은것이냐

P. L. 18 ('65), 69 → even parity

2. f', $K^*(1405)$ Z^+ nonet

Suh Urk Chung et al. PRL 15 (1965) 325

Glashow ~~et~~ and Socolov, " 329

g $\eta(1625)$?　　A_2 $\pi(1324)$ → $\pi(1072)$?　　$\eta(1610)$?

f $\eta(1253)$　　A_1 $\pi(1072)$　　$\eta(1220)$

ρ $\pi(765)$　　ω $\eta(789)$　　X^0 $\eta(959)$

σ^0 $\eta(700)$　　η $\eta(549)$

$\pi\pi$　　3π　　$\pi\rho$　　4π　　η-2π

[illegible]: Non-Trivial Example of QFT without ~~d~~Divergence Difficulties

基研談話会. March 8, 1966

P_μ

$M_{\mu\nu}$

$P_4 = iH$ } with cut-off

M_{4l}

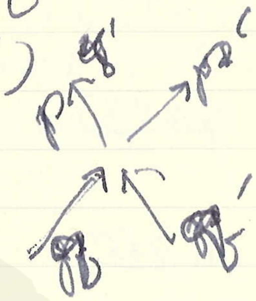
manifest invariance or [illegible]

integrability

causality

m_0 spin 0 charge 0

$[a(p), a^\dagger(p')] = \delta(p - p')$



文部省研究会 March 10, 11, 12 1966

力也会

(武藤): Internal Coordinates and Unified Wave Fn

$$\Psi(X_i\ \xi_\alpha\ t) = \sum_{J,\lambda} f_{J,\lambda}(X,t)\chi_{J,\lambda}(\xi)$$

$\alpha = 1, 2$

grand wave fn : SU(2) scalar

$$\xi_\alpha = \frac{1}{\sqrt{2}}(x_\alpha + i y_\alpha)$$

$$\pi = -i\frac{\partial}{\partial \xi} \qquad \pi^* = -i\frac{\partial}{\partial \xi^*}$$

$$[\xi_\alpha, \pi_\beta] = [\xi_\alpha^*, \pi_\beta^*] = i\delta_{\alpha\beta}$$

$SU_J(2)$

$SU_K(2)$

$SO_\lambda(2,1)$: $\mathcal{L}(3)$

$SU_J(2)$: $\xi'_\alpha = U_{\alpha\beta}\xi_\beta$

$$\pi'_\alpha = ({}^tU^{-1})_{\alpha\beta}\pi_\beta$$

$$J_i = -\frac{i}{2}(\pi\sigma_i\xi - \xi^*\sigma_i\pi^*)$$

$$= \frac{1}{2}\sum(\sigma_i)_{\alpha\beta}\left(\xi_\alpha^*\frac{\partial}{\partial\xi_\beta^*} - \xi_\beta\frac{\partial}{\partial\xi_\alpha}\right)$$

$SU_K(2)$: $\tilde{\xi} = i\sigma_2\xi^*$

$$\Xi_\alpha = \begin{pmatrix}\Xi^1_\alpha \\ \Xi^2_\alpha\end{pmatrix} = \begin{pmatrix}\tilde{\xi}_\alpha \\ \xi_\alpha\end{pmatrix}$$

$$\Pi = (\tilde{\pi}_\alpha, \pi_\alpha)$$

$$K^r = \frac{i}{2}\Pi\rho_r\Xi \qquad [K^r, K^s] = -iK^t$$

$$[K^r, J_i] = 0, \qquad \sum_r (K^r)^2 = J^2$$

$SO_1(2,1)$

$\begin{pmatrix}\xi\\ \pi^*\end{pmatrix} \to \begin{pmatrix}a & b\\ c & d\end{pmatrix}\begin{pmatrix}\xi\\ \pi^*\end{pmatrix}$

$SL(2,R) \sim SU(1,1) \sim SO(2,1)$

$\Lambda_1 = -\frac{i}{2}(\pi\xi + \xi^*\pi^*)$

$\Lambda_2 = \frac{1}{2}(\xi^*\xi - \pi\pi^*)$

$\Lambda_3 = \frac{1}{2}(\xi^*\xi + \pi\pi^*)$

$[\Lambda_m, J_i] = [\Lambda_m, K^i] = 0$

$$\left.\begin{aligned}[\Lambda_1, \Lambda_2] &= i\Lambda_3\\ [\Lambda_2, \Lambda_3] &= -i\Lambda_1\\ [\Lambda_3, \Lambda_1] &= -i\Lambda_2\end{aligned}\right\}$$

$G = -\Lambda_1^2 - \Lambda_2^2 + \Lambda_3$

$G = \Lambda(\Lambda - 1)$

$\Lambda = 1, \frac{3}{2}, 2, \ldots$

$\Lambda_3 = \Lambda, \Lambda+1, \Lambda+2, \ldots$

$G = J^2$ i.e. $\Lambda = J+1$

$(J^2, J_3, K^3, \Lambda_3)$

$x_i^2 = -\frac{\ell}{2}\Xi^*\rho_2\sigma_i\Xi$

$$\sum_k x_k^r x_k^s = \rho^2 \delta_{rs}$$

$$\rho = l_0 \xi^* \xi$$

$$l_0(\Lambda_2 + \Lambda_3) = \rho$$

$$\Lambda_1 = i\left(\rho\frac{\partial}{\partial\rho} + 1\right)$$

$$= -\rho P_\rho$$

$$P_\rho = \frac{1}{2\rho}\sum_{r,k}\{x_k^r, p_k^r\}$$

$$\Lambda_3 = l_0\left(\frac{1}{2}\rho P_\rho^2 + \frac{1}{2l_0^2}\rho + \frac{1}{2\rho}J^2\right)$$

$$\Lambda_3 = J + 1 + n_r, \quad n_r = 0, 1, 2, \cdots$$

$$e^{-\rho/l_0\Lambda_3}$$

$$a = \frac{1}{\sqrt{2}}(\xi + i\pi^*)$$

$$b = \frac{1}{\sqrt{2}}\sigma_2(i\xi^* - \pi)$$

$$B = \begin{pmatrix} B_\alpha^1 \\ B_\alpha^2 \end{pmatrix} = \begin{pmatrix} b_\alpha \\ a_\alpha \end{pmatrix}$$

$$[B_\alpha^x, B_\beta^{*\lambda}] = \delta_{x\lambda}\delta_{\alpha\beta}$$

$$B_\alpha'^x = U_{x\alpha,\lambda\beta}B_\beta^\lambda \rightarrow U(4)$$

$$\Lambda_3 - 1 = \frac{1}{2}B^*B = \text{inv},$$

$$SU_J(2) \otimes SU_K(2)$$

$M_i^r = -\frac{1}{2} B^\dagger \rho_r \sigma_i B$

$\underbrace{J_i, K^r,}_{\downarrow} \Lambda_3, M_i^r$

$\Lambda_3, J_i, K^3, M_i^3$

$U_a(2) \otimes U_b(2)$

$SU(4) \supset SU_J(2), \; SU_K(2)$

$T^r = (K^1, \sum_k \hat{p}_k M_k^2, \sum_k \hat{p}_k M_k^3)$

$\hat{p}_i = \frac{p_i}{\sqrt{p^2}}$

$[T^r, T^s] = -i T^t$

$\{T^r, \Lambda_3\} = 0$

$\sum_r (T^r)^2 = T(T+1) \qquad T = 0, \frac{1}{2}, 1, \cdots$

$h = \frac{1}{\sqrt{p^2+m^2}} (\sum_k p_k M_k^3 - m K^1)$

$(T, \cdots -T)$

$(\Lambda_3, \sum_r (T^r)^2, h, \eta)$

$\eta = \hat{p}_i J_i$

$U(4)$ $\Lambda_3 = 1$ Ψ^0

Dirac $\leftarrow$ $3/2$ $\Psi(x, \xi, t)$

$2 \to$ Kemmer

$= \sum_{\alpha=1,2} \{ f_\alpha(x,t) \chi_\alpha^{(a)} + g_\alpha(x,t) \chi_\alpha^{(b)} \}$

$$\psi = \begin{pmatrix} f_\alpha(x,t) \\ g_\alpha(x,t) \end{pmatrix}$$

$B^* \gamma_A B \Psi \longleftrightarrow \rho_1 \gamma_A \rho_1 \Psi$

拡大コロキウム
"Fundamental Triplet" 1966
於 日大理工学部 5号館 . 世話人 原・石田

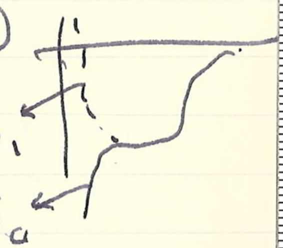
3月22日 [illegible]; phenomenology

boson level : O.O.S.
^1S_J ^1P_J
$(t\bar{t})$ の考え方
Matumoto relation → $V \sim 2M_t$
Ishida-Zweig formula → δm
SU_6 ⇒ Nambu, Morpurgo
Dalitz, van Hove . . .

Postulates :
i) massive triplet(s) $M_t \gtrsim 3 M_p$
ii) non-singular superstrong force central
($V \sim 2M_t$)
iii) unitary spin indep. LS force
iv) S.B.I. → dominantly δm

結論
○ 1^1S_0 $^3S_1$; degenerate
○ 1^1P_J

$K - \pi \cong 350$ MeV
$K^* - \rho \cong 120 \sim 130$ MeV



$M_t \gtrsim 5$ BeV
$M_t \approx 10$ BeV　LS-force

5. I,
a) $\pi^- + p \to \omega + n$ 〃 } G. Goldhaber
$\pi^- + p \to \phi + n$ 〃

$\pi^-(t_2\bar{t}^1)$, $p(N_{[1,2],1})$

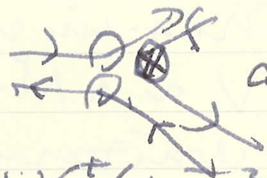
$\to \omega + n$, allowed
$\frac{1}{\sqrt{2}}(t_1\bar{t}^1 + t_2\bar{t}^2)$

$\to \phi + n$ forbidden
$(t_3\bar{t}^3)$

i.e. $\frac{g^2_{\phi NN}}{4\pi} < \frac{g^2_{\omega NN}}{4\pi}$

b) meson-nonet & 3 line vertex

$\binom{t_i}{\bar{t}^j} \to \binom{t_i}{\bar{t}^k} + \binom{t_k}{\bar{t}^j}$



allowed

① $\phi(t_3\bar{t}^3) \to K^-(t_3\bar{t}^1) + K^+(t_1\bar{t}^3)$

② $\rho^+(t_1\bar{t}^2) \to \rho^+(t_1\bar{t}^2) + \pi^-(t_2\bar{t}^1)$
$\to \pi^+(t_1\bar{t}^2) + \omega\{\frac{1}{\sqrt{2}}(t_1\bar{t}^1 + t_2\bar{t}^2)\}$
$\to \pi^+(t_1\bar{t}^2) + \phi(t_3\bar{t}^3)$

③ $f'(t_3\bar{t}^3) \to K^- + K^+$
$\to \pi^+ + \pi^-$

forbidden

① Nakion model:

$\Psi = \begin{pmatrix} p \\ n \end{pmatrix} \xleftarrow[B^+]{} l = \begin{pmatrix} \nu \\ e^- \end{pmatrix}$

baryon ~ (Ψ, l)

meson ~ $(\bar{B}B)$ or $(\bar{\Psi}, \Psi)$

② Ridiculon model

$\phi = \begin{pmatrix} \xi_1 \\ \xi_2 \end{pmatrix}$ $\quad +\frac{1}{2}e$, $-\frac{1}{2}e$

baryon ~ $(\phi\phi)$

meson ~ $(\bar{B}B)$ or $(\bar{\phi}\phi)$

Electromagnetic interaction

electric dipole of $(\bar{\Psi}\Psi)$ or $(\bar{\phi}\phi)$

実験：Quark が見つかったか？

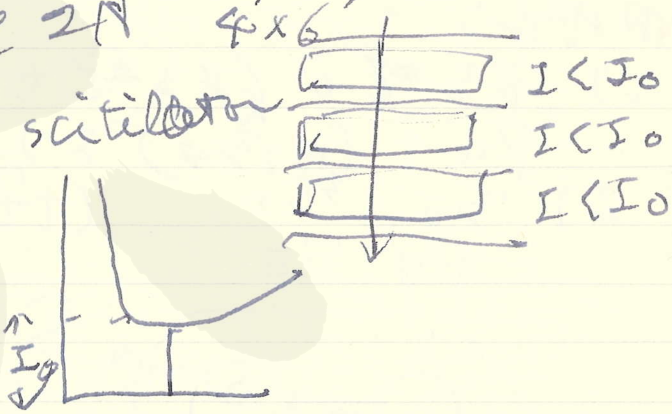
西脇：[illegible] 2月 4'×6'

$Q = e/3$

宇宙線

e^2 : $0.1e^2$ に 6個

$0.43e^2$ にも 2個



甘利：Baryon Resonances

理論で predict したものの少数しか

見つかっていない,

殊に πN resonances については, どう

これ以上は見つかりそうもない,

SU(6)　56次元

$t\,t\,t$　para-fermion

$H \sim \frac{1}{2m}\sum_i p_i^2 + V(\underline{r}_1, \underline{r}_2)$

r_2　$V(\underline{r}_1, \underline{r}_2) = \frac{a}{2}(r_1^2 + r_2^2)$

r

$H = \frac{1}{2}(\tilde{p}_1^2 + \tilde{p}_2^2 + r_1^2 + r_2^2) + \frac{1}{2M}\tilde{P}^2$

$L=0$: $l_1 = l_2 = 0$　$J = \frac{1}{2}, \frac{3}{2}$

$L=1$: 符号が変るので、どうしてもならぬ

$[r_{1\alpha}, r_{2\beta}] = i\delta_{\alpha\beta} f$

$[\tilde{p}_{1\alpha}, \tilde{p}_{2\beta}] = i\delta_{\alpha\beta} g$

$[r_{i\alpha}, p_{j\beta}] = i\delta_{\alpha\beta}\delta_{ij}\eta$

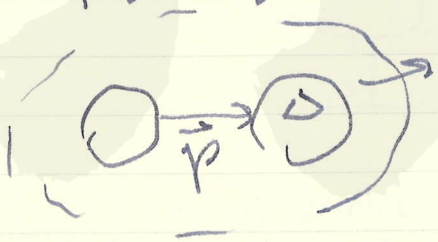
問題 :

1) 同じ型が[illegible]

P_8 : ([illegible]) より $(t\tilde{t})$ がなさそう

2) $^1S_0$, $^3S_1$　$(t\tilde{t})$

P_8　V_8



δ　$\sqrt{(M+\Delta)^2+p^2} - \sqrt{M^2+p^2}$

$\sim \frac{\Delta M}{\sqrt{M^2+p^2}}$

$\delta = \Delta\int \frac{M}{\sqrt{M^2+p^2}}|\psi(p)|^2 d^3p$

$\delta \lesssim \Delta$

1) ([illegible]) では　$\delta \simeq m_K - m_\pi$

の max は φ/d ratio a=0.62 で
240 MeV (実際は 360 MeV)
$(\bar{\tau}t)$ の場合
$(M_{t_3} - M_{t_{1,2}}) > 360$ MeV
2) $^1S_0$, $^3S_1$
混がやはり入ってる

3) $l=1$. $(\bar{\tau}t)(\bar{\tau}t)$

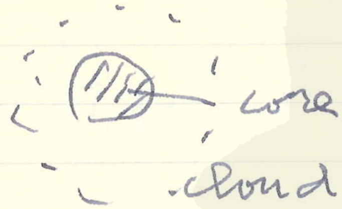
木下(答方):

岡村(答方):
Derrida: triton

N.P. $\frac{8}{16}$

基本的エネルギー

反発力　exclusion principle



1) nuclear force から考えられる hard core

$r_0 \simeq 1/M$

baryon

2) 非弾性散乱からのひろがり

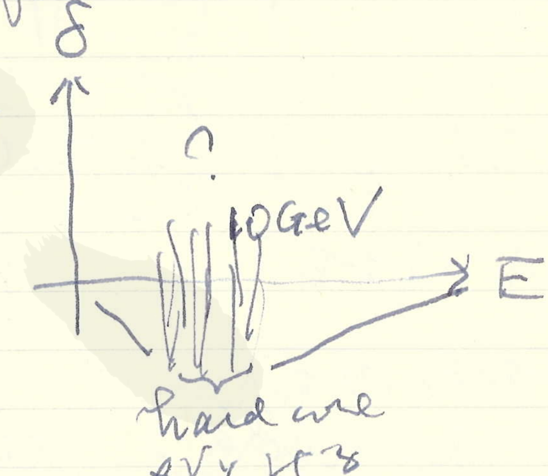
$q^2 \simeq 100\mu^2$

$r_0 \simeq \frac{1}{M}$

3) pp phase shift

$E \gtrsim 10$ GeV

?{ large angle scattering
forward Re/Im }



meson-nucleon scattering

分類　$\pi^+ + p \to \pi^+ + p$

$\underbrace{(p\bar{n}) + p}$　exchange of p → backward peak あり

E&L

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

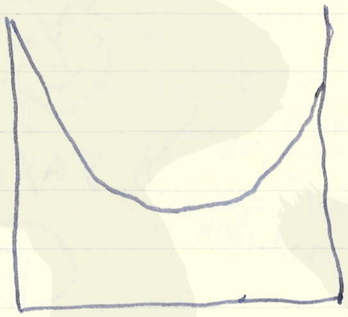
$(n\bar{p}) + p$

charge exchange scattering

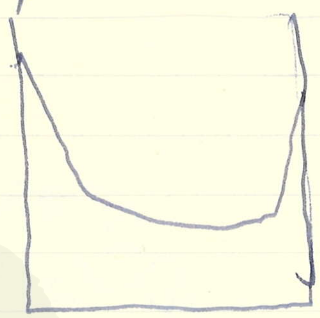
$\pi^- + p \to \pi^0 + n$ ✓ back peak あり)

	$B\bar{B}$-type	$t\bar{t}$-type
$\pi^+ p \to \pi^+ p$	○	△
$\pi^- p \to \pi^- p$	×	△
$\to \pi^0 n$	○	△
$K^+ p \to K^+ p$	○	△
$K^- p \to K^- p$	×	×
$\to \pi^0 \Lambda$	○	△
$\to \pi^- \Sigma^+$	?	△

4 GeV $\pi^+ p$

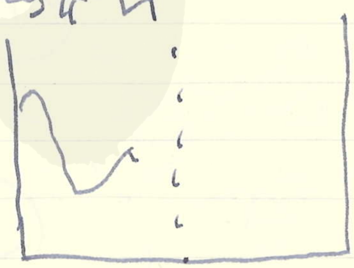


$\pi^- p$



$\pi^- p \to \pi^0 n$

1 GeV
~15 GeV



$\pi^+ p \to \pi^+ p$
$(u\bar{d}) + (uud)$

$\pi^- p \to \pi^- p$
$(d\bar{u}) + (uud)$

impulse近似 + exclusion principle

3月23日　第2回

7ルの問:

I. Magnetic moment　　$\mu_t = a_t \mu$

II. e. M. mass difference

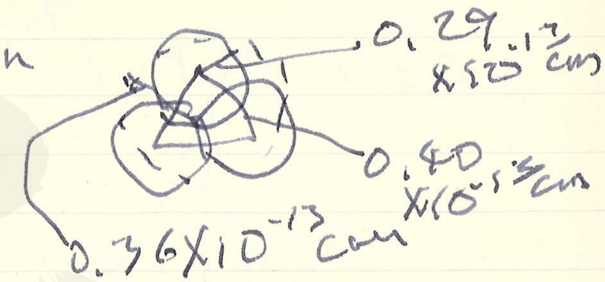
III. Form. factor

IV. Radiative decay

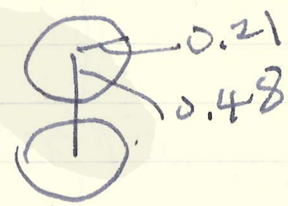
extended quark

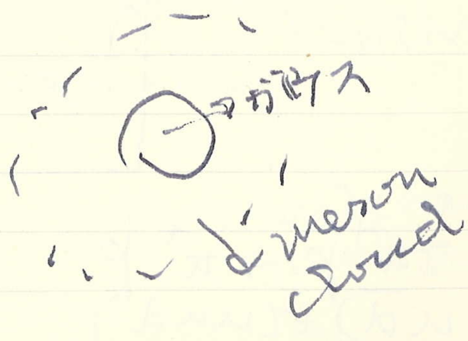
$\exp(-\alpha^2 r^2)$　　$\alpha \sim 1$ BeV

baryon

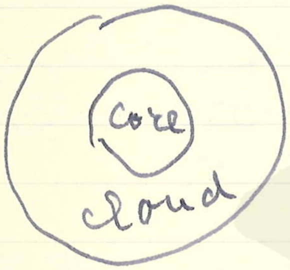


meson





並木:



core 電荷が single body に集中して存在,

$$F_p(q^2) = \rho\, F_{core}(q^2) + (1-\rho^2)\, F_{boson}(q^2) + \rho(q^2)$$

田中正: Fundamental Problem

Thomson: ぶどう模型
Nagaoka:

quark
triplet
a) 粒子性
b) 内部のモード
時空構造の違い,

divergence ⟷ 相互作用
Regge behavior

triplet と lepton

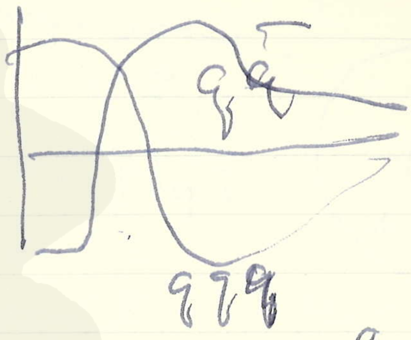
強い力
{ 二体力
三体力

correlation
topology

3体 correlation, 4体 〃
立体構造

c033-775～779挟込

pair suppression



para 統計
para-locality

non-rela.

Klein-paradox

Sauter 1931
ZS.

問題点:
quark triplet

i) { Fermi 統計?
para-fermi?
bose 統計?

ii) fractional charge

iii) Mc

boson (非局所的) でしかも.

spin $1/2$ $3/2$ ......

素域 model (suppl. Extra Number 1965)

3 $\gamma\ \theta\ \varphi\ \psi$ spinor 3組

3組の constraint

四脚 spinor

$J=1/2$ ~~が 4~~ の eigen 値 が 4つ.

$J=3/2$ は 3組固定する.

運動式:

$$P_\mu(\gamma^\alpha_\mu - \gamma^\beta_\mu)\psi = 0$$

$$\Psi(x, \xi^\gamma_\alpha) \to U(6)$$

$$\xi_\alpha \quad i\frac{\partial}{\partial \xi_\alpha} = \pi_\alpha$$

課題:

一様変形 (α)

shear 3 → spin 2

dilatation 3 → gravit

non-uniform

"素粒子の時空記述" 研究会
May 16~28, 1966
湯川研究室にて

片山・宮島・梅村・井口 ~~[illegible]~~ 牧・湯川
山田 木村・大貫 中村・[illegible]・鈴木
宮地 河原 以上14人

16日午後
湯川: elementary domain theory
(convergence
(space-time ordering
木村:
$\Psi(X_\mu, \xi_1 \cdots \xi_n)$
$\to \Phi(P_\mu, \xi_1 \cdots \xi_n)$
Darwin $\psi(X, \theta, \varphi, \chi)$
$\to$ Pauli $\psi_\alpha(X)$ (spin 1/2 だけ)
internal
Polarization: ~~effect~~ $\xi_1, \xi_2 \cdots \xi_n$

real skew tensor
$\xi_{\mu\nu} = -\xi_{\nu\mu}$
$\xi_{\mu\nu}\xi_{\mu\nu} = 0 = \xi_{\mu\nu}\tilde{\xi}_{\mu\nu}$ $\quad \tilde{\xi}_{12} = i\xi_{34}$
$6 - 2 = 4$ $\quad \vec{H}$
$\vec{E}^2 = \vec{H}^2$ $\quad \vec{E}\vec{H} = 0$ $\quad \vec{E}$
$\xi_{\mu\nu} + i\tilde{\xi}_{\mu\nu} = \beta_{\mu\nu}$ complex self-dual tensor
$\tilde{\beta}_{\mu\nu} = \beta_{\mu\nu}$

c033-780挟込

$$C_k = E_k - i H_k$$

$$C_k C_k = 0 \quad \text{null-vector}$$

$$X_\mu \to L_{\mu\nu} X_\nu$$

$$P_\mu \to L_{\mu\nu} P_\nu$$

$$L(4) \approx O(3)$$

$$\xi_\alpha \to \lambda_{\alpha\beta}\xi_\beta \qquad SL(2, C)$$

$$\alpha, \beta = 1, 2$$

$$C_k = \xi \sigma_2 \sigma_k \xi$$

$$(\xi, (\xi\sigma_2)^*) = \text{Majorana spinor}$$

$$\alpha_\mu = \xi^* \sigma_\mu \xi : \text{null-four-vector}$$

$$\alpha_0 = \sqrt{\alpha_k^2}$$

または

$$\left.\begin{aligned} \xi_{\mu\nu}\hat{P}_\nu &= x^2_\mu \\ \tilde{\xi}_{\mu\nu}\hat{P}_\nu &= x^1_\mu \end{aligned}\right\} \quad \hat{P}_\mu = P_\mu / \sqrt{P}$$

$$x^3_\mu = O_{\mu\nu}\alpha_\mu \qquad O_{\mu\nu} = \delta_{\mu\nu} + \hat{P}_\mu \hat{P}_\nu$$

$$x^r_\mu P_\mu = 0$$

$$x^r_\mu x^s_\mu = \delta_{rs}\rho^2 \qquad \rho^2 = -\hat{P}_\mu \alpha_\mu$$

$[X_\mu, x^r_\nu] \neq 0$ という要請

x^r_ν is non-local.

5月17日(火)午前
片山氏:

TYPE OF NON-LOCALITY (number of points)	INTERNAL FREEDOM space	time	LORENTZ INV GROUP	POSSIBLE COMBINED GROUP
2	1×3	0	Sp(1) SU(1,1)[1]; O(3)[2] U(2)[3]	
	1	1×1		
3	2×3	0	Sp(2) U(2)	SU(2)[6]
	2×3	2×1	U(2)×U(2)	
4	3×3	0	Sp(3) U(3)[4]	[7] U(2)
	3×3	3	U(3)×U(3)[5]	×SU(2)
⋮				

U(3)×SU(2)[8] はど~~うして~~こから出るか, ?

$x^1, x^2, x^3 \to r, r', \#$

$$\frac{x}{r} = e^3$$

$$\frac{x'}{r'} = e^3 \cos\gamma + e^1 \sin\gamma$$

---

1) Yukawa
2) Hara, Marumori, Ohnuki ‥
3) Katayama, Yukawa
4) Takabayashi, Hara-Goto, Green, Takeda
5) K. Yam. T.
6) Bopp-Haag. (Darwin ?)
7) Nakano
8) Takabayashi

$$e^3 = \frac{1}{s} q^* \sigma q$$

$$e^1 = \frac{1}{2s}(q \sigma_2 \sigma q + q^* \sigma \sigma_2 q^*)$$

$$e^2 = -\frac{i}{2s}(q \sigma_2 \sigma q - q^* \sigma \sigma_2 q^*)$$

$$q_1 = \sqrt{s}\, e^{-i\left(\frac{\chi+\phi}{2} - \frac{\pi}{4}\right)} \cos\frac{\theta}{2}$$

$$q_2 = \sqrt{s}\, e^{-i\left(\frac{\chi-\phi}{2} + \frac{\pi}{4}\right)} \sin\frac{\theta}{2}$$

$$q^* q = s$$

$$(r, r', \sigma, \underline{\theta, \phi, \chi})$$

$$L = \sum_a x^a \times p^a - X \times P$$

$$= x \times p + x' \times p'$$

$$= \frac{1}{2} \xi^\dagger \sigma \xi$$

$$\xi = \begin{pmatrix} a_1 \\ a_2 \\ b_1^* \\ b_2^* \end{pmatrix} \qquad a_1 = \frac{1}{\sqrt{2}}(q_1 - i p_1^*) \qquad b_1 = \frac{1}{\sqrt{2}}(q_1^* + i p_1)$$

$$\xi^\dagger = (a_1^*, a_2^*, -b_1, -b_2)$$

$$[\xi, \xi^\dagger] = 1$$

i) 2価表現がでるには 平面が指定されねばならぬ、さらに
2つのvectorが必要、

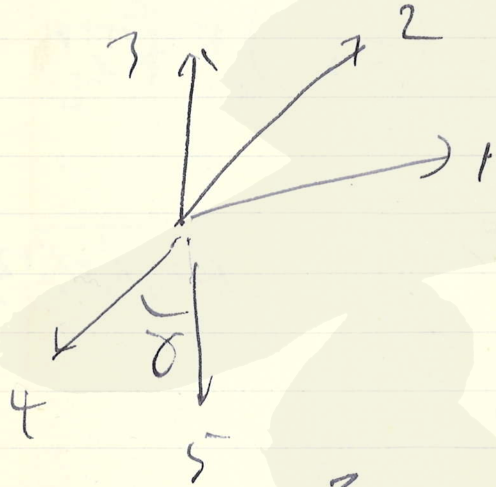
27) $r, r', \gamma; \theta \phi \chi$

$n=6$; 3組の Euler angle

$\cancel{3n} = 6 \quad 3n = 18$

15 $\quad r' \cdots r^5$

$15 - 5 = 10$



$\underbrace{r^1 \cdots r^5 \ \gamma}_{s^1 s^2 s^3}$

3つずつ

$$\mathbb{L} = \frac{1}{2} \sum_{i=1}^{3} \xi_i^\dagger \Omega \xi_i$$

$$K_\alpha = \sum \xi_i^\dagger P_\alpha \xi_i$$

$s_1 = r_1 r_2 \sin\alpha$
$s_2 = r_1 r_3 \sin\beta$
$s_3 = r_4 r_5 \sin\gamma$

$\left.\begin{array}{l} \text{面の形状の変化} \\ \text{之の回転} \quad \Omega \\ \text{之の面積変形} \quad P \end{array}\right\}$ 之が素領域

大貫氏：Half Integer Spin をもつ粒子

$x \to x' = Rx$

$\psi(x) \to \psi'(x) = \psi(R^{-1}x)$

$L = \cancel{x \times p}\ [x \times p]$

$\psi'(x) = e^{i f_R(x)} \psi(R^{-1}x)$

$p \to Rp$ X or $\left(\frac{\partial}{\partial x_i}\right)' \neq \frac{\partial}{\partial x_i'}$

$J = L + K(x)$

$J_1 = L_1 + \frac{x_1}{x + x_3} S$ $\qquad x = \sqrt{x_1^2 + x_2^2 + x_3^2}$

$J_2 = L_2 + \frac{x_2}{x + x_3} S$

$J_3 = L_3 + S$

$[J_i, J_j] = i \epsilon_{ijk} J_k$

square integral, J_i: Hermite

$S = 0, \pm\frac{1}{2}, \pm 1, \pm\frac{3}{2}$

$u_j^\mu = C e^{i(\mu - s)\varphi} (1-z)^{-\frac{\mu - s}{2}} (1+z)^{+\frac{\mu + s}{2}}$

$\times \left(\frac{d}{dz}\right)^{j-\mu} [(1-z)^{j-s}(1+z)^{j+s}]$

$j \geq |s|$

mass 0 particle:
two component theory

$s=1$: 右まわり photon
$s=-1$: 左まわり photon

弾性体: Deformable sphere model

$u(x,y,z,t)$

$$B_{ij} = \frac{1}{2}\left(\frac{\partial u_i}{\partial x_j} + \frac{\partial u_j}{\partial x_i}\right)$$

$$\omega_i = \frac{1}{2}\left(\frac{\partial u_k}{\partial x_j} - \frac{\partial u_j}{\partial x_k}\right)$$

$$D = \mathrm{sp}\, B$$

$$(\lambda+\mu)\frac{\partial D}{\partial x_i} + \mu \Delta u_i = \rho \ddot{u}_i$$

$$\mu \Delta B_{ij} = \rho \ddot{B}_{ij}$$

$$\mu \Delta \omega_i = \rho \ddot{\omega}_{ij}$$

$L =$

$B = K e K^T$

$K(t)$

SU_6 quark 說

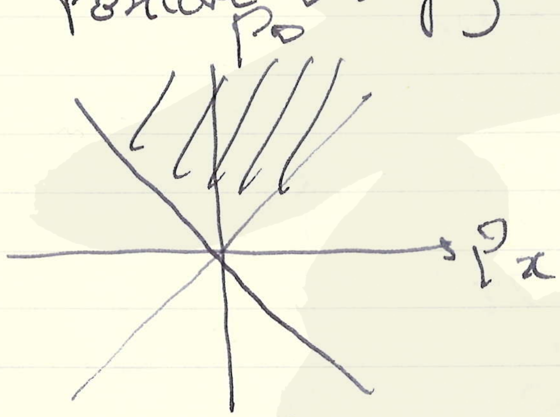
粒子 ether

後藤鉄夫氏：芯のない ごむまり

$$\int x^a u^\mu dV = 0$$

$$\frac{\partial^2}{\partial t^2}\int x^a u^\mu dV = 0$$

中野董夫氏：euclid parameter
Positive energy state しか存在しない…



後藤粒子

大[illegible]氏： spin (half integer)
mass zero

5月18日(水)

中村誠太郎氏:

Baryon の mass formula

$$M_{\pm}^2 = L(L+1)\alpha^2 + M_{0,\pm}^2 \quad (1)$$

$$L = J - \frac{1}{2} \quad (2)$$

parity

Feb. 1965

	MeV	10^4 MeV^2		
$N(\frac{1}{2}^+)$	940	88		
$(\frac{3}{2})^+$	1240	153	N^*_{33}	
$(\frac{5}{2})^+$	1690	282	N^{***}	
$(\frac{7}{2})^+$	2190	477		
$(\frac{9}{2})^+$	2710	737		
$(\frac{11}{2})^+$	3240 (3245)	1062	$\rightarrow (\frac{1}{2})^-$	1270
$(\frac{3}{2})^-$	1510	228	$N^{**}_{1/2}$	
$(\frac{5}{2})^-$	1920	368		
$(\frac{7}{2})^-$	2350	552		
$(\frac{9}{2})^-$	2825	812	(2825)	
$(\frac{11}{2})^-$	3320	8[illegible]		

$$\alpha^2 = 32.5 \times 10^4\ \mathrm{MeV}^2$$

$$M_{0+}^2 = 88 \times 10^4\ \mathrm{MeV}^2$$

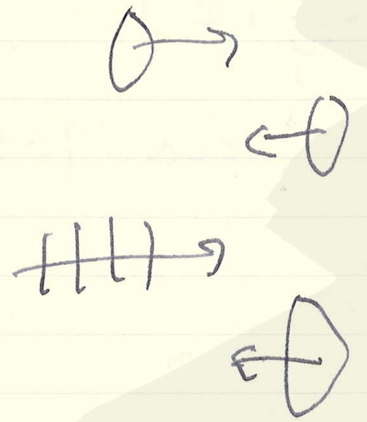
$$M_{0-}^2 = 163 \times 10^4\ \mathrm{MeV}^2$$

$\propto U(r)$

spin A 0, 1/2　B 0, 1/2

星崎憲夫氏: Extended object と
高エネルギー散乱.

elastic
quasi-elastic } scattering



$$\rho(r,t) = \rho_0(r) + \rho_1(r,t)$$

$$\rho_0(r) = \overline{\rho(r,t)}$$

$$\overline{\rho_1(r,t)} = 0$$

$$T \gg \tau \approx \frac{l}{v}$$

+ 素粒子による散乱[illegible]

$$I = \overline{\left| \int f \rho_{\cancel{1}}(r,t) e^{ikr} dr \right|^2}$$

$$= |M_0|^2 + \overline{|M_1 \cancel{(k,t)}|^2}$$

coherent　　incoherent

$$M_0 = \int f \rho_0(r) e^{ikr} dr$$

$$M_1 = \int f \rho_1(r,t) e^{ikr} dr$$

主に
前方散乱

large angle scattering
に多く.

核力と相互作用研究会

箱根 1966 May 24～25

5月24日

下田 (綿野、下平)

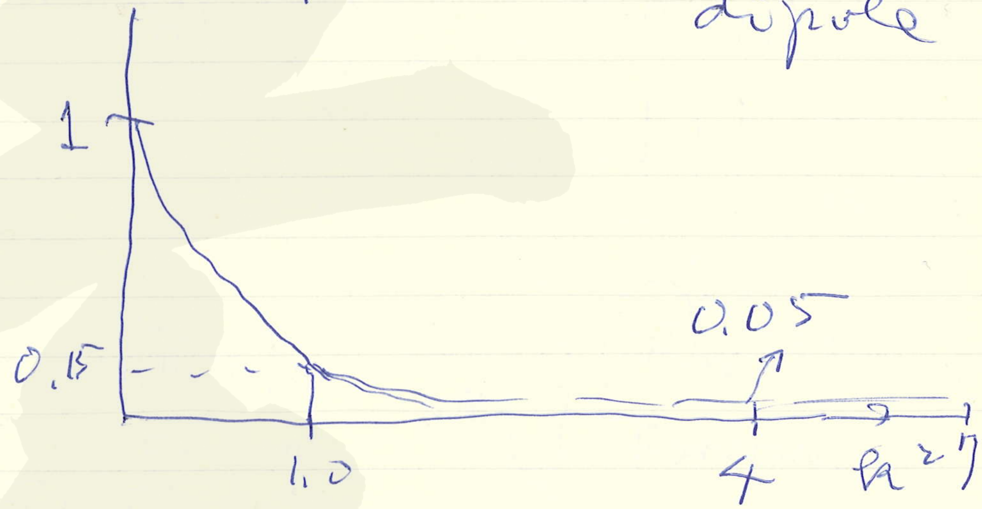
Baryon の電磁的構造.

I.

II. Form factor: experiment　　q^2 in $(\mathrm{BeV})^2$

$$G_{Ep}(k^2) = \frac{G_{Mp}}{M_p} = \frac{G_{Mn}}{M_n} = \left(\frac{1}{1+q^2/0.71}\right)^2$$

dipole



[Vector-meson] : Γ, γ

$$G = \sum_i c_i \frac{M_i^2}{M_i^2+k^2}$$

V. M. D.

Wilson (Harvard)

p, n.　　　　p, n

① 1) ρ, ω, φ では説明出来ない

2) ρ', ω, φ　　$\rho' = 510$ MeV

3) ρ, ρ', ω, φ　　$\rho' = 875$ MeV

(ρ: 760, ω: 780, φ: 1020)

ρ, ρ'　　ω, φ

I = 1　　I = 0

© + ~~−~~　　+ −

Quark model

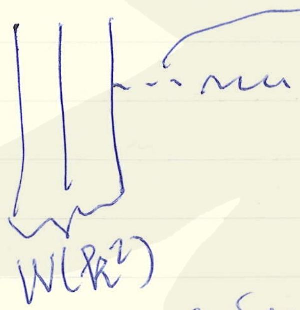
$G_{PS}(k^2) = G_q(k^2)\,W(k^2)$

$W(k^2) = \frac{1}{(2\pi)^3}\int w(k', -k'+\frac{k}{3}, k'-\frac{2}{3}k)\,dk'$

w : $|\psi(r_{12}, r_{23}, r_{31})|^2$ の F.T.

Ishida

$G_{PS}(k^2) = \underbrace{\left(\sum c_i \frac{M_i^2}{M_i^2+k^2}\right)} W(k^2)$



nonet $\{ \delta M_s$

$m_1^0 = m_8^0$

$\varphi = s\bar{s}$

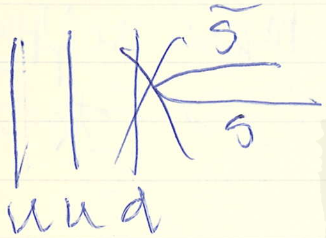
$\omega = \frac{u\bar{u}+d\bar{d}}{\sqrt{2}}$

$G_p^E = [\frac{2}{3}u + \frac{1}{3}d] = \frac{1}{2}[\rho\rho] + \frac{1}{2}[\omega\omega] + c[\varphi\varphi]$ ($c\varphi$)

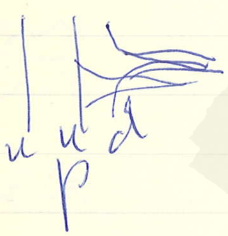
$G_n^E = [\frac{1}{3}u + \frac{2}{3}d]$

$G_p^M =$

$G_n^M =$



$\varphi = s\bar{s}$ $\quad C_\varphi = 0$

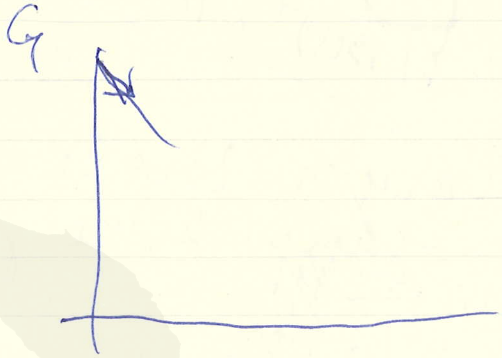


$\omega = \dfrac{u\bar{u} + d\bar{d}}{\sqrt{2}}$

$$|\psi(r_{12}, r_{23}, r_{31})|^2 = \frac{1}{r_{12} r_{23} r_{31}} e^{-\lambda(r_{12}+r_{23}+r_{31})}$$

$2\lambda = 0.51$ BeV $\qquad W(k^2) = (\ )\tan^{-1}(\ )$

$\sqrt{\langle (r_p^E)^2 \rangle} = 0.8$ f



III. Form factor & mass difference

$$H = \sum \frac{e_i e_j}{r_{12}} + \frac{8\pi}{3}\mu_i \mu_j \delta(r_{12}) + \delta m_d$$

$\delta m_d = 1.9$ MeV $\quad (d-u)$

$H_E = \langle \frac{e^2}{r} \rangle = 3.57$ MeV

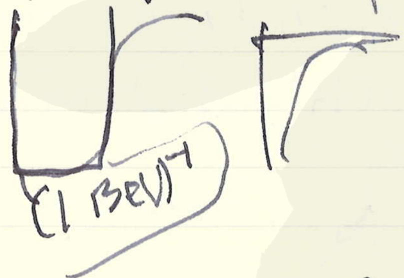
$H_M = 3 \times \frac{8\pi}{3} \langle \delta(r) \rangle \mu^2 = 5.25$

$n-p,\ \Sigma^- - \Sigma^+,\ \Sigma^- - \Sigma^0,\ \Xi^- - \Xi^0$

Form factor | Mass difference

$\langle R^2 \rangle$ 小 | 大

田地氏：素粒子の高次的描像



Matsumoto
SU_6 Nambu, Hori
Iijima "Mozurgo",
Nagai, Okada, Tati

baryon levels N^*
gauss like potential
or square well
$3 \times 3 \times 3 = 1 + 8 + 8 + 10$

$(1s)^2(2s)$ — $3/2^+$, $1/2^+$

$(1s)^2(1d)$ — 10 $7^+/2$, 8 $5^+/2$

$(1s)^2(1p)$ — 10 $5/2^-$, 8 $3/2^-$

$(1s)^3$ — 10 $3/2^+$, 8 $1/2^+$

○ Pauli principle
SU_3 V-spin triplet, singlet

○ one particle excitation
○ space part : symmetric
(first unitary singlet
$(1s)^2 (1p)$)

0 $J - L = I = S$

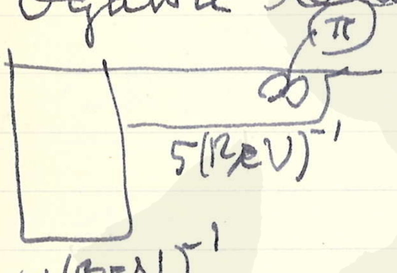
(Kycia - Riley :
J N^* $(\underbrace{N, \pi}_{L})$ $J - L = I - 1$)

superstrong　　basic 4 4 4 4
very short range

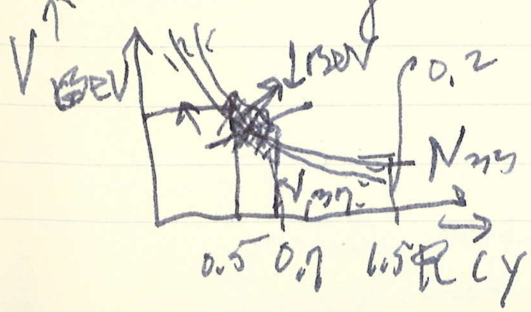
Fujii boson : U-singlet V-octet
pair suppression

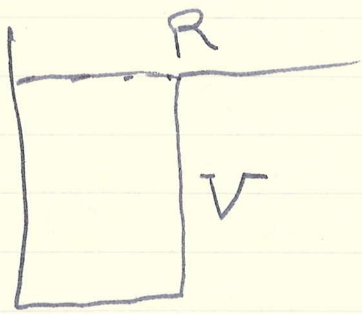
沢田氏 : Baryon levels (沢田・大槻)
Kycia - Riley
$I = 3/2$　　$J = L + 1/2$
$I = 1/2$　　$J = L - 1/2$
decuplet　$J = L + 1/2$
octet　$J = L - 1/2$
M, B

Ogawa relation



πN system
Klein-Gordon





2240 MeV　　$L = 6$

$V = V_c^I + LS\, V_{LS}^I$

$I = 1/2$; $R = 0.6$ Y　　$V_c = -0.45$ GeV
　　　　　　　　　　$V_{LS} = +0.16$ GeV

$I = 3/2$　　　　　　$V_c = -0.45$ GeV
　　　　　　　　　　$V_{LS} = -0.14$ GeV

基本との類似: Nucleon levels
$3/2^+$ $1/2^+$ … 56次元 ttt

$(ttt)(t\bar{t})$

核力; meson 描像の存在する2つの領域
と unified picture

5/8 25日

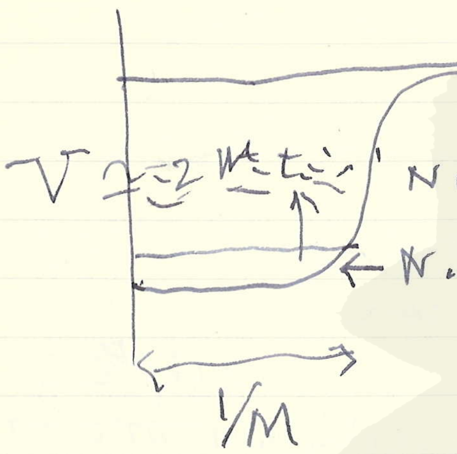
小林氏: Weak Interaction
$\Delta I = 1/2$ isospinor
$\Delta Q/\Delta S = +1, 0$
current algebra で weak interaction の (はうまく) ~~方が~~ が 計算 のでなく, current algebra は 残った.
weak boson ?

$\Delta I = 1/2$ isospin が 内部自由度 と関係あり
1体を除 ⇄ 2体を除 (内部自由度に関して, 普通の回転でなく) (内部自由度
$\frac{1}{2}\left(\begin{matrix}2体 \times 2体 \\ 1体 \times 1体\end{matrix}\right)^{1/2}$ 全スピン 最高の所
$\frac{1}{2}\left(\begin{matrix}2体 \times 1体 \\ 1体 \times 2体\end{matrix}\right)^{1/2}$ 全スピン 最高の

並木氏: → energy
quasi states　resonance etc.　rearrange-ment　dissociation
e.m. structure
hard core　3245　πN backward　前方 (Chilpkin Van Hove)　5~1 GeV NN large angle
$p+p \to p+N^*$

---

energy ↑ 20~30 GeV
→ × particle production
statistical な性質



N.R. が悪くなる，↑ statistical picture

← N.R. ではどういう意味か
（が良い）

$p+p \to p+N^*$ incident energy
BNL, CIT: 6 ~ 30 GeV
$|t| \simeq 0.04 \sim 5$ $(\mathrm{BeV}/c)^2$

$e^{-b|t|} \propto \frac{d\sigma}{dt}$

N^*:	$N^*_{3/2\,3/2}$ (1,238)	b: 17
	$N^*_{?}$ (1.4)	18 } $r_0 = \frac{4 \sim 5}{M}$
	$N^*_{1/2\,3/2}$ (1,52)	4
	$N^*_{1/2\,5/2}$ (1,69)	5 } $r_0 \simeq \frac{2}{M}$
	$N^*_{1/2\,?}$ (2,19)	5

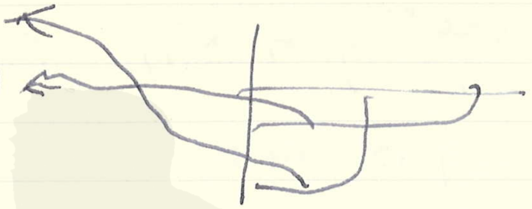
(10 BeV ~ 30 BeV)

elastic $b \simeq 10$

Chang - Kobe
V. Hove) unitarity condition $b_{inel} > b_{el}$.
Byers - Yang
Bialas,) coherent drop
Wu - Yang
Namiki ← $b_{inel} < b_{el}$ がありうる

$(\tau\tau\bar{\tau})$

$(\bar{\tau}\tau\tau)(\tau\bar{\tau})$



$r_0 = \sqrt{\sigma}$

interaction region

長谷川謙一：多重発生

部分的 potential

急激な shock

"火の玉" 生成から

black body

幻のエネルギー量　2〜5 BeV

10^{12} eV　emulsion stack

10^{15} eV　emulsion chamber　$\pi^0 \to \gamma$

→ 加速器実験　30 BeV/c でも

火の玉が出きそう

24 BeV/c　22.6 BeV/c　proton beam

"火の玉"の普遍化

10^{12}　emulsion stack ～ 600 event

$E_0 \gtrsim 10^{12}$ eV　(100 events)

$K_M \simeq 1$

mirror system

$p_T \sim 0.4$ BeV/c

火の玉の mass　M　12〜20 BeV　3個

~~の例もある。~~　(数％程度の割合)

M ～ 6〜12 BeV のもある。　3個

Mass : discret $\gamma \to \Delta^2_{11}$ (γ : Lorentz factor)
$\underline{I}$: 〃
$\gamma \sim 1.7$ 7.0 40 . . .

Resonance
→ π の γ
boson resonance ω, ρ, ξ, K^* など
では π $\gamma \sim 2$
baryon resonance baryon にくらべて
π の $\gamma \sim 2$
de Broglie 波長 ~ $M/2$ → M

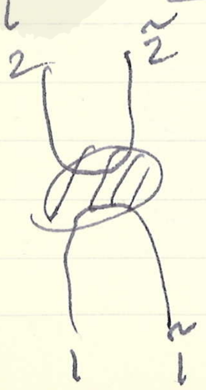
IVa. Summary

	I		II	III . . .
hadron level	baryon	meson	(ttt)	
	Taki Ozaki -Sawada		(t+t) (t$\bar{t}$)	
		nonet (Iizuka)		
E.M. form factor mass ~~difference~~ splitting		Kinoshita	Ishida	
dynamics [illegible]		N.R. pair-suppression ([illegible] principle)		
[illegible]	$p+p \to p+N^*$ H-quanta →		〃 〃	
			場: 相互作用 (pair suppression) C(?) (non-local) (momentum spectrum)	
W. I. yet untouchable (CP, "θ", V-A)	$\Delta I = 1/2$			

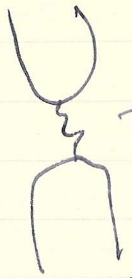
{ quarks と Nambu rule
pair suppression　　　pair [illegible] relativistics ?
$\Delta I = 1/2$

大~~野~~ q はわからんこと. N, Λ, それ何か.
電磁場.
$\sum_{i=1}^{3} \bar{t}_i \gamma_\mu t_i B_\mu$
← Nagoya model

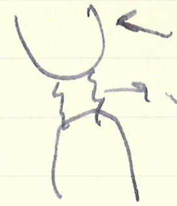
meson ~ $t_i \tilde{t}_j$
π^0 としては $\dfrac{t_1\bar{t}_1 - t_2\bar{t}_2}{\sqrt{2}}$ のかわり?
superposition はどう?
superposition は pair effect による
$\eta = \dfrac{t_1\bar{t}_1 + t_2\bar{t}_2 - 2t_3\bar{t}_3}{\sqrt{6}}$



ps　　vector
$^1S_0$　　$^3S_1$
36　nonet $\times 1$　　nonet $\times 3$
$\pi, \eta, K,$ $X(960)$　　$\rho\ \varphi\ K^*$ ω

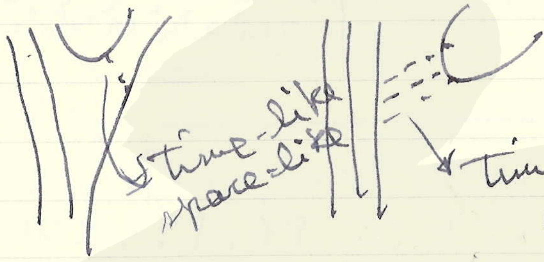


Fujii meson
(vector)



ps. meson
vector

V-spin で考えると?



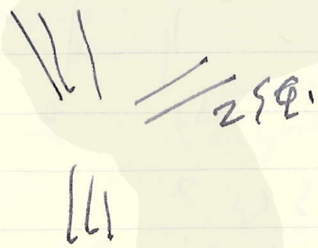
time-like
space-like

time-like
only

$\partial_\mu J^A_\mu \propto \pi$ (W. I.)

は non-rela. では理解しにくい。

小川:



2 g.

S(I=0) ε_0(720)
V(I=0)
V(I=1)

U(3) singlet

W. I.

服部:
$\pi^- + p \to n + \omega + \pi + \cdots$ 大
$\to n + \varphi + \pi + \cdots$ 小
P.R.L. 11 (1963), 508
Y. Y. Lee et al.

$$\frac{\sigma(\pi^- p \to \varphi n)}{\sigma(\pi^- p \to \omega n)} \simeq 0.012$$

$$\pi^- + p \to N^* + \chi^0 + \pi + \cdots$$

$$+ (K\bar{K}) + \cdots$$

(φ では 12 ‥)

$\bar{B}BM$

$N_{[ij]k}$

$\bar{N}^{(\alpha i]j} N_{(\beta i]j} M^{\beta}{}_{\alpha}$

$\bar{N}^{[ij]\alpha} N_{[ij]\beta} M^{\beta}{}_{\alpha}$

$$H(\bar{B}BM) = g_F\{\mathrm{Tr}(\bar{N}[N,M]) - \mathrm{Tr}(M)\mathrm{Tr}(\bar{N}N)\}$$

$$+ g_D\{\mathrm{Tr}(\bar{N}\{N,M\}) - \mathrm{Tr}(M)\mathrm{Tr}(\bar{N}N)\}$$

$$\cancel{+ g'\,\mathrm{Tr}(M)\mathrm{Tr}(\bar{N}N)}$$

次回:

c033-787挟込

梅村:

Maglicty: Preprint

(Y=0) $N^* - N$ と meson (Y=0) mass

の level がよく一致する.

素研談話会　1966.5.31

第二部：素粒子の構造と強い相互作用の模型

(Dynamical Approach to
Non-local Interaction：現在の意義)

Composite model

Triplet $U(3)$

$m \sim t\bar{t}$ $\quad U_6 \times U_6$, $\quad m_t, m_{\bar{t}}$：任意

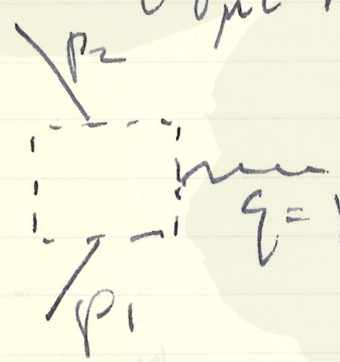
$\left\{ \begin{array}{l} \text{Iizuka} \\ \text{Becchi-Morp (Dalitz)} \end{array} \right\}$ N.R.

$b \sim (ttt)$ or $(tt't'')$

or plus t_0

力：vector meson b_μ (Fujii, Yasunori)

$\bar{t}\gamma_\mu t b_\mu$



$q = p_1 - p_2$

$$\delta^4(x) = 2\pi \int_{-\infty}^{+\infty} d\lambda\, \Delta^{(1)}(x;\lambda)$$

$$\Delta^{(1)}(x;\lambda) = \frac{1}{(2\pi)^3}\int \delta(q^2+\lambda)\, e^{ipx} d^4q$$

$$\Delta^{(1)}(x;-\lambda) = -\Delta^{(1)}(-\tau;\lambda)$$

$x = -\tau$

$$b_\mu(x) \to B_\mu(x) = \frac{1}{2\pi}\int d\lambda\, d^4\xi\, c(\lambda) \times \Delta^{(1)}(x-\xi;\lambda)\, b_\mu(\xi)$$

$$= C(\Box)\, b_\mu(x)$$

$$\eta(x) \to \bar{\eta}(q) = C(-q^2)$$

$$\eta(x) = 2\pi \int_{-\infty}^{+\infty} d\lambda\, C(\lambda)\, \Delta^{(1)}(x;\lambda)$$

(i) Local Int. $n_i(\lambda) = 1 \quad -\infty < \lambda < +\infty$

(ii) $c(\lambda) = \sum_i \frac{n_i}{\lambda - \lambda_i}$

(iii) $c(\lambda) = \sum_i c_i \delta(\lambda - \lambda_i)$

基研 colloquium 水曜日 10時～ ; Informal meeting 月曜日午後

June 1, 1966
梅沢氏 : Shin; Born Reciprocity and unitary symmetry

(June 6, Monday
湯川氏 : 素領域理論（第1回）)

June 8, 1966
~~[illegible]~~田氏 : generalize Dirac equation

$$\delta \mathcal{L} = -\delta\bar{\Psi}\begin{pmatrix} a+b & 2D^* \\ 2D & a+b \end{pmatrix}\Psi = 0$$

$$(\gamma_\mu \partial_\mu + \kappa)\begin{pmatrix} \psi \\ \psi^c \end{pmatrix} = 0$$

→ $(1 \pm \gamma_5)\psi$ formalism による.

June 15, 1966
河辺氏 : Current Algebra
1. はったん
2. ことのしだい
3. あげくのはて

Gell-Mann
$\Delta I = 1/2$

c033-788～795挟込

片山泰久氏：非局所場論
基研談話会　June 14, 1966

~~1. 序 [illegible]~~
~~2. ことのしだい~~
~~3. あげくのはて~~

~~Gell-Mann Eightfold Way~~

Regge Pole と ~~[illegible]~~ 小研究会

June 17, 1966

田中さん:

39年 物理学会 第5, 9号 84頁

(井上、田中さん)

regularization の役を Regge がしている。

(June 27 湯川 $\eta^0 \to \pi^+\pi^-\pi^0$ πの崩壊)

June 29 1966

田中さん (坂田, 高橋, 井上)

1) Regge $s^l \to s^{\alpha(t)}$

regularization

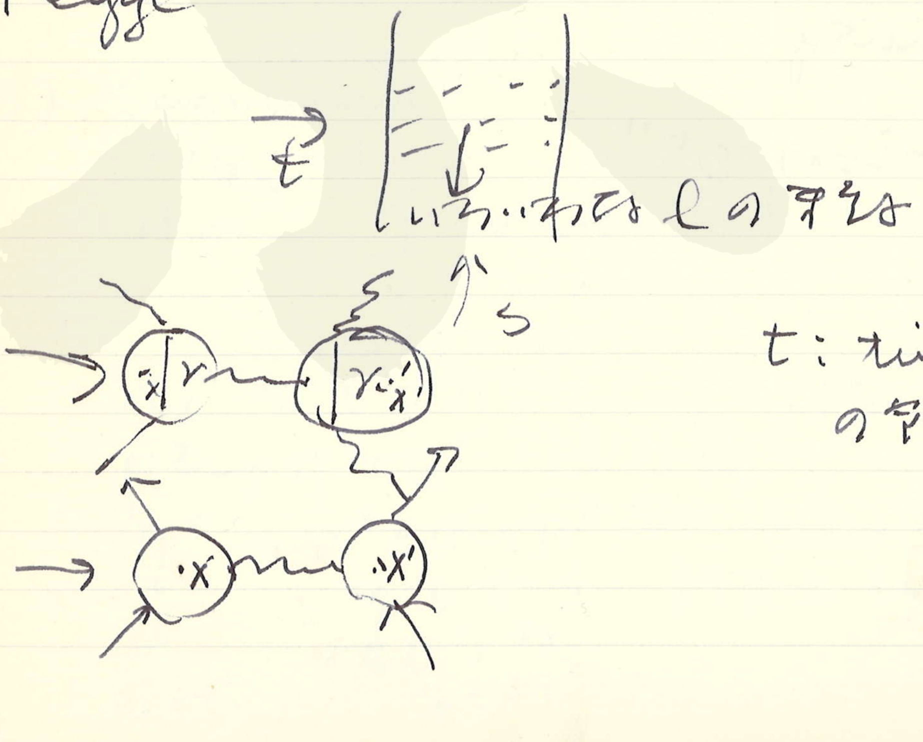
2) $\alpha'(t) \sim \langle r^2 \rangle$

拡がり { 内部 / 函数

shell model (Yukawa 1950)

Fierz

Regge



t: time-like の領域

Niels Bohr研究所と原子核理論

(丹生氏?)　基研談話会　June 21, 1966

N. B. 研 :　50 人　　Aage Bohr

Nordita :　50 人　　Møller

CERN との関係

"Copenhagen, 1960"

$$H^{(1)}_{int} = G(C^+C^+)_{J=0}(CC)_{J=0} \qquad \text{BCS}$$

$$H^{(2)}_{int} = \chi\, Q(C^+C)\, Q(C^+C)$$

$$H = H_{shell} + H^{(1)}_{int} + H^{(2)}_{int}$$

state の correlation が reality を持つ?

A　150〜190

A　> 225

simplicity

"mysterious 0^+"

廿日会：C.C. non-Invariance
菅原コロキウム　　July 13, 1966

(Lee, Physics Today 1966
中村：科学 1966 7月号
坂田より回游原稿 June 27, 1966 に受取)

1. $K_2^0 \to \pi^+ + \pi^-$ と $\eta^0 \to 3\pi$ の関係

$$\frac{R(K_2 \to 2\pi)}{R(K_1 \to 2\pi)} = \text{energy indep}$$

vector meson を考える

一般に 今後の実験に俟たねばならぬ

1) superweak

$G/G_W \sim 10^{-7} \sim 10^{-8}$

$\Delta Q = -\Delta S$

$K_2^0 \to 2\pi$

2) weak で CP が破れている.

3) ~~semiweak~~ strong

$F/G_W \sim 10^3$

H_F : P : conserved

C, T : ×

$|\Delta I| = 0, 1, \ldots$

$K_2^0 \to \pi^+ + \pi^-$　　H_W; H_G

$\rho^0 \to \pi^+ + \pi^-$ は H_G でおこる

$\eta^0 \to \pi^+ + \pi^- + \pi^0$ は H_{em} 単独では

禁ずるから H_F と complete

し 起しうる.

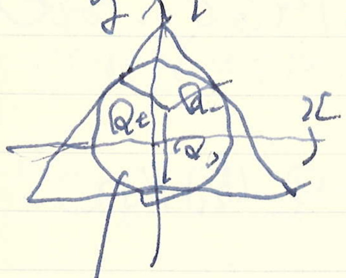
$G = +1$,　$G = -1$

2. $\eta^0 \to 3\pi$ の崩壊と実験

T. D. Lee, P. R. 138, 139, 140 (1965)

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

$Q_+ \quad Q_- \quad Q_0$



$Q_0 = y + Q$

$Q_\pm = \pm \frac{\sqrt{3}}{2} x - \frac{y}{2} + Q$

$Q = \frac{1}{3}(m_\eta - 3m_\pi) \simeq 48$

momentum conservation

$x = Qr\sin\theta \quad y = Qr\cos\theta$

$Q_0 = Q(1 + r\cos\theta) \quad Q_{\pm 1} = Q(1 + r\cos(\theta \pm \frac{2\pi}{3}))$

$R^2 = \frac{1}{1+\epsilon}[1 - \epsilon R^3 \cos 3\theta]$

$\epsilon = 2m_\eta(m_\eta - 3m_\pi)/(m_\eta + 3m_\pi)^2$

$\simeq 0.16$

$A(r,\theta)$: $(+-0)$ decay の amplitude

C X : $A(r,\theta) \neq A(r,-\theta)$

$C = -(-1)^I \quad C = -1 : I = 0, 2 \cdots$

π-π interaction が大きい (C violation の他に)

5% 程度の asymmetry が予想される (Lee)

実験: Baltay, Franzini, Kim, Kirsch, Zanello

Lee-Franzini, Loveless, McFadyen, Yarger

(P.R.L. 16 (1965) 27 June, 1224)

$A = 0.0072 \pm 0.028$

$\omega \to 3\pi$ 実験が進行中.

$C_\gamma \neq C_{st}, \quad T_\gamma \neq T_{st}$

H_{st} : P_{st}, C_{st}, T_{st}

$H_{free} + H_\gamma$: $P_\gamma, C_\gamma, T_\gamma$

$C_{st} N + N C_{st} = 0$

p, n : $N = 1$

π : $N = +1, -1$

a^I : $N = 0$

3. $H_F = H_\gamma$ の[illegible] (Lee, P.R. 140 957, 959)

$\langle N'|j^M_\mu|N\rangle = ie\bar U_{N'}(\gamma_\mu F_1 + i(N'_\mu + N_\mu)F_2$
$\quad + (N'_\mu - N_\mu)F_3]U_N$

$l^\pm + N \to l^\pm + N$ X

G_A, G_V relative phases

$(\pi^0\to3\gamma)/(\pi^0\to2\gamma) \cong 3\times10^{-6}$ (theory)
$\quad < 5.8\times10^{-4}$ (exp.)

Reciprocity $\left.\begin{array}{l}\gamma + n \rightleftarrows p + \pi^- \\ \gamma + p \rightleftarrows n + \pi^+\end{array}\right\}$ をつかいテストできる

spin 1
spin 0, 1/2

$j^M_\mu = 2i\frac{\partial}{\partial x_\nu}(\bar\psi_\nu M\psi_\mu)$

H_{st} は C (particle-anti particle conj.) に対して不変.
しかし H_γ は C に対して不変ではない.

$j_\mu = J_\mu + K_\mu$ $\qquad CJ_\mu C^{-1} = -J_\mu$
$\qquad\qquad\qquad CK_\mu C^{-1} = K_\mu$

$Q_J \equiv -i\int J_4 d^3x$ $\qquad Q_K = -i\int K_4 d^3x$

$Q = Q_J + Q_K$

$\left.\begin{array}{l}CQ_J + Q_J C = 0 \\ CQ_K - Q_K C = 0\end{array}\right\}$ $\qquad [H_{st}, Q_K] = 0$

$C_\gamma j_\mu C_\gamma^{-1} = -j_\mu$ $\qquad C_\gamma[H_{free} + H_\gamma]C_\gamma^{-1}$
$\qquad\qquad = [H_{free} + H_\gamma]$

$\left.\begin{array}{l}C_\gamma H_{st} C_\gamma^{-1} \neq H_{st} \\ T H_{st} T^{-1} \neq H_{st}\end{array}\right\}$ $(C_\gamma T)H_{st}(C_\gamma T)^{-1} = H_{st}$

既知の粒子に対しては $Q_K = 0$

$C_{st} = C$; $\quad T_{st} = C^{-1}(C_\gamma T)$; $\quad P_{st} = P_\gamma = P$

$T_\gamma = T$; $\quad C_{st}P_{st}T_{st} = P_\gamma C_\gamma T_\gamma$