NOTE BOOK

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NO会研究記 June, 1965 ~

~ Dec. 1965

VOL. XX

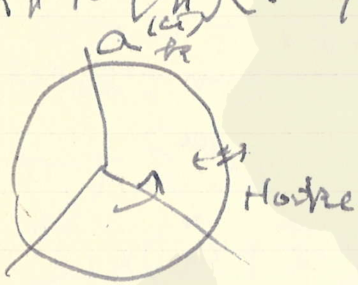
日章 G △50

Nissho Note

時空研究会　6月11日，12日
於 基研　1965

	午前	午後	
11日	後藤 微小剛体 model	原 総合報告	湯川 2,30～3,00 micro-space-time
12日	池内 Embedding の問題 10.30→12,00	宮沢 De-sitter model 田地 時空の inhomog. と CP-violation	

11日 午前
後藤鉄夫：微小剛体 model



strain tensor S_{ab}

$$V = \frac{\lambda}{2}(\mathrm{Tr}\, S)^2 + \frac{\mu}{2}\mathrm{Tr}(S^2)$$

$$T = \frac{x_0}{2}\left(\frac{dX_k}{dt}\right)^2$$

X_k : lab. coord.

x^a : body frame coord.

$X_k = X_k(x^a)$

$x_k = a_k^{(a)} x^{(a)}$ du

平衡点

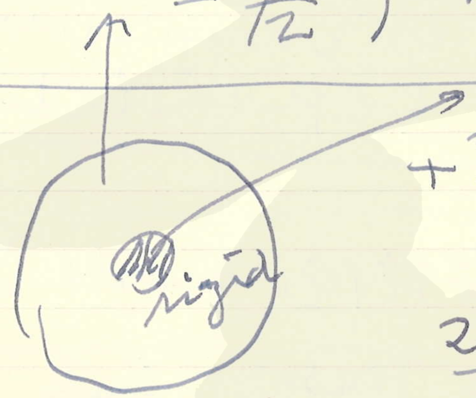
$$x^a \to x^a + u^a(x)$$

$$s_{ab} = \frac{1}{2}\left(\frac{\partial u^b}{\partial x^a} + \frac{\partial u^a}{\partial x^b}\right)$$

$$X_k = a_k^{(\alpha)}\left(x^{(\alpha)} + u^{(\alpha)}(x^{(\beta)}, t)\right)$$

$$L = \frac{\kappa_0}{2}\int\left(\frac{dX_k}{dt}\right)^2 - \frac{\lambda}{2}\left(\int \mathrm{Tr}\, S\right)^2 dV$$

$$- \frac{\mu}{2}\int \mathrm{Tr}\, S^2\, dV$$



$$+ \frac{\kappa_1}{2}\int\left(\frac{dx_k}{dt}\right)^2 dV$$

2 流体模型 = core + 超流体

力学変数は　$a_k^{(\alpha)}(t)$　　$u^{(\alpha)}(x, t)$

$$\frac{dX_k}{dt} = \vec{a}_k\left(\partial_t \vec{u} - (\vec{x} + \vec{u}) \times \vec{\omega}\right)$$

$$\frac{dx_k}{dt} = \vec{a}_k \cdot \vec{x} \times \vec{\omega}$$

$$\vec{\omega} \sim \dot{a}_k^{(\alpha)} a_k^{(\beta)}$$

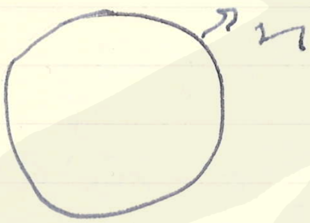
can. conj.

$$\vec{\omega} \to \vec{L} = I_1 \vec{\omega} + \square\, \omega + \square\, \partial_t u$$

$\vec{u} \to \vec{\pi} = \rho_0 \partial_t \vec{u} - (\vec{x} + \vec{u}) \times \vec{\omega}$

$$H_{KE} = \frac{1}{2I_1}\left[\vec{L} - \int dV (\vec{x} + \vec{u}) \times \vec{\pi}\right]^2 + \frac{1}{2\rho_0}\int \vec{\pi}^2$$

$$V = \frac{\lambda}{2}\int (\mathrm{Tr}\, S)^2 + \frac{\mu}{2}\int (\mathrm{Tr}\, S^2)$$



$n^\beta T^{\alpha\beta} = 0$

$T^{\alpha\beta} = \dfrac{\partial V}{\partial S_{\alpha\beta}}$

$\vec{u} \to 1,\ l \to \cancel{0}\ 1$ or 3縮退

$\vec{Y}^m_{1;1l} = \vec{L}\, Y_l^m / \sqrt{l(l+1)}$

3縮退 $\left[\begin{array}{l} \omega_1 = \omega_2 \\ \omega_3 \end{array}\right.$

1) $\vec{n}\vec{u} = 0$ 横波 $\mathrm{div}\, \vec{u} = 0$

$\vec{L}\, Y_l^m$

ω_3

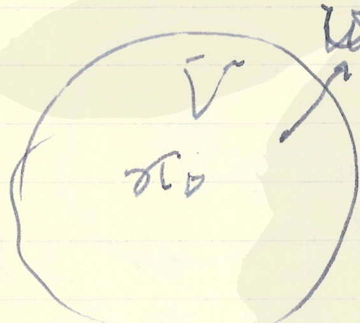
2) 縦波 + 横波

ω_1, ω_2

$$H = \frac{1}{2}\sum_{i=1}^{2}\left(\vec{p}_i^{\,2} + \omega_i^2 \xi_i^2\right) + \frac{1}{2I}\{\vec{L} - \underbrace{\sum \vec{\xi}_i \times \vec{p}_i}_{\text{coupling}} - b\vec{p}_3\}^2$$

相対論的 model

$\varkappa_0 \; V$



$$\delta s^\mu(x) \sim \varkappa_0 \int \qquad ds_i = -\varkappa_0 \int d\xi_0 d^3\xi \times\sqrt{g_{00}}$$

$$ds_i = \sqrt{dx_i^\mu dx_{i\mu}}$$

lag. frame L ξ^α

euler frame E x^μ

$$g_{\alpha\beta} = \frac{\partial x^\mu}{\partial \xi^\alpha}\frac{\partial x_\mu}{\partial \xi^\beta}$$

$$U_\mu dx_\perp^\mu = 0$$

$$dx_\perp^\mu dx_{\perp\mu} = 0 \qquad \text{rigidity の条件 (Born)}$$

$$x^\mu = f^\mu(\xi^0) + a^\mu_\alpha(\xi^0)\xi^\alpha$$

$$L = -\varkappa_0 \int dt \int d^3\xi \sqrt{(1-\vec{\omega}\vec{\xi})^2 - (\vec{\omega}\times\vec{\xi})^2}$$

$$\frac{\partial f^\mu}{\partial \xi^0} = \Lambda a_0^\mu$$

$$\left.\begin{aligned} \dot a_0^\mu &= -\overset{\to\vec\omega_0}{\omega_{0a}}\, a_a^\mu \\ \dot a_a^\mu &= \omega_{a0} a_0^\mu - \omega_{ab} a_b^\mu \end{aligned}\right\}$$

$$L = \frac{I}{2}\vec\omega^2 - M_0 \quad \to \frac{I}{2}(\dot a_a^\mu \dot a_a^\mu + \dot a_0^\mu \dot a_0^\mu)$$

(for $|\vec\omega_0|\cdot r_0 \ll 1$
$|\vec\omega|\, r_0 \ll 1$ )

$$L = \frac{1}{2}\sum_a I_a \omega_a^2 + I'_a \omega_{0a}^2$$

$$\xi^a \to \xi^a + u^a$$

3つ harmonic oscillator

手取

原注: 素粒子の模型

Newton $3+1$

$p = \frac{1}{3}u$

Pielat 4

(divergence
isospin, SU(3))

i) Non-local Field

$\psi(x_\mu, r_\mu) \to$ spin SU(2)

$\downarrow$

$\psi(x_\mu, r_\mu^{(a)}) \to$ SU(3)

$a = 1, 2, 3$

ii) non-linear
非線型方程式, 素粒子内部
自己

iii) Tati
N_μ

iv) Extended Model
剛体モデル J, J_3, J^3
deformable → SU(3) symmetry violation
弱結合

4+3=7 → 7次元空間

$g_{\mu 5}, g_{\mu 6}, g_{\mu 7}$ → [illegible]

湯川：あの世とこの世

武村：Triad model

light cone 上 3本の軸

$\alpha^1_\mu \quad \alpha^2_\mu \quad \alpha^3_\mu$: real null vector

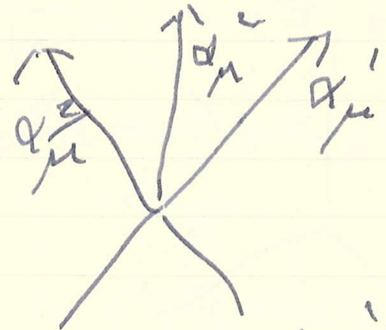
$\alpha^1_\mu \alpha^1_\mu = 0$

U(3)

$\alpha^{(r)}_\mu = \xi^{*(r)} \sigma_\mu \xi^{(r)}$ 　 ξ : two comp

$\xi^{(r)}_\alpha$: 12-component

$[\xi^r_\alpha, \pi^s_\beta] = i\,\delta_{rs}\delta_{\alpha\beta}$



$\zeta = \begin{pmatrix} \xi \\ i\pi^* \end{pmatrix}$ 　 4-comp. spinor

$\xi^r_\alpha + i\pi^{r*}_\alpha = a^r_\alpha$

$\xi^* + i\pi = b^r_\alpha$

$\tilde{U}(12)$ 　 $\bar{\zeta}\zeta$: invariant

$\supset U(6) \times SU(3)$

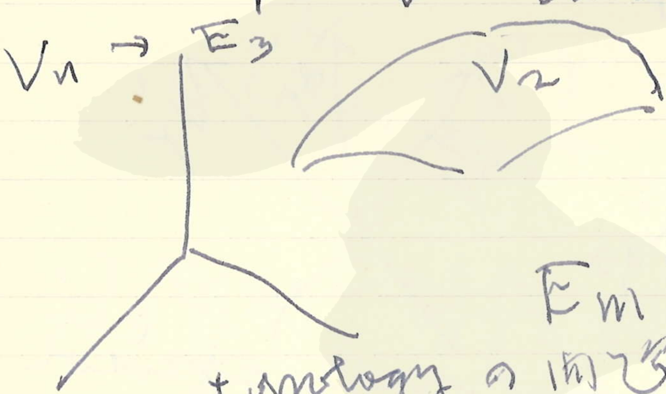
$\tilde{U}(2)$

1
35
56
20 はでない

extension
dilatation
oscillation

第12回　6月12日
池田峰夫氏: Embedding

$V_n \to E_3$



$E_m \supset V_n$

topology の問題.

plane　$ds^2 = (dx^1)^2 + (dx^2)^2 \quad (-\infty < x^1, x^2 < +\infty)$

はずみ車

$\frac{m}{2}(\dot{x})^2 + \frac{I}{2}(\dot{\theta})^2$

$(dx^1)^2 + (dx^2)^2 \quad \begin{cases} -\infty < x^1 < \infty \\ 0 \le x^2 < 2\pi \end{cases}$

$(dx^1)^2 + (dx^2)^2 \quad \begin{cases} 0 \le x^1 < 2\pi \\ 0 \le x^2 < 2\pi \end{cases}$

non-Euclidian metric にならざるを得ない.

E^4 の中には入る.　　E_3 の中だけには入らない.

$z^1 = \cos x^1$
$z^2 = \sin x^1$
$z^3 = \cos x^2$
$z^4 = \sin x^2$

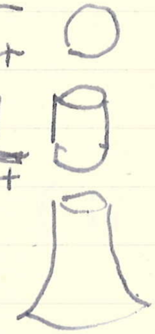
$\sum_\alpha (dz^\alpha)^2 = (dx^1)^2 + (dx^2)^2$

locally に同じで (ds^2 は一寸 [illegible] 同じ)
globally に違う (topology が違う)

de Sitter
Einstein
Relativistic cosmology
V_4 ---+

$\subset E_5 = 4+1$

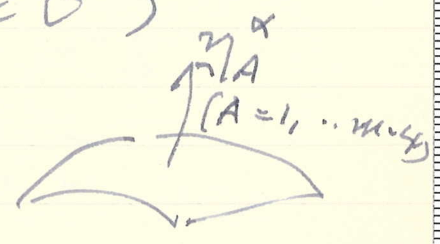
$- - - + -$
$- - - + +$
~~+ + + + +~~



{geodesic &
motion ($g_{\mu\nu}$ を不変にする変換)}
が因子につける.

Schwarzschild $\subset E_6$ (Kasner ('21))
Fronsdal ('59)
singularity $r = 2m$
(Kruskal ('60): 4次元の座標変換で除去できる)(しかし、今の論文 $J \to r = 2m$ で $J = 0$)

local embedding
偏微分方程式
積分可能条件
E_m $z^\alpha (\alpha = 1, \dots m)$
$z^\alpha{}_{,\mu}$ unique ではない



$z^\alpha(x)$

i) 楕円型

~~i) 楕円型~~ $ds^2 = (dz^1)^2 + (dz^2)^2 - - - -$

$z^1 = k\gamma^{\frac{1}{2}} \sin(t/k)$

$z^2 = \text{''} \cos(\text{''})$

$z^3 = f(r)$

$z^4 = r \sin\theta \sin\varphi$

$z^5 = r \text{ ''} \cos\varphi$

$z^6 = r\cos\theta$

$\gamma = 1 - \dfrac{2m}{r}$

$\left(\dfrac{df}{dr}\right)^2 = \dfrac{2mr^3 + m^2k^2}{r^3(r-2m)}$

(Kasner $k=1$)

ii) $ds^2 = (dz^1)^2 - \text{''} - - - -$

$z^1 = k\gamma^{1/2} \sinh(t/k)$

$z^2 = \text{''} \cosh(\text{''})$

$z^3 = g(r)$

⋮

$\left(\dfrac{dg}{dr}\right)^2 = \dfrac{2mr^3 - m^2k^2}{r^3(r-2m)}$

(Frondal $k = 4m$)

iii) 放物型

ds^2 : ii) と同じ

$z^1 = (t^2-1)\gamma^{1/2}/2 + h(r)$

$z^3 = (t^2+1)\gamma^{1/2}/2 + h(r)$

$z^2 = t\gamma^{1/2}$

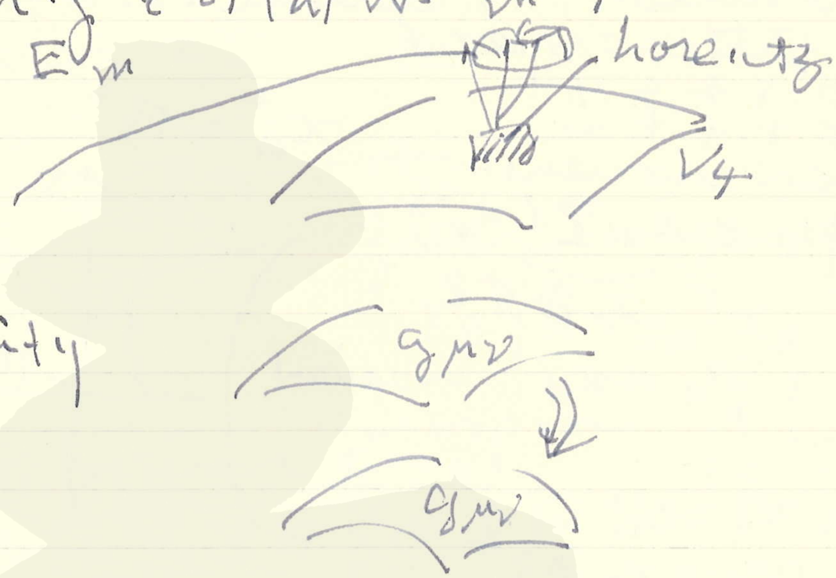
- - -

$\dfrac{dh}{dr} = r\gamma^{-1/2}$

rigidity of embedding

Symmetry との関係 m-4

$V_4 \subset E_m$



G.

Rigidity

$z^\alpha \to a^\alpha_\beta z^\beta$

第2回会議
分科会：素粒子とCosmology

1. Minkowski space
Translation → energy, momentum
rotation → angular momentum
(Lorentz transf. → spin)

$+++-$ $P_4 < 0$ → anti-particle
$P_4 > 0$; $P_4 < 0$
Reciprocity
$x_\alpha^2 \gtreqless 0$

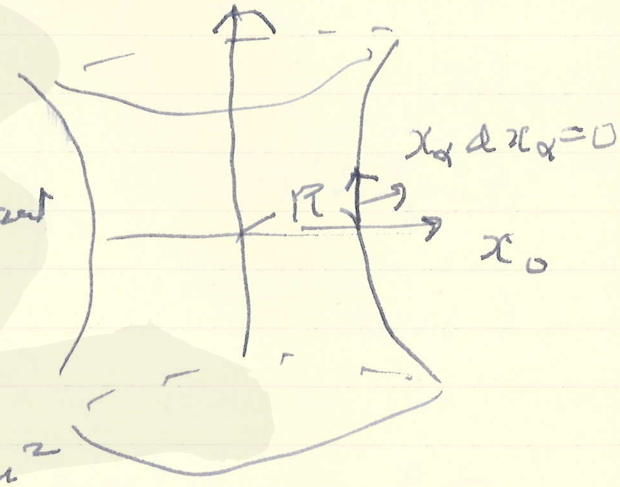
2. constant curvature
translation → local

rotation → global に成立しうる.

de Sitter space

$\begin{array}{ccccc} 0 & 1 & 2 & 3 & 4 \\ - & + & + & + & - \end{array}$

$x_\alpha^2 = R^2$



linear momentum

$\underline{p_\alpha + x_\alpha \Phi(x_\alpha^2)}$

不定性

$\int p_\alpha dx_\alpha$: invariant

$p_\alpha x_\alpha = 0$,

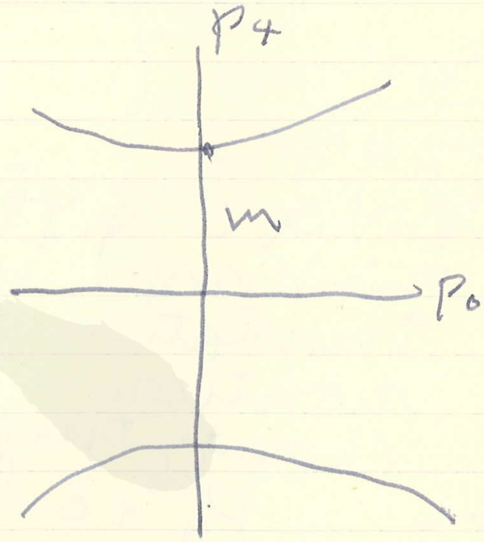
$(p_\alpha + x_\alpha \Phi)^2$

$= p_\alpha^2 + x_\alpha^2 \Phi^2 = -m^2$

$x_0 = R$ の附近だけ考える

momentum space

$R = m = 1$



$\int \left(p_\alpha \frac{dx_\alpha}{d\tau} + \lambda p_\alpha p_\alpha + \mu x_\alpha x_\alpha + \nu p_\alpha x_\alpha\right) d\tau$

$\lambda = -\mu, \quad \nu = 0$

$\frac{dx^\alpha}{d\tau} = -p^\alpha, \quad \frac{dp^\alpha}{d\tau} = -x^\alpha$

$= m^{\alpha\beta} x_\beta \qquad = m^{\alpha\beta} p_\beta$

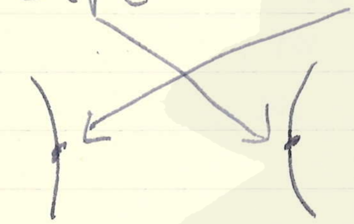
$L = p_\alpha p_\alpha + x_\alpha x_\alpha$

$H = -p_\alpha p_\alpha + x_\alpha x_\alpha$

$\tilde{O}(10)$ $\tilde{U}(5)$ $S\tilde{U}(5)$

$45-20=25$ $25-1=24$

$x_0=+R$ $x_0=-R$



Zitterbewegung

$\gamma_\alpha p_\alpha + \gamma'_\alpha x_\alpha$

isospin

10次元の spinor を作る

$2^5=32=8\oplus 8\oplus 8\oplus 8$

$$(\gamma_\alpha p_\alpha + \gamma'_\alpha x_\alpha)\underbrace{\psi(x_0,\dots x_4)=0}_{=\frac{\partial\psi}{\partial\tau}}$$

田地氏: $K_2^0\to\pi^++\pi^-$

1 BeV ~ 10 BeV

$$\frac{K_2^0\to2\pi}{K_1^0\to2\pi}\sim10^{-6}$$

N_μ

CP-non-invariance

$$P_\mu=P_\mu^{(0)}+N_\mu\int H(x,N)\,d\sigma$$

$$[\phi(x,N),\phi(x',N)]=$$

σ_N

$cp=+1$

$\Phi_{K_1^0}\ \varphi^*\varphi$

$cp=-1$

$$\Phi_{K_2^0}[\varphi^* F(N\,i\partial)\varphi-\varphi F(N\,i\partial)\varphi^*]$$

News [illegible]

原氏:

1. D. Ivanenko, On Mesons and Cosmology

intermediate boson

$\Delta S = 0$: W_1, m_1

$\Delta S = 1$: W_2 m_2

$m_1 \neq m_2$

CP-non-invariance

$ds^2 = (1 \pm F)^4 ds_0^2$

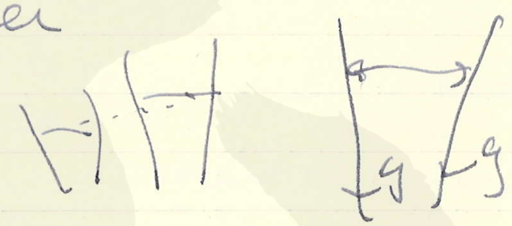
conformal

$K_2^0 = (K_2^0)_0 + F \cdot (K_1^0)_0$

2. J. A. Wheeler, The Non-Locality of Force

[illegible]　[illegible]

内山氏: Wheeler 同上



3. [illegible]氏

Wentzel: On Baryon Ground states in Yukawa Theories

strong coupling

SU(3) singlet が ground state で [illegible] ?

D-coupling　singlet が [illegible]

F-coupling (Dallemond) singlet が [illegible]

Lindau June July 1965

第15回

July 1, Dirac: Foundation of Q. M.
Yukawa: Space-Time Description and Matter
Heisenberg: Feinstructure constant

模型 II 研究会　　基研

July 19 ~ July 21, 1965

19日：午前

坂田：

座長：原田

~~石田：核子の〜〜~~

原康夫：Urbaryon

Urbaryon 間の引力が必要か？

magnet　$\boxed{N \leftrightarrow S}$ → ξ, ξ^*

χ_i, ξ_j　monopole の非存在証明

monopole が spin をもつ，baryon number N をもつ → 最低 2 つの

$j=1/2$　triplet → $N = 0, \pm 2, \ldots$

$B=1$　(ξ, ξ^*) Urbaryon ($\xi = 0$　$B^{\#} = 0$)

でいける．

A_i, $\bar{A}^i$　R-symmetry

	π_8	π'_8	N_8	N'_8
R:	+1	−1	+1 (−1)	−1 (+1)

→ 1480 N_1^*

$\bar{N}_8, N_8 \pi_8$ → D-type

$\bar{N}_8 N_8 \pi_8$ → F-type

$\pi'_8 \to \pi_8 + V_8$

$V_8 \to 2\pi_8$

baryon；　$\chi_i \bar{A}^j \pm \xi_j A_i$

$B^{\#}$ \ M.C.	+1	−1
1	χ_i	ξ_j
0	A_i	$\bar{A}_j$

不在因: Urbaryon, 磁気能率

i) $t\bar{t}$

ii) $t\,t\,t$

磁気能率　$SU(6)$

$\mu_P/\mu_N = -3/2$

困難: quarks の $\mu_t \propto Q_t$

$$\mu_t = \frac{e Q_t}{2Mc}\,\kappa\,S$$

$\mu_B = \frac{e}{2M}\sum Q_i J_t^{(i)}$

($\kappa = 1$　for without S.I.)

($\kappa > 1$?　with S.I.)

$t\,t\,t$: $J = 1/2$

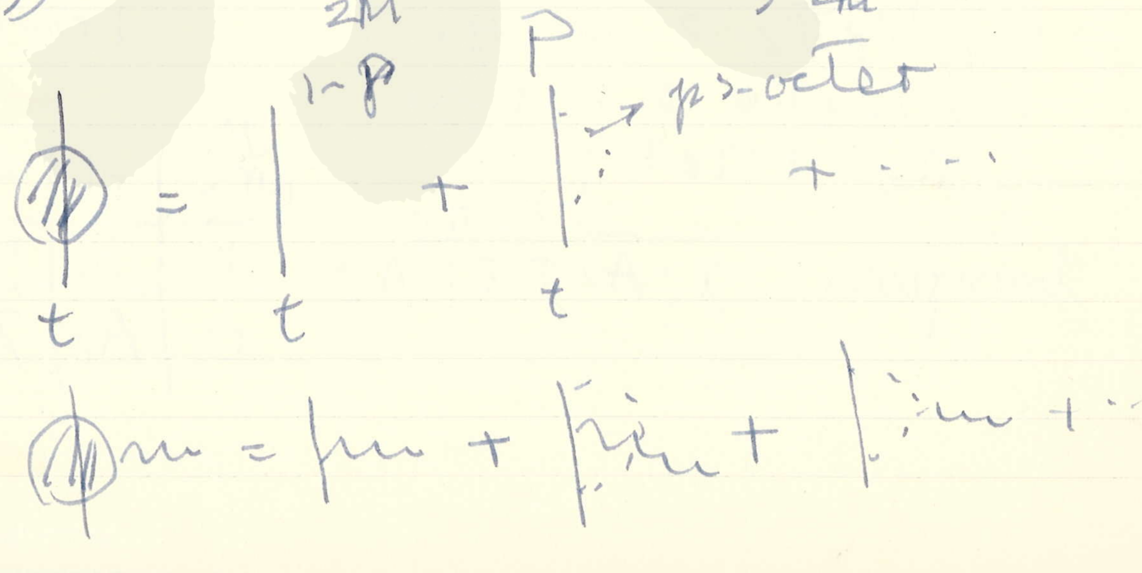
(A)　fermion　8次元 ← $SU(6)$ 20次元

(B)　para-fermion　8次元 ← $SU(6)$ 56次元

fermion 8次元

(A)　$-\frac{1}{3}\frac{e}{2M}\kappa$　　$\frac{2}{3}\frac{e}{2M}\kappa$

(B)　$\frac{e}{2M}\kappa$　　$-\frac{2}{3}\frac{e}{2M}\kappa$



u
d　$-\frac{1}{3}$　: π^+
u　$\frac{2}{3}$

u
s　: K^+
u

$$\frac{\kappa}{2M} \simeq (1-P)\frac{1}{2M} + P\frac{1}{2M}\left(\frac{1}{24} + \frac{M}{\omega}\frac{3}{4}\right)$$

ω: meson cloud の平均エネルギー

form factor

$$\rho^{(p)}(r) = Q^{(p)}\{R(r)\}^2$$

$$\rho^{(m)}(r) = \mu^{(p)}\{R(r)\}^2$$

$Q_{En} = 0$ も説明できる.

20日：午前

杉本：相原

原：松本・田代・若林：CP-non-inv.

$K_2^0 \to \pi^+\pi^-$

N_μ $n_\mu = \lambda N_\mu$

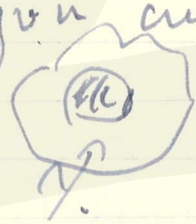
$\pi^+ F(n_\mu \partial_\mu)\pi^-$

$\lambda \approx 10^{-17}$ cm

中川、豊田：baryon current

level I

baryon



level II mbaryon

case いくつか

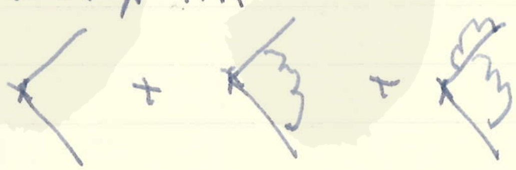
cloud の構造.

Fukawa

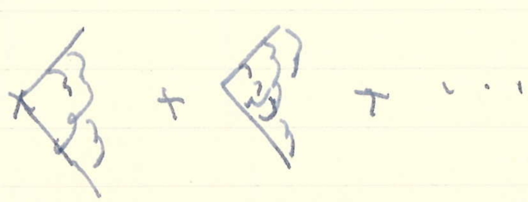
$F/D = f/d = 1/3$

weak strong

cloud の分類



"single cloud"



"double cloud"

定理：1. octet cloud に限られない self-energy diagram は D/F ratio を変えない。

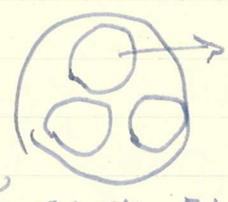
定理 2. single cloud の場合, $d/f = \pm 1/3$ のみ。ratio は不変.

$$J_{(8)} \simeq J^V + J^A$$
$$F \qquad D:F = 3:1$$
$$SU(6) \to F, \quad D:F \simeq 3:2$$

定理 3. single cloud correlation は $d/f = \pm 3$ のときには $D/F = \pm 3$ or $\mp 5/3$ → 実験に近い 2倍 ~ 3/2 のとき D/F ratio は変らぬ.

f/d の物理的意味は何か？

core の中で quarks の結合がきくのか


q

$\Sigma^+ \leftrightarrow \Lambda \quad d_A = \frac{3}{2} \langle \sum_i y^{(i)} \sigma_z^{(i)} \rangle_{\Sigma^+}$ non-rela.

$\Sigma^+ \leftrightarrow \Sigma^0 \quad f_A = \langle \sum_i I_z^{(i)} \sigma_z^{(i)} \rangle_{\Sigma^+ \text{ spin} \uparrow}$

$\Sigma^+ \quad u^\uparrow u^\downarrow s^\uparrow$

$f_A = 0$ (SU$_6$ の結果と一致)

$d_A = -1$

$$|\Sigma^+\rangle = a|u^\uparrow u^\uparrow s^\downarrow\rangle + b|u^\uparrow u^\downarrow s^\uparrow\rangle$$

$$f_A = |a|^2 \qquad d_A = 2|a|^2 - |b|^2$$

$f_V = 1$, $d_V = 0$

昔の：Vector boson (bosons with double structure)

$3\times 3^*$
$0^+ \sim 700$ MeV とあるのか，どうしてか？

$T^{\{\mu\nu\}}_{(\lambda\rho)}$ 10元 → 10^*

$T^{(\mu\alpha)}_{(\nu\alpha)}$ 8 → $\tilde{8}$

$$M_8^{(\pm)} = \frac{1}{\sqrt{2}}(M_8 \pm \tilde{M}_8)$$

K	725
$\bar{K}^*$	890
ρ	780
ϕ	1020

	ρ_1	ρ_2	Φ_1	Φ_2
G	+1	−1	−1	+1
CP	+1	−1	+1	−1

ρ ω^0 ϕ $2\pi+\gamma$
($\omega^\pm$はできない)
(できても，わからない)
$(3\pi^\pm + \gamma)$

千鳥：花塩 仙山
伝田・相原・白浜・三浦・林：PS bosonの複合性

[1] level I.
[中間型] $Z_3 \to 0$
[複合型] $Z_3 \to 0$, $\delta Z_3 \to 0$

[2] PS meson

I. π中間子

$(\pi\pi\pi) + \cdots\cdots (N\bar{N}) + \cdots\cdots$

$\sim (\rho\pi) + \cdots\cdots (N\bar{N}) + \cdots\cdots$

S-

[1] $(N\bar{N})$

相互力だけときめると

ρ π

ω η

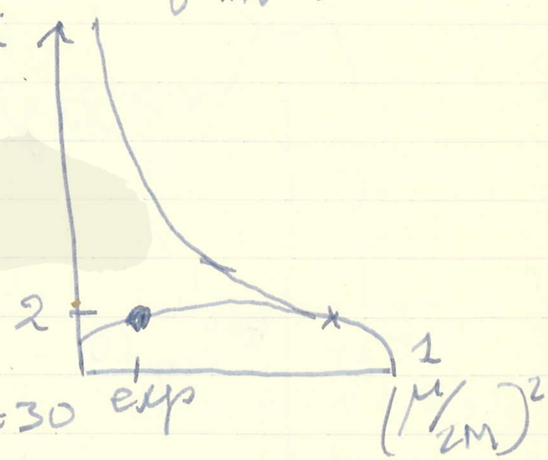
"結合型"

"中間型"　$\mu^2 \gtrsim 2M^2$

$g^2_{\pi NN}/4\pi \gtrsim 2$

$g^2_{\pi NN}/4\pi \gtrsim 2$

近距離($<\bar{\pi}$)の強い引力



(2) $\rho-(\rho\pi)$

ρ π

ω

"結合型"

"中間型"　μ 大きい　$\frac{g^2_{\rho\pi\pi}}{4\pi} \gtrsim 30$

$g^2/4\pi \gtrsim 1$ (実験 2)

$\rho\pi\pi$

II. K-meson :　$K = (K\pi\pi) + \cdots (Y, N) + \cdots$

$\sim (K^*\pi) + (K\rho) + \cdots$

i) [illegible] $5(\bar{\Lambda}N)$　×

ii) $Y(K^*\pi)$　中間型　$\frac{g^2_{K^*K\pi}}{4\pi} \approx 0.5$

[3] B8 : "中間型" ($g_{\pi NN}/4\pi \sim 20$) → 構成かな 決まるか?

[V8 :

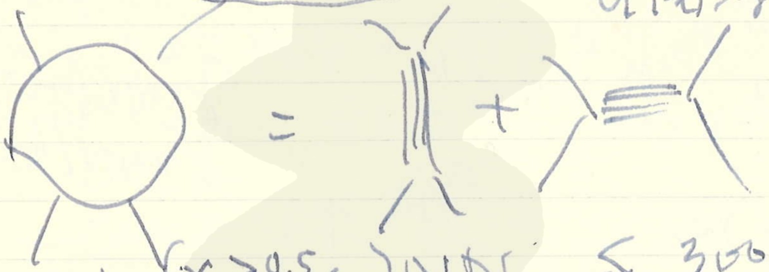
B10 :

[4]

広島 group：核力（沢田）

OBEC：~~[illegible]~~ その考え。

level I. → II　粒子，resonance の同等性。



($r \gtrsim 0.5 \sim 0.6\,g$) NN $\lesssim 300$ MeV

π		◎	$G_\pi^2 \sim 14$
η		△	$G_\eta^2 \lesssim 5$
I=0 0^+	600MeV $\sim m_?$	◎	$m_S = 700 \to \varepsilon_0$ (ABC (310 $\sim$ 320 MeV) [illegible]) $g_S^2 \doteqdot 15 \sim 20$
I=1 0^+		×	?? $g_S^2 \gg 1$ ($m_S \sim 700$ MeV)
ρ		◎	tensor coupling main
ω		◎	vector coupling main
I=1 B	1260MeV	?	
I=0 φ	1020	?	
2^+ f_0			$^3P_0$ に影響がない。

小川：TPEP は利かない領域

武谷：TPEP はいらぬ
　Hamiltonian の適用限界

际站: Gemisch

$\Phi_1, \Phi_2 \ldots\ldots$ states

$w_1 \; w_2 \ldots\ldots$ statist. weight

$$\Phi = \Phi_1(x_1)\Phi_2(x_2)\ldots\ldots$$

$$\overline{R} = \sum_n w_n \overline{R_n}$$

$$\mathbb{R} = \frac{1}{N}\sum_i \mathbb{R}_i$$

$$\mathbb{R}_i = \frac{1}{N}\mathbb{R}_i$$

i) $\frac{1}{3}$

ii) $t \; t \; t$　相互力なし

iii) どうして quarks が あらわれないか?

i) $N = 3$

$$H = \frac{1}{3}\sum H_i$$

$$\{t_i, t_i\} = \delta$$

$$[t_i, t_j] = 0 \; (i \neq j)$$

$$a_3^\dagger a_2^\dagger a_1^\dagger |0\rangle$$

$(1, 2, 3)$ symmetric

SU_3 を既定.

$|||$

相互に空間的

沢田: gemisch

崎田: SU_6 invariance を interaction に認めうるか?

dynamical な対称性

水素 hydrogen atom は $O(4)$ 対称性をもつ! (Pauli)

$[L_i, L_j] = i L_k$

$[A_i, L_j] = i A_k$

$[A_i, A_j] = -2 i H L_k$

$\vec{A} = \frac{1}{2}\{\vec{L} \times \vec{p} - \vec{p} \times \vec{L}\} + \frac{\vec{r}}{r}$

energy (H) とともに対称性が崩れる.

strong coupling の symmetry

$[A_\alpha, A_\beta] = 0$

$[I_i, I_j] = i\, C_{ijk} I_k$

$[A_\alpha, I_j] = i\, D_{\alpha\beta}(j) A_\beta$

hydrogen atom $E=0$ の場合と同じ.

$SU_2 \otimes SU_3 \rightarrow \overset{\text{ps meson}}{A_{i\alpha}} \rightarrow SU_6$

田中：対称性の破れの起源

SU(3)の破れ

μ-e difference

$Z_2(\mu)$

新しい lepton

(t_1, t_2, t_3) $n_B = 0$

B $n_B = 1$ t

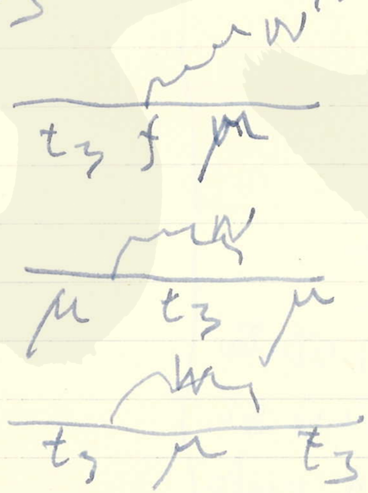
$(t t t)$
$(t \bar{t})$

新しい charge の neutral state

$t_1^0 \quad t_2^- \quad t_3^-$ B^{++} $\left\{ \begin{array}{l} l = +3 \\ a = +2 \end{array} \right.$

t の崩壊

semi-weak



$$\bar{t}_3 \gamma_\mu \{ \mu W_1 + \frac{(1+\gamma_5)}{2} \nu_\mu W_2 + \frac{(1-\gamma_5)}{2} \nu_\mu W_3 \}$$

weak $\{ \bar{\mu} \nu_\mu + \bar{e} \nu_e + (\bar{t}_2 + \bar{t}_3) t_1 \} W_3$
$+ W_1^* W_2$

Okun et al.

21日 第3日：沢田 片山
Summary, discussions
沢田：
baryon 3体 → B^*
meson 2体 → M^*
片山：片山、山田 et al の片山解釈

triplet (cap 3)
para (OK) 統計
strong

q_λ $\lambda = 1, 2, 3$

T	S	Z
1/2	0	1
0	-1	1

Q, Y, N の eigenstate でない combination は eigenstate に対応する

$[[q_\lambda q_\mu]_+ q_\nu]_+$
$[\tilde{q}_\lambda q_\mu]_-$
1, 3, 8, 56

相互作用は他の state が現れないという super selection rule

green-Ansatz
$$q_\lambda = \frac{1}{\sqrt{3}} \sum_\alpha t_{\lambda\alpha}$$
subtriplet
$Q_1 + Q_2 + Q_3 = -1$

electromagnetic interaction は subtriplet で書かれなければならない。

武谷：核力

OBEC

Potential　大・玉垣 et al.

Dispersion　l が入った（玉垣）

core　宮崎・町田.　3 BeV まで

S-wave

8 BeV まで core はあるらしい。

（三田：$^1S_0$ でたしかに core がある。

$\sum_i \frac{e^{-\kappa_i r}}{r}$ で O.K.（ρ, ω 程度の mass）

坂田：Concluding Remarks

4 階段説

非局所性研究会　7.26〜7.29
1965　基研

午前
1. unitary symmetry の相対論的拡張
2. 内部空間とLorentz群の結合
3. parastatistics

午後：模型 I 研究会の報告

午後：B.S 方程式と norm

その

究極：SU_6, SU_9 と Lorentz 群.

$$\text{Sakita}\left\{\begin{matrix} K^+ & K^0 & \eta \\ p_\uparrow & n_\uparrow & \Lambda_\uparrow \\ p_\downarrow & n_\downarrow & \Lambda_\downarrow \end{matrix}\right. \qquad SU(9)$$

symmetry breaking

kinetic energy ?: non-rela で初めて quantization が symmetry を破る!!!

1. parafermion

|||

symmetric

2. particle と anti-particle or adjoint repres.

$SU(9)$ は conditional symmetry

空の一部で成立.

(Lorentz 群 $SL(2,C)$, $SU(9)$ } を含む群 $SL(9,C)$, $U(18)$

$$(\Gamma_\mu P_\mu + m)\begin{pmatrix} \vdots \\ \vdots \end{pmatrix} = 0$$

$\mu = 1, \cdots 18$

scalar 成

spurion ?

加藤：

$\tilde{U}(12) \supset L \otimes SU(3)$

谷川：de Sitter space の中の素粒子。

空間の性質と素粒子の性質の間は

10次元の中の embedding

global symmetry

5次元の pseudo-Euclid space

$(+ + + + -)$

$p_\alpha^2 + x_\alpha^2 = \mathrm{inv} \to a_\alpha^* a_\alpha = \mathrm{inv}.$

proper de Sitter $M_{\alpha\beta}$ の作用は

$x_i \to -x_0$

$x_4 \to -x_4$

4種類の独立な変換，

$\tilde{SU}(5) \times SU(4)$

崎田：Dynamical symmetry

strong coupling による symmetry の拡大。

C. J. Goebel：

$[A_\alpha, A_\beta] = 0$

Kinematical group → dynamical group

第2回 July 27, 金曜
中野：$O(5)$ 対称性
higher spin の運動方程式

Type I, $S \geq 3/2$

Type II $S \geq 1/2$

$$D_5(L_1, L_2) = \sum_{l_1 = L_2}^{L_1} \sum_{l_2 = -L_2}^{L_2} D_4(l_1, l_2)$$

$L_1 \geq L_2$

m_{12}, m_{34}

$$D_4(l_1, l_2) = \sum_{l = |l_2|}^{l_1} D_3(l)$$

$$\vec{m} = (m_{23}, \cdot\cdot, \cdot\cdot)$$

$$\vec{n} = (m_{14}, \cdot\cdot, \cdot\cdot)$$

$$(\vec{m}^2 + \vec{n}^2)| \rangle = \{l_1(l_1+2) + l_2^2\}| \rangle$$

$$\vec{m}\vec{n}| \rangle = (l_1+1) l_2 | \rangle$$

$\alpha_\mu = m_{5\mu}$

$$(V_\mu \partial_\mu + MS)\psi = 0$$

$$V_\mu = \sum_{l_1 = L_2}^{L_1} \sum_{l_2 = -L_2}^{L_2} \sum_{(a,b)} a_{(a,b)}(l_1, l_2)$$

$$\times P(l_1+a, l_2+b)\, \alpha_\mu P(l_1, l_2)$$

$$(a, b) = \left\{ \begin{matrix} (0, \pm 1) \\ (\pm 1, 0) \end{matrix} \right.$$

$$S = \sum_{l_1 = L_2}^{L_1} \sum_{l_2 = -L_2}^{L_2} b(l_1, l_2) P(l_1, l_2)$$

Lagrangian

$$\psi^\dagger = \psi^* \eta$$

$$\psi^\dagger (V_\mu \partial_\mu + MS)\psi$$

$\eta^2 = 1$ $\quad \left.\begin{array}{l} \eta V_k + V_k \eta = 0 \\ \eta V_4 - V_4 \eta = 0 \end{array}\right\}$

ηV_μ: hermitian

Type I : $S = 1$

$l_1 = l_2$: $a_{(a,b)}(l_1, l_2) = a^*_{(a,b)}(l_1 + a, -l_2 - b)$

spin of l_2

spin 1/2 : $(\Box - M^2)\psi_a = 0$

$$\frac{1}{2}(1-\gamma_5)\gamma_a \psi_a = 0$$

$$\frac{1}{2}(1-\gamma_5)\left(\delta_{ab} - \frac{1}{4}\gamma_a\gamma_b\right)\psi_b = 0$$

$$\frac{1}{2}(1+\gamma_5)\psi_a = \frac{1}{2}(1+\gamma_5) \times \left[\frac{1}{\sqrt{3}}\partial_a - \frac{1}{4\sqrt{3}}\gamma_a \gamma\partial\right]\gamma_b \psi_b$$

16 成分 ... → 4 成分

propagator:

$$\frac{\partial^5}{(\Box - M^2)^2}$$

吉川: Unitary symmetryの
相対論的拡張
特に SU(6)の拡張。

1. Non-relativistic limit　X?
2. Strong coupling limit
3. Exact symmetry → SL(6, C) → Γ_μ $\begin{pmatrix}\mu = 1 \\ \cdots 36 \\ \cdots 72\end{pmatrix}$
4. Dynamical symmetry

3. $[\Gamma^A P_A - m]\psi = 0$ → quarks ([illegible]) → (1, 2 [illegible])

$A = 0, 2, \cdots 71$

12列12列

$\Gamma^A = \begin{pmatrix} 0 & J_A \\ J_A & 0 \end{pmatrix}$　　$A = 0, \cdots 35$

$\Gamma_5^A = \begin{pmatrix} 0 & J_A \\ -J_A & 0 \end{pmatrix}$

$J_A = \sigma_\mu \lambda_l$

$\det[\Gamma^A P_A - m] = 0$

P_0 = energy　　P_i (71) : real
P_i = momentum　　→ P_0 : real

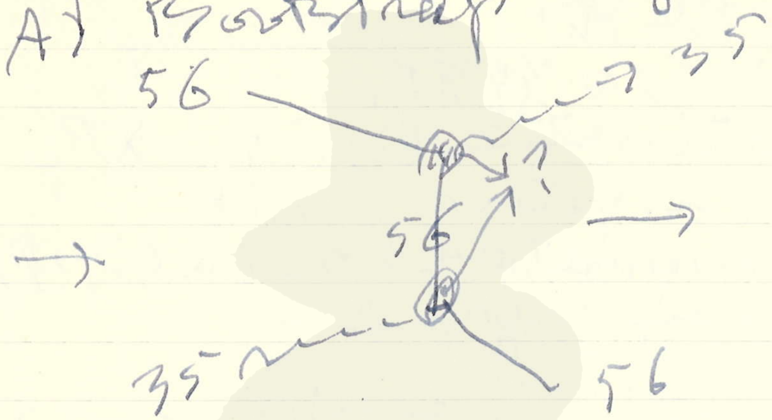
ghost が出る…,

light cone:

mass shell:

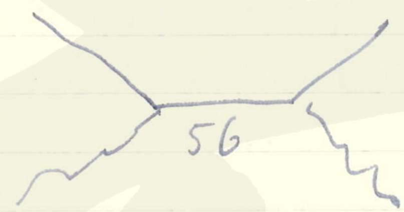
4. Dynamical symmetry

A) Bootstrap



31(木)力

56	11/15
70	-2/5
200	2/15
1134	-2/45



B) $[H, J_i] \neq 0$

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

$|b(\alpha)\rangle = e^{i\alpha_i J_i}|a\rangle$ の定性.

H.O. H, $a^\dagger, a$

$$\left.\begin{aligned} [H, a] &= -a \\ [H, a^\dagger] &= a^\dagger \\ [a, a^\dagger] &= 1 \end{aligned}\right\}$$

$[a, a] = 0$

鈴木　結合: internal space と Lorentz 群

	group	generator	
20VP	$\mathfrak{I}$	I	(H_i, E_i)
I.H.L.	$\mathfrak{P}$	L	$(P_\mu, M_{\mu\nu})$
	$\mathfrak{g}$	G	

$[I, L] = 0$ と限らない.
例えば $[P_0, E_\alpha] \neq 0$
(γ と Λ のいれかえ)
$\mathfrak{g} \supset \mathfrak{I} \times \mathfrak{P}$
$\mathfrak{g} \supset \mathfrak{P}$

McGlinn (1964) $\longrightarrow$ O'Raifeartaigh (1965)
$\mathfrak{g} = \mathfrak{I} \otimes \mathfrak{P}$
if (i) $\mathfrak{g} \supset \mathfrak{P}$
(ii) G: 有限個の parameter をもつ Lie group algebra,
(iii) $P_\mu P^\mu = -m^2$ self-adjoint, m^2 が discrete spectrum をもつ
(iv) Hilbert space or positive metric

(a) Hilbert space of indefinite metric X
(b) P^2: self-adjoint をやめる X
(c) G: infinite dim.
(d) $\mathfrak{P}$ を modify

(b) Ottoson ('65)

第3日 28日

片山・山田・梅村：Variant Triplet Model and Integral charge

1) Greenberg
2) Van Hove, Nambu } →

---

(1) 外へ出ると charge の固有値が現われるという考え方。

$$q_\lambda = \frac{1}{\sqrt{3}} \sum_{\alpha=1}^{3} \omega_\alpha f_{\lambda\alpha}$$

中でも外で存在しているのは $f_{\lambda\alpha}$

観測は強い電磁的相互作用を利用してするか？

核分裂による neutron の観測，

一体何を見ているか？ (level 0 or 1)

核の中の (n, p)

baryon-meson は多体問題 (level 1

charge conservation の絶対性

(2) 階層論 と 統一理論

(5) 素粒子の性質

<u>絶対的保存則</u>

charge
baryon number
lepton number

宗教観：多次元化

小心文
胆大文) 文章軌範

論理的の other theory

Wigner, Relativity 記念号 (Helvetica)

$$\left.\begin{matrix} x_\mu \\ \frac{\partial}{\partial x_\mu} \end{matrix}\right\} \rightarrow \left.\begin{matrix} \varphi_\mu \\ \frac{\partial}{\partial \varphi_\mu} \end{matrix}\right\} \qquad \Psi(\varphi(x))$$

physical (field?)

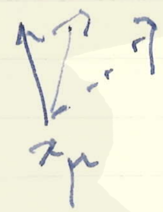
plenum reality —— → strong

minkowski → weak

(一元的 world
(4) plenum に潜在的
energy をあたえられば 顕在化されるか)

各点に 3種の何ものかが
あって、

$\chi_a^\mu(x)$ 自由度 12



$\varphi(x_\mu : \chi_{a\mu}(x))$

1) Translation x_μ だけ displace
2) Lorentz x_μ, $\chi_{a\mu}(x)$ が変化
3) SU_3 $\chi_{a\mu}(x_\mu)$ だけが変化

(5) 構造の内の転化 → 相互作用
相互力

(6) 7点構造 又は 5, 3

構造の成立
構成力

4点　　　　4点

<1>　　　　<4>

(3)　　　　(3)

8点 (7) →(5)→(3)

(4面あり)は(1面あり)にかわり [?]

(2面あり)は(3面あり)がかわり [?]

4点　　　　2点

<1>(2)　　　(1)

6

(5) →(3)<1>

S行列理論の統一研究会
July 29, 1965〜, 基研

宮沢：…
今村
湯川、中野 …
林（学大物理）…

素粒子 シンポジウム

京都会館

Sept 21, 22, 23, 1965

Opening Address

素粒子国際会議
Sept. 24～30, 1965
京都会館
Opening Address

Oct. 27, 1965

[illegible]

chap. 1. High Energy Scattering

elastic backward $\pi^\pm p \to \pi^\pm p$

charge exchange

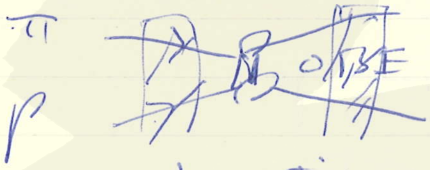
forward $\pi^\pm p \to \pi^\mp p$

large angle scatt. $K p \to K^* p$

$(\sim 90^\circ)$

§1. Byers-Yang

§2. peripheral absorption model



absorption

§3. Large angle scattering

§4. Analyticity, – 8 = Analysis

chap. 2 Symmetry

Byers-Yang: πp charge exchange scattering and a "coherent Droplet" model ; H.E.E.P.

$$-t = 2k^2(1-\cos\theta) \doteqdot \left(2k\sin\frac{\theta}{2}\right)^2$$

$$\frac{d\sigma}{dt} = \pi \lambda\!\!\!^{-2} \frac{d\sigma}{d\Omega}$$

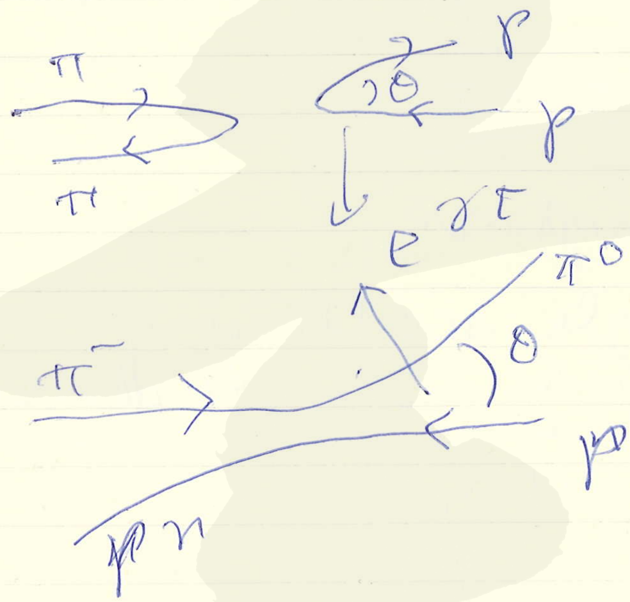
Exp. Results

$$\frac{d\sigma}{dt} = A e^{\gamma t} \qquad \gamma \sim \frac{1}{2} R^2$$

$\sigma \sim 10\,(\mathrm{GeV}/c)^{-2}$

→ $R \sim 0.8\,Y$ → 10^{-13} cm

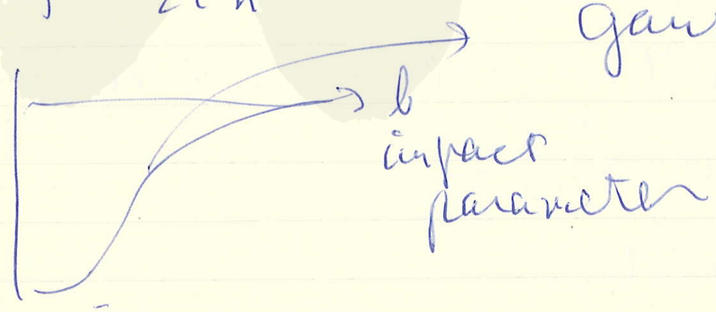
([illegible] 0.2 Y
~~hadron~~
hard core 0.5 Y
meson 1.4 Y)



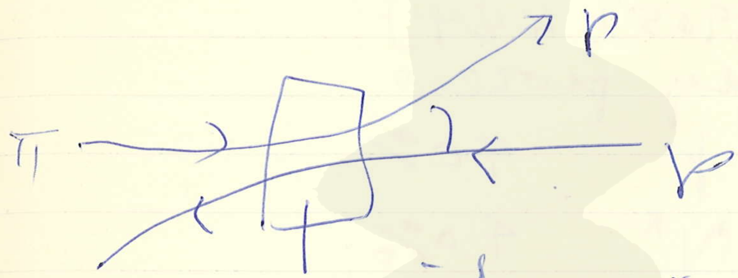
diffraction scattering

$$f = \frac{1}{2ik}\sum(2l+1)(e^{2i\delta_l}-1)P_l(\cos\theta)$$

gauss 型 分布



charge exchange でも そうなるのは、どうして か、



with quantum number {exchange / transfer

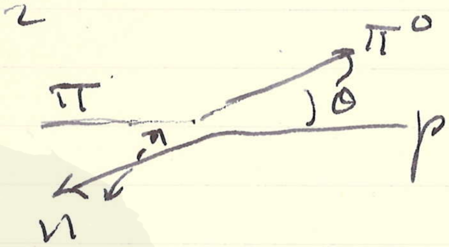
0.8 y.

第2回 Nov. 5, 1965

Polarization

$$f = A + B\, i\, \sigma \cdot \hat{n}$$

$$P = \frac{2\,\mathrm{Im}\, AB^*}{|A|^2 + |B|^2}$$



polarization がある ことは、diffraction では説明できない

2 GeV　$\pi + p \to$ elas　実験
Suwa et al,　P.R.L
Sept. 27, 1965

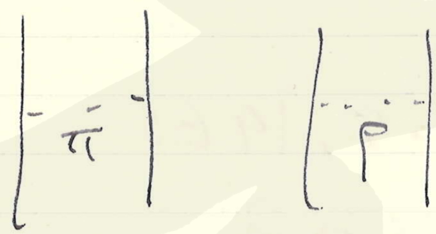
J. D. Jackson, Peripheral Production and decay correlations of Resonances (RMP 37 (1965), 484)

quasi-two-body process

$K^+ p \to K^{*+} p$ 40%

$\to K\ N^*$ 40%

$\to K N \pi$ 20%
non-resonant



etc

Hama. p-p collision
素研 Nov. 19, 1965

π-p collision

[illegible]: Energy dependence
Large angle scattering

[illegible] Nov. 17, 1965

(つづき)

$$-t = 2k^2(1-\cos\theta)$$

$$\frac{d\sigma}{dt} = Ae^{\gamma t}$$

	experimental Data	Yang	Peripheral	Regge
elastic forward	$\left.\frac{d\sigma}{dt}\right\vert_{t=0}$ = ~~$Ae^{\gamma t}$~~ const	diffraction OK	diffraction	3 pole (P, P', ρ)
backward		OK	(?)	(P, ω, ...) P (?)
$\pi^- p$ charge exchange forward	$\left.\frac{d\sigma}{dt}\right\vert_{t=0} = \frac{1}{p_L}$	—	const. X	OK (ρ) $\mathrm{Re}\,\alpha(0) = 1/2$

$p_L = 6 \sim 18\ (\mathrm{GeV}/c)$

Polarization

		Yang	Peripheral	Regge
elastic	forward	ゼロ	ゼロ	大 $\pi^+ p > 0$, $\pi^- p < 0$
	backward	大	—	?
$\pi^- p$ C.E. forward		大	ゼロ	ゼロ

elastic pp $\sigma(90^\circ)$
$e^{-aE_{lab}}$

Nov. 24, 1965

廿四日: Pomeranchuk's Theorem and its Extension

Pomer. Theorem (1958)

$p + p \to p + p \quad \sigma_+$

$\bar{p} + p \to \bar{p} + p \quad \sigma_-$

i) $\sigma_+(s) \xrightarrow[s\to\infty]{} \sigma_+(\infty) \neq 0, \infty$

ii) $\sigma_-(u) \xrightarrow[u\to\infty]{} \sigma_-(\infty) \neq 0, \infty$

iii) dispersion relation at $\theta = 0$ で成立,

iv) force range ρ is finite (for p-p)

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

$\sigma_+(\infty) = \sigma_-(\infty) \qquad |f(0)|^2 < C E \rho^2$

$\theta \neq 0$ (しかし 小さい) へ拡張

von Hove P.L. July 15, 1963

$\sigma_{tot} \propto A(s,0)/s$

ii) $A(s,t)/s \xrightarrow[s\to\infty]{} a(t)$

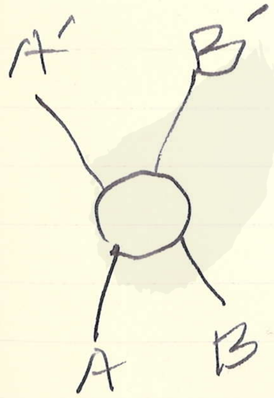
iii) $\bar{A}(u,t)/u \xrightarrow[u\to\infty]{} \bar{a}(t)$

i) $d\sigma_{el}/dt = \frac{4\pi^3}{k^2 s}\{|A|^2 + |D|^2\}$

$D/s < \infty$

$\downarrow$

$\bar{a} = a$



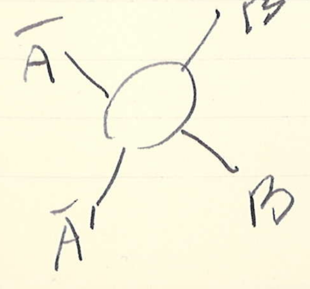
$T(s,t) = D(s,t) + i A(s,t)$

$s = (p_A + p_B)^2$

$t = (p_A - p_B)^2 = (p_{A'} - p_{\bar{A}})^2$

$T(u,t) = \bar{D}(u,t) - i \bar{A}(\bar{u},t)$

$u = (p_B - p_{A'})^2$



$\pi p \begin{cases} T = 1/2 \\ T = 3/2 \end{cases}$

Exchange Contribution
van Hove, PL Oct. 15, 1963

せひ書 : High Energy Collisions
of SIP (R. M. P. April 1964
L. van Hove 655)

[illegible] Dec. 10 1965

梅沢 SG: Symmetry group

Salam: Theory of Groups and the symmetry physicist, July 1965

Jan. 1964
1) 8 particles spin 1/2
2) 9 particles spin 3/2
3) 8 ps-meson spin 0
4) 9 ~~meson~~ excited spin 1

$2(Q - I_3) = Y$

$I_3, Y \rightarrow$ rank 2. $\rightarrow U_3$

Sept. 1964

N	$J = 1/2$	$8 \times 2 = 16$	} 56
N^*	$J = 3/2$	$10 \times 4 = 40$	
M	$J = 0$	$8 \times 1 = 8$	} 35
M^*	$J = 1$	$9 \times 3 = 27$	
	$8+1$		

U(6)

Dynamical Considerations and Non-Compact Group
i) U(3)　　ii) IL　SL(2, C)
[illegible] group
$SL(6, C) \supset U(6)$
$\tilde{U}(12) \supset U(6) \times U(6)$
$\tilde{U}(12) \supset SL(6, C)$

Dec. 18, 1965

SU(6) model

1. mass formula
2. mag. mom.　　$F/D = -2/3$
3. ps-meson - baryon scattering
4. strong decay　　$\rho \to 2\pi$
5. ~~break~~ int.
   a. leptonic decay
   b. non-leptonic decay

Dec. 22, 1965

Lipkin, Meshkov, PRL. 19 April 1965　Vol 14, Nr. 16, 610

W-spin, B-spin

$SU(6)_W$

$W_i = \{ \frac{1}{2}\beta\sigma_1, \frac{1}{2}\beta\sigma_2, \frac{1}{2}\sigma_3 \}$

Λ_{34} と commute

z-方向の運動　W_3 の固有値

B	8	$W = 1/2$	
B^*	10	$W = 3/2$	
$V_{\pm 1}$		$W = 1$	$W_z = \pm 1$
ρ_0		$W = 1$	$W_z = 0$
V_0		$W = 0$	$W_z = 0$

i) $\rho \to 2\pi$

ii) $N^* \to N + \pi$

iii)

最近の宇宙論
(基研談話会) Dec. 21, 1965
林忠四郎

1930 Expanding Universe
~ Hubble's law
big ban theory?
1948 Steady state universe
~ Bondi, Gold, Hoyle

Hubble's Law

$$\frac{\delta\lambda}{\lambda} = \frac{v}{c} \qquad v = \frac{dl}{dt} = H_0 l$$

H_0 (in km/sec Mpc)

Mpc = 3×10^{6} light year

1929	500
1936	550
1952	290
1958	75 ± 25

time-scale $\frac{1}{H_0} = 13 \times 10^9$ y $\pm 30\%$

$\left(\frac{\delta\lambda}{\lambda} < 0.1 \quad l \ll R \right)$

現在の matter density

1958 $\rho_0 \cong 1 \times 10^{-31}$ g/cm³

1965: (1) Quasar (starlike) の
red shift $\frac{\delta\lambda}{\lambda} = 0.16 \sim 2.01$
3C9 発見 Ly α 1217 Å
→ 3666 Å
C IV 1550 Å → 4668 Å

9個

steady state とあれば…,

(2) Quasi-stellar galaxy (blue stellar object)
数 for Quasar の500倍
2×10^5 コ
$\frac{\delta\lambda}{\lambda}=0.09,\ 0.13,\ 1.24$

(3) 電波の noise
波長 7cm 10cm
$T_0=3.5\pm1.0\ {}^\circ K$ black body radiation

(4) 銀河の初期の He量
球状星団 non-zero
惑星雲 $Y=0.30$
宇宙初期 He の形成 $\sim \underline{Y\cong0.30}$
星の進化 $\Delta Y=0.02$ $\Delta Z=0.02$
観測値 $Y=0.30$ $Z=0.02$
$X=0.68$

$X=0.70$ $\underline{Y=0.30}$ $Z=0$

(5) $\frac{1}{H_0}$ 古い星の age
$13\times10^9 y$ $25\times10^9 y$ (Sandage 1958)
↓ Sears
$11\times10^9 y$
U^{235}/U^{238}, U/Th
$(7\sim13)\times10^9 y$

c033-769挟込

一様な等方的宇宙論: co-moving coordinates (χ, θ, φ)

$$ds^2 = c^2 dt^2 - R^2(t)\{d\chi^2 + \sigma^2(\chi)(d\theta^2 + \sin^2\theta\, d\varphi^2)\}$$

$$\sigma(\chi) = \begin{cases} \sin\chi & (\text{closed}, k = +1) \\ \chi & (\text{flat}, k = 0) \\ \sinh\chi & (\text{open}, k = -1) \end{cases}$$

$$\left\{ \begin{array}{l} \dfrac{\dot{R}^2}{R^2} + \dfrac{2\ddot{R}}{R} + \dfrac{8\pi G p}{c^2} = -\dfrac{kc^2}{R^2} + \cancel{\Lambda c^2} \\ \dfrac{\dot{R}^2}{R^2} - \dfrac{8\pi G\rho}{3} = -\dfrac{kc^2}{R^2} + \cancel{\dfrac{\Lambda c^2}{3}} \end{array} \right.$$

$$\frac{d}{dt}(\rho c^2 R^3) + p\frac{d}{dt}R^3 = 0$$

$p < \rho c^2$

$H_0 = \dot{R}_0 / R_0$

deceleration parameter q_0

$$q_0 = -\ddot{R}_0 / R_0 H_0^2 = -R_0 \ddot{R}_0 / \dot{R}_0^2$$

$$q_0 = \frac{4\pi G\rho_0}{3H_0^2}$$

$$2q_0 - 1 = kc^2 / H_0^2 R_0^2$$

$\frac{1}{2} > q_0 > 0$ open

$q_0 = \frac{1}{2}$ flat

$q_0 > \frac{1}{2}$ closed

$H_0^{-1} = 13 \times 10^9\, y$

$\rho_0 = 2.1 \times 10^{-29} q_0\ g/cm^3$

$(\rho_0 \gtrsim 1 \times 10^{-31}\ g/cm^3)$

$q_0 = 0 \sim 1$

q_0	0	0.5	1.0
$H_0 t_0$	1.00	0.667	0.571
$t_0 (10^9 y)$	13.0	8.7	7.4

redshift-magnitud relation

$t_1 \longrightarrow t_0$

$R_1 \quad\quad R_0$

$$1+z \equiv \frac{\lambda+\delta\lambda}{\lambda} = \frac{R_0}{R_1}$$

$z \to \infty$　地平線

3C9　$z = 2.01$

$q_0 = 1$　$\sin\chi = \frac{2}{1+z}$, $\chi = 42^\circ$

count-magnitude relation

Q.S.G. (Sandage)　$q_0 = 0 \sim +1$

膨張宇宙の初期

ρ_0, T_0　　$\rho_{rad} \gg \rho_{mat.}$ (α-β-γ)

$$\frac{\dot{R}}{R} = \sqrt{\frac{8\pi G\rho}{3} - \cancel{\frac{kc^2}{R^2}}}$$

$\rho = \rho_{rad} + \rho_{el.\,pair} + \rho_{\nu_e\text{-}pair} + \rho_{\nu_\mu\text{-}pair}$

$10^{12}\,°K > T \gtrsim 10^{9}\,°K$

Hayashi

$$n + e^+ \rightleftarrows p + \bar{\nu}$$
$$n + \nu \rightleftarrows p + e^-$$
$$n \rightleftarrows p + e^- + \bar{\nu}$$

昔: $p/n = 4$

今: $p/n = 5.5 \sim 6.0$

佐藤君

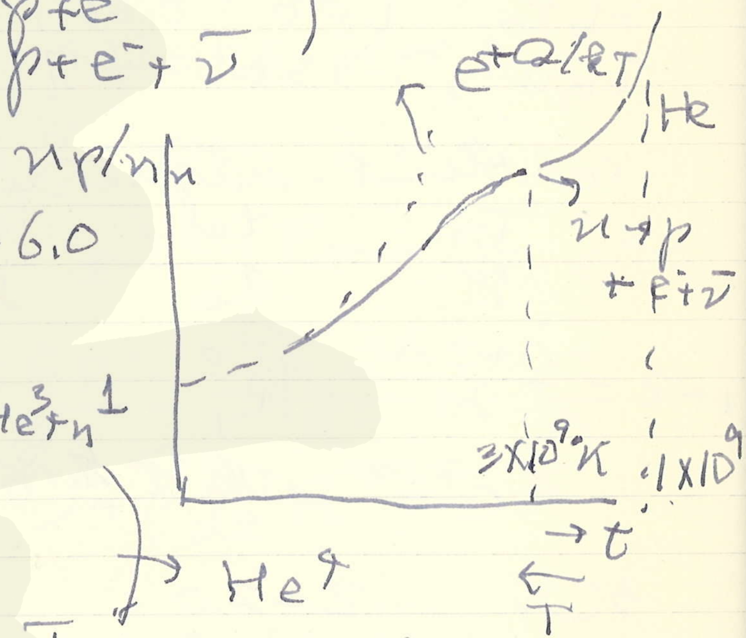
$$n + p \rightleftarrows d + \gamma$$
$$d + d \to t + p,\ He^3 + n \quad 1$$
$$d + t$$
$$d + He^3$$
$$He^3 + n$$
$$\to He^4$$
$$n \to p + e^- + \bar{\nu}$$

$T_0 = 3.5 \times 1.0\,°K$

$\rho_0 = 10^{-31} \sim 10^{-29}$ g/cc

数の比

$$\frac{He}{H} = 0.06 \sim 0.11$$



梅沢

Dec. 22 つづき

Harari, Lipkin
preprint, Trieste June 1965
(P.R.L. in press)
exp. test of Broken $\tilde{U}(12)$

$\gamma_0 p_0$, $\gamma_3 p_3$
λ_j, $\sigma_3 \lambda_j$, $\gamma_4 \sigma_1 \lambda_j$ } $SU(6)_W$
$\gamma_4 \sigma_2 \lambda_j$,

$\tilde{U}(12)$ symmetry
Delbourgo et al. (Trieste Aug. 1965)

$$\begin{cases} \gamma_k^+ = -\gamma_k \\ \gamma_0^+ = \gamma_0 \end{cases} \qquad \gamma_5^2 = -1, \quad \gamma_5^+ = -\gamma_5$$

$U(6) \times U(6)$
$B = (56, 1)^+$
$M = (6, \bar{6})^- = 35 + 1$
ρ_s 950 MeV

c033-770挟込