

## Main research achievement

Masao Ninomiya

1) No-go Theorem of Chiral Fermion on Lattice Gauge Theory

(number of citations 1392)

In Quantum Field Theory, quarks and leptons (electron, neutrino, ...) are massless because the Standard Model of particle physics has chiral symmetry, thus the symmetry is exceedingly important.

Ninomiya and Nielsen proved that in lattice theory (discrete space) chiral particles appear necessarily as pair, right-handed and left-handed particles. Thus it is impossible to realize chiral symmetry on lattice. This is shown as a theorem by applying homotopy theory. (Nucl. Phys. B185(1) 20-40, and 193(1) 173-194 and physics. Letters B 105(2) 219-223)

2) In a finite lattice spacing such as condensed matter materials, we predicted in energy-momentum dispersion relation under some materials positive and negative energy region has no gap. That is to say despite of usual semiconductor which has a gap between plus and minus energy region there is no gap, i.e. gapless semiconductor.

Our prediction is as a specific materials plus and minus energy region contact at a point. In this region dispersion relation has a light-cone approximately.

In these materials we can make “gapless semiconductor” or chiral semiconductor or Weyl semiconductor (because of Weyl fermion we used such naming)

This subject has been widely accepted in USA and Europe as “Topological insulator”.

[参考までに Google Scholar において “Masao Ninomiya” で検索していただきますと、私の citation list と共に以下の記事が出ます。

記事： Institute of Advanced study, Princeton のグループが実験的に 50 年かけてとうとう我々が予言した Chiral anomaly の特異な性質を普通の実験室で見出した。]

3) In recent years we, Prof. Hikaru Kawai of Kyoto University and Associate Prof. Yasuhiro Sekino of Takushoku University have been working on very early universe theory. Indeed we obtain very detailed, new data of universe from the Planck Satellite, particularly Cosmic Microwave Background(CMP).

- 4) This observation well supports “The Standard Model of Cosmology”.

In particular, it is clearly supported that there was inflation period in the past.

In our view, that the so called inflation (particle causing inflation still unknown ) is mysterious in the sense that there exist more than 120 models depending the choice of inflation.

We consider big gravity and matter quantum effects causes inflation so that we assert.

We do not need to introduce “inflaton”.

- 5) In the past 10 years, I have been working with Holger Bech Nielsen on a novel string field theory.

The very reason of the difficulty of the string field theory stated above is the lack of full understanding of “non-perturbative effects.”

We believe that field theory of string may make a new development.