SOKENDAI KEK Tsukuba/J-PARC
Summer Student Program

Supported by

The Graduate University for Advanced Studies, SOKENDAI

International and Inter-institution Network for Accelerator Science to Next Generation, IINAS-NX

JENNIFER2 a HORIZON2020 MSCA-RISE project, g.a. 822070

Summer Student Program Joint Event

About Me

Name: Sibtain Ali

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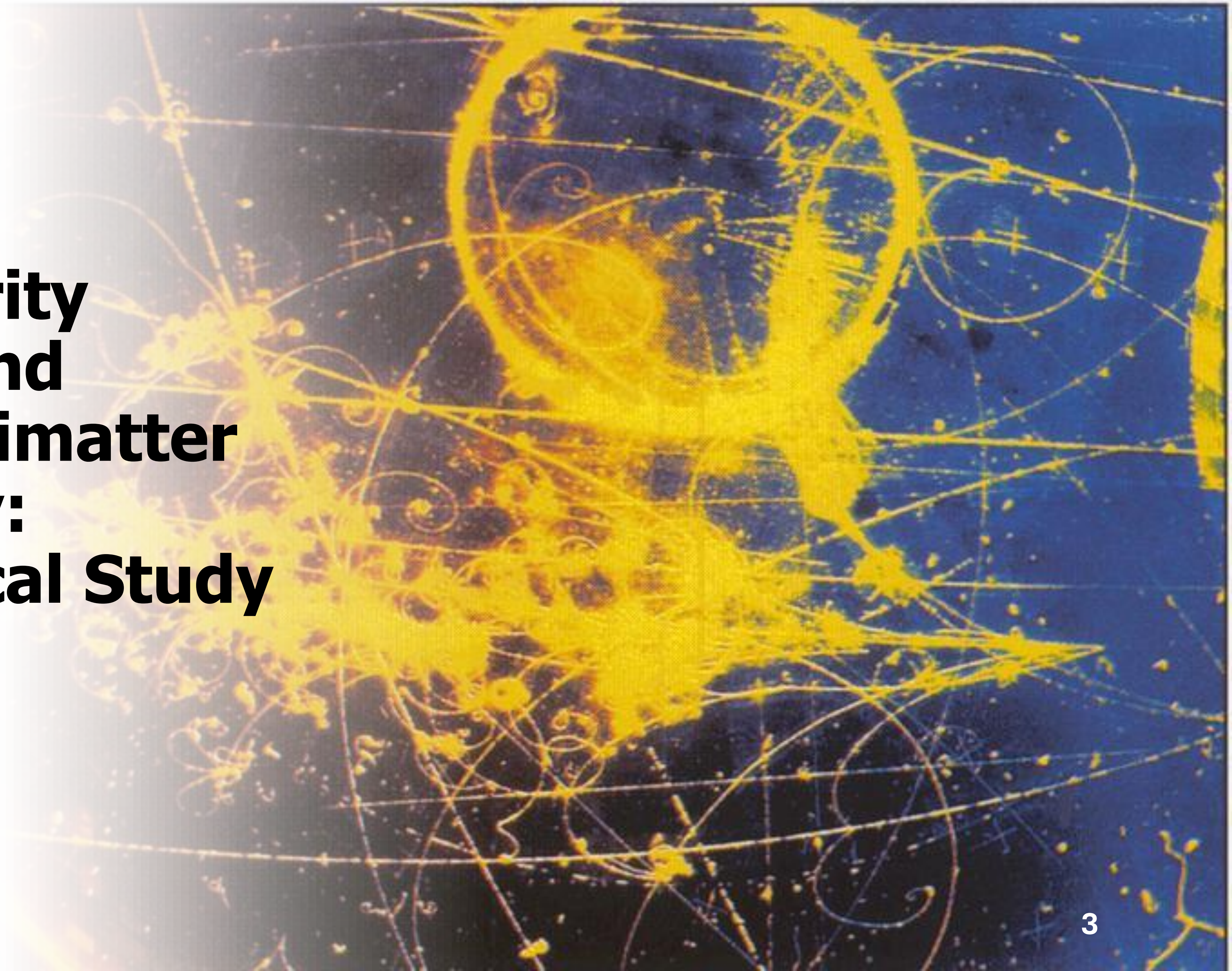
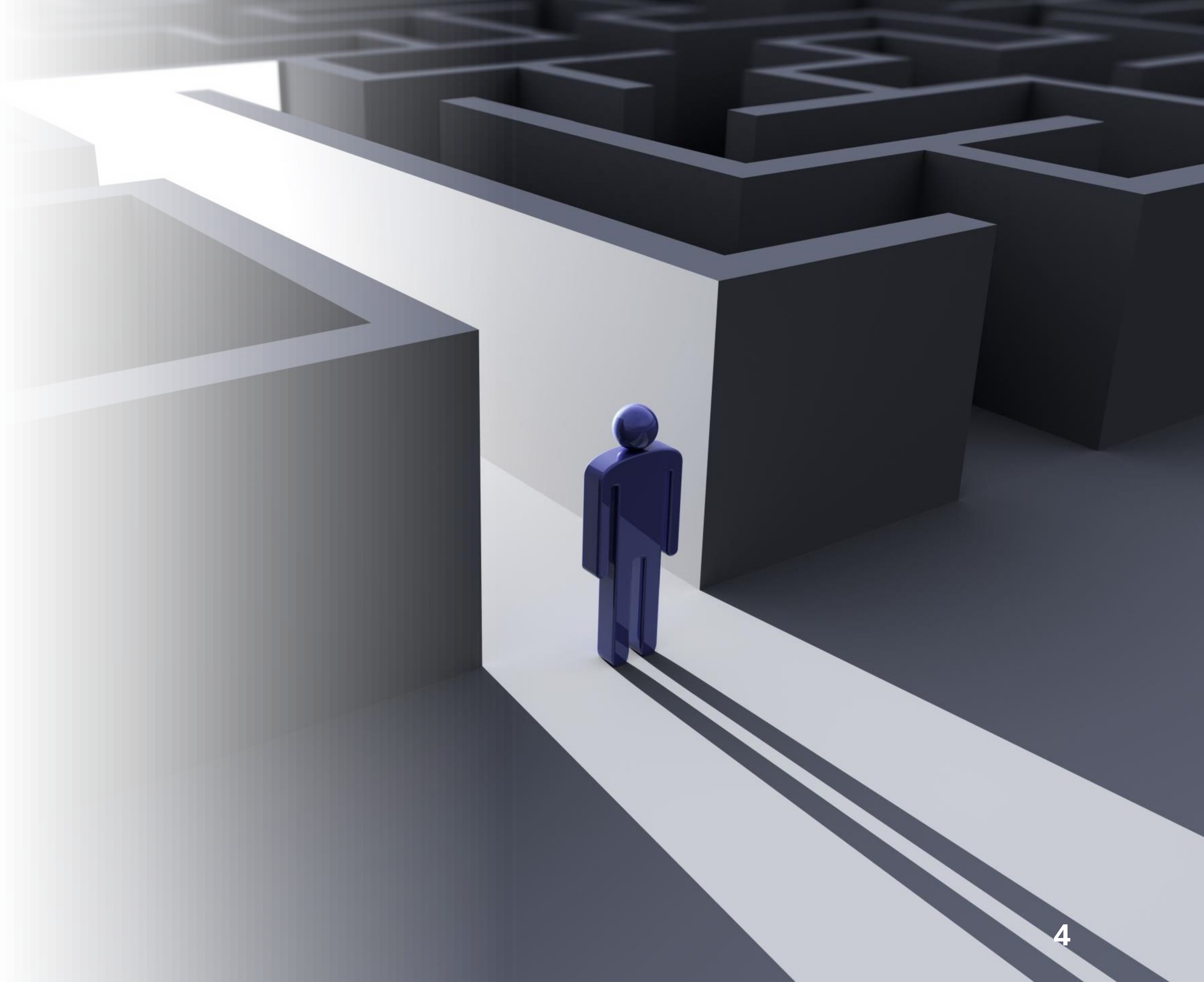
Affiliation: COMSATS Islamabad (BS Physics)

Charge-Parity Violation and Matter-Antimatter Asymmetry: A Theoretical Study



WHY DO WE EXIST!



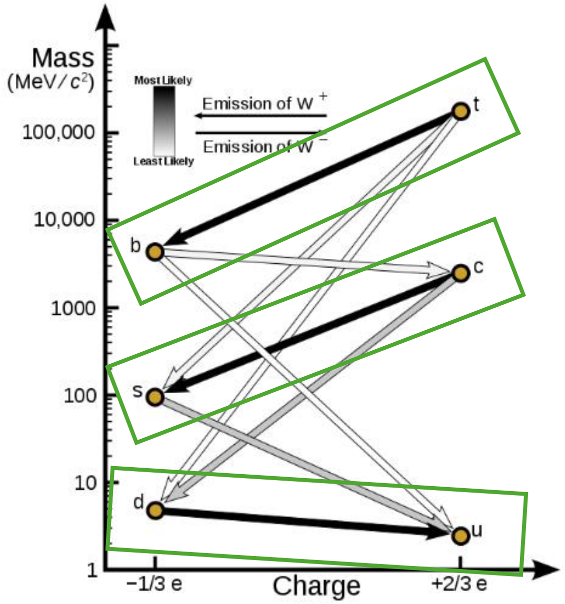
Background

- *1928:* Antimatter Prediction by Dirac (-ve energy solutions)
- *1956:* Parity Violation in “Cobalt-60 decay” Wu’s Experiment
- *1964:* CP Violation in “K^0 Decay” at BNL $\boldsymbol{\epsilon = 10^{-4}}$
- *1967:* Sakharov Three Conditions for BAU
- *1973:* CKM $\boldsymbol{e^{i\delta}}$ ($\boldsymbol{\delta} =$ CPV Phase)

Cabibbo-Kobayashi-Maskawa Matrix

$$V_{CKM} = \begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix} = \begin{pmatrix} c_1 & -s_1 c_3 & -s_1 s_3 \\ s_1 c_2 & c_1 c_2 c_3 - s_2 s_3 e^{i\delta} & c_1 c_2 s_3 + s_2 c_3 e^{i\delta} \\ s_1 s_2 & c_1 s_2 c_3 + c_2 s_3 e^{i\delta} & c_2 s_2 s_3 - c_2 c_3 e^{i\delta} \end{pmatrix}$$

where each $V_{ij} \equiv$ Transition Amplitude $q_i \rightarrow q_j$



Cabibbo, N. (1963) Physical Review Letters, 10, 531
Cabibbo–Kobayashi–Maskawa matrix - Wikipedia

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The Jarlskog's Invariant

VOLUME 55, NUMBER 10 PHYSICAL REVIEW LETTERS 2 SEPTEMBER 1985

Commutator of the Quark Mass Matrices in the Standard Electroweak Model and a Measure of Maximal *CP* Nonconservation

C. Jarlskog
Department of Physics, University of Bergen, Bergen, Norway, and Department of Physics, University of Stockholm, S-11349 Stockholm, Sweden
(Received 20 June 1985)

The structure of the quark mass matrices in the standard electroweak model is investigated. The commutator of the quark mass matrices is found to provide a convention-independent measure of *CP* nonconservation. The question of maximal *CP* nonconservation is discussed. The present experimental data indicate that nowhere is *CP* nonconservation maximal.

- A Convention-Independent measure of CP Violation ➡ Amount of Asymmetry

$$J \equiv \det[M_u, M_d]$$

$$J = (m_t^2 - m_c^2)(m_t^2 - m_u^2)(m_c^2 - m_u^2)(m_b^2 - m_s^2)(m_b^2 - m_d^2)(m_s^2 - m_d^2) J_{\text{eff}}$$

where $J_{\text{eff}} = s_1^2 s_2 s_3 c_1 c_2 c_3 sin\delta$

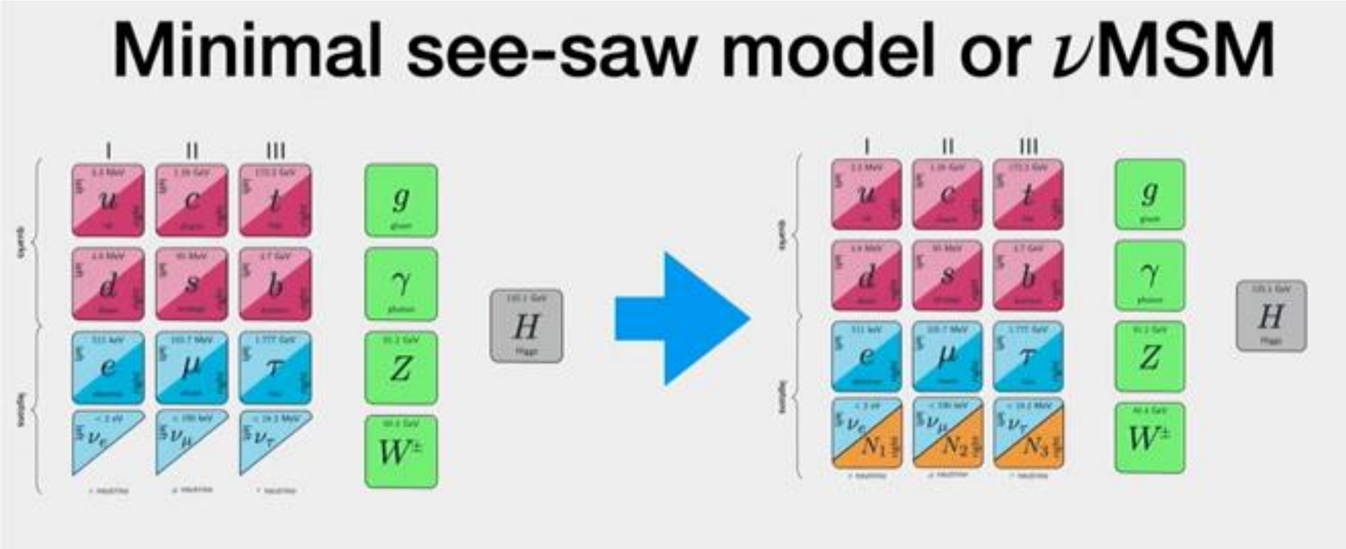
or $= \text{Im} V_{ii} V_{jj} V_{ij}^* V_{ji}^*$, for $i \neq j$

Jarlskog_PhysRevLett.55.1039.pdf

$$\frac{J}{(100\ \text{GeV})^{12}} \sim 10^{-20}$$

BEYOND THE STANDARD MODEL (BSM)

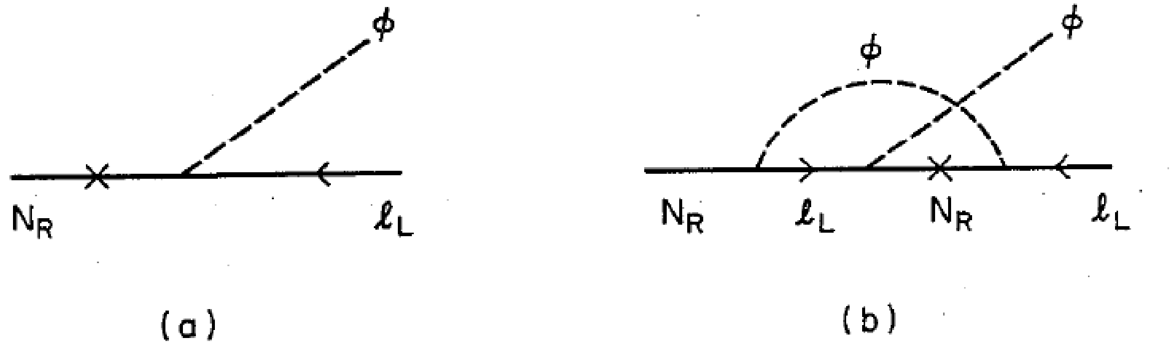
Baryogenesis via Leptogenesis in Seesaw Type-I Mechanism



Leptogenesis via Seesaw Mechanism

$N_R \to \ell_L + \bar{\phi}$ (a)

$N_R \to \overline{\ell_L} + \phi$ (b)



- Lepton number non-conservation: $0 \to \pm 1$

$\epsilon \approx 10^{-6}$ - Lepton asymmetry number

- Lepton asymmetry ⟷ Baryon asymmetry ⇨ *Sphelaron Interactions*

$$k\frac{\Delta B}{s} \backsim 10^{-10}$$

Conclusion

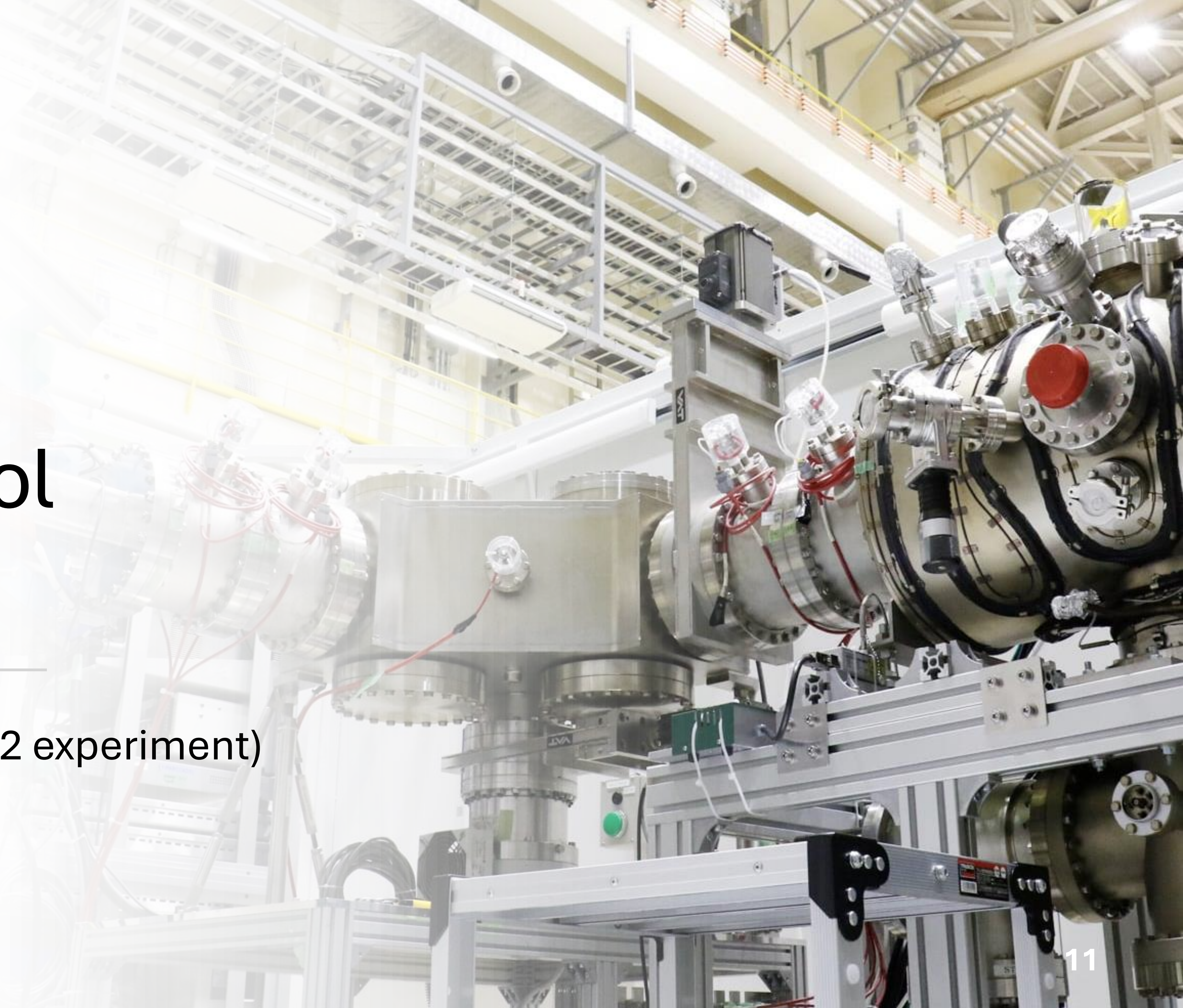
We all are the children of broken symmetry

Summer School Program

Group: E34 (*muon* g-2 experiment)

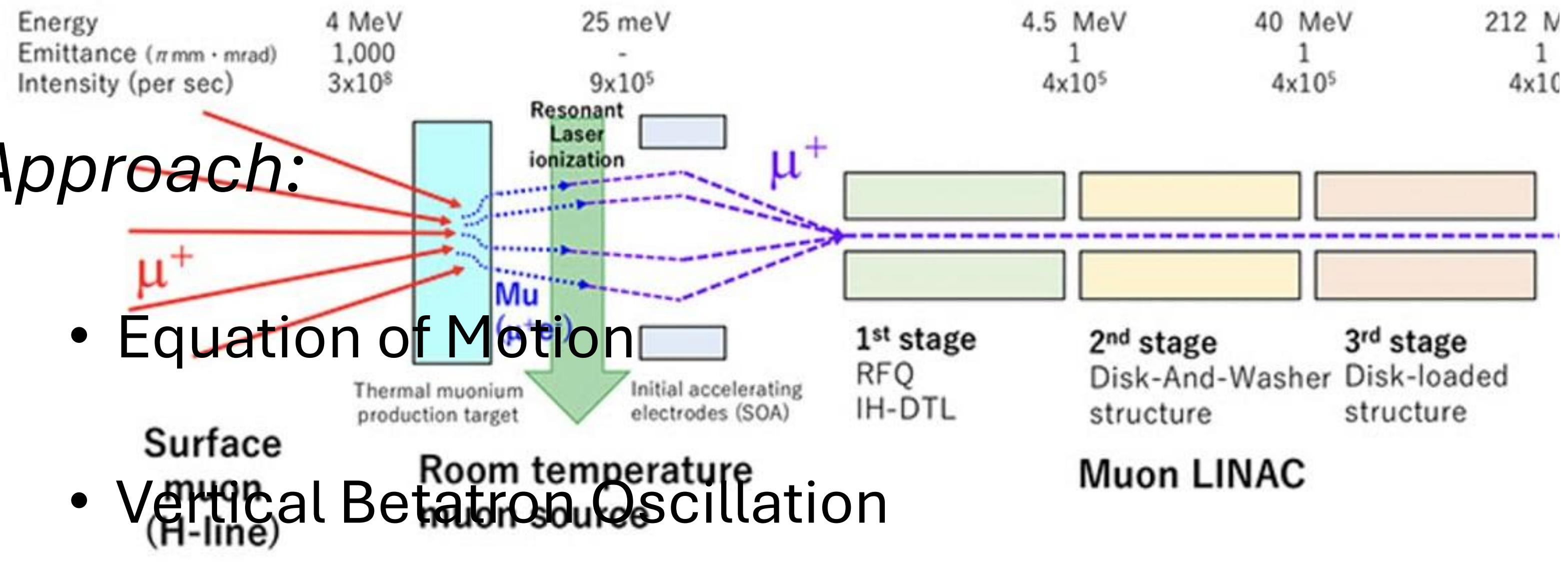
Supervisors: Prof. Mibe

Prof. Shinji



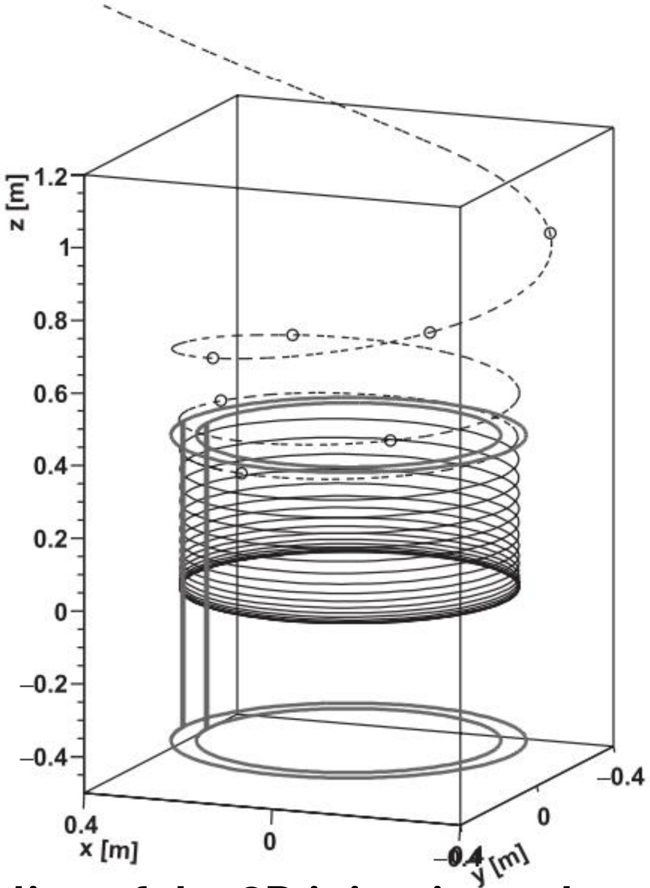
Preliminary Studies: Motion of Stored Muons

My Goal: Motion of Stored Muons



Approach:

- Equation of Motion
- Vertical Betatron Oscillation
- Simulate Muon Motion (C++ Root)
  - Predict muons position and momentum at any time



Outline of the 3D injection scheme

DOI: 10.1093/ptep/ptz030

Gantt Chart

Activity	19-26 July	26-02 August	02-09 August	09-16 August	16-23 August	23-30 August	30-06 Sept
Motion of Stored Muons							

About Japan

Thank you