

Nambu's Career in US

H.Sugawara, Sendai, October 28,2019

Nambu' career in US

1952-----moved from **Osaka City University** to
Institute of Advanced Study, Princeton

1954----- moved to **University of Chicago**

1958-----promoted to Professor of UC

1970-----became a US citizen

Most famous works:

1. Y. Nambu and Jona-Lasinio, Phys. Rev. 122 (1961)345
2. Y. Nambu and M.Y. Han, Phys. RevB. 139(1965)1006
3. Y. Nambu, Talk given at International Conference on Symmetries and Quark Models, Wayne University, 1970
This is on the string idea.

Most of Nambu's works are collected in the book,
“Broken Symmetry” edited by T. Eguchi and K. Nishijima
published by World Scientific, 1995

Late 1950's to early 1960's it was fashionable for elementary particle theorists to work in the field of **condensed matter physics**.

As a student, I read papers by **Feynman, T.D.Lee, Tomonaga** who applied particle physics ideas to condensed matter physics.

Nambu-Jona-Lasinio paper was unique in the sense that it applied the idea in condensed matter physics to particle physics with new ingredient —**spontaneous symmetry breaking**—(more on this later).

My personal encounter with Nambu

In summer of 1965, on my way to Ithaca for my first job as a postdoc in Cornell, I attended summer school at Madison, Wisconsin. Yasuo Hara, Nambu's postdoc at that time took us to see Nambu at his home in Chicago.

Most of the conversations took place between his wife (Chieko-san) and my wife. Yo-chan (so Chieko-san called him) was very quiet and always smiling. I have not seen such reserved person even in Japan. I understood he was very very Japanese.

I moved from **Cornell to UC Berkley** in 1966.

One day, I got a call from Nambu to come to Chicago. He offered a better salary than normal Postdoc.

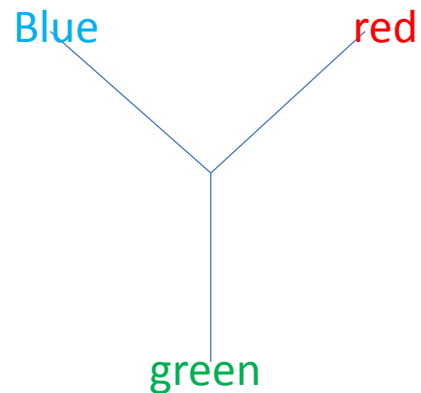
I went there (not for money) and spent a year with Nambu from 1997~1998

One day, when I was in his office for some other business, he started talking about the **color of quarks** (I was not aware of his paper written together with Han).

He said,

“ I think there are three kinds of quarks; **green**, **red** and **blue**”.

When he saw me being puzzled, he drew the following pictures on the blackboard:



He was not sure how the line of force can be bundled up in the **SU(3) gauge model** (now called QCD) to bind the quarks never to get out.

Later he invited one of **Dolen, Horn and Schmidt** (I do not remember who) to give a talk on what they called S-channel –t-channel duality. It's basically a phenomenological analysis and a precursor to **Veneziano model**.

Nambu got very much interested in this observation especially **the linearly rising Regge trajectory** possibility which lead him to the string theory.

All what he was doing around this time was very interesting to me but I was working on my own project of current-current theory and could not work with him seriously.

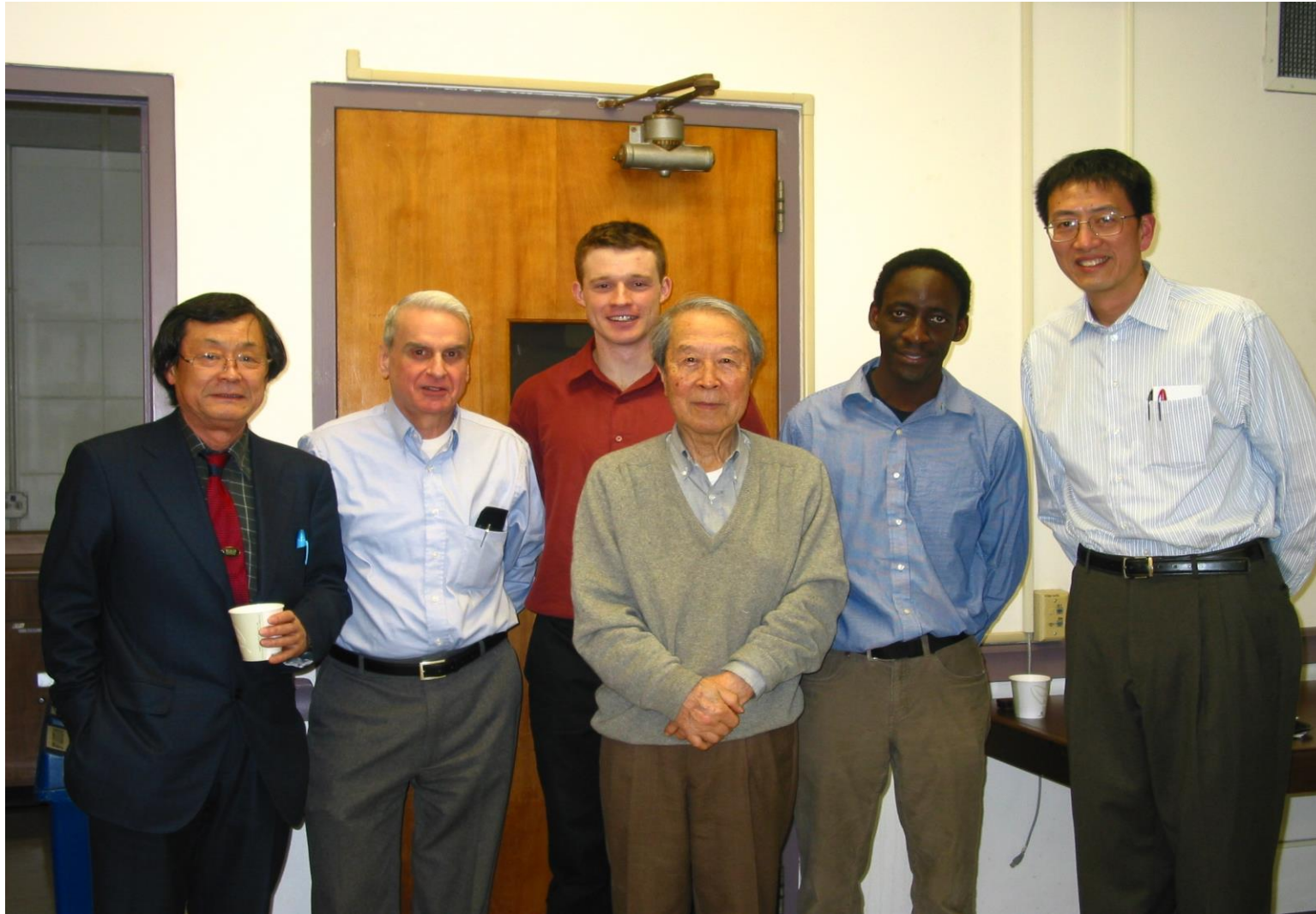
One day, he came back from some prestigious physics symposium and told me, “Your **current-current model** was one of the hot topics in the symposium. I felt very proud”.

I felt so relieved for I was not able to devote much of my time on his color dynamics .

I was invited by Nambu again in 1973 as a visiting professor and visited him numerous times afterwards. My last visit to him in Chicago was in 2009, one year after he got **Nobel prize**.

(My last meeting with him was in a hospital in Osaka a few months before he passed away.)

2009 picture when I visited Nambu in Chicago



His work on broken symmetry is deeply rooted in the concept of beauty in **Japanese culture** as compared to the **Western culture**.



Broken symmetry is caused by,

$$\Delta = \langle \psi \psi \rangle \quad = \quad \lambda \langle H \rangle$$

Superconductor Elementary particle

Higgs couplings λ give the spectrum of particle masses.

It is most important to study them in ILC.

In my opinion, λ may be deeply connected to string theory and to number theory.

ILC should be called “Nambu-Higgs Factory”.