



# Welcome to the 4<sup>th</sup> KMI school

## “Statistical Data Analysis and Anomalies in Particle Physics and Astrophysics”

Junji Hisano  
Director of KMI, Nagoya Univ.

## KMI school (2018, 2019, 2020, 2022)

## Newly started activity since 2018.

## Annual school for a dedicated hot topic.

# Invite young students & PD all over the world.

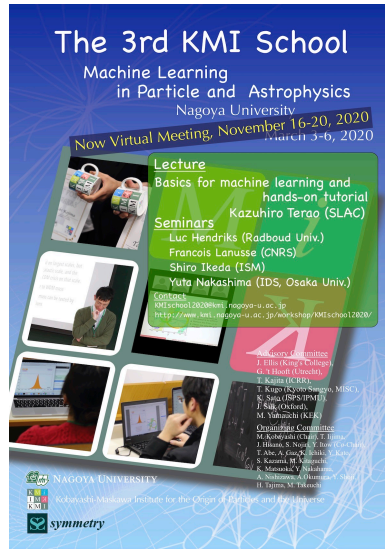
**dark matter  
(2018)**



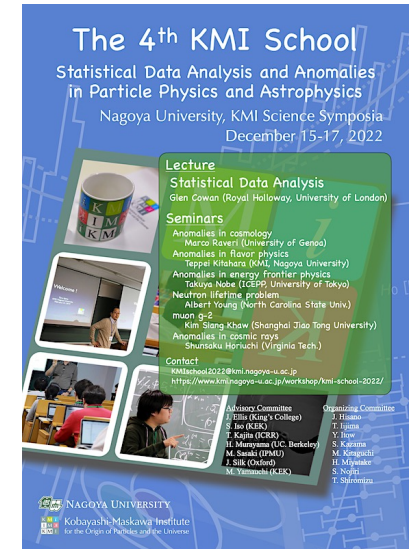
# Matter-antimatter asymmetry (2019)



# Machine learning (2020)



## Statistical Data Analyses (2022)



# Lecture : Statistical Data Analysis and hands-on tutorial



**Glen Cowan**  
**(University of London)**

# Topical seminars “Anomalies” (12/15)



**Kim Siang Khaw**  
**(Shanghai Jiao Tong Univ.)**

**Muon  $g-2$**



**Marco Raveri**  
**(Univ. of Genova)**

**Anomalies  
in Cosmology**



# Topical seminars “Anomalies” (12/16)



**Takuya Nobe**  
**(Univ. of Tokyo)**

**Anomalies  
in Energy Frontier Physics**



**Albert Young**  
**(North Carolina State Univ.)**

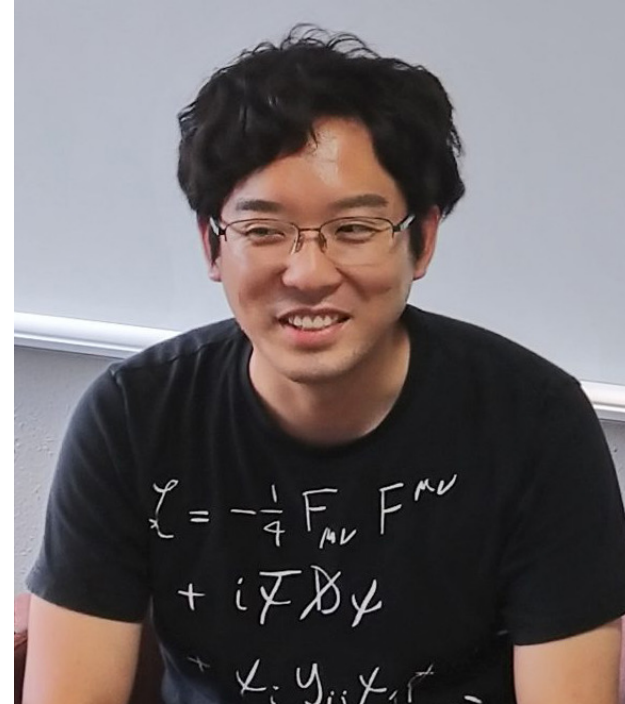
**Neutron Lifetime Problem**

# Topical seminars “Anomalies”. (12/17)



**Shunsaku Horiuchi**  
(Virginia Tech.)

**Anomalies  
in Cosmic Rays**



**Teppei Kitahara**  
(KMI, Nagoya Univ.)

**Anomalies  
in Flavor Physics**



Please enjoy the 4<sup>th</sup> KMI school  
“Statistical Data Analysis  
and Anomalies in Particle Physics and  
Astrophysics”



Introduction to

# Kobayashi-Maskawa Institute for the Origin of Particles and the Universe

in Nagoya University

Junji Hisano  
Director of KMI, Nagoya Univ.



# History

## Physics at Nagoya University



Sakata model  
MNS matrix

Shoichi Sakata



X-ray astronomy

Sachio Hayakawa



Nuclear emulsions

Kiyoshi Niu



Kimio Niwa

Kobayashi-Maskawa Matrix

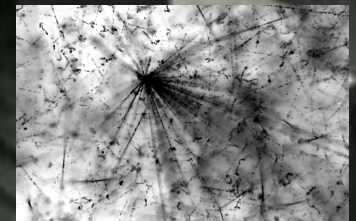


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Makoto Kobayashi



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Photo: U. Montan  
Toshihide Maskawa

- 1955 Sakata Model for hadrons
- 1962 Maki-Nakagawa-Sakata Matrix
- 1965 The first X-ray rocket in Japan
- 1971 Kyoshi Niu found charm quark event in CR.  
(1974 Charm quark was detected at SLAC &BNL)
- 1973 Kobayashi-Maskawa matrix
- 2000 Tau neutrino discovery (DONUT at Fermilab)
- 2001 CP symmetry breaking (Belle at KEKB factory)
- 2008 Nobel prize for Kobayashi-Maskawa matrix
- 2010 Establishment of KMI
- 2010 Observation of a first tau neutrino (OPERA)
- 2012 Discovery of Higgs particle
- 2015 The fifth tau neutrino (OPERA)



# Our Mission in KMI

## Shed Light on the Dark Universe



$$\begin{pmatrix} \cos \theta_1 & -\sin \theta_1 \cos \theta_3 & -\sin \theta_1 \sin \theta_3 \\ \sin \theta_1 \cos \theta_2 & \cos \theta_1 \cos \theta_2 \cos \theta_3 - \sin \theta_2 \sin \theta_3 e^{i\delta} & \cos \theta_1 \cos \theta_2 \sin \theta_3 + \sin \theta_2 \cos \theta_3 e^{i\delta} \\ \sin \theta_1 \sin \theta_2 & \cos \theta_1 \sin \theta_2 \cos \theta_3 + \cos \theta_2 \sin \theta_3 e^{i\delta} & \cos \theta_1 \sin \theta_2 \sin \theta_3 - \cos \theta_2 \cos \theta_3 e^{i\delta} \end{pmatrix}$$

$$V_{KM} = \begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix}$$

Dark  
Universe

Dark Energy

Dark Matter

Missing anti-matter

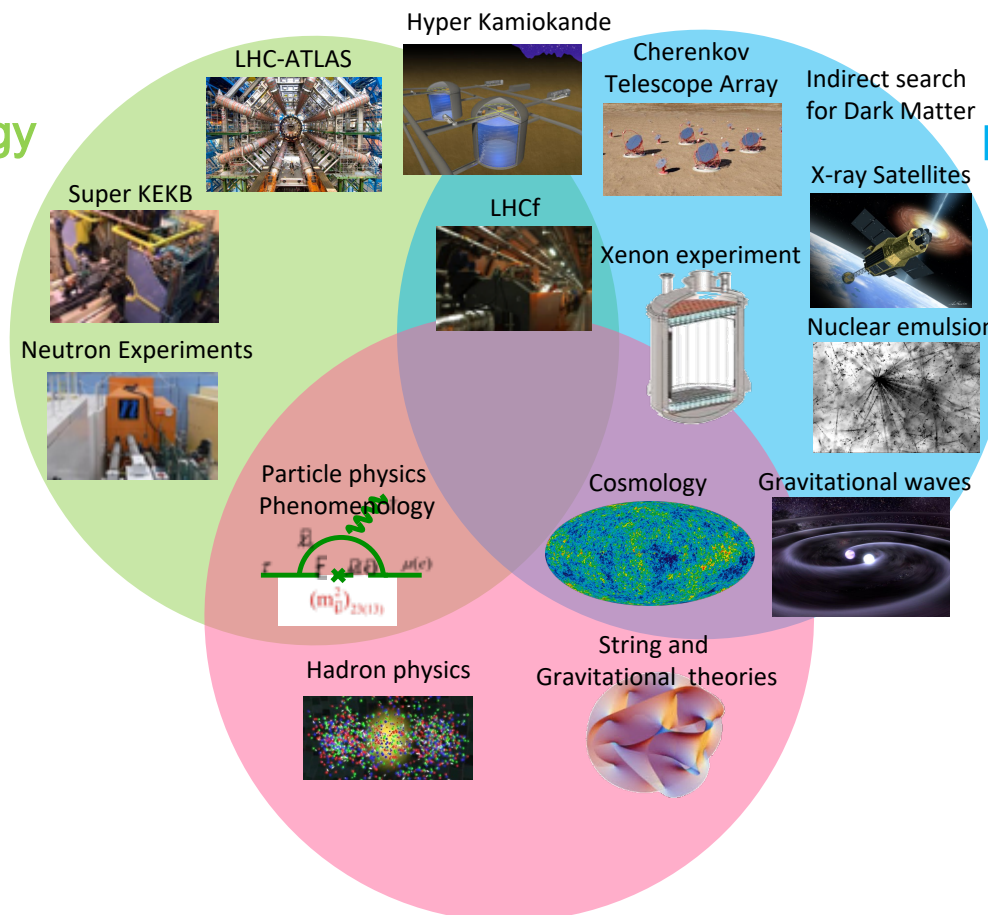
Beyond Kobayashi-Maskawa.

# KMI's Three rings



New Particle  
Phenomenology

Astro-particle  
Phenomenology



Integrative  
Theoretical Researches



Please visit  
[www.kmi.nagoya-u.ac.jp](http://www.kmi.nagoya-u.ac.jp)

Thanks!