Research Institute for Fundamental Physics
Kyoto University

Sept. 21, 1956

Morning Discussions : Serber
Field Theory, Strange Particles.
High Energy Physics

Serber: Charge scalar strong coupling (Serber - Pais)
bound ~~parti~~ states

I. $\pi^+ + p \to \pi^+ + p$ $\quad f_I(-\omega) \neq f_{II}(\omega)$ $\quad$ X if we have bound state
$\to \pi^- + p^{++}$

II $\pi^+ + n \to \pi^+ + n$ $\quad$ —— p^{+++}
$\to \pi^- + p^{++}$

$f_I(-\omega) = f_{I'}(\omega)$ $\quad$ —— p^{++}

—— p

I' $\pi^- + p^{+++} \to \pi^- + p^{+++}$
$\to \pi^0 + p$

Marshak(?): ; consistency $\quad e^2 = \frac{3\pi}{L} \to 0$

fixed: e_0 $\quad L = \ln \Lambda^2/m^2 \to \infty$: $e^2 \to 0$

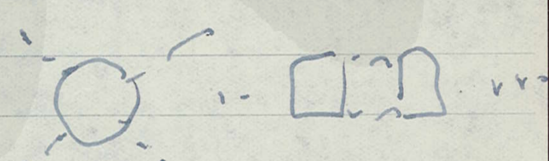
$D = d \cdot \kappa^{-2}$ $\quad L - \xi = \ln(\Lambda^2/-k^2)$

$e_0^2 d(e_0^2, L-\xi) = \Phi(\lambda_0)$ $\quad \lambda_0 = \frac{e_0^2}{1 + \frac{e_0^2}{3\pi}(L-\xi) - e_0^2 f_0(e_0)}$

$\xi = L$; $d = 1$

meson

two cut-off



$(e_0 \ll 1 \quad e_0^2 L \sim 1$
$e_0^2 f(x))$

$\lambda_0 \varphi^4 \to \lambda = \lambda_0 \varphi d^2$

$g^2 = g_0^2 d \alpha^2 \beta^2$

$\varphi' + A\varphi^2 + B\varphi = 0 \to \varphi_{\xi = L} = 0$

Yukawa:

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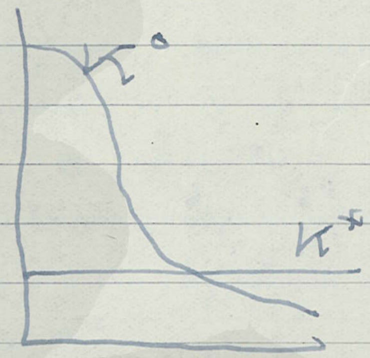
Yang:

Schwinger:

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



$\pi^- + p \; (K^+ + \Lambda^0$
$\qquad K^0 + \Sigma^+)$

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

$\phi_{K_0} \; \phi_{K_-} \; \phi_\pi$

parity symmetry $\{ \quad \phi_{K^+} + \phi_{K_-}$
$\qquad \phi_{K_0} - \phi_{K_-}$

$P_p = +1$

$|K_1 \Lambda_1\rangle \qquad |K_2 \Lambda_2\rangle$

two life-times for charged K

$|K^0\rangle = |K^s\rangle + |K^a\rangle$

$|\bar{K}^0\rangle = |K^s\rangle - |K^a\rangle$

$|K_1^0\rangle = \frac{1}{\cdot\cdot} [|K_+^s\rangle + |K_-'\rangle + |K_+^a\rangle + |K_-^a\rangle]$

4 life-times for neutral K^s μ

$K_\pm \to \mu + \nu$
$\pi \to \mu + \nu$

$K \to e + \nu + \pi$
$K \not\to e + \nu$
$\mu \quad \pi \not\to e + \nu$
$\pi \not\to e + \nu + \gamma$
$\qquad \gamma + \gamma$

$K \to 2\pi$
$\quad \to 3\pi$

β-decay $\quad S + T$

$K_T^s \to 0$

$K^0 \to \mu^+ + \mu^-$?

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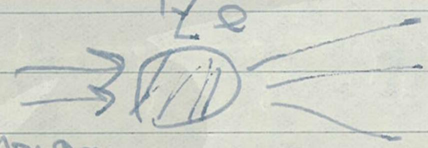
$\phi_{2\pi} = 23\%$

$\phi_{3\pi} = 8\%$ $\phi_e = 6\%$

$$\frac{\tau_-}{\tau_+} = \frac{1-2\phi_{2\pi}}{1-2\phi_{3\pi+\theta}} = 4/3$$

Balashenkov (Volkov); Polarization of Nucleon
non-local meson theory
electric polarization of neutron

$$\bar{P} \sim \alpha \bar{E}$$

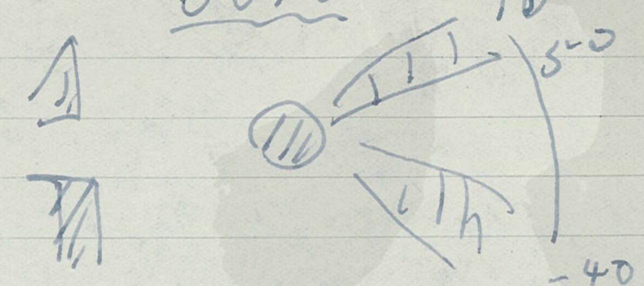


$\alpha \sim 2 \cdot 10^{-41}$ $\times (q^2/\hbar c)$

$R \lesssim d \lesssim a$

$6 \sim 7\%$ (3°)

60% (5°~10°)



$\alpha < 5 \cdot 10^{-40}$

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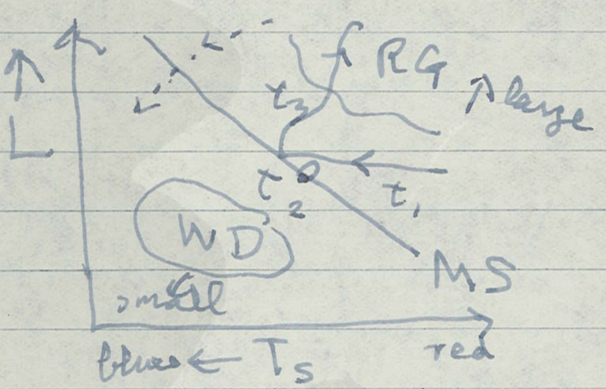
Sept. 21. Afternoon, Vallarta presiding

Salpeter: Stellar Energy Sources

H
He 10%
C, Ne 1/2 %
Fe group 1/2 %
} percentage mass



$T_c \to L$, $T(r)$ $\rho(r) \to R$

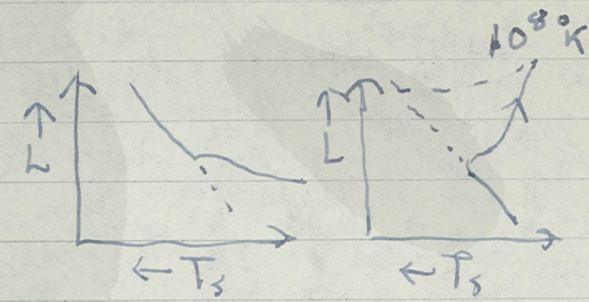
$E_{gr} \sim -\frac{GM^2}{R}$ $E_{th} = NkT$

$-E_{gr} = \alpha E_{th}$ $\alpha > 1$ (except for small stars)

1. stay on the main sequence for a very long time

M	L	t_1	t_2	t_3	
$M_\odot$	$L_\odot$	2×10^7	15×10^7	?	years
$1.3M_\odot$	$10L_\odot$	3×10^6	2×10^7	$\sim10^7$	

2. Pop. II. age ≈ 5×10^9 years
Pop. I. younger



$T_\odot = 12\times10^6$ °K

Cycles:
C^{12}
Ne^{20}
Mg^{24} → Mg^{24}, Si^{32}
He-Li } → He^4
Be-B

10^8 °K: $3\alpha \to C^{12} + \gamma$ (+7 MeV) | (α, n): C^{13}, O^{17}, Ne^{21} ...

$C^{12}(\alpha,\gamma)O^{16} \to Ne^{20} \to Mg^{24}$

10^9 °K: $C^{12} + C^{12} \to \dots$ → Fe-group

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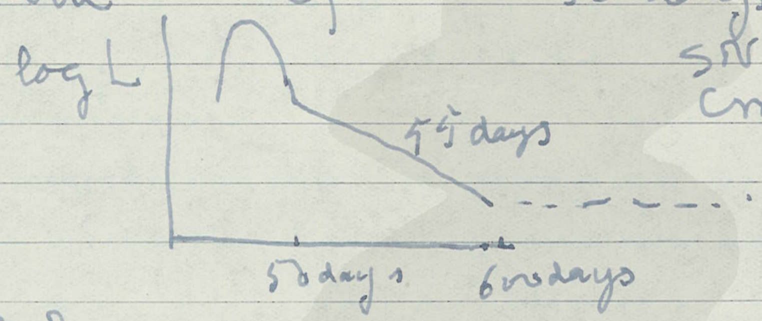
explosion: (i) Expansion:
(ii) supernova　Cf^{254}　55-days



SN I
Crab

Cal. Tech.
H, He, C~Ne
$Ne^{21}(\alpha, n)$ → → Cf

Hayashi: Comment : Abundance of Elements
1, $3\alpha \to C^{12}$ ...... $O^{16} + \alpha \to Ne^{20}$
$\varepsilon \sim \rho^2 T^{20\sim26}$ $(T \gtrsim 1.5 \times 10^{8}\,°K)$

$O/Ne < 10^{-3}$　$C/Ne < 10^{-1}$

($O/Ne \sim 1$　$T_c > 2\times10^{9}\,°K$
$L > 10^6 L_\odot$)

2. α-β-γ
n-p mixture　$n : p = 1:3 \sim 1:6$
Ne

1st stage: $9\times10^9 \geq T \geq 4\times10^9$ K　p+n, d+d, d+t, $d+He^3$
$\rho \doteq 10^6 \sim 10^7$ g/cm³
at $T = 10^{10}$ K
$H : He^4 = 3:1 \sim 6:1$
$D, T, He^3 < 10^{-7}$

2nd stage: $4\times10^9 \geq T \geq 10^9$ K
C, O, N, ~~Ne~~ Ne^{20}
$Ne^{20} + p \to Na^{21} \to Ne^{21}(\alpha, n) Mg^{24}$
Supernova

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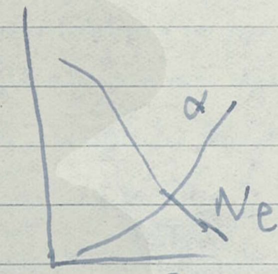
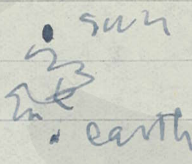
Nakamura:
1. $Ne^{20} \to$ Fe, Ni
2. supply of neutron
$Ne^{20} \to Mg^{24} \to \dots Ca^{40}$
Fe Ni



3. Proton-mixing $< 10^{7}$ years
$Ne^{20} + p \to Ne^{21} + \dots$
n-capture

Gamow: urca process
$Fe^{56} + e^{-} \to Mn^{56} + \nu$
$Mn^{56} \to Fe^{56} + \bar{e} + \nu$ }
10^{17} erg / gm·sec
implosion!!!

Morrison: Origin of Cosmic Rays
Magnetohydrodynamics
Alfven
Galactic Scale



energy density eV/cc

CR	light	turb	rot.
1	1	1~10	1000

nuclear energy source
1) stirring
2) storage and loss ; radio star
3) acc'l'n ± ; Fermi theory versus synchrotron field
4) injection Schwalsky
5) cut-off ? 10^{16} eV Crab nebula 10^{-3} gauss
Baade
Jet of M87 Anti-world → neg Si

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Hayakawa: supernova origin
< 10 BeV
→ Nova
Injection: ripple, solar flare
conversion efficiency 10%

Dinner Party: President's Invitation
after dinner speech on behalf of foreign physicists

Sept. 25, 1956
University of British Columbia
Vancouver, Canada
Unified Theory of Elementary Particles