NOTE BOOK

Manufactured with best ruled foolscap
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March 1960 ~ June 1960

VOL. XIII

Yukawa

Nissho Note

日章 BA4 45

INDEX

CHAPTER	DESCRIPTIONS	PAGE

基研談話会　核子の電磁構造

March 2, 1960　中西 襄

非局所場論 長期計画
相談会（素粒子の人による．具体的組織成る）

期間　35年4月〜7月
費用　21万円

研究会　3回

Topics
現象論的
一般関連的
量子化

非局所場モデル
[illegible]モデル
[illegible]モデル

Indefinite metric

適用限界
粒子の現象論

現在の理論 → non-local
分散式
(asymptotic
B.C.

量子化

[illegible]

[illegible]: B.S. amplitude の理論

Integral representation
Derivation of B.S. equations
Approximate solution (ladder)

$\langle 0 | T[\phi_1(x_1)\, \phi_2(x_2)] | p_n \rangle$

1) Lorentz inv $|0\rangle$ $p(z)$
2) micro causality
3) asymptotic cond.
4) spectral cond.

stability cond.
$m < m_1 + m_2$

An Ether theory of Elementary Particles

by Hideo Fukutome

(March, 1950)

Part I.

$$x^i = x^i(\xi, t)$$
$$\xi^i = \xi^i(x) \qquad x = (x^\mu), \quad x^4 = t$$

undeformed medium:

$$\xi^i = \alpha_\mu{}^i x^\mu \qquad (\alpha_\mu{}^i): \text{Lorentz Transf.}$$

ξ^i: L-frame

x^μ: E-frame

$$dx^\mu = d\bar{x}^\mu - U^\mu U_\lambda dx^\lambda$$

$$\frac{\partial \bar{x}^\mu}{\partial t} = 0$$

$$d\bar{x}^\mu = A_i{}^\mu d\xi^i \qquad (A_i{}^\mu): \text{deformation}$$

$$\frac{d\xi^i}{ds} = U^\mu B_\mu^i = 0$$

$$B_\mu^i = \frac{\partial \xi^i}{\partial x^\mu} \qquad d\xi^i = B_\mu^i d\bar{x}^\mu$$

$$A_i{}^\mu B_\mu^j = \delta_i^j, \quad A_i{}^\mu B_\nu^i = \delta_\nu^\mu + U^\mu U_\nu$$

strain tensor:

$$d\bar{x}^\mu d\bar{x}_\mu = \gamma_{ij} d\xi^i d\xi^j$$
$$\gamma_{ij}\eta^{jk} = \delta_{ik}$$

invariants: η^{ii}, . . , . .

energy-momentum tensor.

$$\frac{\partial T^{\mu\nu}}{\partial x^\mu} = 0$$

$$T^{\mu\nu} = \cdots \qquad L = (\rho_0 + E)\frac{\partial \xi}{\partial t} \cancel{d\xi} d\alpha$$

$$\mathcal{L} = \int \sqrt{\eta}\,(\rho_0 + E)\, d^4x$$
$$= \int (\rho_0 + E) \frac{ds}{dt}\, d\xi\, dt$$

E : elastic potential or elastic mass density

elastically homogeneous medium
→ E depends only on η^{ij} (or γ_{ij})
isotropic → E depends only on ~~I~~ J_1, J_2, J_3.

L - spin
P - character
$F = \sqrt{\eta}\, E$: elastic mass per unit volume of E-frame

ether: $\rho_0 = 0$
undeformed state of ether → vacuum

Part II.
$F = F_{isot.} + F_{cyl.} + F_{anis.}$
baryon meson … lepton

configuration of ether
Hilbert space of ether
one particle state : infinitesimal neighborhood

Remarks on Fukutome's Paper

March 19, 1960

1. Absolute motion
unobservability of uniform motion of the ether versus observability of particle motion or the motion of the center of concentrated deformation.

$$T_{\mu\nu} = \sqrt{\eta}\,(\rho_0 + E)\,U_\mu U_\nu + 2\sqrt{\eta}\, B_\mu^i \frac{\partial E}{\partial \eta^{ij}} B_\nu^j$$

arbitrariness in namely the points of ether

$\leftarrow \frac{\partial \xi}{\partial x} = \delta$ $\qquad\qquad$ $\frac{\partial \xi}{\partial x} = \delta$

2. Size of a particle →
principles which determine E or F
Definition of one-particle state
{ approximate
{ exact

3. Difference between P-character and strangeness.

4. Interaction between particles

5. Gravitation

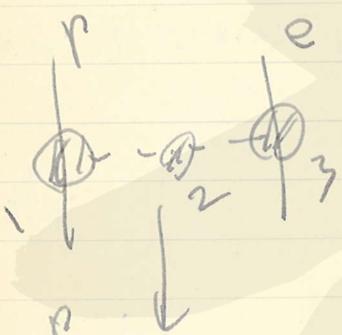
量子力学の適用限界研究会
March 28, 29, 30, 1960

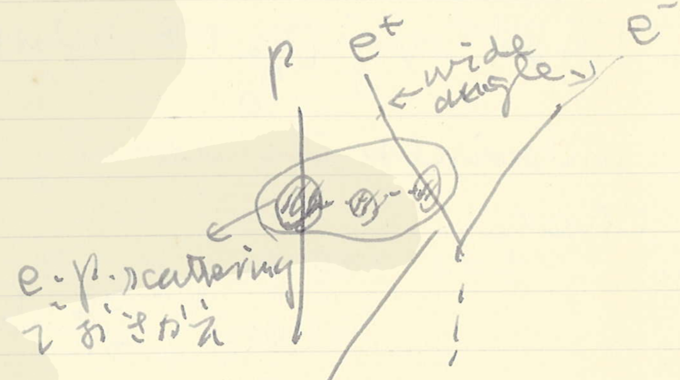
第1日:

[illegible]田氏: プログラム紹介.

[illegible]田氏: 適用限界に関係ある新しい現象.

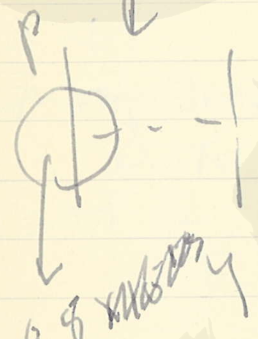
① small distance a dynamics に sensitive
② 計算数値が出る
③ 測定可能





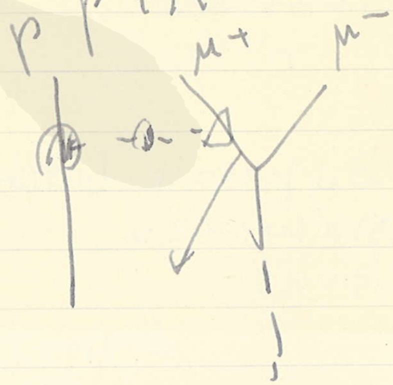
$$\frac{1}{i\gamma p+m} \to f(p) \to \frac{\Lambda^2}{p^2+\Lambda^2}$$

$\frac{1}{\Lambda} \lesssim 0.3y$



0.8 ~~xxx~~ y

$\frac{1}{\Lambda} \lesssim 0.4y$

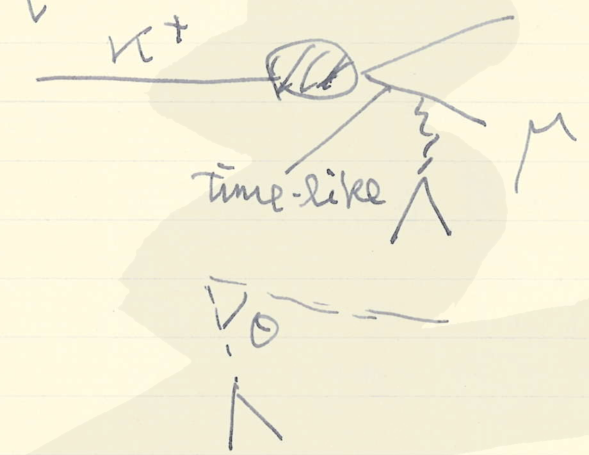


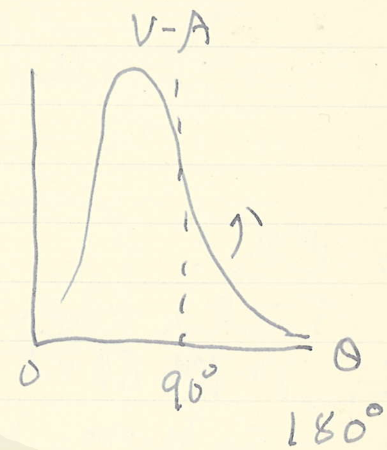
$\langle r^2\rangle_1 + \langle r^2\rangle_2 + \langle r^2\rangle_3$
$=(0.8y)^2$

Lamb shift のずれ: size effect
0.2±0.1 Mc/sec → 0.1±0.1 Mc/sec.

$$x \lesssim K \frac{\sqrt{電}}{\sqrt{E}}$$

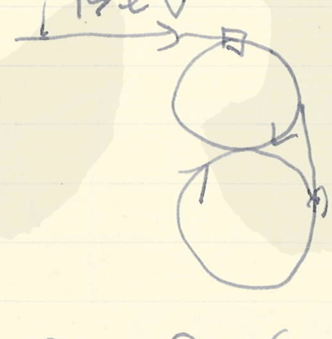
radiative K-μ-decay
q- time-like





e-e-scattering　Stanford Linac
1 BeV CMS → 4000 BeV lab.
10^{15} /sec

intensity: → 囮
→ ← 10^{-10} 弱い
ためて 10^5 10^5 強める (1回でためる)

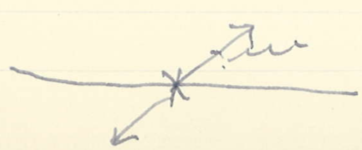


$$x \lesssim K \frac{\sqrt{電}}{E}$$

QEDの breakdownが
$x \gtrsim 0.03$ y いわれる

$$\sigma = \sigma_M \left(1 + a + b \log \frac{k_{max}}{m}\right)$$

α　$a + O(\alpha^2)$　photon of max energy



$E = 1\,\mathrm{BeV}$ $\theta = 90^\circ$

Miida $a = -1.6$) $b = 0.1$

Murota $a = -1$

$$a \sim \alpha\left(\log \frac{E^2}{\mu^2}\right)^2$$

田地氏:

Field theory の基本仮定

I. 相対論的不変

inhom. L.T.

II. 量子力学

kinematics: observable が sep. H.S. の operator.

dynamics: P_μ の存在 測定の順序がある

Ω, a, Ω': $(\Psi_a e^{-iP_\mu\xi^\mu} \Omega' e^{iP_\mu\xi^\mu} \Psi_a)$

III. 場

$i\partial_\mu \varphi(x) = [P_\mu, \varphi(x)]$ で P_μ をきめる.

$\{\xi(x/\sigma)\}$ による complete set の存在

micro-causality

$[\xi(x/\sigma), \xi(x'/\sigma)] = 0$

Mølle の自由論:

Displacement invariance をすてる.

小田・宮沢:

① 測定順序: ξ

(2) 力学系の定義: x

inh. $Lx = ax + \alpha$	hom. $\cancel{L_0}$ $h_0 = ax$

$$\begin{array}{ccc} x & & \xi \\ L & \longrightarrow & L_0 \\ L_0 & \longleftarrow & L \end{array}$$

運動量の保存

別求め:

第2回: 3月 ~~30~~ 29日
大貫氏:

γ　　　$p \leftrightarrow \nu$
　　　　$n \leftrightarrow e^-$
　　　　$\Lambda \leftrightarrow \mu^-$
　　　　B^+

lepton　weak　　　charge exchange 型
B^+　strong

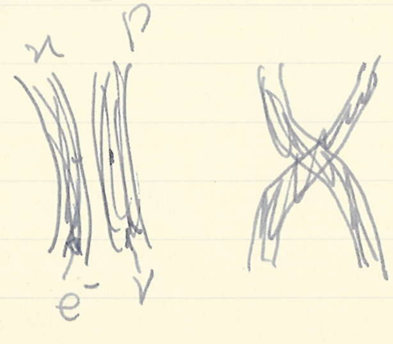
νの残り 2-comp はどうなってくるか:
何が役割をはたしているか?

B^+-conserv. $\Leftrightarrow$ baryon number conserv.

weak

$$\frac{W(K^+ \to 2\pi)}{W(K^0 \to 2\pi)} \simeq \frac{1}{500}$$

Oneda-Sakita　　weak-g^2: Λのwid.小さく $1/10 \sim \frac{1}{100}$
Kawaguchi　　　$\Delta I = 1/2$



strong　　B^+による.

current　$\bar{p}\gamma_\mu p$　　j_μ
　　　　$\bar{n}$　　n
　　　　$\bar{\Lambda}$　　Λ

$$j_\mu = f\{(\bar{e}\gamma_\mu(1+\gamma_5)\nu) + (\bar{\mu}\gamma_\mu(1+\gamma_5)\nu)\}$$

$$J_\mu = f\{(\bar{n}\gamma_\mu(1+\gamma_5)p) + (\bar{\Lambda}\gamma_\mu(1+\gamma_5)p)\}$$

$$H_W = j_\mu^\dagger j_\mu + J_\mu^\dagger J_\mu + j_\mu^\dagger J_\mu + J_\mu^\dagger j_\mu$$

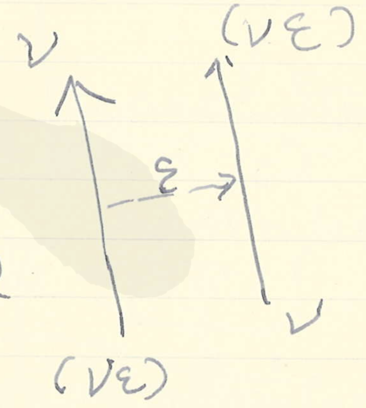
a) hydrogen-atom-like model
B

b) core type

c) Two-fluid

d) vessel

武谷氏 ; T.K. ; San Paulo model
a-charge
b-charge
urneutrino



小川氏 ; Resonance level

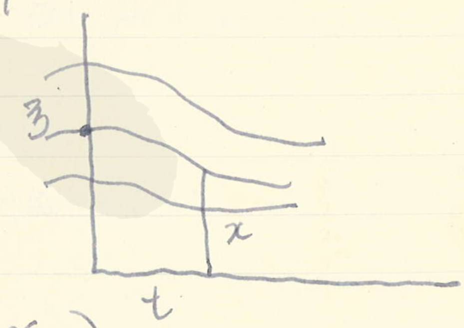
[illegible]氏：B-[illegible]の[illegible].
[illegible]公式 ← classical min. energy
quantum fluctuation の suppression

片山氏：San Paulo model
μ-neutrino 平

$$\frac{e^2}{g^2} = \frac{m_e}{M_B}$$

[illegible]氏：Ether theory
plenum　　Descartes ether
vacuum　　Newton

undeformed medium　ξ^i
moving, deformed　$x^i = x^i(\xi, t)$　~~Euler~~ Lagra
$\xi^i = \xi^i(x^\mu)$
x^i : Euler　ξ^i : Lagrange
$x^\mu = (x, t)$



strain tensor
$$\gamma_{ij} = A_i^\mu A_j^\mu$$
undeformed
$$\gamma_{ij} = \delta_{ij}$$

variation principle
$$\tau^{ij} = -\frac{2}{\sqrt{\gamma}} \frac{\partial E(\xi^i, \gamma_{ij})}{\partial \gamma_{ij}}$$

$$\rho = \frac{1}{\sqrt{\gamma}}\{\rho_0(\xi^i) + E(\xi^i, \gamma_{ij})\}$$
$$\gamma = \det(\gamma_{ij})$$

$E = 0$ for $\gamma_{ij} = \delta_{ij}$

elastic medium, $\rho_0 = 0 \rightarrow$ ether
reversible, isothermal

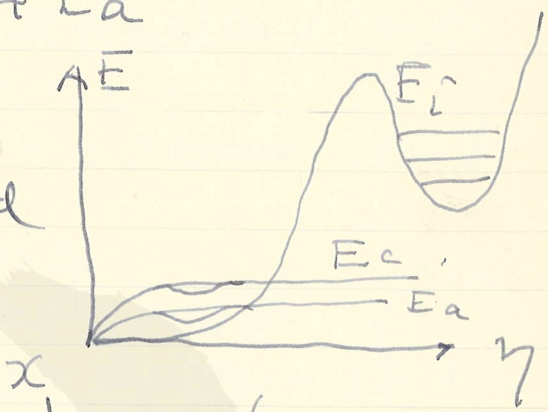
$$\mathcal{L} = \int (\rho_0 + E)\, d^3\xi\, dt = \int \sqrt{\eta}\,(\rho_0 + E)\, d^4x$$

$$P^\mu = \int T^{\mu 4}\, d^3x$$

$$S^{\mu\nu} = \int \{ (x^\mu - X^\mu) T^{\nu 4} - \quad \} d^3x$$

L-spin
p-character $1, \omega, \omega^2$

$$E = E_i + E_c + E_a$$



spin 1/2 粒子.
doubly connected

$\Psi(\xi^i(x/\sigma))$

物理学会年会

4月4日：総論
分散式 Symposium
宮島氏：分散式の証明
composite v. elementary

高林氏：分散式で field theory をおきかえる？
くりこみ可能理論 → finite closed
非線型理論 constant 一つ.

$S = 1 + iT$:

$$\mathrm{Im}\, T = T^* T$$

$$\mathrm{Re}\, T = C + \int_{\omega_0} \frac{\mathrm{Im}\, T(\omega')}{\omega' - \omega}$$

Successive approximation

総括
複合模型 と Fundamental Idea symp.
大貫氏：坂田模型・名古屋模型

猪木氏：weak int.

湯川：
i) 粒子の階層.
ii) 新粒子 の origin
iii) mass (resonance) level

classical — point particle — continuous medium
quantum — field theory
subquantum
Matsumoto's mass formula

福岡氏: ether theory
absolute motion の問題
general relativity

武谷氏: charge を巡る話

夕: 学士会館
1) 朝永・坂田両氏と会談
pugwash 指針.
安保問題) 素粒子グループの声明
2) 伏見氏と plasma研につき相談.

4月5日
午後 1.30〜4.00、Rochester会議出席予定者と打合せ (朝永・宮島氏の室にて、大貫・西田・南・福留・福田氏.) 5月中旬京都に集る (北垣敏中心)
4.00〜8.30、核特委
i) Berkeley: 野中・安田・福井
ii) Rochester: 藤本氏の代りに福田信之を推薦.

P. Morrison

New Channels of Astronomy I
April 13, 1960

Polarization of star-light
Chandrasekhar 1950 eclipse
5% polarization all the time due to magnetic line of force

Transducers
Information $\frac{\text{signal}}{\text{noise}} \gg 1$

fluctuation of signal
Optical noise : airglow
$1 \sim 2 \cdot 10^8$ ph/cm²-sec-ster
bright star
few $\times 10^5$ ph/cm²-sec

$\vec{k}$: $\vec{\Delta\Omega}$, $|k|$ $\left.\frac{\Delta k}{k}\right|_{eye} \sim 1/2$

eye : $\Delta\Omega$: small
S/N = few $\times 10^4$
$5 \cdot 10^4$ ph/cm² sec
1 Palomar : 10^{-2} ph/cm² sec

Supernova : Crab 1056 China, Korea, Japan
Radio window :
noise : 1 oeV/cm²-sec-ster
for normal $\Delta k/k \cong 10^{-3}$
100 MC (good frequency resolution)
$\Delta\Omega \cong 10^{-3} \sim 10^{-4}$ (not very good angular resolution)

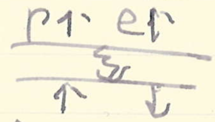
Cosmic rays :
non-solar $> 10^9$ eV
0.1 /cm²-sec-ster ($E \cong 10^{10}$ eV)

$\Delta\Omega \gtrsim 0.1$

$\Delta k/k \simeq 1$

Radio wave : plasma limit (reflection)

hydrogen 1420



doppler shift

Radio star : debris of supernova

P. Morrison

Informal Talk I. April 14, 1960

Detecting life in solar system
(in 3 ~ 5 years ?)
Venus
Earth
Mars

F. Hoyle: Black Cloud
W. Sinton,
Science 130 (1959) 1234

$$CO_2 + H_2O \xrightarrow{\xi h\nu} O_2 + \boxed{CH_2O}$$
$$\boxed{CH_2O} + O_2 \rightarrow CO_2 + H_2O + Q \text{ life}$$

$$2CO_2 + H_2S \xrightarrow{\xi} SO_4 + \boxed{2CHO}$$
$$\boxed{2CHO} + SO_4 \rightarrow 2CO_2 + H_2S$$

sea NH3
↓
protein

USA		USSR	
1960	"near probes"	1960	soft to moon
1961	100 lb. to ~~h~~ soft moon	1961	hard on M, V
1963	200 lb hard ~~track~~ on M, V		
1964.5	→ 100 lb M.V "SOFT"	1964	

radar reflection
soft landing:
decontamination

spectrographic picture
chemical analysis
microbial detection
Visiac device
~~hn~~

New channels of Astronomy II

April 16

Intergalactic matter

Zwicky

Channel: Rocket UV-region

6~9 eV: UV÷nebulae

Spica α Vir

W orionis

X-ray region or γ-ray region

Solar flare

20 γ/cm²·sec

≃ 10 sec

once 0.2–0.5 MeV

bremsstrahlung

0.51 MeV γ-ray

population of anti-matter

fermion fields as channels

neutral single particle:

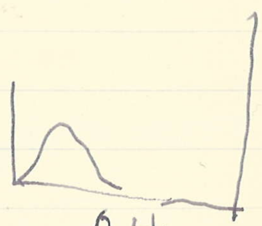
neutrons $(E/Mc^2)\times 10^{-4}$ light year

neutrinos $(\nu, \bar{\nu})$

$$\sigma = 10^{-43} E_{MeV}^2 \ cm^2$$

$$1/2 \quad p + p \rightarrow d + \beta^+ + \nu + 0.4\ MeV$$

$$100 \quad p + p + \beta^- \rightarrow d + \nu + 1.4\ MeV$$



Detectors

Rines: $p + \bar{\nu} + 1.8\ MeV \rightarrow n + \beta^+$

$$Cl^{37} + \nu + 0.8 \rightarrow A^{37} + e^-$$

low energy atoms
Ne
charged particles

anti-particle

energy limit
self-stress
galaxy $E_{proton\ max} \cong 10^{22}\,eV$

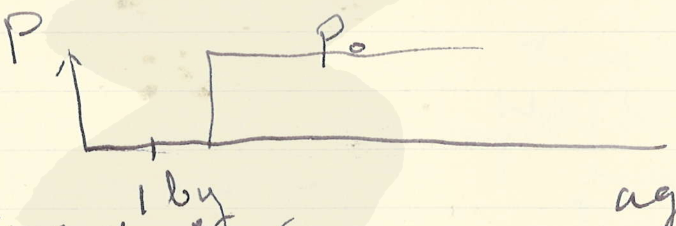
magneto-acoustic wave :
lightening
L. A. G. Storey whistle

P. Morrison

Searching for Interstellar Communication
April 19, 1960

angular momentum
younger stars, larger ang. mom.

1) planets $\leq$ 100% stars later F.
2) life



a) life-time of star
exclude bright stars > 3 times $L_\odot$
b) heat to the planet

$$\frac{L_\odot}{r_E^2} = k \qquad k_{min} \leq k \leq k_{max}$$

bright but not too bright
10^9 stars in Galaxy

radio wave : 1 Mc ~ 10^9 Mc

$$f_{optimum} \simeq 10^4 \left(\frac{R}{diam}\right)^{0.4} \text{ c/s}$$

$$\simeq 10^4 \text{ Mc}$$

21 cm line of hydrogen!!!
1420 Mc or

$\frac{1}{2}\, 10^9$ y : Cornell mirror

Serch for Int. Com.
May 6, 1960

1420 Mc
Doppler shift $\quad$ I 150 kc
modulation $\quad 10^{-4}$ c/sec $\sim 10^{5}$ c/sec
$10^{-2} \sim 10^{4}$

pulse-code modulation
Information content
anti-cryptography
10^4 sec. message overall
repeats
10^7 aids $\quad 9 \cdot 10^7$ infor.
10^4 sections ~~##~~ 10^3 sec. each

10^3 $\quad 10^4$

code $\quad$ inf.

$\boxed{\alpha}$

code: 
measure 0.1 sec
geometrical figure
picture

α	$+$
β	$=$
γ	$-$
δ	O
μ	$\div$
ν	π

[illegible]

第一回　April 20

湯川：Introductory Talk

内山氏

$$mc^2\left(1 - \frac{\gamma m}{r_0 c^2}\right) \Rightarrow \text{finite}$$

$r_0 \to 0$, $m \to 0$

e の内因

伏見氏

$$(\operatorname{div} \vec{D} - \rho)\Psi = 0$$

$\operatorname{div} \vec{D} \to$ discrete

$\rho \to \sum n e$

武谷氏：

岡本氏：

原子核理論
量子力学) model (harmonic oscillator)

福留氏: Ether 理論の問題点.

Field ↑ $A_\mu(x)$ ↓

Particle $\psi_a(x)$

$\xi^i(x) \sim \alpha^i_\mu x^\mu$

group of gen. coord. transf. の上での微分.

i) $\Psi(\alpha)$ $\alpha \in \mathcal{G}$

$R_\beta \Psi(\alpha) = \Psi(\alpha\beta)$

$L_\beta \Psi(\alpha) = \Psi(\beta\alpha)$

ii) 絶対空間

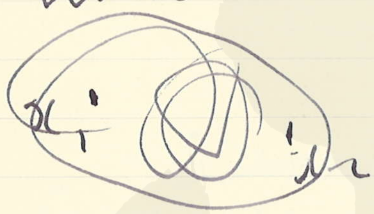
Lorentz

Stokes

位田氏: B-S amplitude

abnormal solution

$\phi(X, x)$



$f(x_1, x_2) = \langle 0 | \phi(x_1) \phi(x_2) | B \rangle$

$= f(X, x)$

microcausality

江沢氏; 相対論における問題.

$K(4, 3; 2, 1) = K(3, 1) K(4, 2)$

第2回　April 21

片山氏：非局所理論の発展

30　35　40　45　50　55　60

Q.E.D. → H.P → .... T.S → .... → 高エネルギー
H.P

Q.M.T.F → Y. .... 核力, π-N → dispersion theory

→ 素粒子の構造 →

universal length (H)
(H.O)
(H.W)
non-local (Markov)
[x, u] ≠ 0

non-local field (Y)
quantized space (Snyder)

周辺組　Yamamoto
好酷組　van Hove, Kiev

.... rel. cut off P.U.

model-like H.P. .... Bopp, Tanikawa
Indef. metric

Nakano B.T.V. → Fuk-utome

Yamamoto,
1. S-matrix の存在
2. Lorentz invar.
3. Macro causality

討論：
岡崎：
大塚：
高林：

坂田氏:

量子: a, b　　$|a_i + a_j, b_j\rangle$

$|0,0\rangle \equiv \nu$

$|-1,0\rangle \equiv e, \mu$

$|1,1\rangle \equiv n, \Lambda$

$|1,1\rangle \equiv p$

$|0,1\rangle \equiv n, \Lambda$

流れ:　$\langle a,0|$　$|a,0\rangle$

$\langle a,b|$　$|a,b\rangle$

$\langle 0,b|$　$|0,b\rangle$

$\langle 0,b|$　$|a,b\rangle$

1) b, a: 保存　b の流れ　$\Delta N_p = \Delta N_n = \Delta N_\Lambda = 0$

2) b, a: 保存　a の流れ　$\Delta N_e = \Delta N_\mu = \Delta N_p = 0$

3) b 保存

4) a 保存

5) 両方 不保存

6) b, a なし

1) $\frac{b^2}{M^2} B_\mu B_\mu$

2) $\frac{a^2}{M^2} A_\mu A_\mu$

3) $\frac{f^2}{M^2} J_\mu^+ J_\mu^-$

$$f^2\left(\bar\nu \gamma_\mu \frac{1+\gamma_5}{2} \nu\right)^2$$

photon

Heisenberg 理論 ?

宮武氏:

geon → graviton ν, ν', γ $(e^+ + e^-)$ $(p + \bar{p})$

$\mu^- \to e^- + \nu + \bar{\nu} + G_\mu$

$\pi^- \to e^- + \nu + 2\bar{\nu} + G_{\pi^-}$

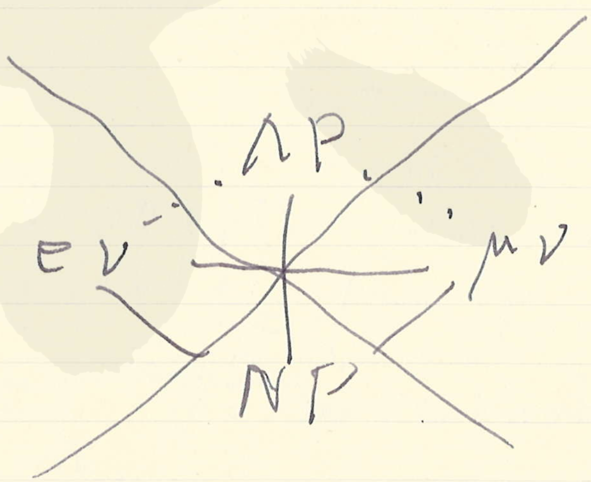
$(e^+ + e^-)$
$(\nu + \bar{\nu})$ $\sim \gamma$

(I) 基本粒子: p, e, ν ; ν' (→ strangeness 1)

(II) compound model

(III) $(I_3)_{\nu'} = 0$, $(I_3)_{e^-} = -\frac{1}{2}$ $(I_3)_{\nu} = \frac{1}{2}$

小川氏:



第3回
内山氏：量子化の問題．

classical
canonical formalism
P.B.

→

quantum
H.P.
C.R. commutator
J.W., J.P.
相互作用表示

$H_0 + H_{int}$

$\frac{\partial^n}{\partial t^n}$ $\quad \frac{\partial^m}{\partial t^m}$

$\underline{n > m}$

$n = m$

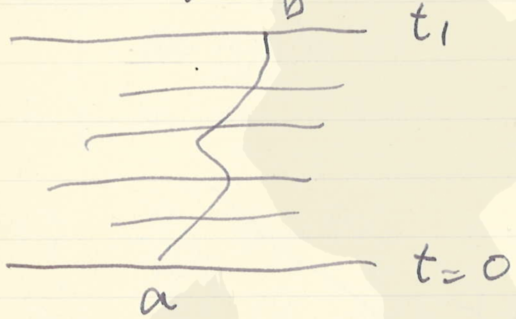
$m \to \infty$

Taniuti
second kind
non-local

$$\frac{d^2x}{dt^2} + \nu^2 x = \varepsilon \sum \left(\frac{d}{dt}\right)^n x$$

$t=0 \quad q=0$) 与ふ $\dot{q}=0$ $\quad x \ \dot{x} \ \ldots \ x^{(n-1)}$

$t_1=0 \quad q=0$



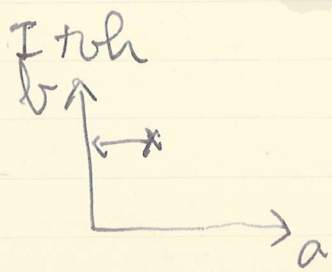
(Feynman, path integral,
Schwinger, Variation
Coester, 4次元定式化

Lagrangian による[illegible]．

$$F = \int e^{iL(x)} \ \delta x_1 \delta x_2 \cdots$$

$a+ib \quad \to a \to 0$

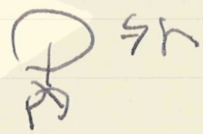
Itoh



measureの問題．

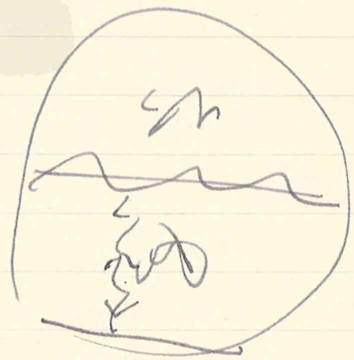
non-local action
P. V.　　$f(\square)\psi = 0$
negative energy
indefinite metric

谷川氏 : Surface wave



X_μ , r_μ

外の世界 : Lorentz invariance
内の世界 :
境目の surface wave



c, $\hbar$: 外できまる
r_0　mass
分離元現象 ?

表林氏 : Indefinite metric
42　Dirac (42)
　　Pauli (43)
50　Tanikawa (50)　P. U. (50)
56　Watanabe (56)　Phillips (55)　Visconti
　　　K. P. (55) → Umezawa (56)
　　Heisenberg (56)
60　　　　Markov-Komar (59)
58　A. M.
~59　U.
　　B. M. P. , Schlieder

50　Gupta-Bleuler

Gupta (57)　Sunagawa (58)
K. O. (59)　G. (58)

multiple mass　ghost
形式論の negative metric

(背面2)

44　Pontrjagin
↓ Iohvidov (49)　Nevanlinna (52)
I & Krein (56, 59)　↓
observableは何が　Pandit (59) Pau
内積
$(x \cdot y)$
$(x \cdot x) = 0 \Rightarrow x = 0$
$(x \cdot x) \geq 0$　Q.E.D.
$p = p^* ;\quad \bar{p} \neq p \rightarrow (x \cdot x) = 0$
p の eigenvector の空間 $\leq n$
dipole-ghost
K. L. : spectre 分解
Riesz-Herglotz
$\{c_p\}\quad p = 0, 1, \ldots$
$$c_p = \int_{-\pi}^{\pi} e^{ipt}\, d\alpha(t)$$
$$\Leftarrow \sum_{p,q=0}^{n} c_{p-q}\, \xi_p \bar{\xi}_q \geq 0$$

Bochner の定理

~~島津氏:~~
経国氏;
$G = G_1 + G_2$
1. G.B.,

2、4次元運動化

3. Bogoliubov: $\Phi_1(+\infty) = PS\frac{1}{1+(1-P)S}\Phi_1(-\infty)$

島津氏:
Form Factor
1) rel. inv.
2). unitarity　Bloch, Hayashi, Katay.
3) causality　S.W.
4) convergence　Bloch

内部状態の話.
B-matter

$S = \frac{1-iK}{1+iK}$:　$\frac{K_1 = PKP}{\text{unitary}}$

macro causality ×
~~fac~~ form factor
non-hermite H_1
free B : Φ_2

田中正氏：超光速度の物理

i) R. I.

ii) H. P.

iii) 相互作用

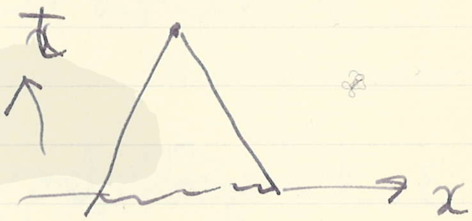
$$(\Box + m^2)\phi(x) = 0$$

$$E^2 = \vec{p}^{\,2} - m^2$$

$$v_g = \frac{cp}{E} > c$$

$p > m$ normal
$p < m$ abnormal

H → indef. metric
無理に define できぬ.



$\phi(x, \xi)$
↓
time-like unit vector

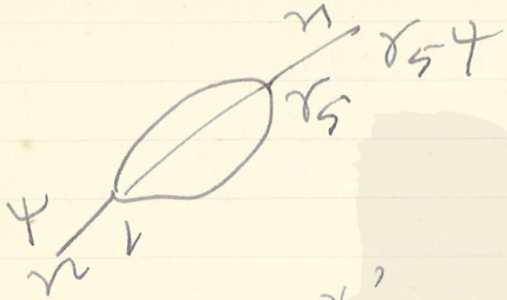
$$(\Box - m_1^2 + m_2^2)\phi = j(x)$$

acausal:

岡部氏：陶思統一記
統一理論.

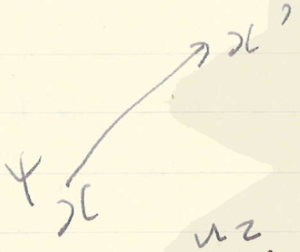
質量,
相互作用
素粒子
統一
model

Indefinite Parity Space
[illegible]



$$\{i\overbrace{\gamma_\mu(a+b\gamma_5)}^{\gamma_\mu}\partial_\mu + m\}$$
$$\times\psi = 0$$

6次元でなしに



connection
$$\partial_\mu \to i\gamma_\mu(a+b\gamma_5)$$

$$\begin{pmatrix}\psi \\ i\gamma_5\psi\end{pmatrix}$$

	strong	weak
η	OK	NO
parity	OK	NO

$$\left.\begin{array}{ll}\sigma & (\infty)^2 \\ \rho & \log\infty \\ \zeta & \text{finite}\end{array}\right\}\ ?$$

問題:

April 23

吉沢尚明：不定計量の数学

Indefinite metric の空間

$\mathfrak{H}$ $\qquad \varphi_1, \varphi_2, \cdots$ CONS

$$x = \sum_{n=1}^{\infty} x_n \varphi_n \qquad \|x\|^2 = \sum_{n=1}^{\infty} |x_n|^2 < \infty$$

$L \qquad \{x_n\}$

$$\langle x, y \rangle = \underbrace{-x_1\bar{y}_1 - \cdots - x_k\bar{y}_k + x_{k+1}\bar{y}_{k+1} + \cdots\cdots}_{0 \leq k < \infty}$$

Pontrjagin

Krein - Iohvidov

$x = x_- + x_+$

$\mathfrak{H} = \mathfrak{H}_+ + \mathfrak{H}_- \qquad x \perp y \quad \langle x, y \rangle 0$

$\|x\|^2 = |x_-|^2 + |x_+|^2$

isometric norm はかえない.

unitary $L \to L$

symmetric $\langle Tx, y \rangle = \langle x, Ty \rangle$

self adjoint $T^* = T$

A : unitary self-adj.

$\mathfrak{H} = \mathfrak{H}_1 \oplus \mathfrak{H}_2$

finite dim. $\qquad$ pos

A-inv.

一般的定義：1. 空間の定義

2. 主な定理

3. Lorentz 群

§. application (spectral decomp.)

1. $\mathfrak{H}$ linear space (complex)

$\langle x, y\rangle$ が定義されている

$\mathfrak{H} \supseteq R$ $\quad \langle x, y\rangle$: negative definite form

$\dim R \leq k$

$\mathfrak{H}$: ~~[illegible]~~ complete $\quad x_1, x_2 \cdots x_n, x_\infty \in \mathfrak{H}$

$$\underset{\text{complete}}{\mathfrak{H}} = \underset{\text{有限次元}}{R} \oplus \underset{\text{definite}}{R^\perp}$$

$x \in R$

$\langle x, y\rangle = 0 \rightarrow$ in $R^\perp$

すべての

non-degenerate

$y \in \mathfrak{H}$. $\langle y, x\rangle = 0 \Rightarrow x = 0$

$R^\perp$: complete Hilbert space

$\|x\|^2 = -\langle x_-, x_-\rangle + \langle x_+, x_+\rangle$

completion:

$\mathfrak{H} = R \oplus \overline{R}^\perp$ (complete)

$\overline{\mathfrak{H}}$ は [illegible] depend する

Lorentz 群の表現:

$\mathcal{L} \ni \underset{\text{proper}}{L} \rightarrow T_L$ 無限次元表現

indefinite, unitary

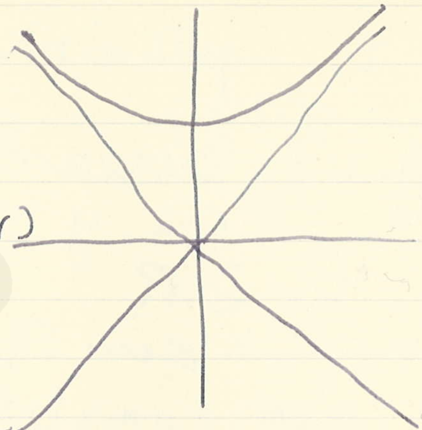
unitary (pos.) repr. 無限次元

c033-651挟込

$\Box f = k^2 f$

固有函数　$f_{\rho,l,m}$

$$Y_l^m(\theta,\varphi)\cdot\frac{P^{-\frac{1}{2}-l}_{-\frac{1}{2}+i\rho}(\mathrm{ch}\, r)}{\sqrt{\mathrm{sh}\, r}}$$



D_σ　　R_σ 函数空間

B_σ : self-adj

$i\rho$

unitary irred. rep.

$D_{i\rho}$　$D_{\frac{1}{2}}$

σ

unitary σ

pos.

4. Spectral repres

G. $\{U^{h}\}$ unitary

T_g: unitary, positive repr.

$\varphi(g) = \langle x_0, T_g x_0\rangle$　　$g \in G$

pos. def. –

$$\sum_{j,k=1} \xi_k \bar{\xi}_j \varphi(g_j^{-1} g_k) \geq 0$$

$\varphi(t) \leftrightarrow \{U_t\}$

Bochner　　Stone

沢田 君定.
世話人 勝華.
6月1,2,午　$\boxed{6-9}$　8-11

electromagnetic field?
What is the
and electric charge

Maxwell
~~fusion~~ components → Fukutome
Heisenberg　Nagoya - Omuki
Geometry　Katayama
Born　Mie　Okabayashi,
Utiyama
Tanikawa

P. A. M. Dirac, Nature 168 (1951), 906
Is there an Æther?

For a particular physical state the velocity of the all-pervading æther at a certain point of space-time will not usually be a well-defined quantity, but will be distributed over various possible values according to a probability law obtained by taking the square of the modulus of a wave function. A wave function which makes all values of for the velocity of the æther equally probable may well represent the vacuum state, but it can-not be normalised because of the Lorentz symmetry. Thus, the vacuum state should be regarded as an ideal state which cannot be attained in practise.

Dirac, P. R. S. 209 A (1951), 291

The gauge transformation must be destroyed in order that the superfluous variables may have physical significance.

$$A_\mu A^\mu = k^2$$

$$\partial F_{\mu\nu}/\partial x_\nu = \lambda A_\mu \quad \left(L = -\frac{1}{4} F_{\mu\nu} F^{\mu\nu} + \frac{1}{2}\lambda (A_\mu A^\mu - k^2) \right)$$

$$j_\mu = -\lambda A_\mu \qquad k = m/e$$

Nature 169 (1952), 538

E. Schrödinger, Dirac's New Electrodynamics

$$\left(\frac{\partial}{\partial x_k} - iA^k\right)\left(\frac{\partial}{\partial x^k} - iA_k\right)\psi = -m^2\psi$$

$$F^l{}_{k,l} = -j_k$$

$$j_k = -\frac{i}{2}(\psi^*\psi_{,k} - \psi\psi^*_{,k}) - A_k\psi\psi^*$$

$$\begin{cases} \bar{A}_k \equiv A_k + \left(\frac{i}{2}\log\frac{\psi}{\psi^*}\right)_{,k} \\ \sqrt{\psi\psi^*} = \varphi \end{cases}$$

$$j_k = -\bar{A}_k\varphi^2$$

$$\frac{\partial^2\varphi}{\partial x_k \partial x^k} = (\bar{A}_k\bar{A}^k - m^2)\varphi$$

For slowly varying φ,

$$\bar{A}_k\bar{A}^k - m^2 \cong 0$$

非線型理論について
May 7, 1960
基研，核の理論 Seminar

1. 非線型性と非局所性
indefinite metric
{ 超光速
multimass
structure
(vacuum の縮退
対称性.

2. 非線型理論の簡単な example

$$L = -\frac{1}{2}\frac{\partial\phi}{\partial x_\mu}\frac{\partial\phi}{\partial x_\mu} - V(\phi)$$

$$\frac{\partial}{\partial x_\mu}\left(\frac{\partial L}{\partial\frac{\partial\phi}{\partial x_\mu}}\right) = \frac{\partial L}{\partial\phi}$$

$$\frac{\partial^2\phi}{\partial x_\mu \partial x_\mu} - V'(\phi) = 0$$

$$H = \frac{\partial\phi}{\partial x_4}\frac{\partial L}{\partial\frac{\partial\phi}{\partial x_4}} - L = -\frac{1}{2}\left(\frac{\partial\phi}{\partial x_4}\right)^2 + \frac{1}{2}(\nabla\phi)^2 + V(\phi)$$

$$V(\phi) = \phi^2(a + b\phi + c\phi^2)$$
$$V'(\phi) = \phi(2a + 3b\phi + 4c\phi^2)$$
$$V''(\phi) = 2a + 6b\phi + 12c\phi^2$$

$$V'(\phi_\alpha) = 0 \rightarrow \phi_\alpha = \phi_1, \phi_2, 0$$
$$V'(\phi) = 4c\phi(\phi - \phi_1)(\phi - \phi_2)$$
$$\cancel{V''(\phi)} \quad \phi_1 + \phi_2 = \frac{-3b}{4c}, \quad \phi_1\phi_2 = \frac{a}{2c}$$

$$V''(\phi) = 4c\phi_1\phi_2 - 8c(\phi_1+\phi_2)\phi + 12c\phi^2$$

$$\phi = \phi_0 + \phi' : \quad V'(\phi_0) = 0$$

$$\frac{\partial^2\phi'}{\partial x_\mu \partial x_\mu} - V''(\phi_0)\phi' = 0$$

$$V''(\phi_1) = 4c(\phi_1\phi_2 - 2\phi_1\phi_2 - 2\phi_1^2 + 3\phi_1^2)$$

$$= 4c\phi_1(\phi_1 - \phi_2) = m_1^2$$

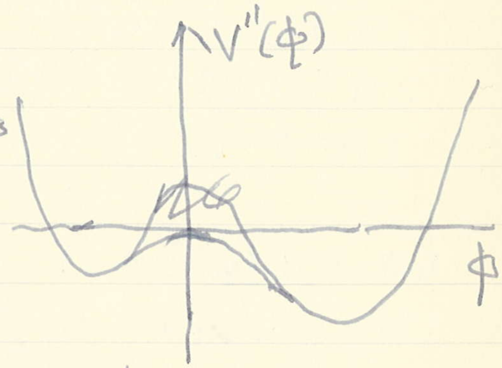
$$V''(\phi_2) = 4c\phi_2(\phi_2 - \phi_1) = m_2^2 \Big\} \text{ real mass}$$

$$V''(0) = \cancel{12}\,4c\phi_1\phi_2 = -m_0^2 \ (\text{imag. mass})$$

故に $\phi_1 < 0 < \phi_2$ とおく.

~~$V(\phi_1) = 4c\phi_1^2($~~

$$V(\phi) = 2c\phi^2\left(\phi_1\phi_2 - \frac{2}{3}(\phi_1+\phi_2)\phi + \frac{1}{2}\phi^2\right)$$



$$V(\phi_1) = \frac{2c}{3}\phi_1^3\left(\phi_2 - \frac{1}{2}\phi_1\right)$$

$$V(\phi_2) = \frac{2c}{3}\phi_2^2\,\cancel{(\phi_2 - \phi_1)}(\phi_1 - \tfrac{1}{2}\phi_2)$$

$$|\phi_1| \gtrless \phi_2 : \quad V''(\phi_1) \lessgtr V''(\phi_2)$$

$$|V(\phi_1)| \lessgtr |V(\phi_2)|$$

$$\because \ \left|\frac{1}{2}\phi_1^3(\phi_2 - \phi_1) + \frac{1}{2}\phi_1^3\phi_2\right|$$

$$\lessgtr \left|\frac{1}{2}\phi_2^3(\phi_1 - \phi_2) + \frac{1}{2}\phi_1\phi_2^3\right|$$

即ち 副 ~~lowest~~ energy state の附近の
~~小振幅~~ 弱い場は 副次的な 確定の概念に

対応している。

特に $b=0$, $|\phi_1|=\phi_2$ なる場合には lowest energy state が degenerate していることになる。

$$\phi=\pm\phi_0+\phi'.$$

(このような degeneration は QED の場合にもあった。

$$A_\mu = A'_\mu + \frac{\partial\Lambda}{\partial x_\mu} \qquad \Box\Lambda=0.$$

$A^{(0)}_\mu=\frac{\partial\Lambda}{\partial x_\mu}$ をどうとっても、電磁場の energy は同じであった。(indefinite metric) しかし この degeneracy は 新しい問題を引きおこさなかった。)

$b\neq0$ の場合には 空間全体としては ϕ の値は $V(\phi)$ の小さい方に近くなっていなければならないが、局部的には 例えば $|\phi_1|>\phi_2$ なる場合 $\phi\approx\phi_2$ でもよい。そういう領域を II となづけると、そこで ϕ が僅かに変化しても この変化は 外の領域 I へは伝わっていかない。

∵ 外向的に ゆるく 振動する波は II と I の境界で damp するだろうからである。

そこで この様な 局部的 ~~に 場~~ に ϕ_2 に近い 場所ができている場合を ある種の 素粒子の 内部的構造 と見ることもできよう (ether 模型)

量子化の問題:

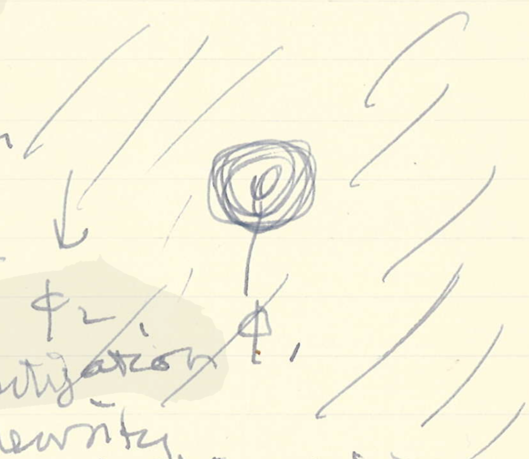
意味や

場の意味によって量子化の仕方が違ってくる。 either の modes of motion or configuration の量子化。

boson 場

fermion 場

4 次元量子化。



場の意味 → lagrangian

i) → energy-momentum density, surface stress (force density) → ordinary quantization

ii) ~~matter~~ particle density → mass density (probabilistic) → commuting or anti-commuting operators

relativistic では i), ii) は形式的に energy-momentum-stress density に統一される。

I 但し、このような一様な状態のエネルギーは

$$\int (V(\Phi_2) - V(\Phi_1))\, d^3x$$

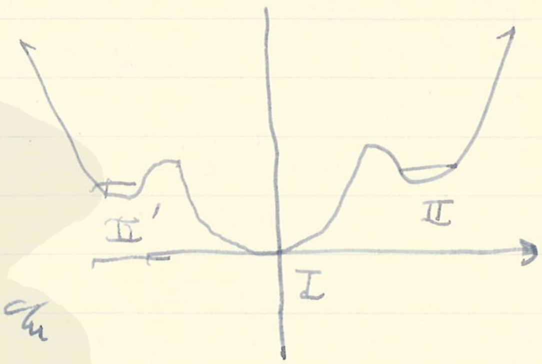
II

である。

これに反して、I なる領域の中に起った波に対応する粒子の質量は

$$m_1 = \sqrt{V''(\Phi_1)}$$ である。

若し $V(\phi)$ が ϕ^6 以上までふくんでゐなければ
明白に ~~[illegible]~~ ϕ の
他の異なる状態
が同じ energy
を持ちうることに
なる.



fermion場の論
は wrong

吉澤氏：群の表現

I.　May 20, 1960

Introduction

無限次元の表現,

Laplacian

球面　$-\Lambda = \frac{1}{\sin\theta}\frac{\partial}{\partial\theta}\left(\sin\theta\frac{\partial}{\partial\theta}\right) + \frac{1}{\sin^2\theta}\frac{\partial^2}{\partial\varphi^2}$

Λ ; $\lambda = l(l+1)$

$Y_l^m(\theta,\varphi)$; R の表現, 次元 $2l+1$ の base

$\varphi'(s) = \varphi(R^{-1}s)$

unitary, irreducible

すべての表現が得られる.

E_2 ; $-\Delta = \frac{\partial^2}{\partial r^2} + \frac{1}{r}\frac{\partial}{\partial r} + \frac{1}{r^2}\frac{\partial^2}{\partial\varphi^2}$

$0<\lambda<\infty$

$e^{im\varphi}J_m(\sqrt{\lambda}\, r)$　　$-\infty<m<\infty$

$\mathfrak{H}_\lambda \ni \varphi \Rightarrow \varphi'(p) = \varphi(M^{-1}p) \in \mathfrak{H}_\lambda$.

無限次元の表現.

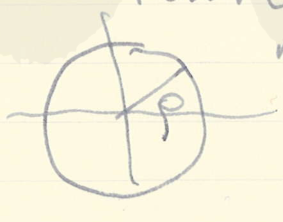
平面の運動群の表現.

$M = M(\varphi, r, \theta)$

$f(\rho,\psi) \to e^{i\rho r\cos(\varphi-\psi)} f(\rho, \psi-\theta)$

Fourier transform

momentum space



$\mathfrak{H}_\rho$

unitary, irreducible

$\mathfrak{H}_\rho : f_n(\psi) = e^{in\psi}$ $(n = 0, \pm 1, \cdots)$

$u_{mn}(\varphi, r, \theta) = \langle f_n, V_m f_m \rangle_{\mathfrak{H}_\rho}$

$u_{0n}(\varphi, r)$: 関数 on E_2

$$= \frac{1}{2\pi}\int_0^{2\pi} e^{in\psi} e^{i\rho r\cos(\varphi-\psi)}\, d\psi$$

$$= i^n e^{in\varphi} J_n(r\rho)$$

空間 X : G : 推移群、可換な

$D_1 \cdots D_r$: Gに対して不変な、独立な微分作用素

$D_k f = \lambda_k f$　　$k = 1, 2, \cdots, r$

$\mathfrak{H}_{\lambda_1 \cdots \lambda_r} = \{f\}$　　即ち $g \circ D_k = D_k \circ g$

f : spherical function

$u_{00} = J_0(r\rho)$: zonal function

三次元空間 : E_3　　G : Galilei群,

$\triangle$

Program

Lorentz群

1. 既約 unitary 表現
2. すべての表現の分類
3. 固有函数の展開
4. Clebsch-Gordan

その他の群.

表現論の応用
双対定理 duality

(x_1, x_2, x_3, x_0)

$\mathfrak{L}_4 = \mathfrak{L}$

$S(x) = x_1^2 + x_2^2 + x_3^2 - x_0^2$
proper L. gr.

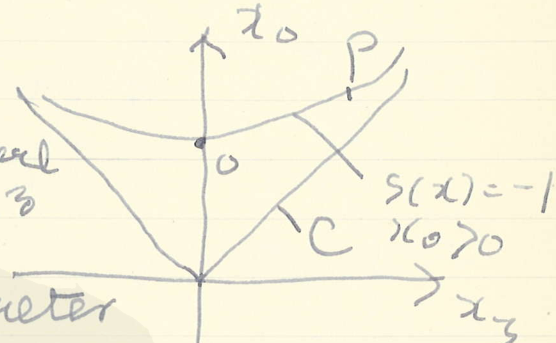
$L_{ij} \quad i \neq j \quad i, j = 1, 2, 3$

$$L_{12}(\varphi) = \begin{pmatrix} \cos\varphi & \sin\varphi & & \\ -\sin\varphi & \cos\varphi & & \\ & & 1 & \\ & & & 1 \end{pmatrix}$$

$$L_3(t) = \begin{pmatrix} 1 & & & \\ & 1 & & \\ & & \operatorname{ch} t & \operatorname{sh} t \\ & & \operatorname{sh} t & \operatorname{ch} t \end{pmatrix}$$

$$\overset{3}{L} = \overset{1}{R} \, L_3(t) \cdot \overset{2}{R'}$$

R': P を 03-plane にもってくる 変換
2-parameter



$\omega = (s, r)$
球面, $0 \leq r < \infty$

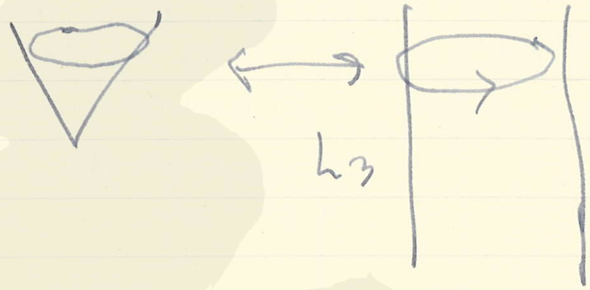
$L_3(t): (s, r) \to (s', r')$

$d\omega = ds \cdot \dfrac{dr}{r}$

$L^2(C) \qquad f(\omega) \to f(L_3^{-1}\omega)$

$$f(w) = f(s, r) \to \tilde{f}(s, \rho) = \frac{1}{\sqrt{2\pi}} \int_0^\infty f(s, r)\, e^{-i\rho - 1}\, dr$$

$$L^2(C) = L^2(s, r) \longleftrightarrow L^2(s, \rho)$$



$$(z, r) \xrightarrow[g]{} (z', r')$$

$$g = \begin{pmatrix} a & b \\ c & d \end{pmatrix}$$

$$\begin{cases} z' = \dfrac{az + c}{bz + d} \\ r' = r\,|bz + d| \end{cases}$$

$$f(z) \to f\left(\frac{az+c}{bz+d}\right) \cdot |bz+d|^{i\rho - 2}$$

$$-\infty < \rho < \infty$$

$$L^2(z), \quad dx\,dy \quad (z = x + iy)$$

一般の表現:

$$D_{m, i\rho} : V_g^{m, i\rho} \qquad f(z) \to f\left(\frac{az+c}{bz+d}\right) |bz+d|^{-m+i\rho-2} \times (bz+d)^m$$

$$(m = 0, \pm 1, \ldots, \quad -\infty < \rho < \infty)$$

unitary, irred

$(m, \rho) \simeq (m', \rho') \Longleftrightarrow m = -m', \rho = -\rho'$

主系列, principal series

$\mathfrak{L}_{n+1}$ $(x_1, \cdots x_n, x_0)$

すべての表現をつくしているか?

$\mathfrak{D}_{m,s} : V^{m,s}_{g}$

s: complex

equivalence ; $(m, s) \simeq (-m, -s)$

irreducible in almost all cases

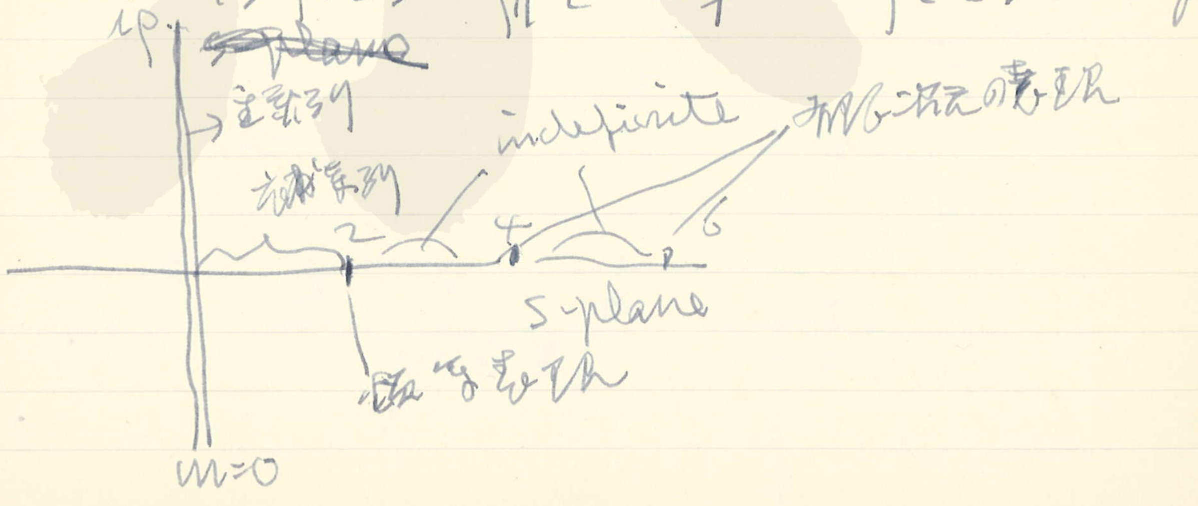
$$\langle f_1, f_2 \rangle = \iint f_1(z) \overline{f_2(z)}\, dx\, dy$$

$L^2(z)$ B : pos. def. V は可分.

$$(f_1, f_2)_B = \langle f_1, B f_2 \rangle$$

$\mathfrak{D}_{m,s}$ $m = 0$, s : real $0 \leq s < 2$

$$B f(z') = \int |z - z'|^{-2+s} f(z)\, dx\, dy$$



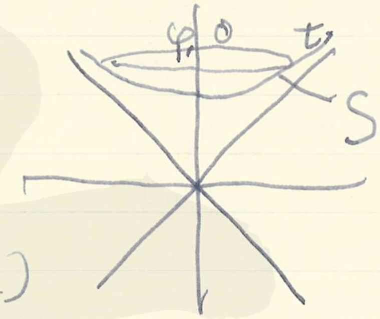
$$s, m \text{ ; } \begin{matrix} \text{even} & \text{even} \\ \text{odd} & \text{odd} \end{matrix}$$

$$s > 0 \qquad s - m = 2, 4, 6, \ldots$$

May 21, 1960

固有函数の展開

$$D \to \underset{S}{\overset{\frown}{D}}$$



$$DF = \lambda F$$

$$F_{\rho, l, m}(\varphi, \theta, t)$$

$$= \sqrt{\frac{\pi(2l+1)}{2}}\, Y_l^m(\theta, \varphi)\, \frac{\Gamma\left(\frac{i\rho}{2}\right)}{\Gamma\left(\frac{i\rho}{2} - l\right)}$$

$$\times \frac{P_{-\frac{1}{2}+i\rho}^{-\frac{1}{2}-l}(\mathrm{ch}\, 2t)}{\sqrt{\mathrm{sh}\, 2t}}$$

$$D^0 = -\frac{1}{\mathrm{sh}\, 2t}\frac{d^2}{dt^2}\, \mathrm{sh}\, 2t$$

$$\text{general } f\underline{n} \qquad F_\rho(t) = \frac{2}{\rho}\, \frac{\sin \rho t}{\mathrm{sh}\, 2t}$$

$$D^0 F_s = -s^2 F_s \qquad \lambda = -s^2$$

complex

F_s : [illegible] !

$0 < s \leq 2$; 補系列.

Mehler, Fock

$$\int_0^\infty f(t)\, F_{i\rho}(t)\, dt = \tilde{f}(\rho)$$

Casimir operator

$L_i(t), \quad L_{ij}(\varphi)$

$X_i \qquad X_{ij}$ infinitesimal op.

$$\begin{cases} Q = X_{23}^2 + X_{31}^2 + X_{12}^2 - X_1^2 - X_2^2 - X_3^2 \quad \text{(Casimir operator)} \\ R = X_{23}X_1 + X_{31}X_2 + X_{12}X_3 \end{cases}$$

$\| u^{m,s}_{\dots} \| \qquad Q \quad -s^2$

$\qquad\qquad\qquad R \quad -m^2$

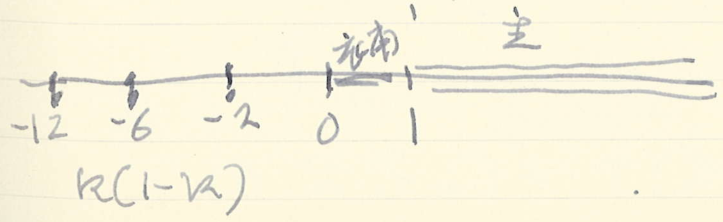
$g \in \mathfrak{L}$

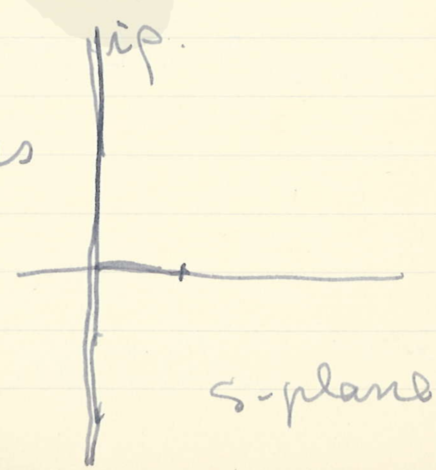
$$f(g) = \frac{1}{(2\pi)^4} \sum_{-\infty}^{\infty} \int_0^\infty \tilde{f}_{m,i\rho}(g)(m^2+\rho^2)\, d\rho$$

Plancherel theorem

$\mathfrak{L}_3 \qquad \overbrace{\mathfrak{D}_{\pm 1, i\rho},}^{\text{主}} \ \mathfrak{D}^{\pm}_m$

discrete series





Clebsch-Gordan

$\mathfrak{D}_1 \otimes \mathfrak{D}_2 = \mathfrak{D}^{(1)} \oplus \cdots \oplus \mathfrak{D}^{(k)}$

integral kernel

その他の群

1) homogeneous

2) inhomogeneous

1) $\mathfrak{L}_n$

SL (n, $\mathbb{C}$)

special linear

det = 1

classical group

matrixで書ける group

exceptional group

2) inhomogeneous　homog. → inhom.

$\mathfrak{L}_4$ → Galilei group

$\mathfrak{L}_5$ → inhom. Lor. 4c,

$\mathfrak{L}_3 \to \mathfrak{M}_2 \leftarrow \mathfrak{R}_3$

表現論の応用.

特殊函数の理論,

積分表示式

例: $P_{-\frac{1}{2}+i\rho}(x)=\frac{1}{2\pi}\int_0^{2\pi}\left(x+\sqrt{x^2-1}\cos\varphi\right)^{-\frac{1}{2}+i\rho}d\varphi$

(Laplace)

Addition formula (K. Neumann)
for Bessel f^{n}

無限次元.

duality theorem

(1°)

l, m

$\{Y_l^m\}$

$f(\varphi,\theta) \longrightarrow c_{l,m}$

$\mathfrak{R}_3 \longrightarrow \Xi = \{\vartheta\}$

$\otimes$

$g_1 g_2 = g_3$　　$\vartheta_1 \otimes \vartheta_2 = \Sigma\vartheta$

$\vartheta \to \{T_g\}$

$g \to$

T_g^{ϑ}

$\vartheta \to \tau(\vartheta)$: matrix

$\tau(\vartheta_1 \otimes \vartheta_2) = \tau(\vartheta_1) \otimes \tau(\vartheta_2) \to \mathfrak{R}_3$

(2°)

球面　　Lobachevsky 平面

$$R_4 \xleftrightarrow{\text{dual}} \mathfrak{L}_4$$

$$R_3 \xleftrightarrow{\text{dual}} \mathfrak{L}_3$$

$$\tilde{\mathfrak{L}}_4$$

$\mathfrak{L}_4 = SL(2, C)$ → complex → $SL(2, R) = \mathfrak{L}_3$ real

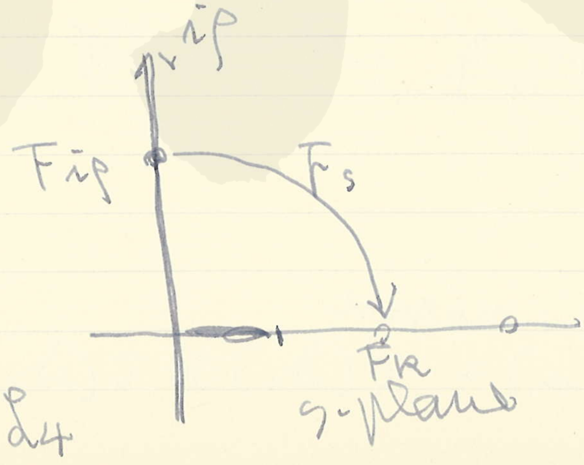
$R_3 = SU(2)$ compact

$\mathfrak{L}_3$ の hyperboloid $L^{(2)}$ $\xrightarrow{(1°)}$ $\{F_\rho ..\}$

(2°)　(2°)　$\downarrow (3°)$

R_3 の sphere $S^{(2)}$ $\xleftarrow{(1°)}$ $\{Y_l^m\}$

(3°)



$\mathfrak{L}_4$　　$\mathfrak{D}_{0,s}$

$F_s(z) = F(z; s)$

$F(t; ip) \to F(t; k)$

$\mathfrak{L}_4 \subset O_4 \supset R_4$

singular

complex

$F(r; k) \longleftarrow F(z; k)$

May, 1960 Space-Time of the Elementary Particles (to be published in P.T.P.)
R. Finkelstein

Physical space is characterized by a torsion, or an asymmetric connection, which is determined by the matter field. It is isotropic and homogeneous with a very large radius of curvature ($R \gtrsim 10^{28}$ cm).
Torsion defines at every point two screw motion of opposite helicity.
Two spinor fields
axial vector coupling between spinors (fermions) and bosons associated with torsion.

Parallel displacement:

$$\frac{\partial \lambda_i^{\ \mu}}{\partial x^\rho} + \lambda_i^{\ \alpha} L^\mu_{\alpha\rho} = 0 \qquad L^\alpha_{\rho\gamma\delta} = 0$$

$$L^\mu_{\alpha\rho} = \frac{\partial \lambda^i_{\ \alpha}}{\partial x^\rho} \lambda_i^{\ \mu}$$

$$\Gamma^\mu_{\alpha\beta} = \frac{1}{2}\left(L^\mu_{\alpha\beta} + L^\mu_{\beta\alpha}\right)$$

$$\Omega^\mu_{\alpha\beta} = \frac{1}{2}\left(L^\mu_{\alpha\beta} - L^\mu_{\beta\alpha}\right) \quad \text{(tensor)}$$

Displacement operators:

$$X_i = \lambda_i^{\ \mu} \partial_\mu$$

$$[X_j, X_k] = C^i_{jk} X_i$$

$C^i_{jk} \neq 0$ if torsion Ω exists

生物と物理　会
第1回　May 30, 1960, 基研

鳴海
井上　近田
吉川
渡辺
山本 三三三

Conjugation　　　sex
Transduction
Transformation

基研談話会

坂田昌一：素粒子の構造

May 31, 1960

$$M \approx m_B(n_B + n_{\bar B}) - V_B(n_{B\bar B} - n_{BB} - n_{\bar B \bar B})$$
$$+ \Delta m(n_\Lambda + n_{\bar\Lambda}) + \Delta V(n_{N\bar\Lambda} - n_{\bar N \Lambda}$$
$$+ n_{N\Lambda} + n_{\bar N \bar\Lambda}) + \Delta V'(n_{\Lambda\bar\Lambda} - n_{\Lambda\Lambda} - n_{\bar\Lambda\bar\Lambda})$$

$m_B \sim 13\frac{1}{2}$, $V_B \sim 25$,

$\Delta m \sim \Delta V \sim 2\frac{1}{2}$ $\Delta V' \sim 2\Delta V$

in units of m_e/α.

$l_0 \sim 0.3\,Y$

Nambu rule

$$m_\Lambda - m_\mu \doteq m_N - m_e + \alpha^{-1} m_e$$
$$n_\Sigma = n_N + \frac{1}{2} n_K = n_\Lambda + \frac{1}{2} n_\pi$$

[illegible] 第2回

June 6, 1960

午前10時30分 より [illegible]:

[illegible]

午後1時: QEDの現状

[illegible]氏:

i) low energy (atomic electron)

ii) high energy (e-e-scattering)

i) atomic electron

1. magnetic moment

$$\mu_e/\mu_0 \simeq 1 + \frac{\alpha}{2\pi} - 0.328\frac{\alpha^2}{\pi^2}$$

よくあう

2. Lamb shift

H, D, He^+

$2S_{1/2} - 2P_{1/2}$

exp. − theo.　　H Mc　0.22 ± 0.23　　He Mc　-16.6 ± 7.5

lowest order $\Delta E = \alpha \cdot (\alpha Z)^4$　　$\alpha(\alpha Z)^5$?

$\alpha(\alpha Z)^6 \begin{cases} \log \alpha Z \\ \log^2 \alpha Z \end{cases}$

1. 10y 程度までの check

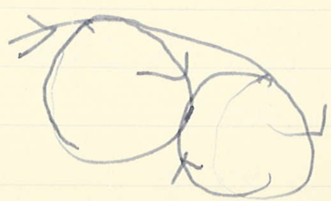
$$r \lesssim \frac{\sqrt{\text{誤差}\,\Delta E_{exp}}}{\sqrt{E}}$$

2. $\delta V \propto \delta^3(r)\langle r^2 \rangle$

ly 程度までの check

ii) electron scattering

500 MeV (CMS)



$$1 - \delta = \frac{d\sigma}{d\sigma_{moller}}$$

c033-652挟込

$$\delta = \frac{4\alpha}{\pi} \log\frac{E}{m} \log\frac{E}{\Delta E} + C \log\frac{E}{m}$$

+ const.

$$\delta \sim \frac{\alpha}{\pi}\left(\log\frac{E}{m}\right)^2 \times \text{cms.}$$

Riida, Smura, Tsai

$d\sigma = d\sigma_{el} + d\sigma_{inel}$

実験値 $\delta \sim 50\%$

$\frac{E}{\Delta E} \lesssim 10$ $\delta(90^\circ) = -9.5\%$

$\delta(35^\circ) = -6.0\%$

0.054.

Goto - Imamura Paradox

Schwinger

$$F(t) = \int \rho(x) f(x) d^3x$$

$$i\langle[\dot{F}(t), F(t)]\rangle_0 = \langle[[F, P_0], F]\rangle_0$$

$$= 2\langle F P_0 F\rangle_0 = 2\sum_n |\langle 0|F|n\rangle|^2 E_n > 0$$

一方 $-\int \vec{\nabla}\vec{j}\cdot f(x)\, d^3x$

$\therefore [\vec{j}(x), \rho(x')] \neq 0$

Q.E.D. is consistent か.

Källen Drell, Zachariasen

Sumra Yennie

dispersion relation

gauge invariance
generalized Ward identity
$(p-q)_\nu \Gamma_\nu(p,q) = S^{-1}(p) - S^{-1}(q)$

charge conservation
local ?
overall ?

細田氏：