

Discovery of neutrino oscillations: The legacy of Bruno Pontecorvo

Y. SUZUKI

*Kamioka Observatory, Institute for Cosmic Ray Research University of Tokyo - Tokyo, Japan
Kavli Institute for the Physics and Mathematics of the Universe University of Tokyo
Tokyo, Japan*

Summary

The Bruno's legacy of "neutrino oscillations" has been proved to exist.

If we look back, early indications from experiments of the neutrino oscillations hypothesis, had arisen from two mysteries:

- i) solar neutrino problem in late 1960's (Homestake)
- ii) atmospheric neutrino anomaly in 1988 (Kamiokande)

There is an interesting early discussion by B. Pontecorvo and S. M. Bilenky, "Lepton mixing and neutrino oscillations" [*Physics Report*, **41** (1978) 225-261] that shed light on cosmic ray neutrino experiments. In there the sensitivity for testing neutrino mixing has been shown to be intermediate between that of the experiments wherein artificial (reactor, accelerator) neutrinos are used, and that of the investigations wherein solar neutrino are used.

We now know oscillations through atmospheric and solar are almost decoupled since

$$- \theta_{13} \text{ is small } (\sin^2 2\theta_{13} \sim 0.1)$$

and

$$- \Delta m_{23}^2 (\sim 2.4 \times 10^{-3} eV^2) \gg \Delta m_{12}^2 (\sim 7.6 \times 10^{-5} eV^2)$$

Therefore, in 2013, 100 years after the birth of B. Pontecorvo and 15 years after the discovery of the neutrino oscillation, we now know all the mixing angles and mass differences precisely.

In conclusion:

- Bruno's Legacy has been proved to be true and now new horizon of neutrino oscillation has opened up.
- We will determine mass hierarchy, octant of θ_{23} and CP phase in near future.
- In conjunction with the determination of Majorana nature of neutrinos, the future study of neutrino oscillation (especially CP phase) may be able to explain the origin of the matter of the Universe.