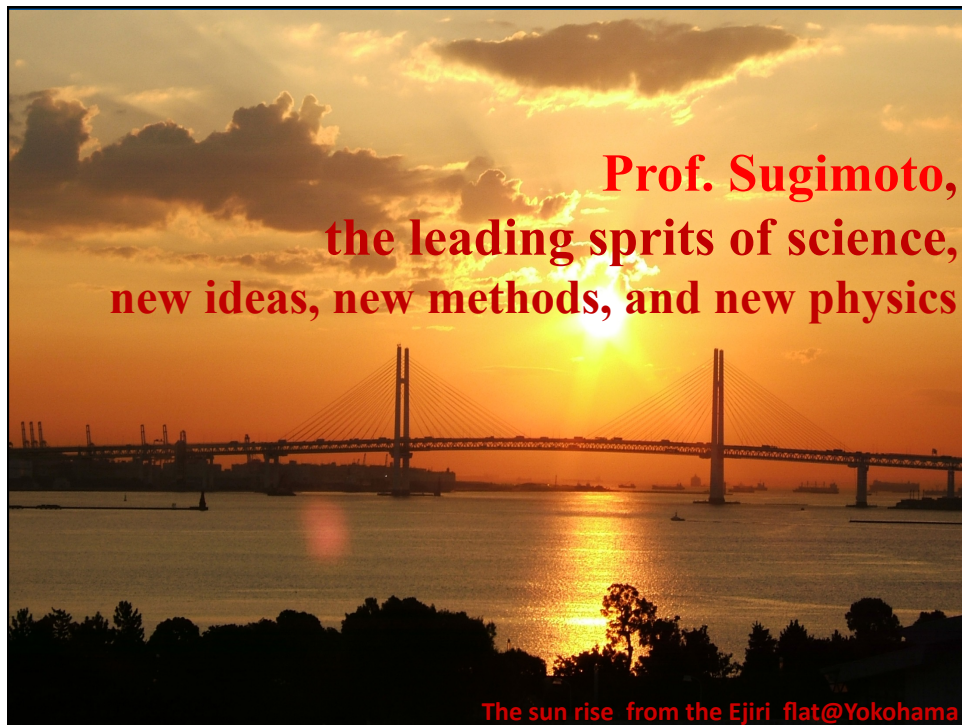




- 1. Prof. Sugimoto, the leading sprit of science & the nuclei, the play fields of Prof. Sugimoto.**
- 2. Hyper nuclear spectroscopy, hyperon spin and weak interactions**
- 3. Perspectives of physics at the nuclear femto laboratory, the play ground of science**
- 4. Thanks Prof. Sugimoto**

Thanks Prof. Nakai for this opportunity



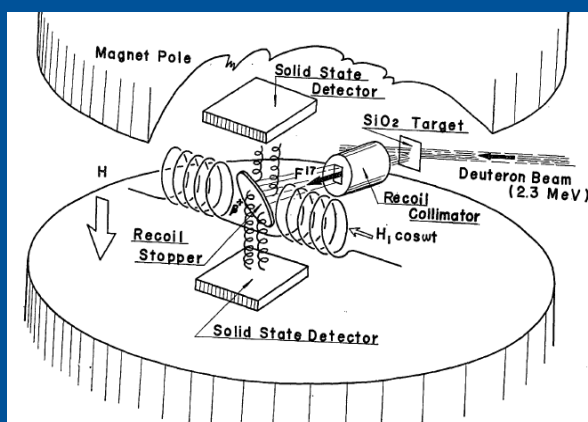


Nucleus, a play field of Prof. Sugimoto with 3 toys

JOURNAL OF THE PHYSICAL SOCIETY OF JAPAN, Vol. 21, No. 2, FEBRUARY,

Magnetic Moment of F^{17} — Nuclear Magnetic Resonance by Polarization Following $O^{16}(d, n)F^{17}$ Reaction —

Kenzo SUGIMOTO, Akira MIZOBUCHI, Kozi NAKAI
and
Kozi MATUDA



Spin-Pol. Beta decay Reaction

Brief remarks
on physics plays
with the 3 toys

Thanks for all with Prof. Sugimoto

1. Osaka Univ since 1971

Spin τ pol. , H. Ejiri et al PRL 35 1975 Cyncrotron lab.

Spin. weak interaction, symmetry Sugimoto's lab.

Weak interaction theory Morita Kotani Takasugi groups

Prof. M. Morita April 2 2013 , message

Most stimulating &productive period on weak interactions at Osaka with Prof. Sugimoto and others.

2. GeV HI γ , Shibata, Rasmussen, Nakai, Nagamiya, LBL

3. Hyper nuclei with INS, KEK , thanks to Prof. Nakai

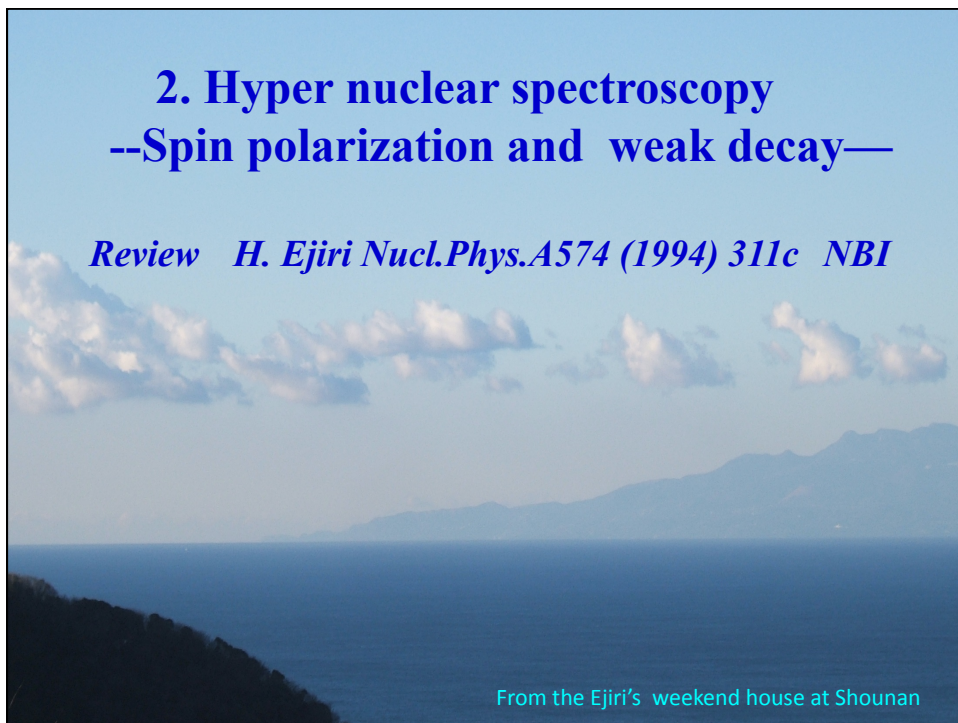
4. Double beta decays , neutrinos and symmetries 1980—

5. Neutrino nuclear responses by CER 1990--

* Cold fusion 1998-

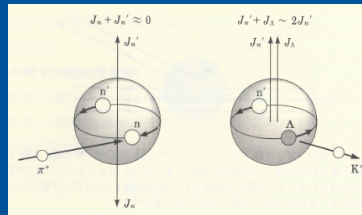
2. Hyper nuclear spectroscopy --Spin polarization and weak decay—

Review H. Ejiri Nucl.Phys.A574 (1994) 311c NBI



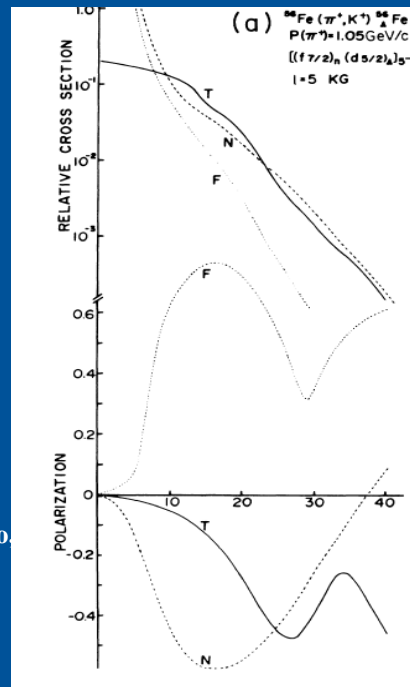
Spin polarization and align in hypernuclei

H.Ejiri, M. Ishihara, M. Skai,
PL 18 1965 Spin alignments
Extension to hyper nuclei



H. Ejiri, T. Fukuda, T. Shibata, H. Bando
K.I.Kubo PR C 36 1987 1435

H. Ejiri, T. Kishimoto, H. Noumi
PL B 225 1989 370

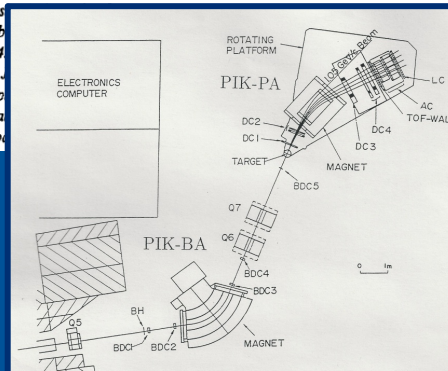


A BROAD RANGE SPECTROMETER PIK FOR MEDIUM-ENERGY MESON SPECTROSCOPY

M. AKEI⁶⁾, J.F. AMANN⁵⁾, J. CHIBA⁴⁾, H. EJIRI⁶⁾, M. FUKUDA⁶⁾, T. FUKUDA^{6,3)},
O. HASHIMOTO³⁾, S. HOMMA³⁾, T. IRIE⁶⁾, Y. ISEKI⁶⁾, A. KASHITANI⁶⁾, S. KATO⁹⁾,
K. KIMURA²⁾, T. KISHIMOTO⁶⁾, K. MAEDA⁷⁾, Y. MATSUYAMA³⁾, J.A. MCGILL⁵⁾,
T. NAGAE³⁾, H. NAGASAWA⁶⁾, C. NAGOSHI³⁾, M. NOMACHI⁴⁾, H. NOUMI⁶⁾, H. OHSUMI⁶⁾,
K. OKUDA⁶⁾, K. OMATA³⁾, H. SANO⁸⁾, O. SASAKI⁴⁾, T. SHIBATA^{6,3)}, F. SOGA³⁾,
F. TAKEUCHI¹⁾, H.A. THIESSEN⁵⁾, S. TOYAMA³⁾, K.H. TANAKA⁴⁾, Y. YAMANOI³⁾
and N. YOSHIKAWA³⁾

- ¹⁾ Faculty of Science, Kyoto Sangyo University, Kyoto 603, Japan
- ²⁾ Department of Physics, Kyushu University, Fukuoka 812, Japan
- ³⁾ Institute for Nuclear Study (INS), The University of Tokyo, Tanas
- ⁴⁾ National Laboratory for High Energy Physics (KEK), Tsukuba, Ib
- ⁵⁾ LAMPF, Los Alamos National Laboratory, Los Alamos NM 8754
- ⁶⁾ Department of Physics, Osaka University, Toyonaka, Osaka 560, J
- ⁷⁾ College of General Education, Tohoku University, Sendai 980, Jap
- ⁸⁾ Department of Physics, The University of Tokyo, Tokyo 113, Japa
- ⁹⁾ Department of Physics, Yamagata University, Yamagata 990, Jap

NIM 283 1089



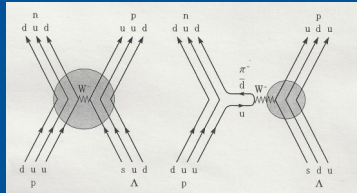
High momentum
polarized Λ hypernucle
(π^+K^+) reaction

Λ polarization & weak decay

PL B 282 1992 293

First Pol. asymmetry of weak decay

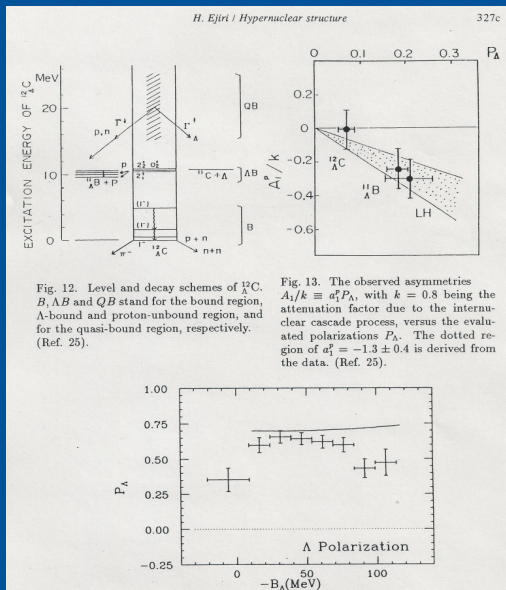
Heavy meson and 6-quark process



Quasi free Λ keep pol. in nuclei
due to small s-spin interaction
P R L 68 1992 2137

Osaka INS KEK TRIUMF Tohoku Tokyo

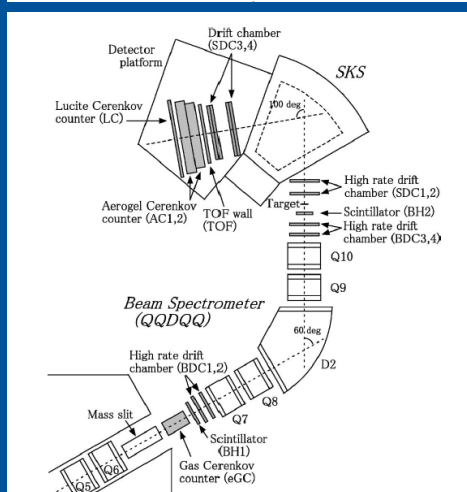
S. Ajimura,⁽¹⁾ H. Ejiri,⁽¹⁾ A. Higashi,^{(1),(a)} G. Inoue,⁽¹⁾ Y. Iseki,⁽¹⁾ T. Kishimoto,⁽¹⁾ F. Nakamura,⁽¹⁾ H. Noumi,^{(1),(b)} H. Ohsumi,⁽¹⁾ H. Sano,⁽¹⁾ D. R. Gill,⁽²⁾ L. Lee,⁽²⁾ A. Olin,⁽²⁾ S. Yen,⁽²⁾ T. Fukuda,⁽³⁾ O. Hashimoto,⁽³⁾ T. Shibata,⁽³⁾ M. Nomachi,⁽⁴⁾ Y. Kimura,⁽⁵⁾ and K. Maeda⁽⁶⁾



PHYSICAL REVIEW C, VOLUME 64, 044302

Spectroscopy of medium-heavy Λ hypernuclei via the (π^+, K^+) reaction

H. Hotchi,^{1,*} T. Nagae,² H. Ohta,² H. Noumi,² M. Sekimoto,² T. Fukuda,² H. Bhang,³ Y. D. Kim,^{3,†} J. H. Kim,³ H. Park,^{3,‡} K. Tanida,¹ O. Hashimoto,⁴ H. Tamura,⁴ T. Takahashi,⁴ Y. Sato,⁴ T. Endo,⁴ S. Satoh,⁴ J. Nishida,⁴ T. Miyoshi,⁴ T. Saitoh,⁵ T. Kishimoto,⁶ A. Sakaguchi,⁶ S. Ajimura,⁶ Y. Shimizu,⁶ T. Mori,⁶ S. Minami,⁶ M. Sumihama,⁶ R. Sawafuta,^{7,§} and L. Tang⁸



Λ potential g,f n-hole + Λ

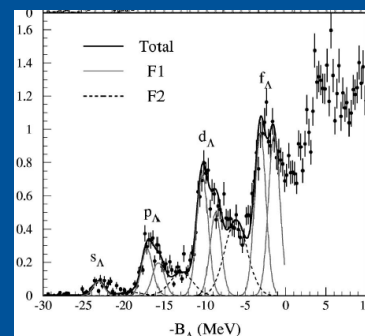


Fig. 5. Hypernuclear mass spectra of ^{86}Y without (up) and with (down) fitting curves described in the text. The quoted errors are 1-sigma.

PRL 86 2001 Osaka,
KEK, Tokyo, Tohoku, BNL,

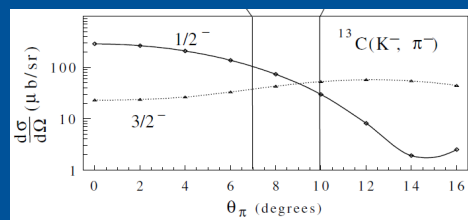
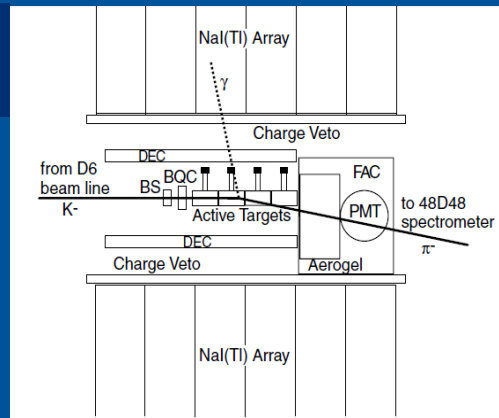
BNL π/γ coincidence

Spin-orbit splitting of Λ

$$P(1/2) - P(3/2) \\ = 152 \text{ keV}$$

0.03-0.05 of nucleon spin

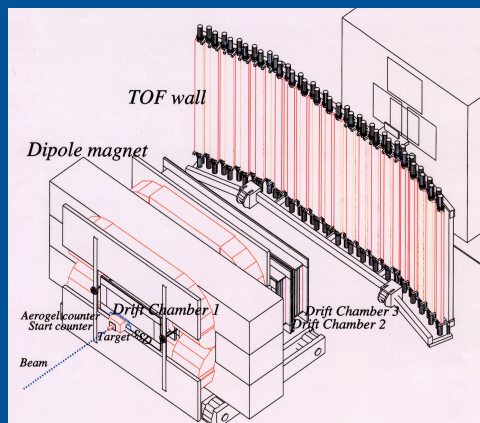
Λ spin is s quark spin

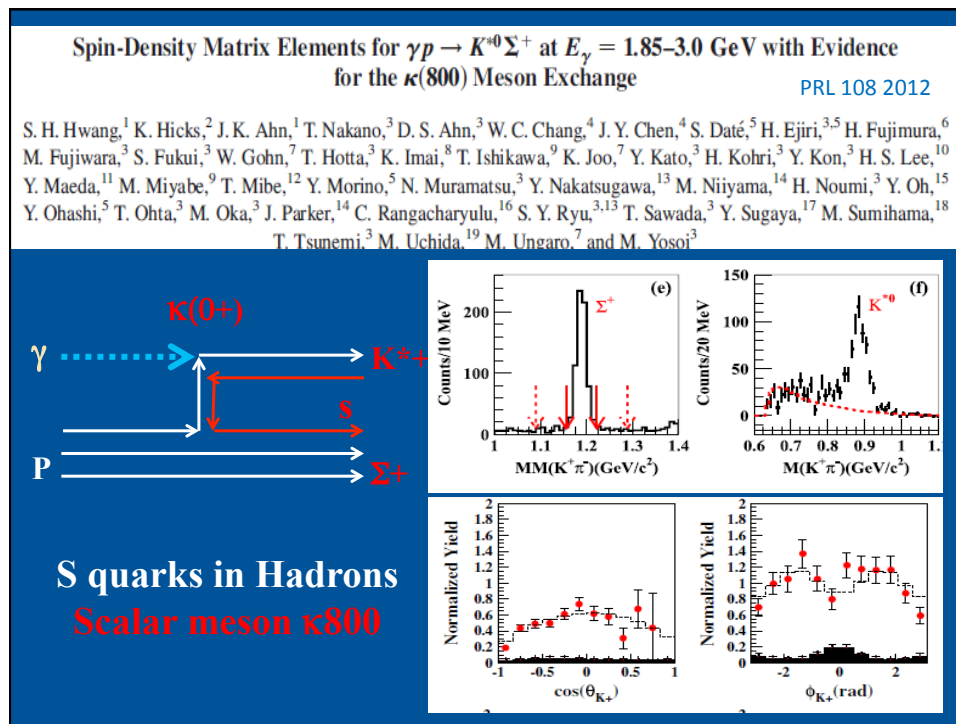


Laser Electron Photon at Spring 8 LEPS 1995--

Nakano

Polarized GeV γ Spectroscopy
For new quarks and hadrons





3. Perspectives of New generation spin physics

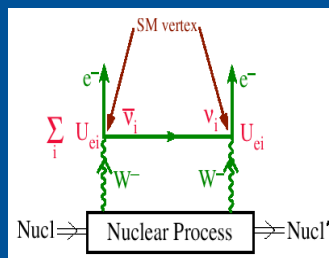


Nuclear FEMTO(fm)- Lab. HC. with S,I,E, T

$$L_N = 10^{48} \text{cm}^{-2} / \text{s}$$

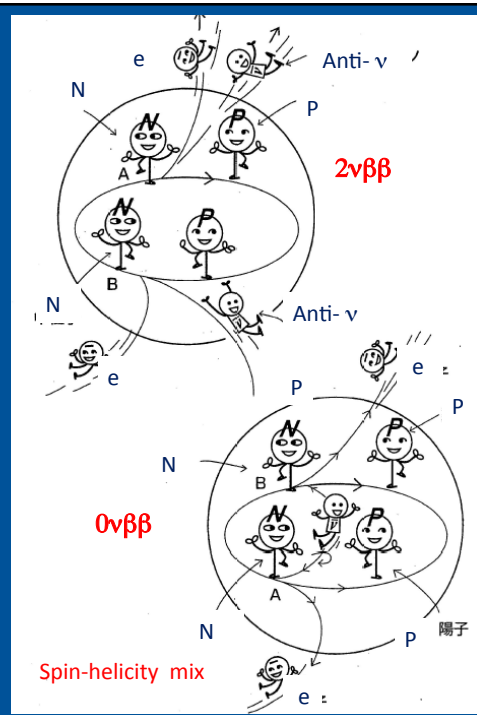
$$1\text{-ton } L = 6 \cdot 10^{75} \text{cm}^{-2} / \text{s}$$

H. Ejiri Prog. Nucl. Part. Phys, 2009



Play field of ν -physics
beyond SM

J. Vergados, H. Ejiri, F. Simkovic
ROPP 75 2012

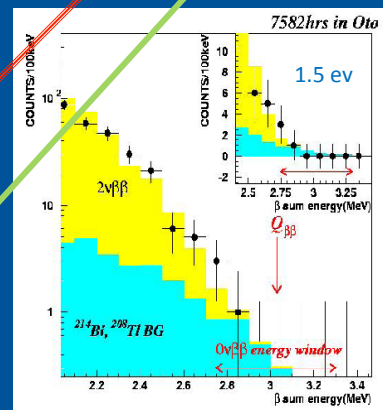
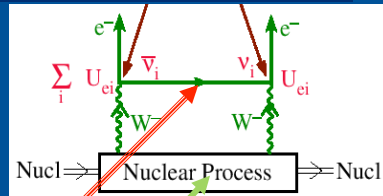


Majorana ν by $0\nu\beta\beta$ with lepton $\Delta L=2$

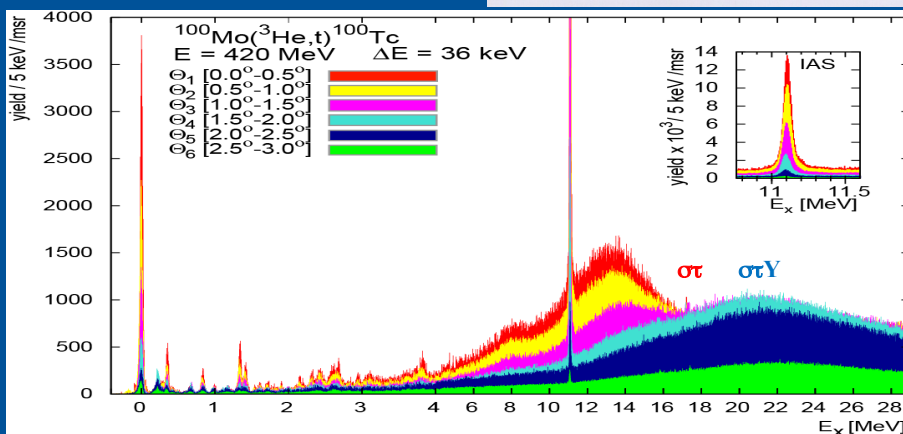
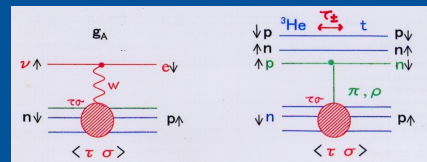
FEMTO(fm)-HC. to enhance ν -exchange
 $L = 6 \cdot 10^{75} \text{cm}^{-2} / \text{s}$ $\sigma \sim 10^{-83} \text{cm}^2$
 reduce single β by 10^{-35}

ν = anti- ν , helicity mix,
 mass mixing = $\sum \nu_1, \nu_2, \nu_3$
 MOON, KamLAND, others
 H.Ejiri et al PL 1991, PRL 2000

Nucl. spin isospin $\sigma \tau$ weak coupling g_A & correlation
@ RCNP/Spring8
 H. Ejiri, Phys. Rep. 338 (2000)



$\beta\beta\tau\sigma$ by CEP $\tau\sigma$ @ RCNP $\Delta E/E = 5 \cdot 10^{-5}$ Ikegami Fujiwara



Frekers, Ejiri, Fujiwara et al. PR C 80 2012

$M(\text{EXP})^{\tau\nu} \sim M^{\tau\nu}(\text{SQP}) g_A$ for $1+2^-$ quenching by $\pi \Delta$

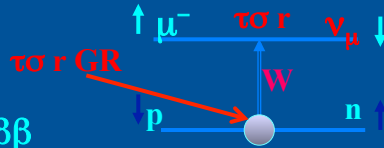
H. Ejiri JPSJ 78, 2009, 81, 2012.

Weak responses by μ capture

$$A + \mu^- = B + \nu_\mu$$

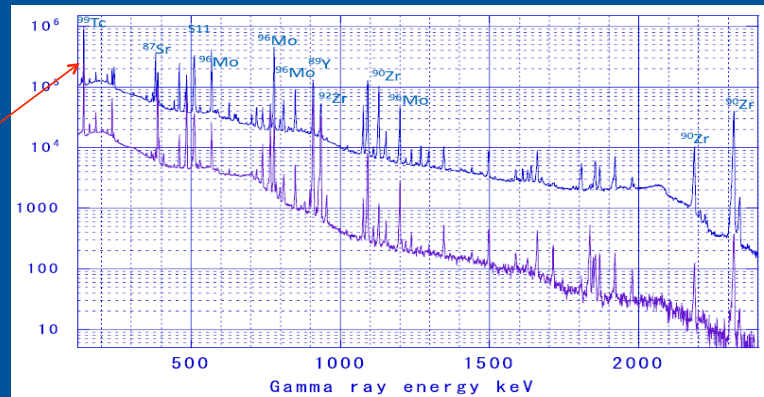
$$A + \beta = B + \nu_\beta$$

$P \sim 100 \text{ MeV}/c$ as $0\nu\beta\beta$



MuSIC Kuno Sato

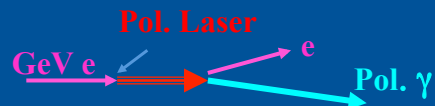
^{99}Tc
Ejiri
PR 5
2012



H. Ejiri Proc. **1972**, Sendai, H. Ejiri, MEDEX11 2009, H. Ejiri, JPSJ 82, **2013**
-3

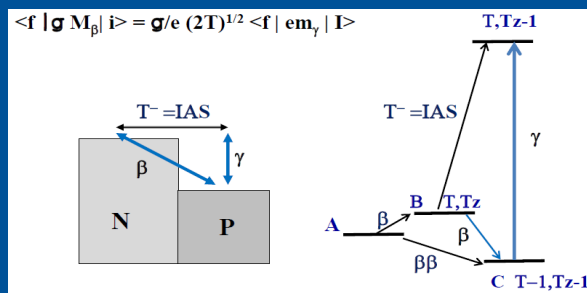
LEPS Photon Probes

Laser electron photon Sources



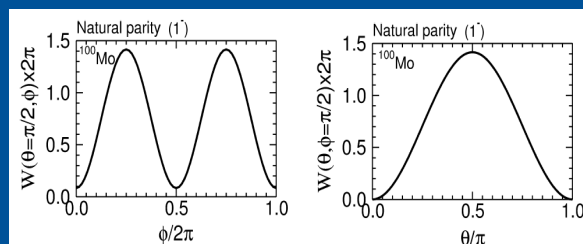
$\tau^+ \sigma \beta$ by
 $\tau^3 \sigma \text{ IAS } \gamma$

H. Ejiri PRL 21 1968,



Polarized γ
correlation

H. Ejiri, A. Titov, et al
2013

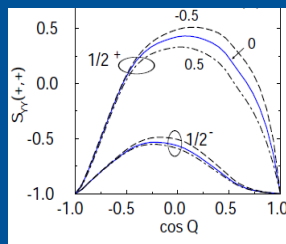


LEPS 2 Laser Electron Photon @SPring8

New generation quark/hadron/hyperon nuclear physics

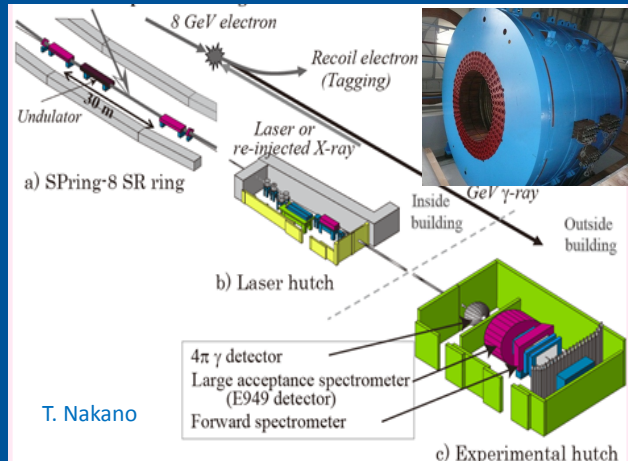
$E \sim 3 \text{ GeV}$ $10^7/\text{s}$ with detector with $\Omega \sim 4\pi$ @ 30m section

Pol. Asym. $\gamma n\text{-}K\text{-}K^+n$



$$\Sigma_{\gamma\gamma}(\uparrow\uparrow) = \frac{\sigma^\perp(\uparrow\uparrow) - \sigma^\parallel(\uparrow\uparrow)}{\sigma^\perp(\uparrow\uparrow) + \sigma^\parallel(\uparrow\uparrow)},$$

Titov Ejiri PR C 71 2005



Encouragements & appreciations by

Prof. Sugimoto

Symposia/conferences

NSNI 84, β/ν 86, Weak89, WEIN95

Good to hold Int. Symp.

Nuclear β/γ & reactions

Great to write up the book

No works with Prof K.S,
but no works without K.S

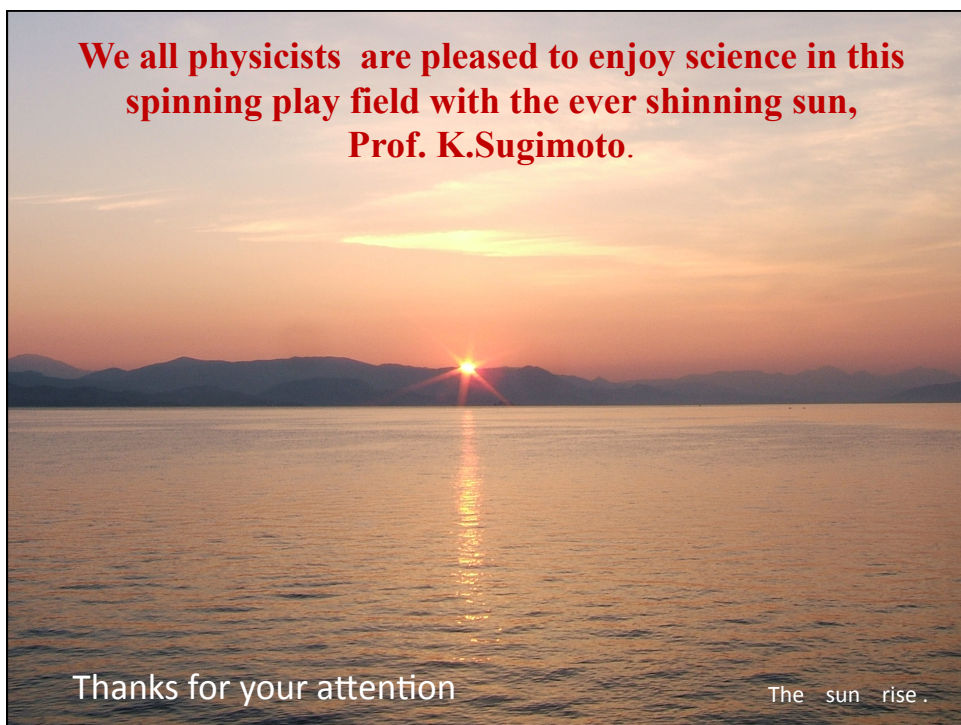
OXFORD STUDIES IN NUCLEAR PHYSICS · 11

Gamma-Ray and Electron Spectroscopy in Nuclear Physics

H. EJIRI
and
M. J. A. de VOIGT



OXFORD SCIENCE PUBLICATIONS



Majorana neutrinos and neutrino-less $\beta\beta$ decays

$$0\nu\beta\beta \quad A = B + \beta + \beta$$

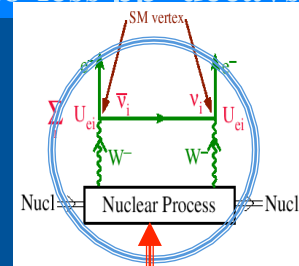
Lepton number $\Delta L=2$ beyond SM.

Particle physics
Majorana ν , m_ν , CP

$$T^{0\nu} = G^{0\nu} [M^{0\nu} m_\nu]^2$$

Nucl. physics. g_A
short-range &
 τ σ correlation

Cosmology
DM
Leptogenesis



FEMTO(fm)-**HC**.

to selectively enhance
 ν -exchange

$$L_N = 10^{48} \text{cm}^{-2} / \text{s}$$

$$1\text{-ton } L = 6 \cdot 10^{75} \text{cm}^{-2} / \text{s}$$

$$\sigma \sim 10^{-83} \text{cm}^2 \quad \text{IH}$$

Nuclear weak/ ν responses for $\beta\beta-\nu$

$$0\nu\beta\beta \quad A = B + 2\beta + 2\nu$$

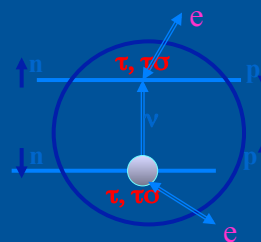
$\Delta L=2$ beyond SM.

$$T^{0\nu} = G^{0\nu} [M^{0\nu} m_\nu]^2$$

$$\langle m_\nu \rangle = |\sum U_i^2 \exp(i\phi_i) m_i|$$

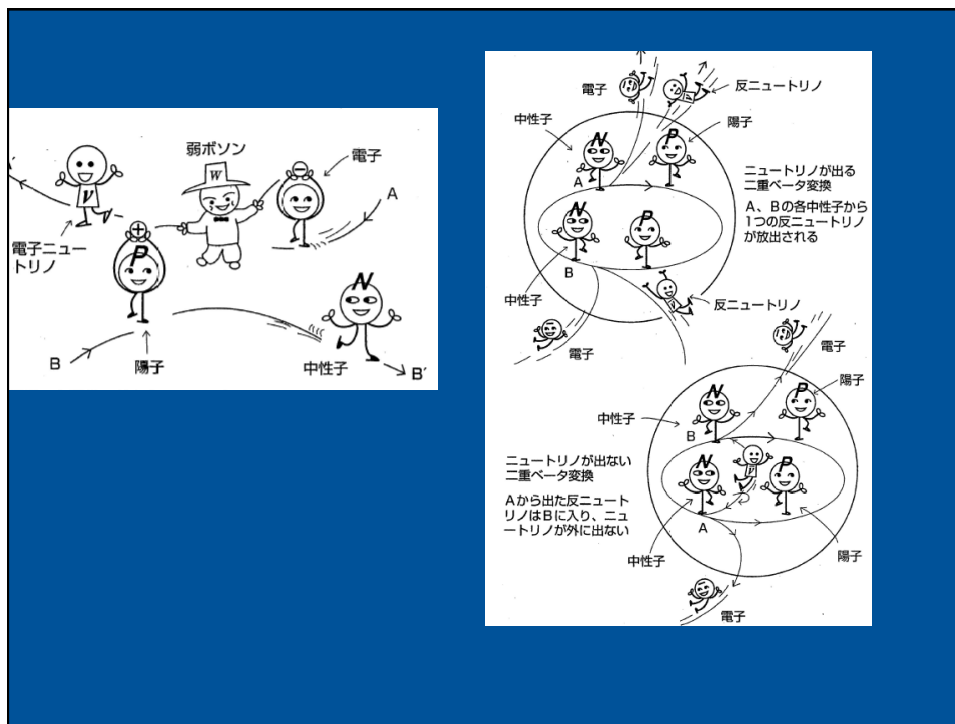
$$\phi_i = \alpha_2 - \alpha_1, \quad \phi_i = \alpha_2 - 2\delta$$

$U_i \Delta m_S, \Delta m_A$ by ν oscillation
 ν exchange in a nucleus

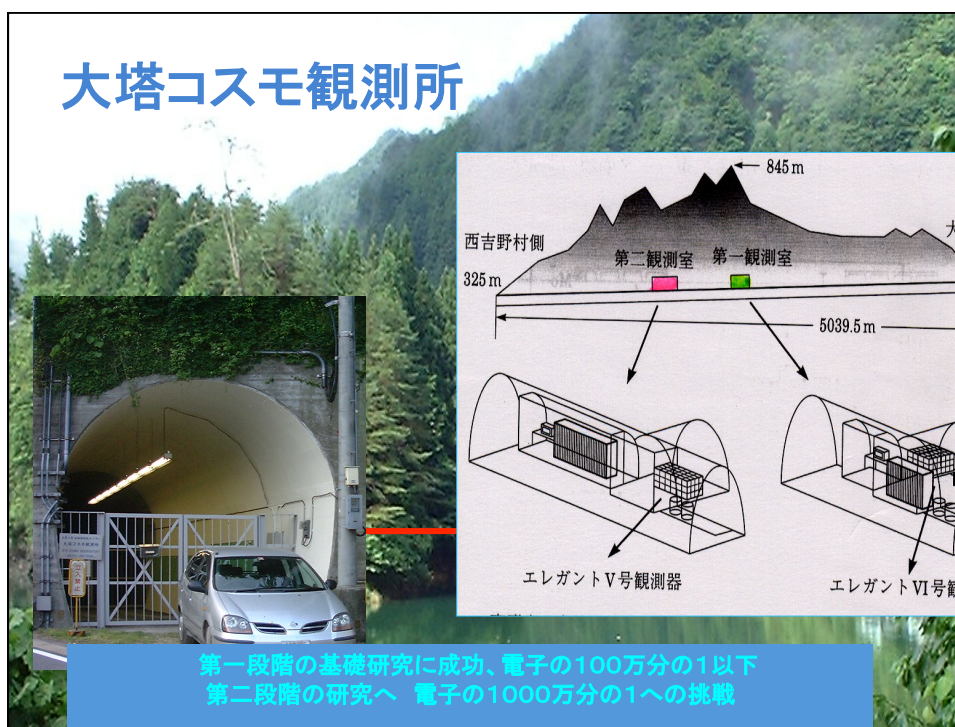


$M^{0\nu}$ Nuclear weak/ ν responses, isospin τ spin $\tau\sigma$

H.Ejiri, Phys. Report 338 (2000) 265.



大塔コスモ観測所



LEPS Laser Electron Photons at Spring 8

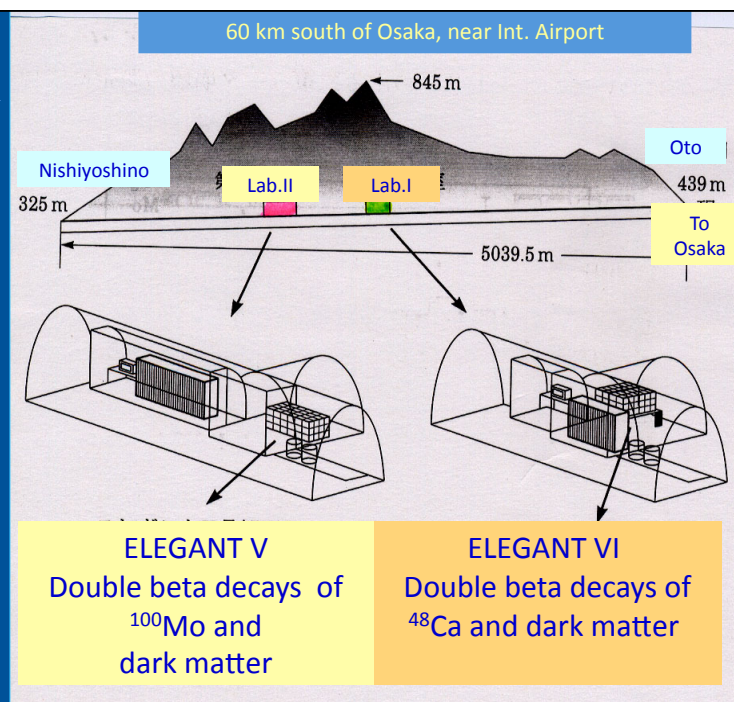


- Multi-GeV laser photon beam ($10^9 \text{ eV} : 3 \cdot 10^{-14} \text{ cm}$) to search for ν -nuclear interaction and quarks in nucleon (10^{-13} cm).

Oto Cosmo Observatory

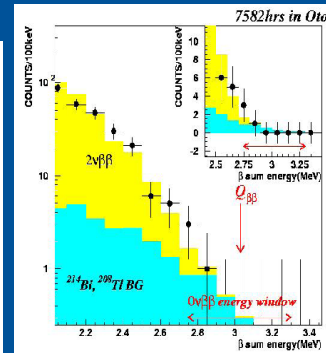
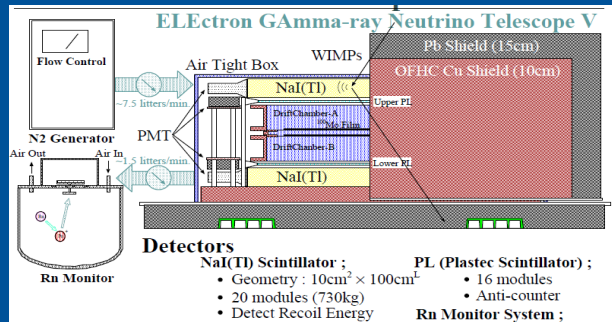
Unused 5 km tunnel
1400 m we

Cosmic μ
 $4 \cdot 10^{-5} / \text{m}^2 / \text{s}$
Neutron
 $4 \cdot 10^{-5} / \text{m}^2 / \text{s}$
Rn
 10 Bq/m^3



ELEGANT VI 11 layers Si-disks with ^{100}Mo T²ⁿ 1989

ELEGANT V 2-layers PL-NaT-DC with ^{100}Mo / ^{116}Cd



T^{2ν} First data 1990/91 & 1995 for ^{100}Mo & ^{116}Cd , UC, NEMO II & III

T^{0ν} > 1.0 · 10²³y, 1.5 eV 68%CL 1995-2001, Renewed by NEMO III

H.Ejiri, et al., Phys. Rev. C 63 '01, 65501

DM Annular modulation with 0.75 ton NaI: Season effect of Rn

電気のない電子「ニュートリノ」の正体

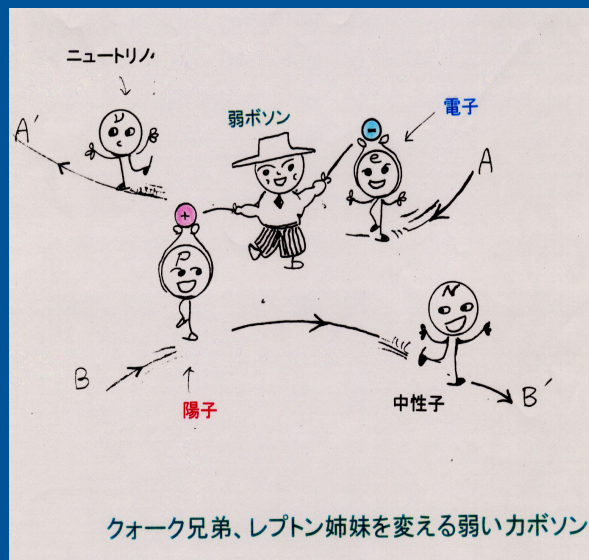
・ ベータ崩壊

電子 → ニュートリノ

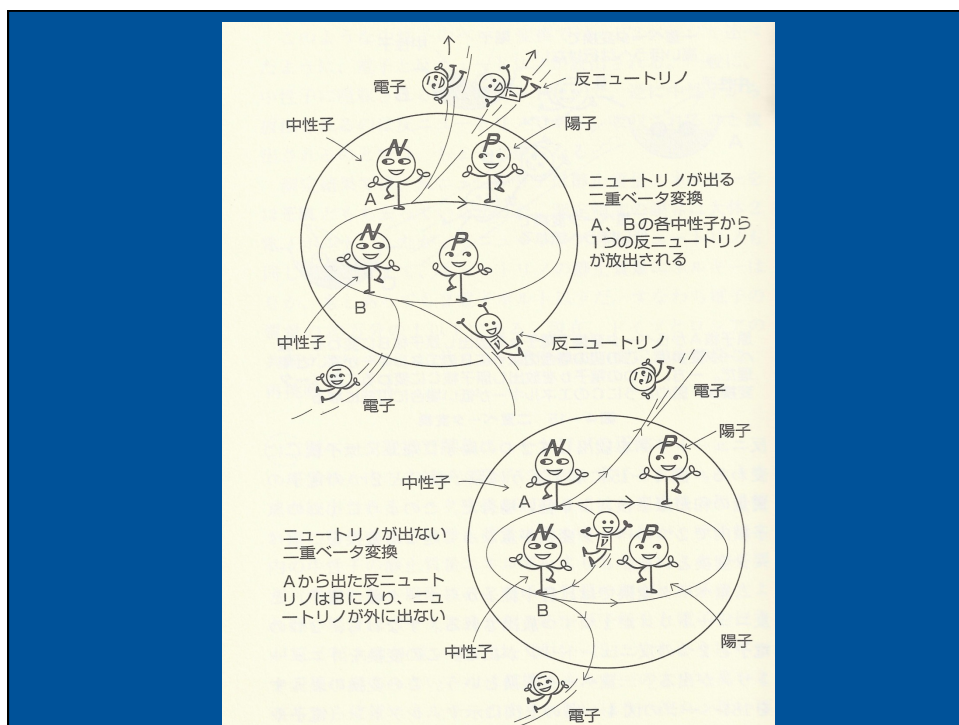
W

陽子 → 中性子

w(弱)ボソンの
仲だちで電子・ニュ
ートリノ姉妹と陽子・中
性子兄弟は変身



2. Neutrino nuclear responses and charge exchange reactions



- PRL 86 4255 2001
- PRC 87 332504
- PRC 53 1996 1201

4 総長時代とその後



サイクロトロン棟の前でボーア教授（ノーベル賞）と若槻先生を囲んで
左より板橋、平山、丸森、杉本、ボーア夫妻、八木、若槻先生、三浦、柴
田、江尻の各氏