Space-Time description of
Elementary Particles
Sept. 24, 1965

1. Comparison of various approaches to a unified theory

a) Composite model
extension of successful efforts in the past to the future
of dividing matter into more and more fundamental constituents
atoms → electron, nucleus
→ elementary particles
→ antibaryons, quarks, ace
etc.

b) group theoretical approach
higher symmetry in order to
introduction of
cover more particle in the scheme
of classification
What is lacking or what is not explicitly
considered in the relation of matter
in a), b) to space-time. What is discovered of
Fractioning in contrast to dichotomy

c) field theoretical approach
Heisenberg: one spinor field
(Ur-materie) → indefinite metric
Three field theory (Marshak)
(chirality)

d) abandonment of field concept
S-matrix approach (Chew)
bootstrap
self-consistency

e) generalization of field concept
nonlocal field
particles with space-time extension

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(e) is the most primitive approach
It was originated by Greek natural philosophers
like ~~Democritus~~ Leucippus and Democritus and
followed by Newton, Dalton, Boltzmann
In classical mechanics, it was not difficult
To give ~~the~~ size and shape to a body.
We may imagine elastic sphere as dealt
with in detail Boltzmann
That such a naive approach could not
account for ~~matter~~ in everything was
clear even in early days
Light was something different from
the things consisting of atoms in
the above sense
electromagnetism
electrodynamics
ether aether pervading in space
should have been introduced.
Or ~~so~~ the present stage
i) size and shape must be understood
in ~~ter~~ terms of internal wave function
ii) special relativistic invariance is
to be taken into account
Since wave function is probability amplitude,
the distinction between an extended
~~by~~ body in q.m sense and the
quantized field is not ~~the~~ clear cut
but rather controversial
~~In~~ A ~~theory~~ nonlinear field theory
(Heisenberg) can be interpret as a
new kind ether theory
This is a rather controversial point.
But, they are very much different
from each other ~~at~~ in start points

This situation may be compared with (one in some respect) shell model versus collective model for the nucleus. If we go further and further, they may come closer and closer to each other. well

Also the distinction between a) composite model and, b) with our approach is not so clear cut as it appears, because as a result of abstraction the difference between many particle system and a rigid body, say, becomes of subtle matter.

Having all such things in mind, let us start talking about my own approach which have been only very slowly and I know I am still very far from the goal, perhaps far behind other approaches

2. Brief Summary of our works until about 1956.

3. Interpretation of Isospin

4. Tetrahedron model

5. ~~Remarks on~~ Problem of Interaction
   Interactive forces
   Constructive forces

6. ~~Remarks on various points not covered in my talk~~

$\sigma_1' = \sigma_3\sigma_1 = i\sigma_2$

$\sigma_2' = \sigma_3\sigma_2 = -i\sigma_1$

$\boxed{\sigma_3' = \sigma_3}$

$[\sigma_1', \sigma_2'] = [\sigma_3, \sigma_1]$

$= -i\sigma_3'$

$[\sigma_3', \sigma_1'] = i[\sigma_3, \sigma_2]$

$= \sigma_1 = i\sigma_2'$

$[\sigma_2', \sigma_3'] = -i[\sigma_1, \sigma_3]$

$= -\sigma_2 = i\sigma_1'$

$\psi^* U^* \sigma_3 \cdot \sigma_3 U \psi$

$=$

$$U^* U = (\cosh\tfrac{\theta}{2} - \sigma_2 \sinh\tfrac{\theta}{2}) \times (\quad - \sigma_2)$$

$$= (\cosh^2\tfrac{\theta}{2} + \sinh^2\tfrac{\theta}{2}) - 2\sigma_2 \cosh\tfrac{\theta}{2}\sinh\tfrac{\theta}{2})$$

$$= \cosh\theta - \sigma_2 \sinh\theta$$

$U = \exp[i\sigma_1\theta/2]$

$= \exp[-\sigma_2\theta]$

$= \cosh\theta/2$

$-\sigma_2 \sinh\theta/2$

$U^* = \cosh\theta/2$

$-\sigma_2\sinh\theta/2$

$U^*\sigma_3 U = \sigma_3(\cosh\frac{\theta}{2} + \sigma_2\sinh\frac{\theta}{2})$

$\times(\cosh\frac{\theta}{2} - \sigma_2\sinh\frac{\theta}{2})$

$= \sigma_3$

$\psi^* U^*\sigma_3 U\psi = \boxed{\psi^*\sigma_3\psi}$