理論物理学
研究室記録
(京大)

理論コロキウム
記録 (阪大)

1938-1939

I

理論物理コロキウム
紀録

大江象太

1938

第1回、April 21, 1938 (木曜 午後1時30分より)
大学本部にて.

湯川、坂田、小林、武谷、岡山、[illegible]、谷川 七人集合.
湯川より大体の方針に就いて 及び分擔 話す

i) Nuclear Force
湯川、[illegible]

ii) Cosmic Ray
小林、岡山

iii) β-disintegration
坂田、谷川、

iv) Formalism etc
武谷、

武谷氏より magnetic moment, self energy の話あり、

第21回. April 23, 1928, Saturday, 1.5 P.M.
大学教室にて. 集会者第1回に同じ.

坂田氏. Spinor Analysis.

van der Waerden, Gött. Nachr. 1929,
Laporte and Uhlenbeck,
Dirac, Generalized Wave Eq.
Proca,

第3回. April ~~30~~ 28, 1938, Wednesday, 1.5 P.M.
大学院室にて. 集会者. 第2回に同じ.
研究者加入.

岡山氏. Heisenberg-Pauli, Quantenelektrodyn. I. 第1回.

三浦の講義室にて，集会所 第2回に同じ.

第4回. April 30, 1938, Saturday, 1.5 P.M.

小林氏. Proca, J. d. Phys. I, II,

+   + −

Energy Density — Charge Density

Particle Density

Relativistic - Non-relativistic. +

1) Lagrangian

2) Current-Charge Vector

3) Energy-Momentum Tensor

4) ~~M~~ Electric and Magnetic Moment

5) spin.

集会者前回ニ同ジ.

第5回. May 5, 1938, 木, 1.5 P.M.

発表. H. P. I. 第二回.

第六回、May 7 (土), 1938 午後一時より 参会者前回に同じ、[illegible]の[illegible]。

湯川、Deuteron の問題、

U-Field による Reduction の問題。

木 午後一時半　参会者、湯川さん共 8人、

第七回, May 12, 1938　座主の為 ‥

岡山君、H.-P, 1/2 復習、第三回.

談話会 第四回目より.

第七回. May 14, 1938. 土, 午後一時半, 教室にて. （会議室）

小林氏: U-粒子のCreationの問題,

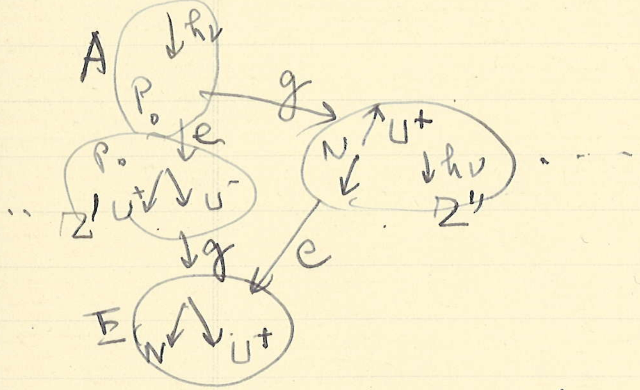
Scalar Theory

$$H = H_0 + H_{ep} + H_{eU^2} + H_g.$$

$$H_g = g \{ \qquad \qquad \} \beta$$

$$H_{eU^2} = \frac{1}{2} \sum_{k,l} \sum_{k_0,\lambda} \sum .$$

(Pauli-Weisskopf)
Heitler



$$H_{AE} = \frac{(A|H_g|Z')(Z'|H_e|E)}{E_A - E'_z} + \frac{(A|H_e|Z'')(Z''|H_g|E)}{E_A - E''_z}$$

$$= \frac{i}{2} g e (\hbar c)^3 \frac{1}{E_{k'}} \sqrt{\frac{2\pi}{E_k}} \sqrt{\frac{2\pi}{E_0}} \sqrt{2\pi} \left\{ \frac{(u^*_{k'} \beta u_0)(\vec{e}_\lambda, \vec{k} - \vec{k}')}{M_p c^2 - E_N - E_{k'}} + \frac{(\vec{e}_\lambda, \vec{k} - \vec{k}')(u^*_{k'} \beta u_0)}{E_0 - E_k - E_{k'}} \right\}$$

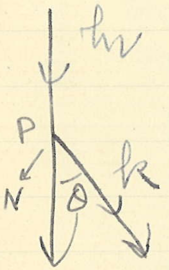
$$M_p c^2 + E_0 = E_N + E_k$$

$$|H_{AE}|^2 = \frac{1}{4} g^2 e^2 (\hbar c)^6 \frac{1}{E_{k'}^2} \frac{(2\pi)^3}{E_k E_0} \frac{1}{2}\left(1+\frac{M_N c^2}{E_N}\right)$$

$$\times \frac{4E_{k'}^2}{\{E_{k'}^2-(E_0-E_k)^2\}^2}$$

$$d\phi = \frac{2\pi}{\hbar c}|H'|^2 \rho_F$$

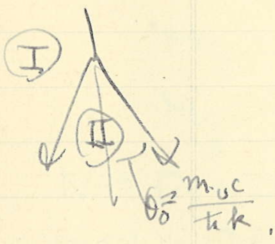
$$= (2\pi) g^2 e^2 (\hbar c)^5 \frac{1}{E_k E_0} \frac{k^4 \sin^2\theta}{\{E_{k'}^2-(E_0-E_k)^2\}^2}$$



$$\times \frac{1}{2}\left(1+\frac{M_N c^2}{E_N}\right)\frac{dk}{dE}\cdot d\Omega.$$

$h\nu \simeq 10^9 eV. (\simeq M_p c^2)$

$1-\cos\theta \gg \frac{1}{2}\left(\frac{m_\upsilon c}{\hbar k}\right)^2 \qquad \theta \gg \frac{m_\upsilon c}{\hbar k} \simeq \frac{1}{10}.$



$$d\phi_{I} = \pi^2 \frac{g^2 e^2}{(m_\upsilon c^2)^2} \frac{\kappa^2}{\cancel{\kappa_0^4}} \frac{1+\cos\theta}{1-\cos\theta} d(-\cos\theta)$$

$$d\phi_{II} = 4\pi^2 \frac{g^2 e^2}{(m_\upsilon c^2)^2} \cancel{\frac{\kappa^6}{\kappa_0^4}}\,\kappa_0^2 \sin^3\theta\, d\theta \quad \times$$

$$\phi \sim \phi_{I} = (2\pi)^2 \frac{g^2 e^2}{(m_\upsilon c^2)^2} \frac{1}{\kappa_0^2} \log 2\kappa_0.$$

$\left.\begin{array}{l}\kappa_0 = 10 \\ m_\upsilon = \frac{M_p}{10}\end{array}\right\}$ $\phi \sim 2\cdot 10^{-29}. cm^2. \quad (2+N)$

Pair creation (Pauli-Weisskopf)

$\phi_{pair} \sim 2\cdot 10^{-32} Z^2$

Y. S. T. ~~p. 12~~ (30)

$$H'_{\sqcup} = \frac{ie}{\hbar}\sum_k\sum_l \dot{A}_{kl}(\vec{p}_l^* \vec{q}_k^* - \vec{p}_k \vec{q}_k)$$

$$- 4\pi c \frac{e}{\hbar}\sum_k\sum_l \{(A_{kl}\, p_k)(p_k^* \vec{l}) + (A_{kl}\, p_l^*)(p_k \vec{k})\}$$

$$- \frac{1}{4\pi\kappa^2}\frac{e}{\hbar c}\sum_k\sum_l \{[A_{kl}\, q_k^*][l q_l]$$

$$+ [k q_k^*][A_{kl}\, q_l]\}$$

y.S.K.T.
生協前. 農芸二階. 食堂にて

第八回, May 19, 1938, 木, 午後一時半.

坂田氏, β-Rayの理論,

IIIの引続き.

$$(36)\left\{\begin{array}{l} \text{——} = \text{——} -4\pi g_1' M' \\ \text{——} = \text{——} +4\pi g_1' M_0' \end{array}\right.$$

$$(37)\left\{\begin{array}{l} \text{——} = \text{——} +4\pi g_2' T' \\ \text{——} = \text{——} -4\pi g_2' S' \end{array}\right.$$

Ψ : Proton $\qquad \psi$: electron

Φ : Neutron $\qquad \varphi$: neutrino.

$M = \tilde{\Phi}\alpha\Psi \qquad M_0 = \tilde{\Phi}\Psi$

$S = \tilde{\Phi}\rho_3\sigma\Psi. \qquad T = -\tilde{\Phi}\rho_2\sigma\Psi$

$M' = \tilde{\psi}\alpha\varphi \qquad M_0' = \tilde{\psi}\varphi$

$S' = \tilde{\psi}\rho_3\sigma\varphi \qquad T' = -\tilde{\psi}\rho_2\sigma\varphi.$

$H_g = H' \quad (47)$

$H_{g'} = H' \left(\begin{array}{l} g_1 \to g_1', \; g_2 \to g_2' \\ M\,M_0\,T\,S \to M_0' M_0' T' S' \end{array} \right)$

$N \to P + U^- \qquad U^- \to e^- + \nu$

$$(56) \quad U^\dagger(\vec{r}_1) = \frac{g_1}{4\pi\varkappa c}\,\mathrm{grad}_1 \int \frac{e^{-\varkappa r}}{r}\tilde{M}_0(\vec{r}_2)\,d\vec{r}_2$$

$$\tilde{U}(\vec{r}_1) = -g_2\,\mathrm{curl}_1 \int \frac{e^{-\varkappa r}}{r} S(\vec{r}_2)\,d\vec{r}_2$$

$$\cancel{\overline{H}_\beta} = H_{gg'} = \frac{4\pi}{\varkappa^2} g_1 g_1' (\tilde{M}_0' M_0 + M_0' \tilde{M}_0) + \frac{4\pi}{\varkappa^2} g_2 g_2' (\tilde{S}' S + S' \tilde{S})$$

$$\bar{H}_{\beta^-} = \frac{4\pi g_1 g_1'}{\varkappa^2}\int \tilde{M}_0(\vec{r}_1) M_0'(\vec{r}_1)\, d\vec{r}_1$$

$$+ \frac{4\pi g_2 g_2'}{\varkappa^2}\iint \tilde{S}(\vec{r}_1) S'(\vec{r}_1)\, d\vec{r}_1$$

$$+ \frac{g_1 g_1'}{\varkappa^2}\iint \operatorname{div}_1 \operatorname{grad}_1 \left(\frac{e^{-\varkappa r}}{r}\tilde{M}_0(\vec{r}_2)\right) M_0'(\vec{r}_1)\, d\vec{r}_1\, d\vec{r}_2 .$$

$$+ \frac{g_2 g_1'}{\varkappa^2}\iint \operatorname{curl}_1 \left(\frac{e^{-\varkappa r}}{r}\tilde{S}(\vec{r}_2)\right) M'(\vec{r}_1)\, d\vec{r}_1\, d\vec{r}_2$$

$$+ \frac{g_1 g_2'}{\varkappa^2}\iint \operatorname{grad}_1 \left(\frac{e^{-\varkappa r}}{r}\tilde{M}_0(\vec{r}_2)\right) T'(\vec{r}_1)\, d\vec{r}_1\, d\vec{r}_2$$

$$- \frac{g_2 g_2'}{\varkappa^2}\iint \underbrace{\operatorname{curl}_1 \operatorname{curl}_1}_{\operatorname{grad}_1 \operatorname{div}_1 - \Delta} \left(\frac{e^{-\varkappa r}}{r}\tilde{S}(\vec{r}_2)\right) S'(\vec{r}_1)\, d\vec{r}_1\, d\vec{r}_2$$

$$= g_1 g_1' \iint \frac{e^{-\varkappa r}}{r}\tilde{M}_0(\vec{r}_2) M_0'(\vec{r}_1)\, d\vec{r}_1\, d\vec{r}_2$$

$$+ g_2 g_2' \iint \frac{e^{-\varkappa r}}{r}\tilde{S}(\vec{r}_2) S'(\vec{r}_1)\, d\vec{r}_1\, d\vec{r}_2 .$$

$$+ g_2 g_1' \int \frac{e^{-\varkappa r}}{r}\tilde{S}(\vec{r}_2) \operatorname{curl} M'(\vec{r}_1)\, d\vec{r}_1\, d\vec{r}_2 .$$

$$- \frac{g_1 g_2'}{\varkappa}\iint \frac{e^{-\varkappa r}}{r}\tilde{M}_0(\vec{r}_2) \operatorname{div} T'(\vec{r}_1)\, d\vec{r}_1\, d\vec{r}_2$$

$$- \frac{g_2 g_2'}{\varkappa^2}\iint \frac{e^{-\varkappa r}}{r}\tilde{S}(\vec{r}_2) \operatorname{grad} \operatorname{div} S'(\vec{r}_1)\, d\vec{r}_1\, d\vec{r}_2$$

$\frac{\operatorname{grad}}{\varkappa} \sim \frac{\Delta E}{M_0 c^2} \ll 1$ ∴ 最初の二項丈を考へると ~~は~~、之は spin を含んだ Fermi 型である.

K, −U に相当する Ansatz.

$$M'_0 = \lambda_1 \tilde{\psi}\phi + \lambda_2 \tilde{\psi}\rho \frac{1}{c}\frac{\partial\phi}{\partial t} + \lambda_3 \tilde{\psi}\rho\alpha\, \mathrm{grad}\,\phi$$

$$M' = \lambda_1 \tilde{\psi}\alpha\phi - \lambda_2 \tilde{\psi}\rho\, \mathrm{grad}\,\phi - \lambda_3\left(\tilde{\psi}\rho\alpha \frac{1}{c}\frac{\partial\phi}{\partial t} + i\tilde{\psi}\rho\vec{\sigma} \times \mathrm{grad}\,\phi\right)$$

$$T' = -\mu_1 \tilde{\psi}\rho_2\sigma\phi + \mu_2\left(\tilde{\psi}\alpha\frac{1}{c}\frac{\partial\phi}{\partial t} + \tilde{\psi}\,\mathrm{grad}\,\phi\right) + \mu_3 \tilde{\psi}\sigma \times \mathrm{grad}\,\phi$$

$$S' = \mu_1 \tilde{\psi}\rho_3\sigma\phi + \mu_2\tilde{\psi}\alpha \times \mathrm{grad}\,\phi + \mu_3\left(\tilde{\psi}\sigma\frac{1}{c}\frac{\partial\phi}{\partial t} + \tilde{\psi}\gamma^5\,\mathrm{grad}\,\phi\right)$$

$$\gamma^5 = \gamma^1\gamma^2\gamma^3\gamma^4 = \alpha_1\alpha_2\alpha_3$$

$$\bar{L} = \int L\, d\tau$$

$$L = \underbrace{L_U + L_M + L_m + L_g}_{\cancel{(5)}\ (41)} + L_{g'}$$

$$L_m = \tilde{\psi}\left(i\hbar\frac{\partial}{\partial t} - c\vec{\alpha}\vec{p} - \rho m c\right)\psi + \tilde{\phi}\left(i\hbar\frac{\partial}{\partial t} - c\vec{\alpha}\vec{p} - \rho\mu c\right)\phi$$

$$L_{g'} = \frac{g'_1}{\kappa}\left(\tilde{U}M' - \tilde{U}_0 M'_0 + U\tilde{M}' - U_0\tilde{M}'_0\right)$$

$$F = \frac{1}{\kappa}\left(-\frac{1}{c}\frac{\partial U}{\partial t} - \mathrm{grad}\,U_0 + 4\pi g_2 T + 4\pi g'_2 T'\right)$$

$$G = \qquad\qquad S \qquad S')$$

$$\psi^\dagger = i\hbar\tilde{\psi}, \quad \tilde{\psi}^\dagger = 0$$

$$\phi^\dagger = i\hbar\tilde{\phi} - \frac{g'_1\lambda_3}{\kappa c}\tilde{U}\tilde{\psi}\rho\alpha - \frac{g'_1\lambda_2}{\kappa c}\tilde{U}_0\tilde{\psi}\rho + \frac{g'_2\mu_2}{\kappa c}\tilde{F}\tilde{\psi}\alpha - \frac{g'_2\mu_3}{\kappa c}\tilde{G}\tilde{\psi}\sigma$$

$$\tilde{\varphi}^{+} = \cdots \qquad + g' \cdots$$

$$M_0' = M_0^{(1)} + M_0^{(2)}$$

$$M' = M^{(1)} + M^{(2)}$$

$$T' = T^{(1)} + T^{(2)}$$

$$S' = S^{(1)} + S^{(2)}$$

(2) に $\frac{\partial}{\partial t}$ を含む項.

$$H = H_M + H_m - \frac{g_1}{\varkappa}(\tilde{U}M + U\tilde{M})$$

$$- \frac{g_1'}{\varkappa}(\tilde{U}M^{(1)} + U\tilde{M}^{(1)}) + 4\pi\varkappa^2 c^2 \tilde{U}^{+} U^{+}$$

$$+ \frac{1}{4\pi}\tilde{U}U + 4\pi\left(c\,\mathrm{div}\,\tilde{U}^{+} + \frac{g_1}{\varkappa}M_0 + \frac{g_1'}{\varkappa}M_0^{(1)}\right)$$

$$\times\left(c\,\mathrm{div}\,U^{+} + \frac{g_1}{\varkappa}\tilde{M}_0 + \frac{g_1'}{\varkappa}\tilde{M}_0^{(1)}\right)$$

$$+ \frac{1}{4\pi\varkappa^2}\left(\mathrm{curl}\,\tilde{U} + 4\pi g_2\tilde{S} + 4\pi g_2\tilde{S}^{(1)}\right)$$

$$\times\left(\mathrm{curl}\,U + 4\pi g_2 S + 4\pi g_2' S^{(1)}\right)$$

$$+ 4\pi c U^{+}(g_2 T + g_2' T^{(1)}) + 4\pi\tilde{U}^{+}(g_2\tilde{T} + g_2'\tilde{T}^{(1)})$$

$$- \frac{4\pi g_1'^2}{\varkappa^2}\tilde{M}_0^{(2)} M_0^{(2)} - \frac{4\pi g_2'^2}{\varkappa^2}\tilde{S}^{(2)} S^{(2)}.$$

$\lambda_2 = 0$, $\mu_3 = 0$ とおくと 0 となる.

~~$\varphi^{+} = i\pi\tilde{\varphi}$~~ [illegible], $\tilde{U}_0$, $\tilde{G}$ の中に φ および φ^{+} を $\tilde{\varphi}$ に書換.

$$\overline{H}_p = g_1 g_1' \iint \frac{e^{-\varkappa r}}{r}\tilde{M}_0(\vec{r}_2) M_0^{(1)}(\vec{r}_1)\,d\vec{r}_1\,d\vec{r}_2$$

$$+ g_2 g_2' \iint \frac{e^{-\varkappa r}}{r}\tilde{S}(\vec{r}_2) S^{(1)}(\vec{r}_1)\,d\vec{r}_1\,d\vec{r}_2.$$

$$G = \frac{4\pi g_1 g_1'}{h^2}$$

$$\frac{1}{\tau} = G^2 \frac{4\pi^4 m^5 c^4}{h^7} \varepsilon \eta \varepsilon_n \eta_n (A\eta_n^2 + B\eta_n + C)\, d\varepsilon.$$

玉木氏. 7人, 合せて.

第九回. May 21, 1938, 土, 午後1時

武谷氏. Siegert, Phys. Rev. 52, Oct. 1937.

Lamb and Schiff, On the Electromagnetic Properties of Nuclear Systems. (Phys. Rev. 53, April, 1938)

$$-\left(\frac{1}{c}\right)A\iiint \dot{i}\, d\tau = -\frac{A}{c}\iiint \mathfrak{r}\,\dot{\rho}\, d\tau$$

i) Fermi

ii) Yukawa

iii) Teller and Critchfield

Gamow,)

出席者，小林氏等八人，会議室にて，

第十回：May 26, 1938，木，午後一時半より．

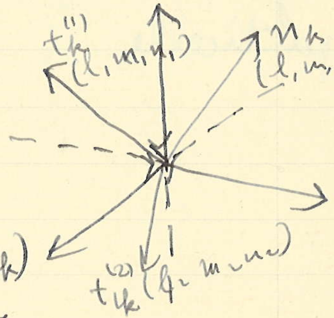
武谷氏．Lamb and Schiff 続き．

Deuteron.

$$m_z = m_{12} = \frac{ie}{4\pi\varkappa^2\hbar c}\left(U_x^* U_y - U_y^* U_x\right)$$

$$U_x = \sum_k \left(q_k l + q_k^{(1)} l_1 + q_k^{(2)} l_2\right) e^{i\vec{k}\vec{x}}$$

$$U_y = \sum_k \left(\qquad \right)$$



$$\int m_z\, dv = \sum K \Big\{ \underbrace{(l m_1 - m l_1)}_{A} \left(q_k^* q_k^{(1)} - q_k^{*(1)} q_k\right) + \underbrace{(l m_2 - m l_2)}_{B} \left(\quad \right) + \underbrace{(\quad)}_{C} \left(\quad \right) \Big\}$$

$$= -\frac{e\hbar}{2m_0 c} \Big\{ A \big(-a_k^* a_k^{(1)} + a_k^{*(1)} a_k - \dots$$

$$- a_k^{*(1)} b_k^* - b_k^{*(1)} a_k \big)$$

$$- \quad B$$

$$- \quad \frac{\varkappa}{k_0} C$$

$$= \psi^* \Big\{ A\left(\qquad \right) + B\left(\qquad \right) + \frac{\varkappa}{k_0} C \left(\qquad \right) \Big\}$$

167號室にて、

第十一回. June 4, 1938. ~~土曜~~ Saturday, 午后一時半より

湯川教授: N. Kemmer, The Charge-dependence of Nuclear Forces. (Proc. Camb. Phil. Soc. , 1938)

(E. Majorana, Teoria simmetrica dell'elettrone e del positrone. (Nuovo Cimento 14, 171, 1937)

G. Racah, Sulla simmetria tra particelle e antiparticelle (ibid. 14, 322, 1937))

167號 [illegible]

第十二回. June 9, 1938, Thursday. 午後二時.
[illegible]君.

P. Jordan u. E. Wigner, ZS. f. Phys. 47, 631, 1928
Über das Paulische Äquivalenzverbot.

参集者 8人. [illegible]

第十三回. 167號室にて 6月11日土曜, 午後一時半,
坂田氏.

N. Kemmer, Quantum Theory of E.-B. Particles and Nuclear Interaction (Proc. Roy. Soc. 166, 127, 1938)

((H. Fröhlich, W. Heitler and N. Kemmer
On the Nuclear Forces and Magnetic Moments of the Neutron and the Proton (Ibid. 154, 1938)))

Proca, (b)

$$\left.\begin{aligned} p^{\dot\alpha\varkappa} A_{\varkappa\lambda} &= \sqrt{2}\, m_0 B^{\dot\alpha}_{\lambda} \\ p_{\dot\alpha\varkappa} B^{\dot\alpha}_{\lambda} &= \frac{m_0}{\sqrt{2}} A_{\varkappa\lambda} \end{aligned}\right\}$$

spin 1
$k = 1,\ l = \frac{1}{2}$

P. W. (a)

$$\left.\begin{aligned} p^{\dot\alpha}_{\varkappa} A &= \sqrt{2}\, m_0 B^{\dot\alpha}_{\varkappa} \\ p_{\dot\alpha}{}^{\varkappa} B^{\dot\alpha}_{\varkappa} &= -\sqrt{2}\, m_0 A \end{aligned}\right\}$$

spin 0
$k = 0,\ l = \frac{1}{2}$

$A \to \psi \qquad B^{\dot\alpha}_{\varkappa} \to \frac{\partial\psi}{\partial t},\ \mathrm{grad}\,\psi$

$B^{\dot\alpha}_{\lambda} \to U_0,\ \vec{U}$

$A_{\varkappa\lambda} \to \vec{F},\ \vec{G}$

c) pseudo-vector spin 1,

d) pseudo-scalar spin 0,

(a) P. W. $\psi(\Psi_N^* \rho \Psi_P)$ $\qquad \Pi(1, \vec{\alpha})$

(b) Proca. $(1, \alpha)$ $\qquad \rho\vec{\sigma},\ \rho\vec{\alpha}$.

d) pseudo-~~vect~~scalar $\vec{\sigma}$ $\qquad \gamma_5 = -i\alpha_1\alpha_2\alpha_3$ ~~[illegible]~~ $\quad \Psi_N^* \gamma_5 \rho \Psi$

c) ps. vector $(\gamma_5, \cancel{\gamma_5\alpha})$ $\qquad (\gamma\ ,\ \ )$

a) $V^a(r) = -g_a^2 \frac{e^{-\varkappa r}}{r}$

b) $V^b(r) = \left[g_b^2 + f_b^2\left((\sigma_N\sigma_p) - (\sigma_N \operatorname{grad})(\sigma_p \operatorname{grad})\right)\right]\frac{e^{-\varkappa r}}{r}$

c) $V^c(r) = -\left[g_c^2(\sigma_N \operatorname{grad})(\sigma_p \operatorname{grad}) + f_c^2\left((\sigma_N\sigma_p) - (\sigma_N \operatorname{grad})(\sigma_p \operatorname{grad})\right)\right]\frac{e^{-\varkappa r}}{r}$

d) $V^d(r) = g_d^2 (\sigma_N \operatorname{grad})(\sigma_p \operatorname{grad}) \frac{e^{-\varkappa r}}{r}$

$V(r) = \left[A + B(\sigma_N\sigma_p) + C(\sigma_N \operatorname{grad})(\sigma_p \operatorname{grad})\right]\frac{e^{-\varkappa r}}{r}.$

a) ^3S: repulsion. ^1S: attract.

b) $^3S > {}^1S$: attraction

c) ^3S : repulsion. ^1S : ~~$3\times{}^3S$~~ repulsion ($3\times{}^3S$)

d) $^3S, < {}^1S$: attraction

Self Energy : g, g^2 $\int k\,dk$ n proportional to divergence,

$$W = \sum \frac{H \quad H}{E - E_0}$$

$$\left(\frac{\partial W(H)}{\partial H}\right)_{H=0} = \mu.$$

出席者7人,

第十四回. 167號にて 6月16日木. 午後三時より.
参考書. Frenkel, Quantum Mechanics.

$$\bar{F}_{12,34}\, a_1^\dagger a_2^\dagger a_4 a_3 + \bar{F}_{12,43}\, a_1^\dagger a_2^\dagger a_3 a_4$$
$$+ \bar{F}_{12,34}\, a_1^\dagger a_2^\dagger a_4 a_3 + \bar{F}_{12,43}\, a_1^\dagger a_2^\dagger a_3 a_4$$

$$= F_{12,34}\, a_1^\dagger a_2^\dagger \cancel{a_4} \cancel{a_3}$$
$$+ F_{12,43}\, a_1^\dagger a_2^\dagger a_3 a_4$$
$$+ F_{21} \bar{F}_{34}\, a_2^\dagger a_1^\dagger a_3 a_4$$
$$+ \cdots$$

談話会 6人

紫さん

第十五回, 167號にて, 6月18日 土, 午後1時30分 公郎.

武谷氏, Fröhlich, Heitler and Kemmer, ...

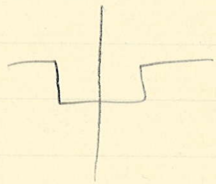
^3S 幅 3×10^{-13} cm 深さ 25×10^{6} eV

^1S 〃 深さ 稍

$$f \doteqdot g \doteqdot .5\,e$$

$$\left(g^2+\frac{2}{3}f^2\right)\lambda = g$$

$$\frac{g^2}{\hbar c} \doteqdot \frac{1}{6}.$$



$$V_{PP} = -\frac{(g^2-2f^2)^2}{\hbar c\, r}\left[\left(1-\frac{1}{(2\lambda r)^2}\right) i H_0^{(1)}(2i\lambda r) + \left(1+\frac{1}{(2\lambda r)^2}\right)\frac{H_1^{(1)}(2i\lambda r)}{\lambda r}\right] = \frac{g^3}{\hbar c} V_{NP}\, e^{\lambda r} \times \text{Han.}$$

$$V_{PP} \propto \frac{1}{r^5}$$

λr	$e^{\lambda r} \times$ Hankel
0.1	−900
0.2	−70
0.5	−2.5
1	−0.5

$$i^{n+1} H_n^{(1)}(iy) \approx \frac{(n-1)!}{\pi}\left(\frac{2}{y}\right)^n.$$

$$d = \frac{1}{2\lambda} \;!!!$$

$$V_{NP}(\text{fourth order}) = \frac{1}{2} V_{PP}$$

	m	m
P	$\frac{1}{2}$	
N	$-\frac{1}{2}$	U^+ 1

Magnetic moment

$$W = W_0 + \frac{4}{3\pi}\frac{f^2}{\lambda^2}\frac{eH}{\hbar c}\int_0^\infty \frac{k^4\,dk}{(k^2+\lambda^2)^2} \sim W_0 + H \frac{f^2}{\hbar c}\frac{e\hbar}{m_0 c}$$

本出席者7人

第十六回. 167號室にて. 6月23日. 金曜二時より,
岡山君, H. u. P. I, §6.

$$a_s = e^{-\frac{2\pi i}{h}\Theta_s} N_s^{\frac{1}{2}} \qquad a_s^* = N_s^{1/2} e^{\frac{2\pi i}{h}\Theta_s}$$

出席者7人.

第十七回. 167號室にて 6月25日 土曜 午後二時より.

武谷君. U-Particle の spin の話.

$$H_{\rho s} j_s = -\frac{\partial L}{\partial A_s}\partial_\rho A_s + \partial_s\left(\frac{\partial L}{\partial A_s}A_\rho\right).$$

$$j_s = -\frac{e}{\hbar c}\frac{\partial L}{\partial A_s}.$$

$$\partial_s j_s = 0$$

$$H_{\rho s} j_s = \partial^r T_{r\rho}$$

$$U_i \to U_i + \varepsilon \frac{2V}{\hbar c}[\bar{\Lambda} U_i]$$

$$\bar{\Lambda} = \int \Lambda \, dv$$

$$\Lambda = \left(\delta_{\alpha\rho} U_\rho - \frac{\partial U_\alpha}{\partial x_{ik}}(i_k x_k)\right) P_{\alpha 4}$$

$$\Lambda_z = -U_x^\dagger U_y + U_y^\dagger U_x + U_y^\dagger \frac{\partial U}{\partial x} - U_x^\dagger \frac{\partial U}{\partial y}.$$

運動方程的.

$$\dot{\Lambda} = 0.$$

出席者7人,

第十八回 16の続きにて. 6月30日 午後1時30分より

紫君, H.P.I. を論ずる.

出席者7人.

第十九回. 167號室にて. 7月2日. 午后1時40分より.

岡山氏. Landau and Rumer, Proc. Roy. Soc. 166, 215, 1938. Cascade Theory of Electronic Shower.

$$\frac{d\Pi(E)}{dx} = 2\int_E^\infty \Gamma(u)\,\gamma(u,E)\,du + \int_E^\infty \Pi(u)\,\pi(u,u-E)\,du$$

$$-\int_0^E \Pi(E)\,\pi(E,E-u)\,du$$

$$\frac{d\Gamma(E)}{dx} = \int_E^\infty \Pi(u)\,\pi(u,E)\,du - \int_0^E \Gamma(E)\,\gamma(E,u)\,du.$$

$$\left.\begin{aligned}\gamma(E,E') &= A\,\frac{E'^2 + (E-E')^2 + \frac{2}{3}E'(E-E')}{E^3}\\ \pi(E,E') &= A\,\frac{E^2 + (E-E')^2 - \frac{2}{3}E(E-E')}{E^2E'}\end{aligned}\right\}$$

$$A = \frac{4}{137}\left(\frac{e^2}{mc^2}\right)^2 ZN\log\left(183Z^{-\frac{1}{3}}\right)$$

$$f(s) = \int_0^\infty f(E)\,E^s\,dE$$

$$\left.\begin{aligned}\frac{d\Pi_s}{dt} &= A(s)\Pi_s + B(s)\Gamma_s,\\ \frac{d\Gamma_s}{dt} &= C(s)\Pi_s + D(s)\Gamma_s.\end{aligned}\right\}$$

小林君。

$$U \leftrightarrow H$$
$$U \leftrightarrow P$$

$$H_U = H_0 + H'$$

$$H' = \frac{4\pi c g_1}{\kappa}\left(\mathrm{div}\, U^\dagger M_0 + \mathrm{div}\, \tilde{U}^\dagger \tilde{M}_0\right)$$
$$- \frac{g_1}{\kappa}\left(\tilde{U} M + U \tilde{M}\right) + 4\pi g_2 c\left(U^\dagger T + \tilde{U}^\dagger \tilde{T}\right)$$
$$+ \frac{g_2}{\kappa^2}\left(\mathrm{curl}\, U \cdot \tilde{S} + \mathrm{curl}\, \tilde{U} \cdot S\right)$$
$$+ \frac{4\pi}{\kappa^2}\left(g_1^2 \tilde{M}_0 M_0 + g_2^2 \tilde{S} S\right)$$
$$+ \frac{ie}{\hbar} A_0\left(\tilde{U}^\dagger \tilde{U} + U^\dagger U\right) + \frac{4\pi i e c}{\hbar}\Big(U^\dagger A\, \mathrm{div}\, \tilde{U}^\dagger$$
$$- \tilde{U}^\dagger A\, \mathrm{div}\, U^\dagger\Big) + \frac{1}{4\pi\kappa^2}\frac{ie}{\hbar c}\left([A\tilde{U}]\,\mathrm{curl}\, U - [AU]\,\mathrm{curl}\, \tilde{U}\right)$$
$$- \frac{4\pi e^2}{\hbar^2}(AU^\dagger)(A\tilde{U}^\dagger) + \frac{e^2}{4\pi\hbar^2 c^2 \kappa^2}[AU][A\tilde{U}]$$
$$+ \frac{i g_2 e}{\kappa^2 \hbar c}\left([\cancel{A}A\tilde{U}]S - \tilde{S}[AU]\right) + \frac{4\pi i g_1 c}{\kappa\hbar}\Big\{(AU^\dagger)M_0$$
$$- (A\tilde{U}^\dagger)\tilde{M}_0\Big\}$$

$$U = \sum_k \left\{ -\frac{i\sqrt{2\pi}\,\kappa c \hbar}{\sqrt{E_k}}\left(-a_k + b_k^*\right) + \sqrt{2\pi E_k}\left(A_k + B_k^*\right)\right\} e^{i\vec{k}\vec{r}}.$$

$$U^\dagger = \sum_k \left\{ \frac{\sqrt{E_k}}{\sqrt{8\pi}\,\kappa c}\left(a_k^* + b_k\right) + \frac{-i\hbar}{\sqrt{8\pi E_k}}\left(A_k^* + B_k\right)\right\} e^{-i\vec{k}\vec{r}}.$$

第廿回、167號室にて、7月14日午後1時半から、集会者、6人、武谷三男、

H. u. P. Zur Quantentheorie der Wellenfelder, II.

第廿一回. 167號室にて, 7月18日(月曜 午後1時40分より). 出席者研究員等8人.

H.P. II. 終了.

數君,

武谷君, Magnetic Moment,

出席者7人.

第廿二回 167號室にて. 7月25日. 月曜日. 午前10時半より

W. Heitler, Showers produced by penetrating C.R.
(Proc. Roy. Soc. 166, 529, 1938)

|Y
PN

$$H_{I}' = \frac{g}{\lambda}\Pi\,[\mathrm{div}\,\psi]_0 + \mathrm{conj.} + \cdots$$

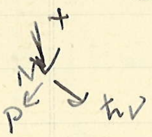
$$H_{II}' = \frac{f}{\lambda}\Pi\,[\sigma\,\mathrm{grad}\,\phi]_0 + \mathrm{conj.} + \cdots$$

$$\frac{g^2}{\hbar c} \doteqdot \frac{f^2}{\hbar c} \doteqdot \frac{1}{6}.$$

Y — E

$$H' = \frac{ie}{4\pi\hbar c}\int dv\Big\{\mathrm{div}\,\psi^*\big(A, \psi + \frac{1}{\lambda c}\dot\psi\big) + \big(\mathrm{curl}\,\phi^*\,[A, \phi - \frac{1}{\lambda c}\dot\psi]\big) + \mathrm{conj}\Big\}$$

Y > E
PN.



$$\Phi = \Phi'_{long} + \Phi''_{trans.}$$

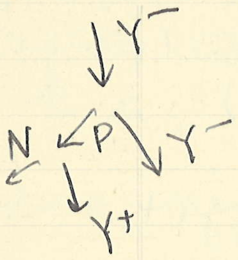
$$\left.\begin{aligned}\Phi' &= \frac{2\pi}{3}\frac{g^2}{\hbar c}\frac{e^2}{\hbar c}\frac{1}{\lambda^2}\frac{\mu c^2}{p}\\ \Phi'' &= \frac{2\pi}{3}\frac{f^2}{\hbar c}\frac{e^2}{\hbar c}\frac{1}{\lambda^2}\frac{\mu c^2}{p}\end{aligned}\right\}\ p \ll \mu c^2.$$

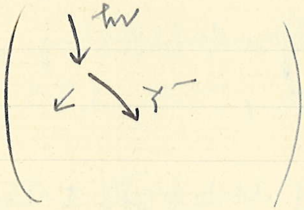
$$\Phi' = \frac{8\pi}{3}\frac{g^2}{\hbar c}\frac{e^2}{\hbar c}\frac{1}{\lambda^2}$$

$$\Phi'' = \frac{44\pi}{3}\frac{f^2}{\hbar c}\frac{e^2}{\hbar c}\frac{1}{\lambda^2}\left(\frac{\epsilon}{\mu c^2}\right)^2\Bigg\}\ p \gg \mu c^2$$

$$\Phi \doteqdot 15\frac{g^2}{\hbar c}\frac{e^2}{\hbar c}\frac{1}{\lambda^2} = \frac{1}{50}\frac{1}{\lambda^2}$$

10^{-27}

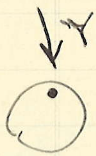




$$\frac{\Phi_2}{\Phi_1} = \frac{3}{5\pi}\frac{g^2}{\hbar c}\left(\frac{\varepsilon}{\mu c^2}\right)^2$$

$$\underline{\varepsilon \sim 5\mu c^2}$$

$$\Phi_1 \simeq \frac{12\pi}{\lambda^2}\left(\frac{g^2}{\hbar c}\right)^2 ?$$

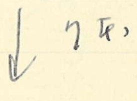


$$\frac{\Phi_{\text{軌}\,Y}}{\Phi_{\text{pair}}} = \frac{1}{5Z} \sim \frac{1}{40} \text{ for air}$$

Electron

280粁 e±　　500粁 hν

|||||　　|||



武谷君。 β-ray.

第廿三回 167號にて 9月10日 土曜日

出席者 小林氏等 8人

湯川秀樹

P. A. M. Dirac, Classical theory of radiating electrons. (Proc. Roy. Soc. 167, 148, 1938)

Appendix.

$$A_{\mu,ret} = \frac{-e\,\dot{z}_\mu}{(\dot{z},\, x-z)} \qquad ?$$

$$(x-z,\, x-z) = 0.$$

$$A_{\mu,ret} = \frac{-e\,\frac{dz_\mu}{dz_0}}{\left(\frac{dz_\mu}{dz_0},\, x^\mu - z^\mu\right)}$$

$$= \frac{-e\,\frac{dz_\mu}{dz_0}}{|\vec{x}-\vec{z}|\left(1 - \frac{(\vec{x}-\vec{z})\vec{v}(s)}{|\vec{x}-\vec{z}|}\right)}$$

$$\vec{v}(s) = \left(\frac{dz_1}{dz_0},\, -\frac{dz_2}{dz_0},\, -\frac{dz_3}{dz_0}\right) = \left(\frac{dz^1}{dz^0},\, \frac{dz^2}{dz^0},\, \frac{dz^3}{dz^0}\right)$$

$$A_{\mu,ret} = 2e\int \dot{z}_\mu\, \delta(x_\mu - z_\mu,\, x^\mu - z^\mu)\, ds.$$

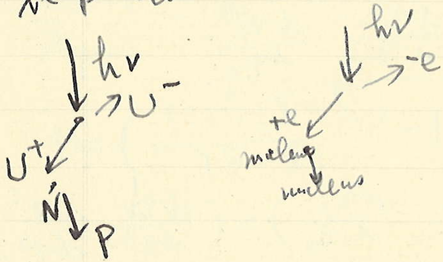
出席者6人
第廿四回 167號室にて 9月15日(木) (武谷不出席)

小林稔氏

Nordheim and Nordheim

On the Production of Heavy Electrons (Phys. Rev. <u>59</u>, 254, 1938)

1. Heavy electron
2. Heavy Quantum
3. Barytron
4. U-particle
5. Yukon
6. Dynaton
7. X-particle



8. New Particle
9. Y-particle

出席者 6人.

1時40分より.

第廿五回 167号室にて 9月22日(木)

~~開~~ Bethe, Nuclear Physics B. Nuclear Dynamics, Theoretical 輪講開始.

第一回. 岡山氏.

9月29日木曜 午後1時40分より

第廿六回 16ヶ遅れて 出席者 6人

Bethe 第二冊，

読了

10月6日 木曜 1時40分

第廿七回 16フ流れて　　出席者 6人

Bethe 第三回

岡山氏。

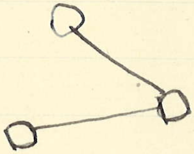
10月8日 第土、午後1時40分より

第廿八回 167號室にて 出席者 6人

小林氏、

Heisenberg, Die Grenzen der Anwendbarkeit der bisherigen Quantentheorie

(Zeits. f. Phys. 110, 251, 1938)



10月15日 土 午後~~生~~時より

出席者 6人

第廿九回 167號室にて

紹介. Bethe

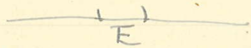
§53. Distribution of Nuclear Energy Levels.

角谷静夫氏 Topology

Friday, Dec. 23, 1938. 167號室にて

$f > c = \aleph > \aleph_0$

measure の問題.



$m(E) \geq 0$

Banach et Tarski, [illegible] Fund. Math. 4.

次元の問題.

Poincaré

Brouwer, Urysohn, Menger 1923 ~

Alexandroff, 1933 ~

Peano の曲線.

homeomorphic な変換

Umgebung

Hausdorff 1914 Urysohn

Frechet Alexandroff-Hopf

Kuratowski

Euclid 空間

距離

~~se~~separable

compact

Umgebungsraum $U(x) \ni x$

Neumann, Math. Ann.

diskretes Raum

Continuous geometry