Research Institute for Fundamental Physics
Kyoto University

Introductory Remarks ~~to~~ by H. Yukawa to Prof. C. F. Powell's lecture "On New Elementary Particles" (1)
at Research Institute for Fundamental Physics
on March 17, 1956

No. 5. 1955. 6. 10.000

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Prof.
C. F. Powell : (New Elementary Particles)
(March 17. 1956)

His great achievements in the investigation of cosmic rays is so well known to all of you, that

It is a great pleasure and privilege for us to have Professor C. F. Powell here today. ~~We owe~~ Hardly any words of introduction is necessary. We theoretical physicists of Japan owe very much to Prof. Powell. His discovery of π and μ mesons ~~in~~ in cosmic rays 1947 was a great stimulus and encouragement to us who had been working meson theory. ~~For~~

Moreover, the subsequent discoveries by Prof. Powell and his group in Bristol of other unexpected new particles ~~in cosmic rays.~~ gave a new challenge to us ~~opened a new before us.~~ theoretical physicists ~~a new world or~~ view ~~forms of possibilities.~~ Nature again shows itself to be much richer than man can imagine. We are very fortunate to ~~have at this time~~ be able to hear from Prof. Powell ~~here to~~ ~~his~~ on ~~New~~ these new elementary particles. I hope that his talk will give rise to vigorous discussions on this most important ~~topic~~ subject today and tomorrow.

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March 17, 1956 (2)

Informal Meeting on International Intercourse of Science and Organization of Research Works

1. Research Organization in Japan (Hayakawa)
2. International Collaboration (Marumori)
3. Atomic Energy Research and Other Branches (Otsuki)
4. Hydrogen Bomb Test in Pacific Ocean (Tamagaki)

Free discussions

March 18, 1956

~~We are goin~~ ~~arranged~~ Today we are going have an informal meeting dealing with the subjects which may be of some interest to Prof. Powell, ~~so that we can~~ may expect good advices from Prof. Powell. We are particularly grateful to Prof. Powell for his attendance despite it is Sunday today.

In the morning, ~~there will be two~~ two topics will be discussed:

1. Koba, Summary report of theory of High Energy Nuclear Phenomena.

2. Nishimura and Oda, ~~Experi~~ Project of the Cosmic Ray Experiments in Japan.

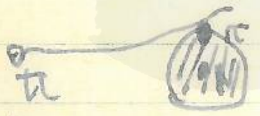
In the afternoon, we are going to discuss ~~the~~ various problems related to new particles. ~~Sakata~~ In particular, Pr. Sakata will talk on his model of el. part.

Koba:
Bristol $N_Y/N_{\pi^0} = 0.65 \pm 0.25$ $10^3 \sim 10^4$ GeV
Y: n, $\tilde{n}$, θ_0
π^0:

Nishijima-Gelman-Markow
θ_0: $S=0$, $I=1/2$
Fermi theory
$N_Y/N_{\pi^0} \gtrsim 3.5$

Landau:
$T_c = (1.2 \pm 0.3)\mu$
ε
ρ } $\bar{E} \sim (4.0 \pm 1.0)\mu$
$l \sim 1/\mu$
$\sigma_{\pi,\pi} \sim (1/\mu)^2$

Cosmotron π-N ~~inter~~ scattering
800 MeV ~ 1.5 GeV



(transverse momenta
200 ~ 500 MeV Bristol)
Fukuda: 10^4 GeV
Heisenberg
50 mesons / for $10^3 \sim 10^4$ GeV jet
too many (~10%)
Takagi

M. Oda: Air Shower Project

energy $\gtrsim 10^{14}$ eV

1) origin
2) ~~air shower~~ elementary processes

1) $^{30\%}N$, $^{5\%}r$, $\varphi \to 5^{\circ}$
2) Accurate r, structure of the core

energy flux → Cerenkov radiation

J. Nishimura: Photographic Emulsion Project

p_T 65 MeV

Schein

$\sim 10^{13}$ eV

$\sim$ several BeV

240

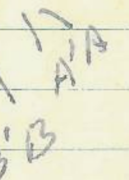
average $\sim$ 100 MeV

$\sim$ several BeV on C. M. S.

Rochester: emulsion Cloud chamber

	primary energy	2ry energy	p_T
1. Schein	$\sim 10^{13}$ eV	several GeV $\sim 10^{3}$ BeV	~ 100 MeV/c
2. Rochester	$\sim 10^{13}$ eV	$\sim 10^{12}$ eV	several hundred
3. Bristol	$\sim 10^{12} \sim 10^{13}$ eV	?	"
4. Kobe	$\sim 10^{12} \sim 10^{13}$ eV		"
5. Cornell	$10^{13} \sim 10^{14}$	$\sim 10^{12}$ eV	"
6. George et al	$10^{12} \sim 10^{13}$	$10^{10} \sim 10^{11}$	a few hundred
7. Sohet	$10^{14} \sim 10^{15}$	$10^{12} \sim 10^{13}$	a few hundred $\sim$ a few BeV/c

$\pi^0 \to 2\gamma$



$E_{\gamma\gamma}$ AA′, BB′ $\sim 10^{12}$ eV

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March 18, 1956 afternoon session (5)

Powell

~~Yukawa~~ Sakata, On the Model of Elementary Particles

	Model		I_3	S	n
n			½	0	1
$\bar{n}$			½	0	−1
Λ			0	−1	1
$\bar{\Lambda}$		↗ 2273	0	1	−1
π	$n+\bar{n}$	↗ 966	1	0	0
K	$n+\bar{\Lambda}$		½	1	0
Σ	$n+\bar{n}+\Lambda$	(2460)	1	−1	1
Ξ	$\bar{n}+\Lambda+\Lambda$	→ 2580	½	−2	1

→ 2340

$$Q = I_3 + \frac{n}{2} + \frac{S}{2}$$

n : baryon charge

(1) baryon n, Λ^0
lepton $e^{\pm}$, $\mu^{\pm}$, ν^0

(2) $N_p = n_p - n_{\bar{p}}$, $N_N = n_N - n_{\bar{N}}$
$N_\Lambda = n_\Lambda - n_{\bar{\Lambda}}$ $N_B = N_N + N_p + N_\Lambda$

(i) the family of π on
$N_B = 0$ { $N_\Lambda = 0$ π
$N_\Lambda \neq 0$ ~~K-m~~ heavy mesons

(ii) 〃 of hyperon
$N_B = 1$ { $N_\Lambda = 0$ nucleon
$N_\Lambda \neq 0$ hyperon

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(iii) The family of atomic nuclei
$N_B > 1$ $\begin{cases} N_\Lambda = 0 & \text{nuclei} \\ N_\Lambda \neq 0 & \text{hyperfragments} \end{cases}$

$N_B = -1$ anti-hyperon
$N_B \leq -1$ anti-nuclei

(3) $S = -N_\Lambda$

(4) (α) Conservation of charge
$\Delta N_p = 0$
(β) Conservation of baryon charge
$\Delta N_B = 0$
Strong interaction:
$\Delta I = 0$, $\Delta I_3 = 0$ $(\Delta S = 0)$
(γ) Conservation of N_Λ: $\Delta N_\Lambda = 0$

(5) Weak interaction
$\Delta N_\Lambda = \pm 1$ $(\Delta S = \pm 1)$

$\pi^- + p \to \Sigma^- + K^+$
$(N\bar{p}) + p \to (\bar{p}\Lambda N) + (p\bar{\Lambda})$
$N_\Lambda = 0$

Stability and mass defect

Matsumoto
$$\Delta M = A\left\{n_\pi n_{\bar{\pi}} - \frac{n_\pi(n_\pi - 1)}{2} - \frac{n_{\bar{\pi}}(n_{\bar{\pi}} - 1)}{2}\right\}$$
$$+ B\left\{n_\pi n_{\bar{\Lambda}} + n_\Lambda n_{\bar{\pi}} - n_\pi n_\Lambda - n_{\bar{N}} n_{\bar{\Lambda}}\right\}$$
$$- C\left\{\frac{n_\Lambda(n_\Lambda - 1)}{2} + \frac{n_{\bar{\Lambda}}(n_{\bar{\Lambda}} - 1)}{2}\right\}$$
$n_\pi = n_N + n_p$, $n_{\bar{\pi}} = n_{\bar{N}} + n_{\bar{p}}$

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A = 3400 m_e
B = 3050
C = 2500

$4\pi, K,$

$N + N + \bar{N}$ 2120 (2380)
very unstable (3/2 3/2) resonance

$(N, N, \bar{\Lambda}, \bar{\Lambda})$ 1730 S = +2
$(\bar{N}, N, \Lambda, \Lambda, \Lambda)$ 2800 S = 3

~~Λ^0 +~~ K + π

Λ + K
Σ + K } energetically impossible
Ξ + π

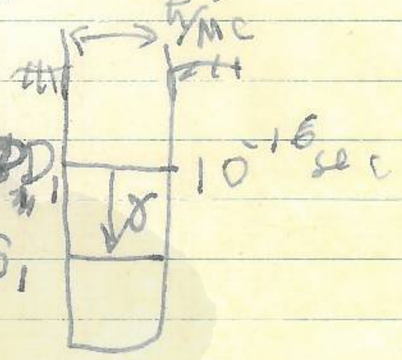
Swami
Eisenberg

Tanaka → Yang-Fermi (vector interaction)
Maki → New Tamm-Dancoff

$$g \sum_i \sum_k (\tilde{\psi} \Omega_i \tau^k \psi)(\psi \Omega_i \tau^k \psi)$$

$N \bar{N}$
$N \bar{\Lambda}$

(740) P_1
(450) $^3S_1 + {}^3D_1$
(273) π(ps) $^1S_1$



charge conserv. and space reflection
○ anti-protonium:
^3S ⇏ any number of π^0 (charge parity)
^1S ⇏ $\pi^0 + \pi^0$, (space reflection)
$\pi^0 + \pi^{0\prime}$
$\pi^0 + \pi^{0\prime}$

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K-meson: scalar
pseudoscalar of same mass