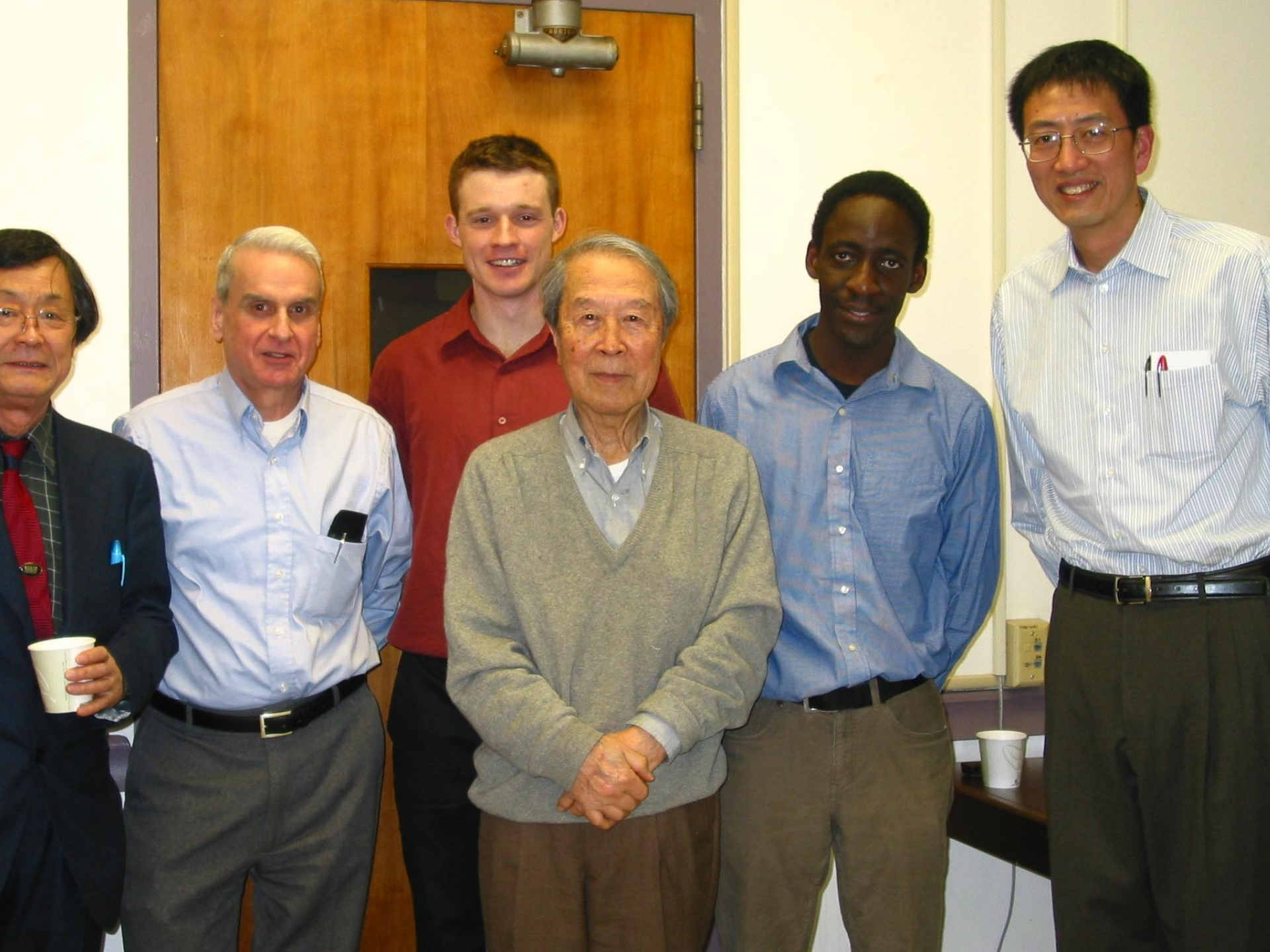


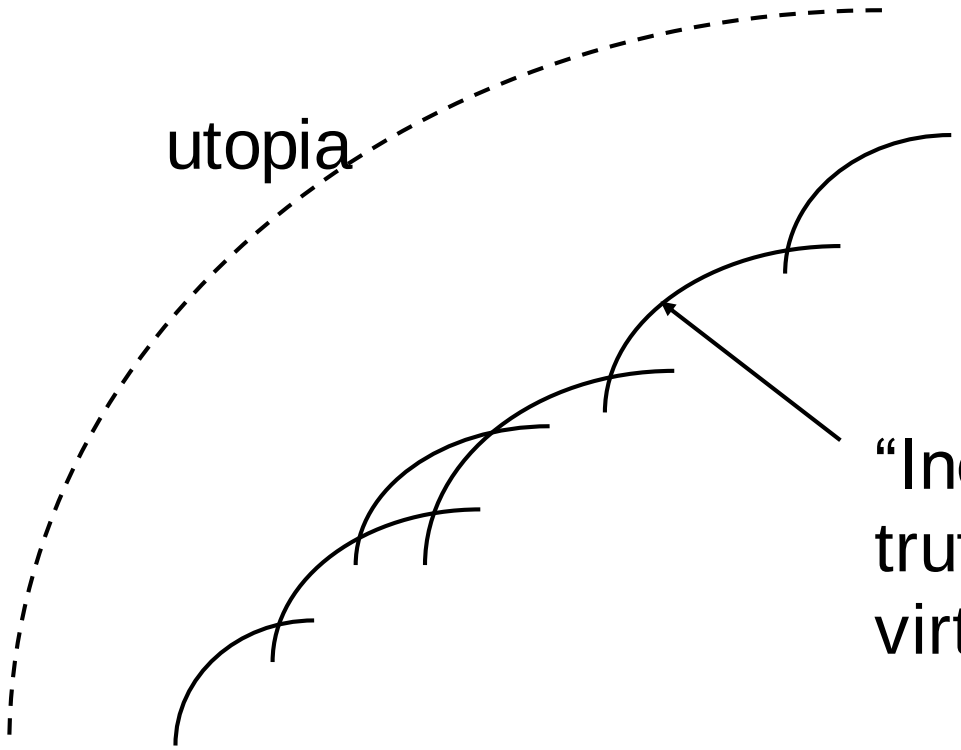
Yoichiro Nambu's Contribution to 20th Century Physics

From the stand point of Unification of all interaction

- Existence of Electromagnetic and Gravity Interactions were known in the early 20^{th} Century

- Einstein tried to unify these two interactions

- Discovery of Strong and Weak interactions came much later time



Individual truth is always an approxi mation———A. Einstein

There is no such thing as abstract beauty,

but individual beauty.—Hideo Kobayashi

From modern view point there are two ways to unify gravity and Abelian guage theory

1. Use Kaluza-Klein mechanism
2. Use supersymmetry or rather supergravity

The first case may give a non-Abelian unfication when the compactified space has some singularity

The second case need more than N=2 (supergravity multiplet can have vector)

1. Weak and strong interactions were found to be described by the non-Abelian gauge theories

- chromodynamics--Nambu

2. Nambu's work on the spontaneous symmetry breaking can be interpreted as the way the unified theory of weak, electromag netic and strong interactions can be reduced to the each individual interaction

3. Nambu's work on the string theory leads a way to unify the gravity and the non-Abelian guage theories

i.e. the anomaly cancelation of non-Abelian gauge theories can occur only when we consider string theory with no dimensional constant
(algebraically, there is a relation between Kac-Moody and Poincare algebra only in superstring theory, not in supergravity theory)

How could he reach such important discoveries?

- Post war atmosphere of Japanese elementary particle physics community may have something to do with it.

Sakata
Taketani } Marxist's view point

Kei Watanabe non-Marxist

They were both friends and rivals to each other

Sakata---some real object behind mathematical equations
Taketani—three stages of physical theory development

Nambu says he explained the hard core of nuclear forces using singlet vector meson thus predicting the omega meson.
<-----direct influence of Sakata

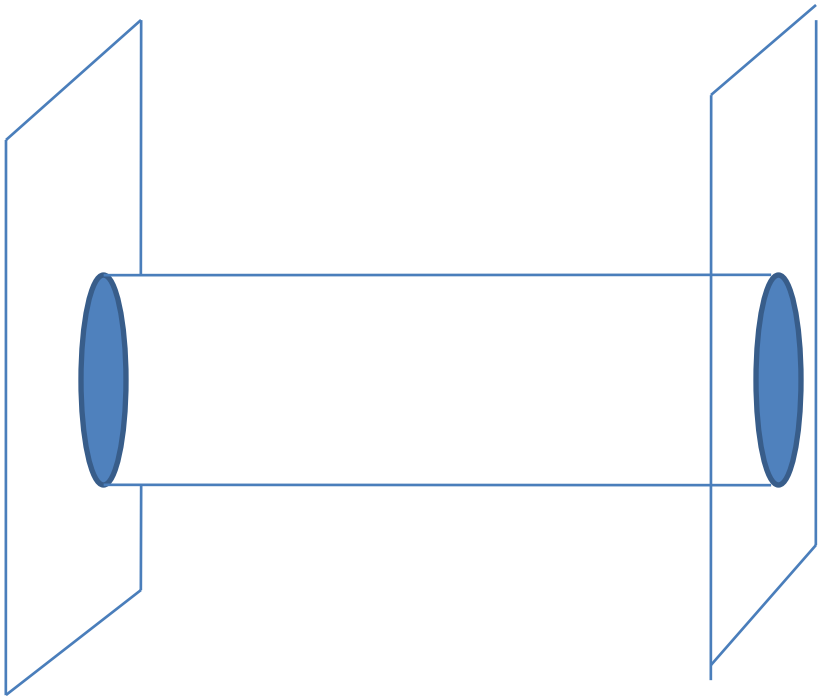
Nambu admits the influence of Sakata and of Taketani at an early stage of his career but does not admit their influence on his much later works on spontaneous symmetry breaking or the string theory.

Most of his works were done in US where he spent most of his research career and so it will be fair to say that his talent ,his insight and his effort in the stimulating American atmosphere made him such important discoveries.

A little bit about future-----

A little bit about superstring model

Most important difference from field theoy



Dual interpretation of Fynman diagram

What do we learn from this?

1. Duality
2. Existence of branes

AdS/CFT duality is a special demonstration in the low energy domain

$e^{-ay}dx^2 + dy^2$ is a metric form of AdS,

This is invariant under

$y \to y + b, x \to e^{ab}x$

Kawai etal.

Regular string must end on something →D-brane

Two ways of describing D-brane

1. As Dirichlet-brane a la Polchinski
2. As brackbrane in a low energy theory

Are these descriptions good enough?
Or considering the importance of Branes in general, is superstring theory good enough?

Beyond the superstring model

Start from IKKT or more or less equivalently from M-theory of Susskind etal. without quenched momentum

$$L = \int \left(\left[A_\mu, A_\nu \right]^2 + \overline{\Psi} \Gamma_\mu [A_\mu, \Psi] \right)$$

This is a reduced model of Eguchi-Kawai and, without the quenched momentum it will describe the vacuum of gauge theory

This will be a suitable starting point to go beyond the superstring model.
Why?

1. It will describe the branes suitably
2. Vacuum is unique by definition
   no space-time ,no matter
   like in string field theory

3. Particle or string excitation will be described as a topological (world sheet) excitation on the brane
4. All possible symmetries could be incorporated
5. Superstring interpretation is just one limit

Conclusion

1.Nambu's contribution to 20th Century physics opened a new perspective towards the unfication of all interactions

2.It will lead a way to 21st century physics providing a clue to the understanding of particles and universe(es)