



THE CHINESE UNIVERSITY OF HONG KONG

Department of Physics

COLLOQUIUM

Why Do We Exist?

The Story of Three Mixed-up Generations & Half a Nobel Prize

by

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Date: November 21, 2008 (Friday)

Time: 4:30 - 5:45 p.m.

Place: TYW LT, Ho Sin-Hang Engineering Building, CUHK

Suitable for Both Undergraduate and Postgraduate Students

(Light refreshments will be served 20 minutes prior to the colloquium.)

ALL INTERESTED ARE WELCOME

Abstract

We exist because of a preponderance of matter over anti-matter in the universe. This arises from a tiny (\sim ppb) asymmetry soon after the big bang, because matter and anti-matter behave slightly differently (violation of CP invariance) in the weak interactions, through a nontrivial complex phase in the amplitudes. In the standard model based on $SU(3) \times SU(2) \times U(1)$ Yang-Mills gauge theory, this phase enters through the mixing of N generations of quarks and leptons. Kobayashi and Maskawa (KM) pointed out in 1972 that a nontrivial phase requires $N \geq 3$. Quarks of the third generation (b , t) were discovered in 1977 and 1994. KM won half the 2008 Nobel Prize in physics “for the discovery of the origin of the broken symmetry which predicts the existence of at least three families of quarks in nature”.

Of the four KM mixing parameters, the complex phase is associated with a very small amplitude ($s_{13} \sim 0.006$) – if $s_{13} = 0$, there would be no CP violation in the standard model. Without CP violation, we would not exist.

The three generations of neutrinos are similarly mixed. The 1-2 mixing suppresses solar neutrinos; the 2-3 mixing suppresses atmospheric muon neutrinos. The 1-3 mixing (s_{13}), small and elusive, relates to the CP phase. CUHK is part of an international consortium that will soon measure s_{13} at Daya Bay.