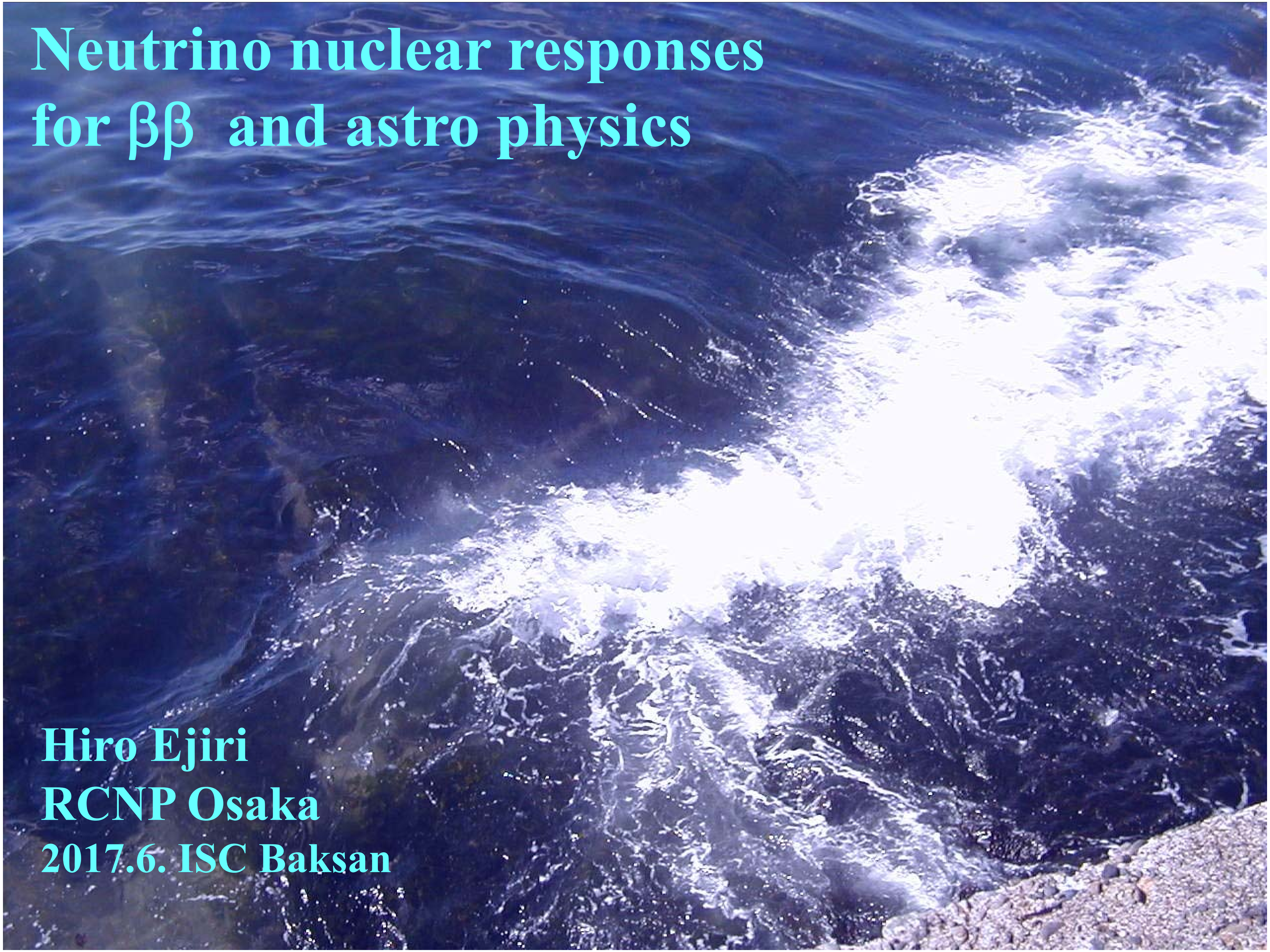


Neutrino nuclear responses for ββ and astro physics

Hiro Ejiri
RCNP Osaka

2017.6. ISC Baksan

1. Neutrino nuclear response and experimental studies
2. Low q CERs (Charge exchange nuclear reactions) of EC/ β decay responses for GT, SD, SO.
3. Medium q ν responses by high E-resolution CER
4. Ga Puzzle and solar ν BGs for DBD experiments
5. Remarks and perspectives

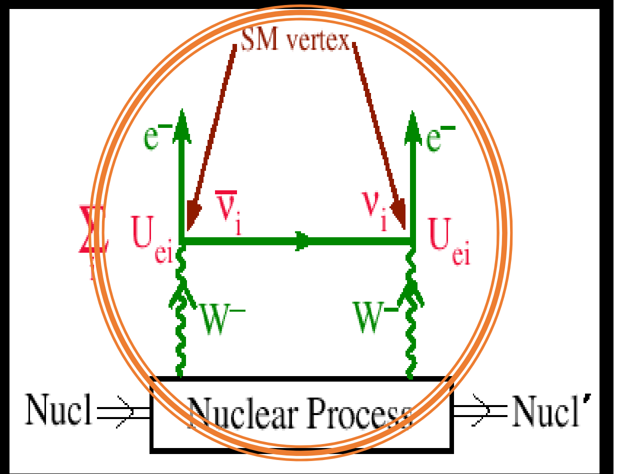
Neutrino nuclear response for ββ–ν and astro-ν.

Neutrino-less ββ decays

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

Nucl. physics. g_A τ σ correlation	Particle physics Majorana ν, m_ν CP

$M^{0\nu} = \Sigma M^\nu \ \overline{M}^\nu$ ν and anti–ν exchange



Astro ν/ $\overline{\nu}$ reactions/synthesis

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

Nucl. physics. g_A τ σ correlation	Astro physic Supernova ν, flux, T

FEMTO(fm)-HC.

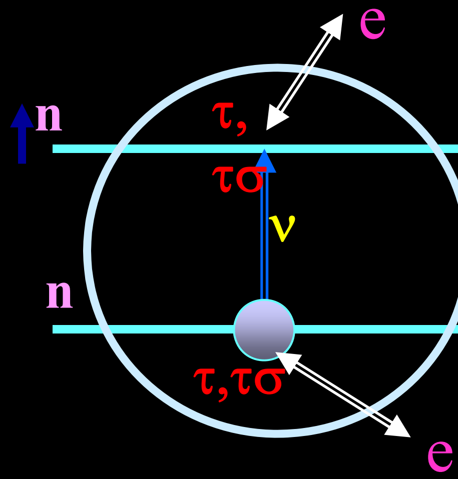
$L_N = 10^{48} cm^{-2}$ /s

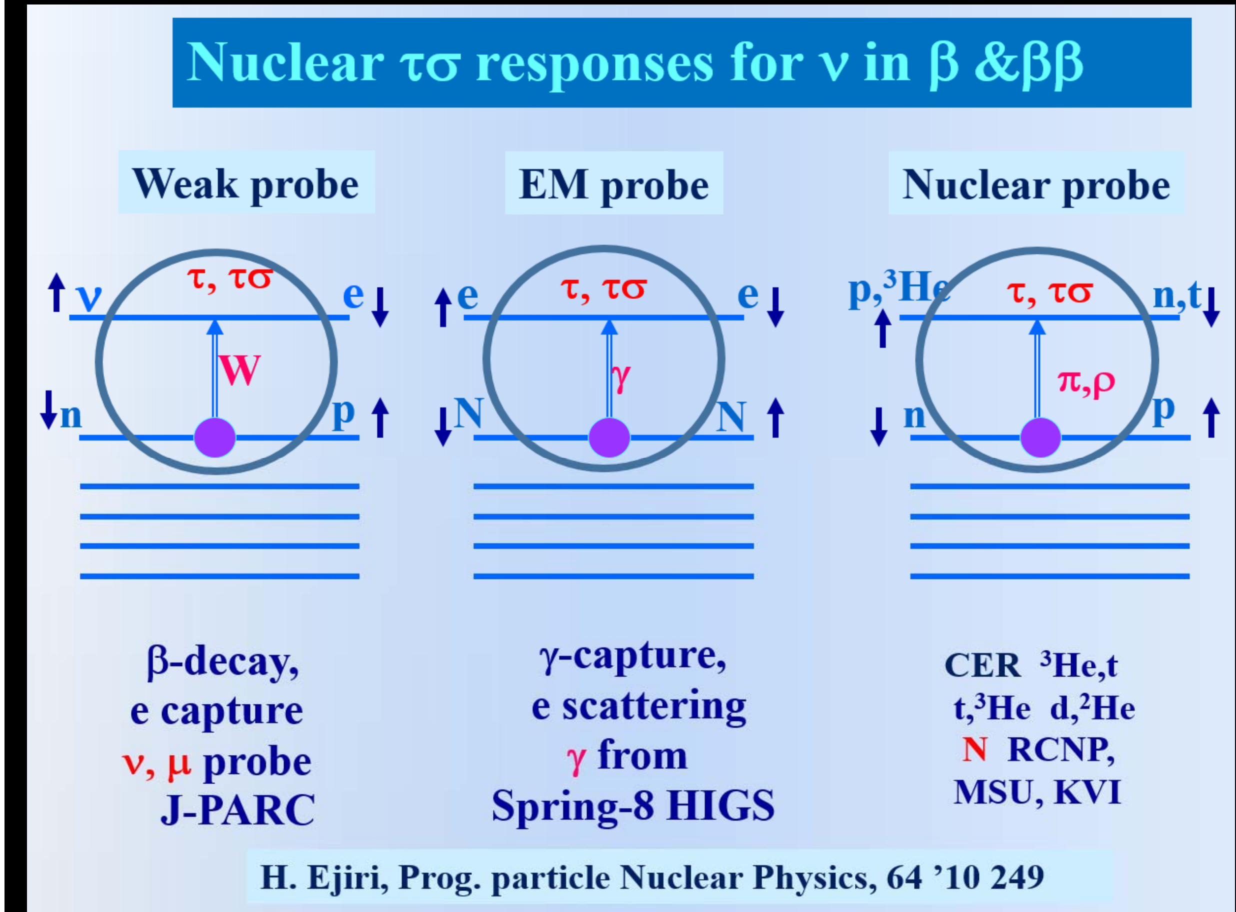
1-ton $L = 6 \ 10^{75} cm^{-2}$ /s

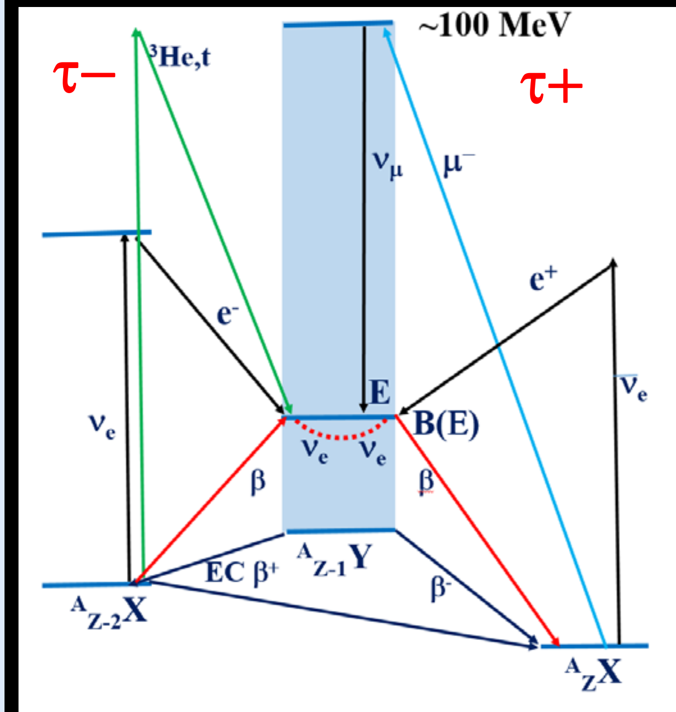
$\sigma \sim 10^{-83} cm^2$ IH

CER Probes for ν-responses

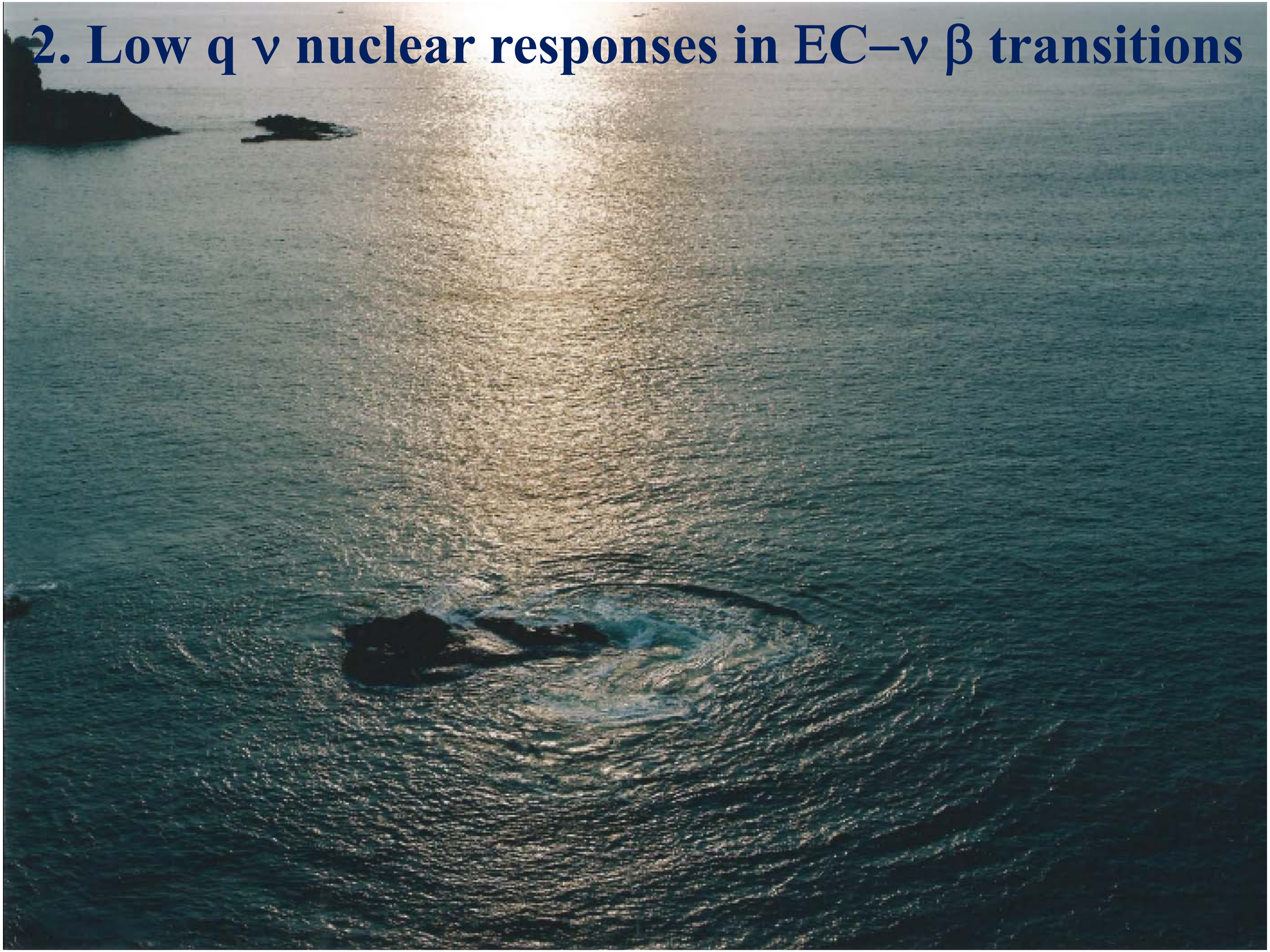
A q~3-10MeV/c β-decay, solar ν
B q~30-150 MeV/c ββ and super-nova ν







2. Low q ν nuclear responses in EC−ν β transitions



A: q~ 5 MeV/c β GT 1^+ 2^-, 4^- τσ axial vecor NMEs

M^m_{exp} =k M_{qp}

k= 0.2 – 0.3= $k_{\tau\sigma}$ k_{NM}

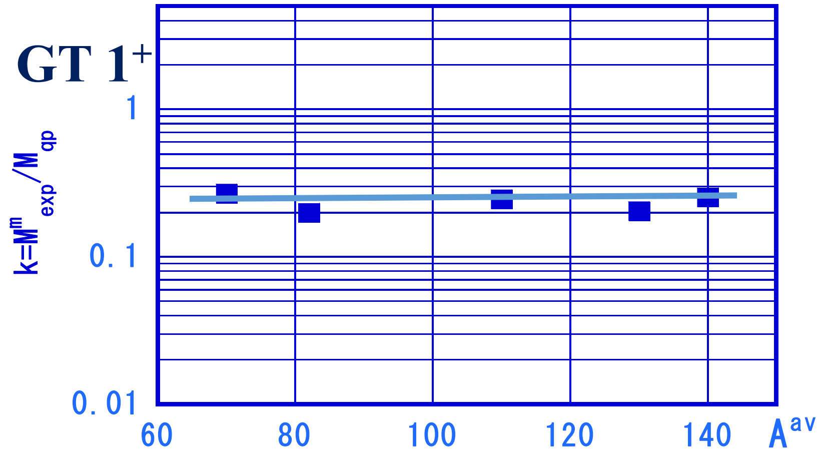
M_{QRPA}= $k_{\tau\sigma}$ M_{QP}

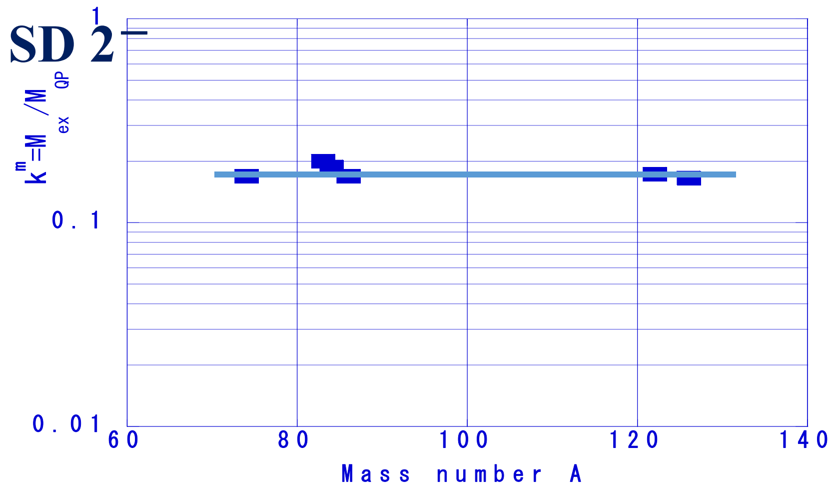
$k_{\tau\sigma}$ ~ 0.4 NN τσ

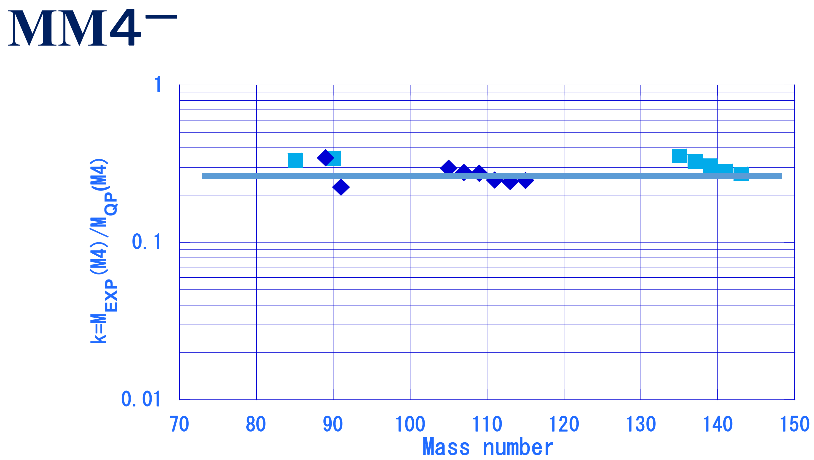
M_{exp}= k_{NM} M_{QRPA}

k_{NM}~ 0.6 = g_A^{eff} /g_A NΔ NM

H, Ejiri J. Suhonen J. Phys. G. 42 2015 0552
H. Ejiri N. Soucouti, J. Suhonen PL B 729 27
L. Jokiniemi J. Suhonen H. Ejiri
AHEP2016 ID8417598







Universal reductions Axial vector β

$M(SL)=<\tau^{\pm}(\sigma \times r^l Y_l>_J$

$M(EXP)=k\ M(QP)$

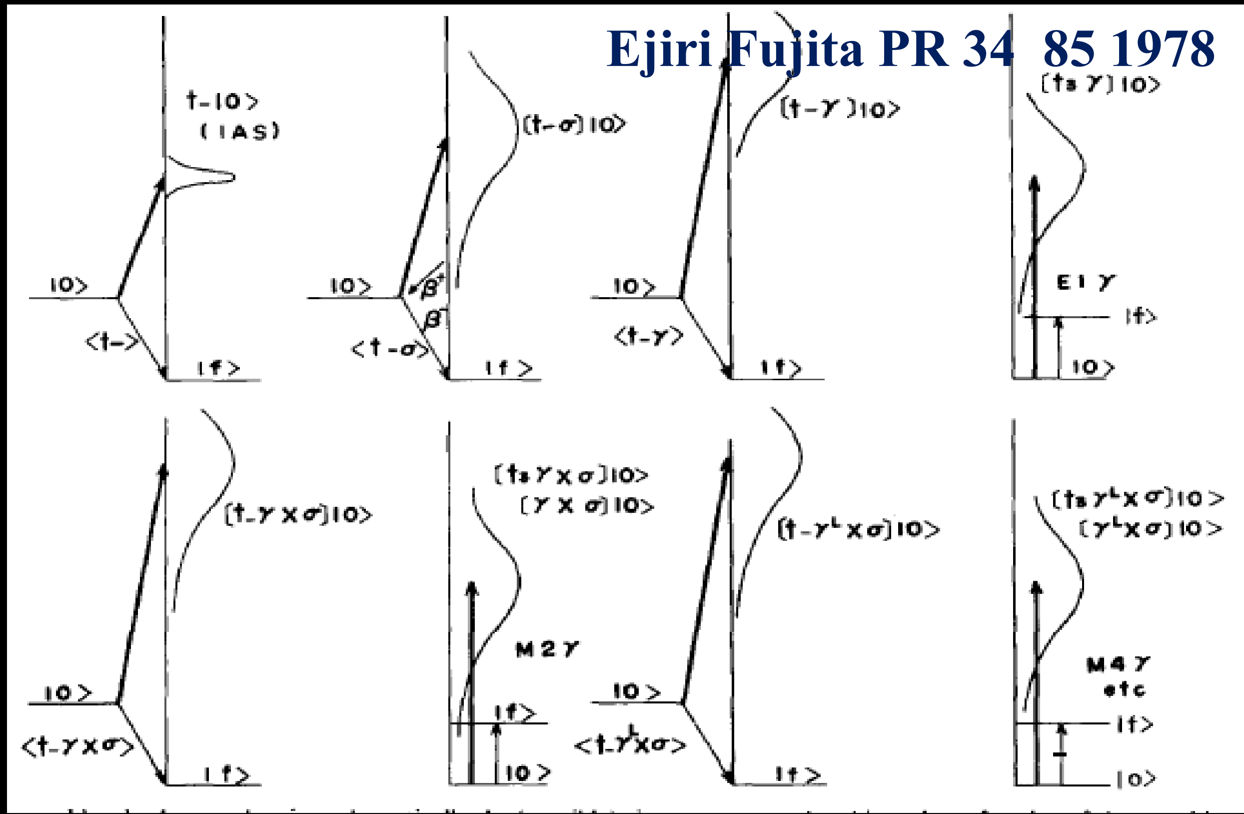
k~0.25
for spins of J=1,2,4
for low-q EC, β, 2νββ

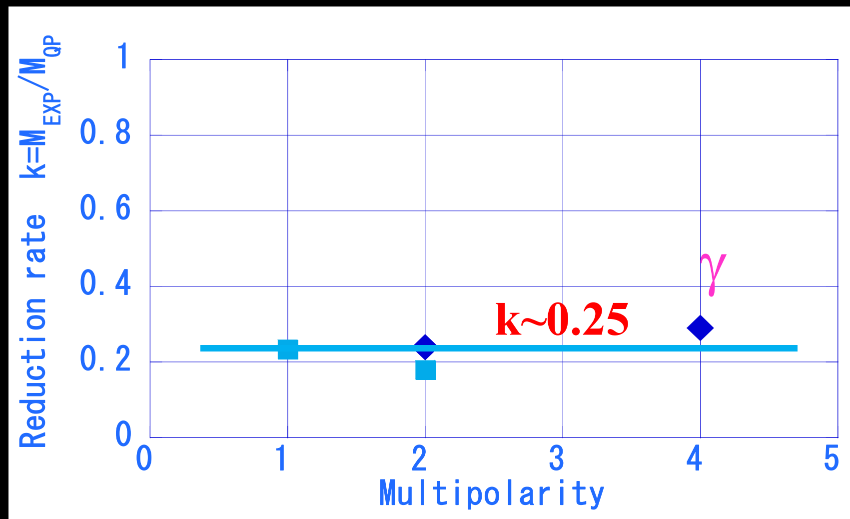
$k=k(\tau\sigma)\ k(NM)\sim 0.25$

$k=k(\tau\sigma)\sim 0.5$ τσ GR

$K(NM)\sim g^{eff}_A/g_A\sim 0.6$ Δ isobar GR

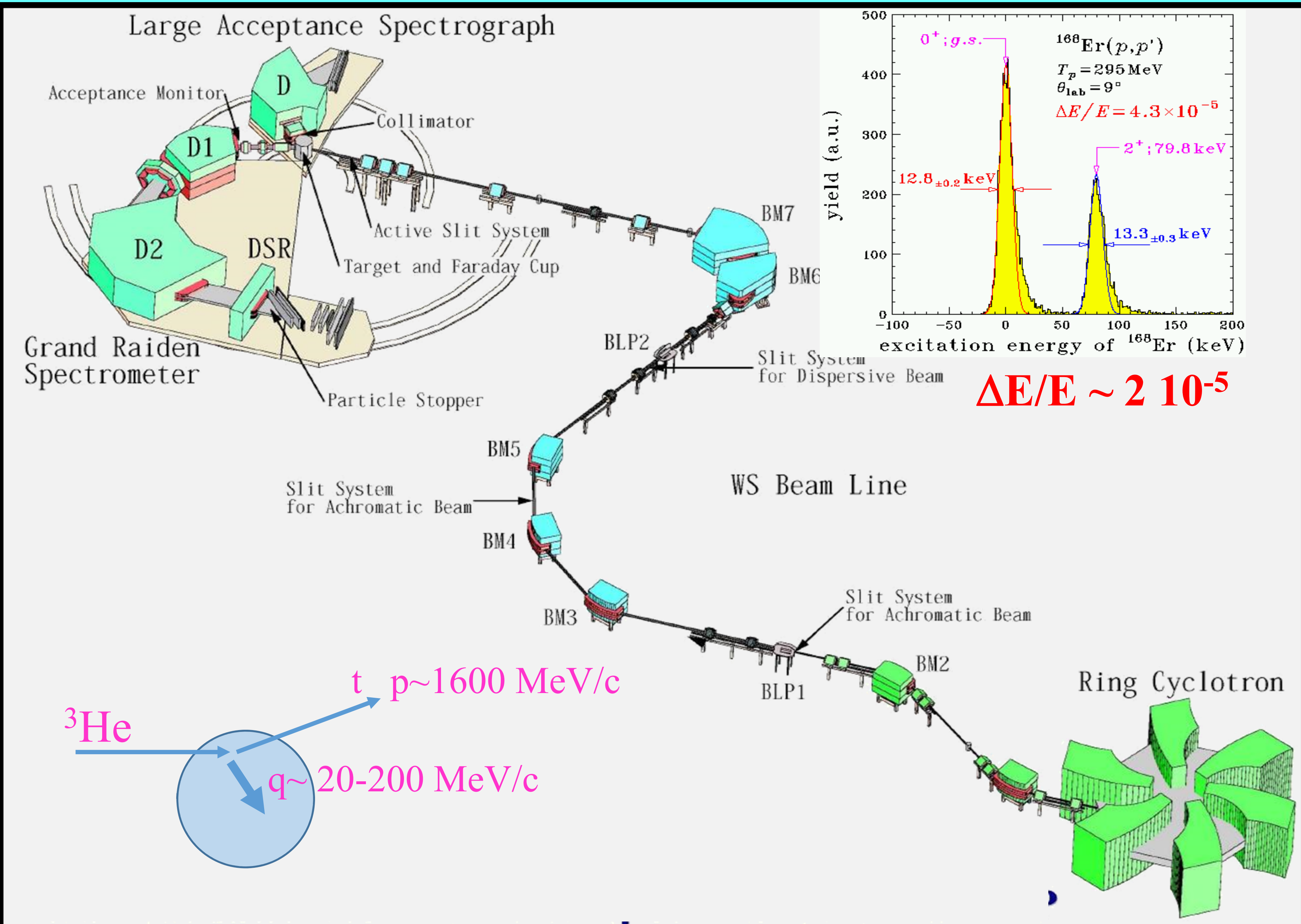
Ejiri Fujita PR 34 85 1978





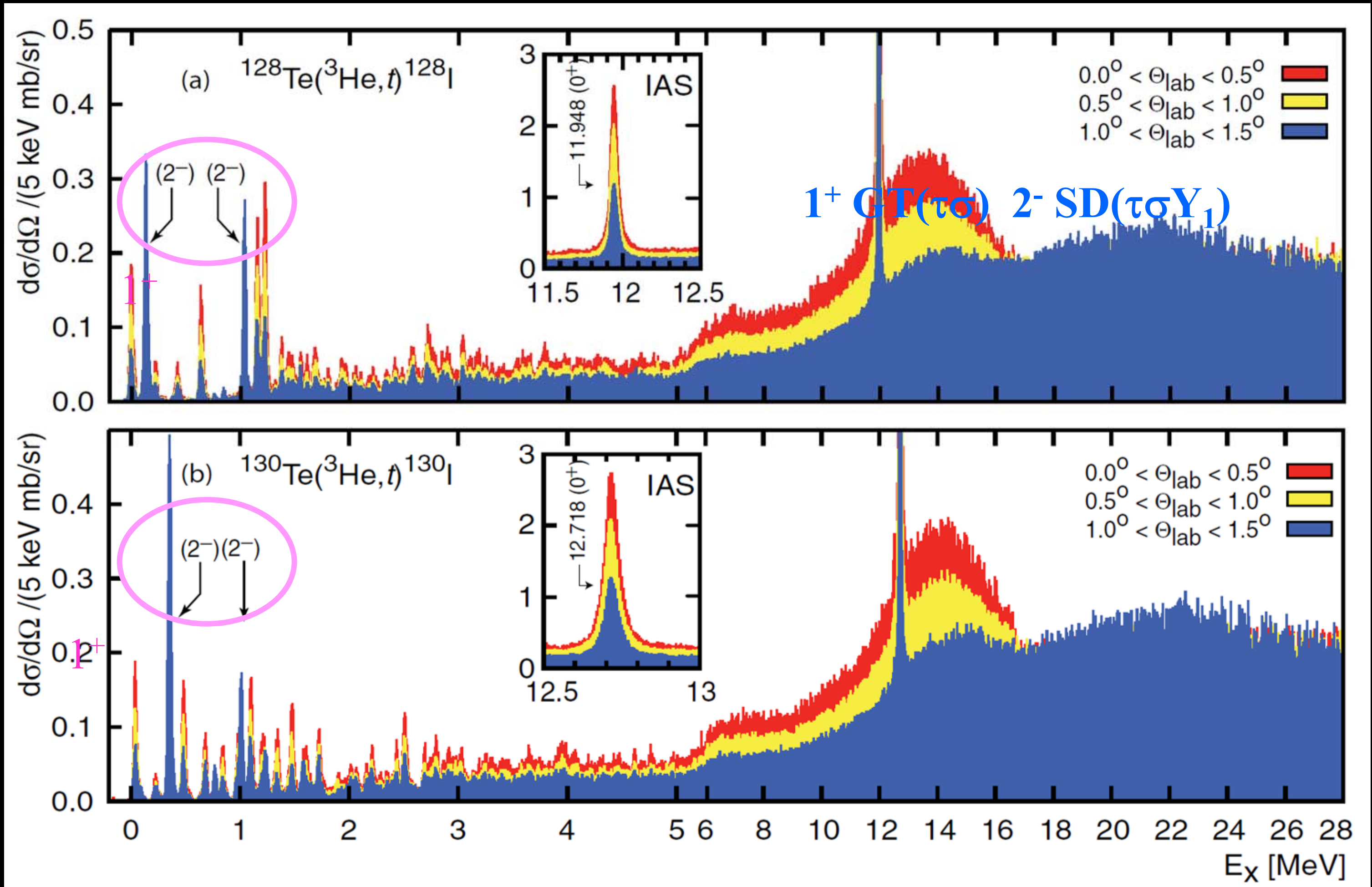

3. Medium q ν responses for DBD and SN νs.

B: High E resolution (^3He,t) CERs at RCNP Osaka for q~100MeV/c



DBD ^{76}Ge, ^{82}Se, ^{100}Mo, ^{128}Te, ^{130}Te ^{150}Nd show F, GT SD SQ states.

$M(J)= [\sigma\tau \times rY_l]_J$ θ=0~4 deg., q~ 20-150MeV/c J=0+, 1+, 2-, 3+



Several small low-states and large high-lying giant resonances

Te: Puppe, Akimune, Frekers, Ejiri, et al. PRC 86 044603 2012

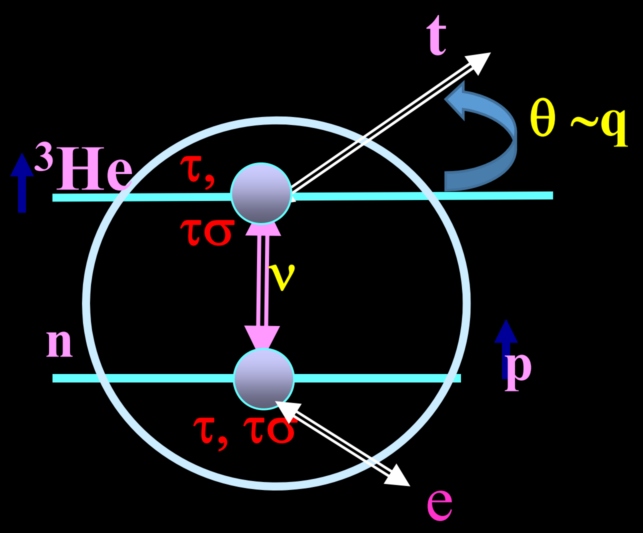
CER EXP at RCNP Akimune, H.Ejiri, D.Frekers et al 1994- 2016.

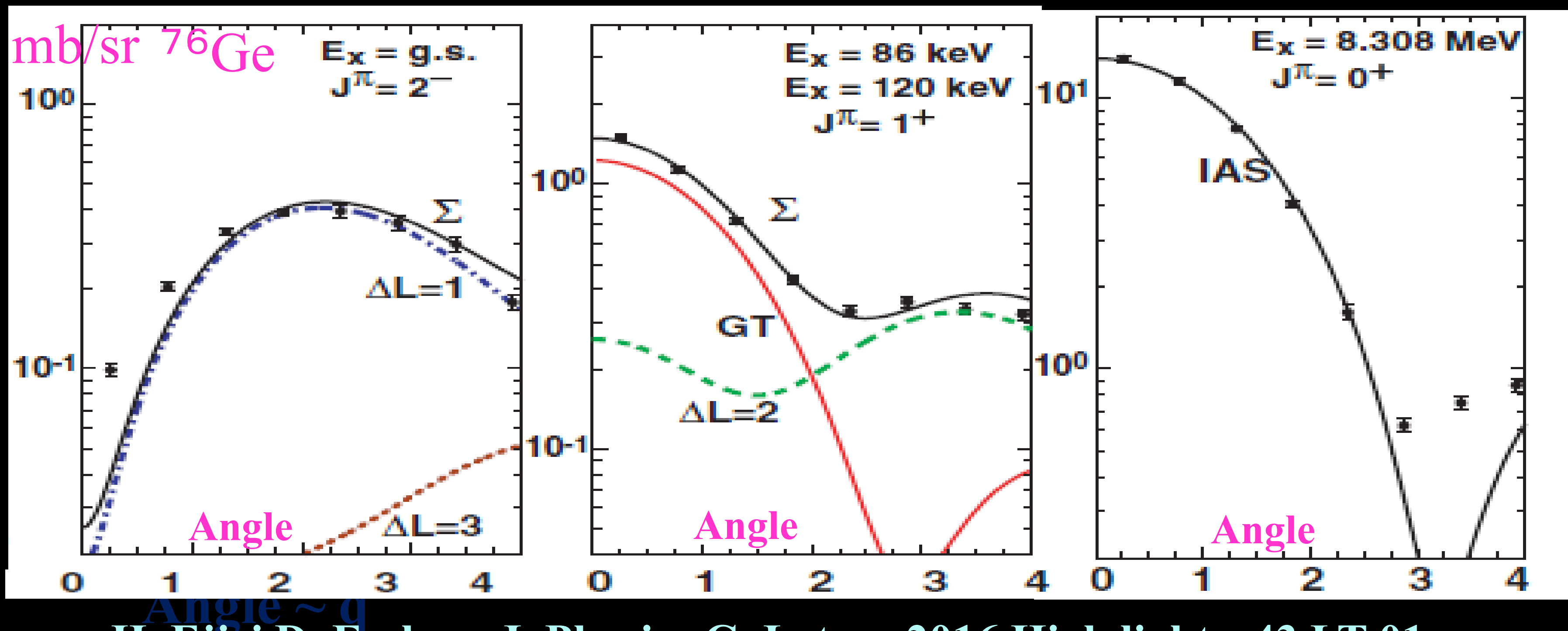
CER. F, GT &SD

$\sigma=[M(q)\,(j_l(qr)]^2 \sim K\,(g_A\,(q)j_l(qr)]^2$

j_0 for IAS, GT, j_1 for SD

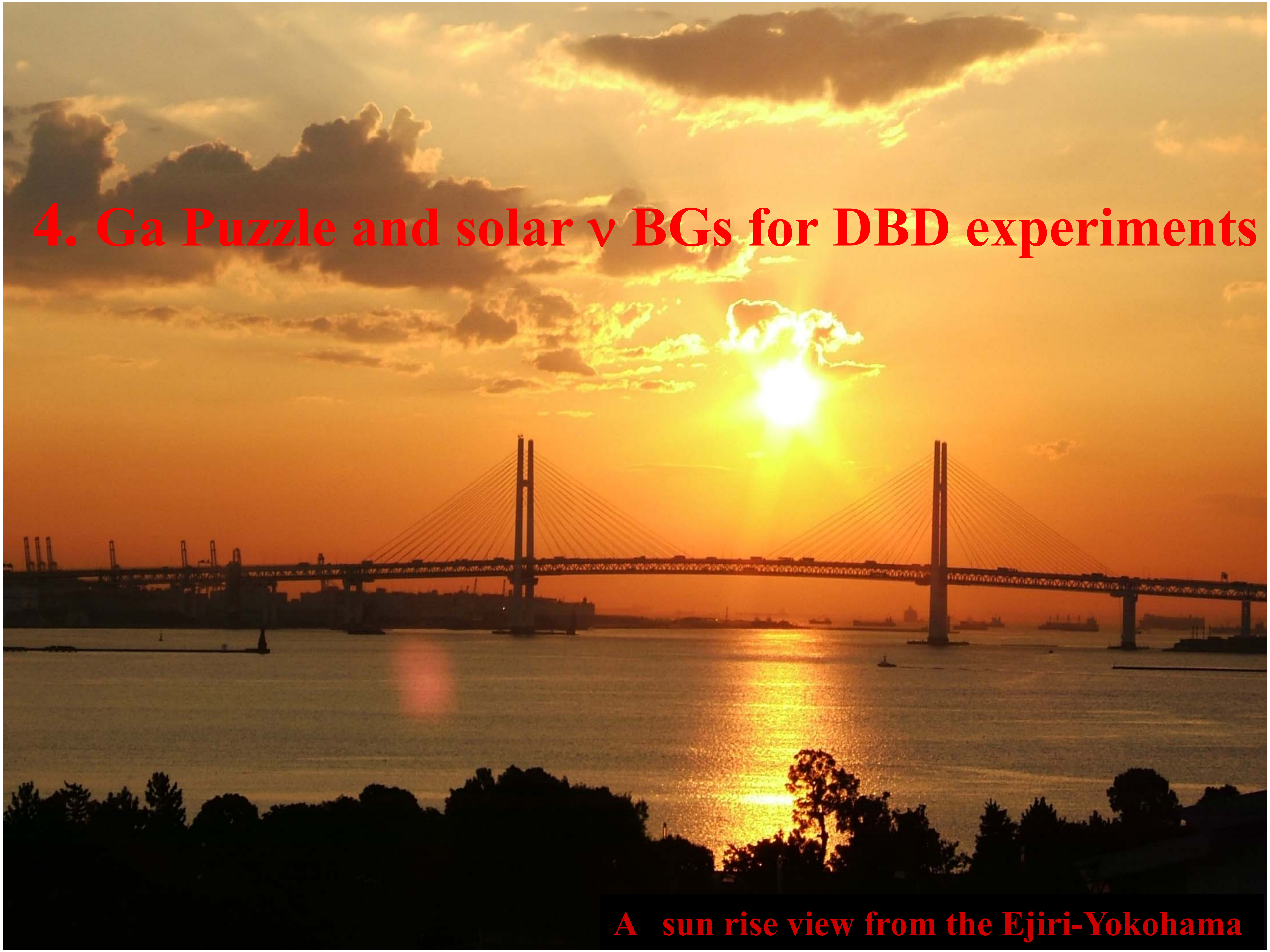
k(q), $g_A(q)$~const 0.25
over θ= 1-4 deg. q=0-150 MeV/c





H. Ejiri D. Frekers J. Physics G. Leter 2016 High lights 43 LT 01

4. Ga Puzzle and solar ν BGs for DBD experiments



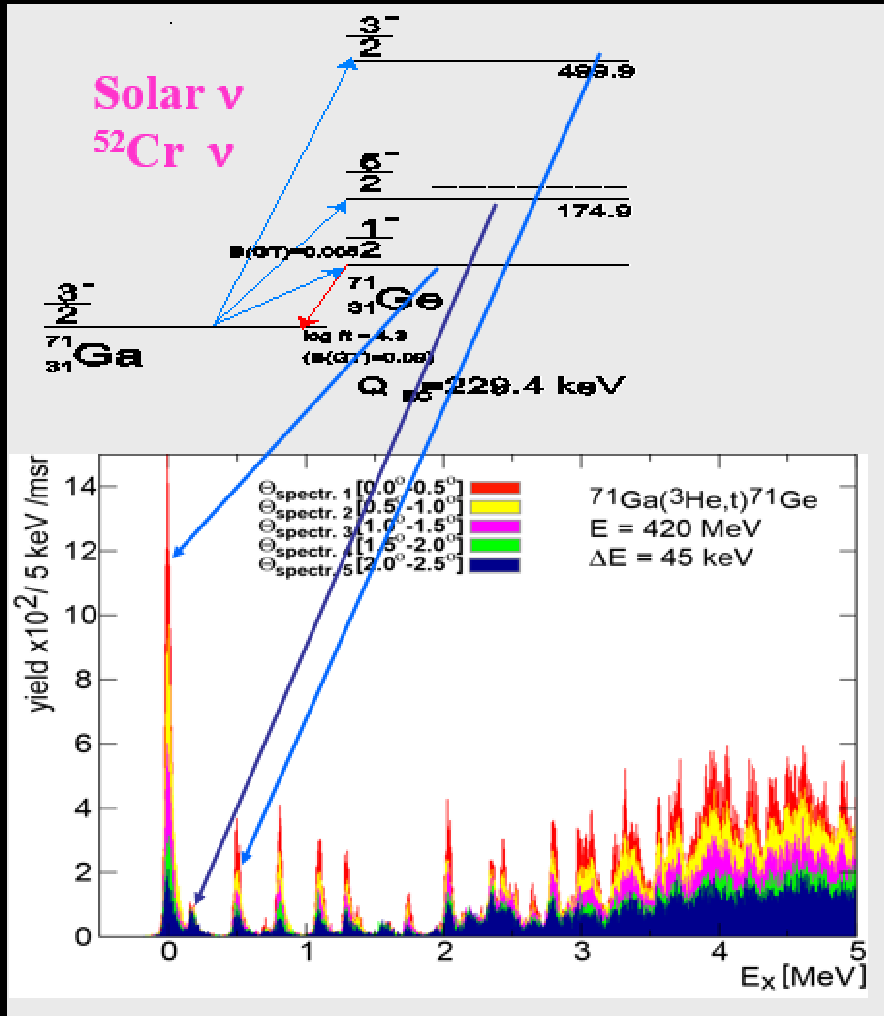
A sun rise view from the Ejiri-Yokohama

^{71}Ga neutrino response for ^{51}Cr and sterile ν ?

Ga detectors EXPs by
SAGE ^{51}Cr ^{37}Ar ,GALEX ^{51}Cr

Exp. average /Ga ν response
=0.87 ±0.05

1. GT response ?
2. Detector calibration ?
3. Sterile ν oscillation ?

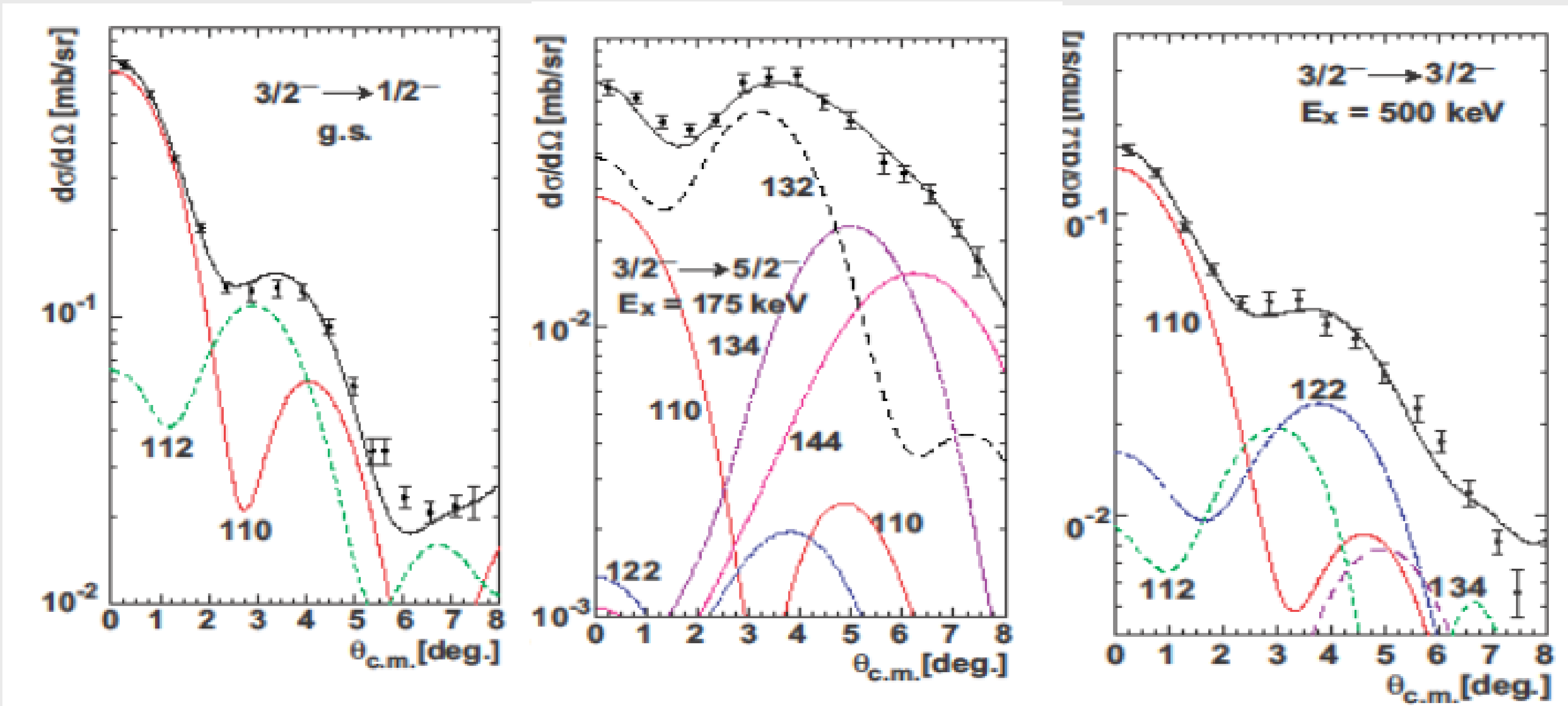


Ga response is based on Bahcall
Ga response by exp. (^{3}He,t) RCNP
V. Gavrin and H.Ejiri.

1998 H. Ejiri PL B 433 257
2011 Frekers Ejiri Gavrin et al. PL B 706 134 (2011)

Non-GT in CER $\sigma(q\sim0) = \Sigma\sigma(J_p, J_T, J_R) = \sigma(110) + \sigma(112) + \ldots$

$^{71}Ga \rightarrow ^{71}Ge$ **Ground state 1/2 known B(GT)**



Gr	0	GT ratio 92%	B(GT) =8.52	R(51Cr)=1.00
1 st	175	40%	0.34	0.027
2nd	500	87%	1.76	0.045

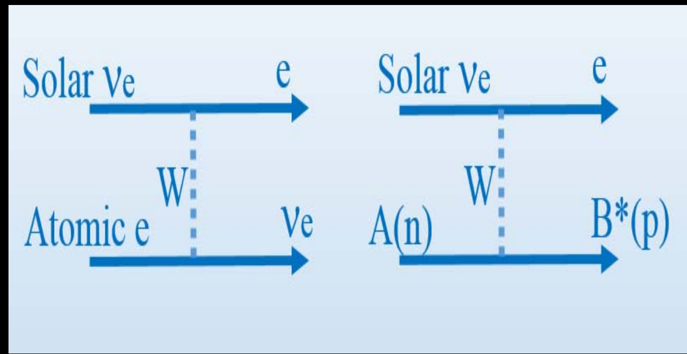
Excited state contribution=7.2 ±2% (Bahcall 5%, Ejiri 8%)

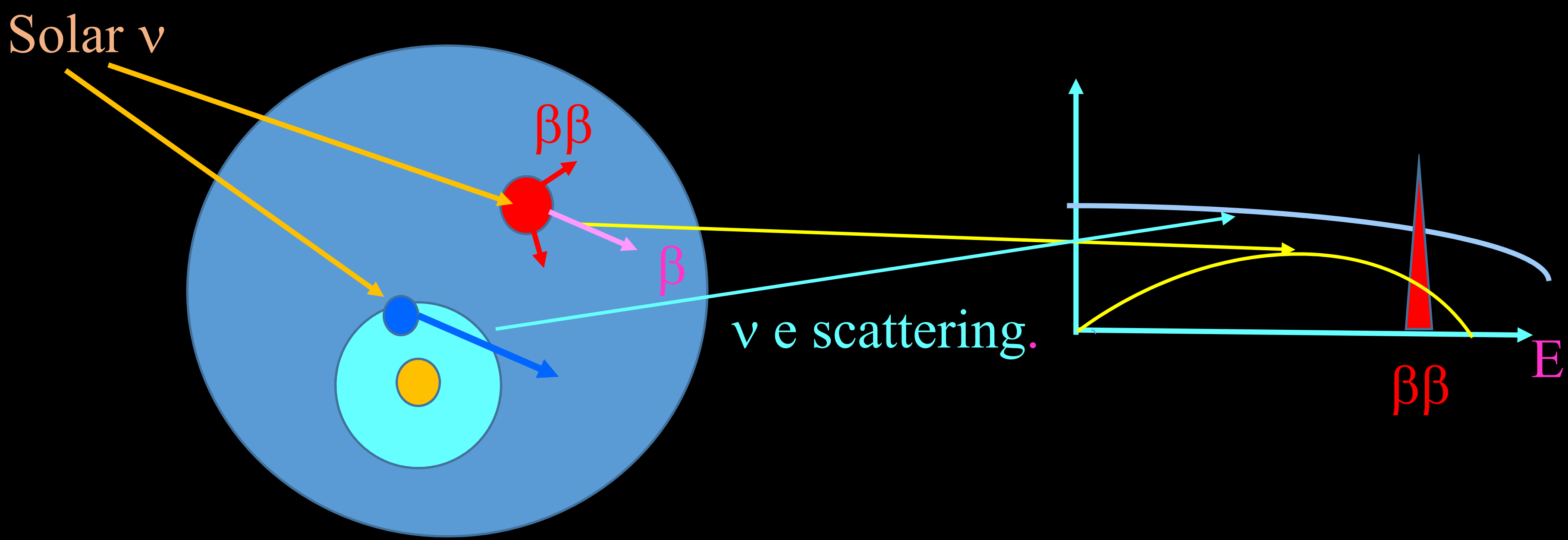
Using the measured response, missing = 0.85 (uncertainty 2%)

Solar-ν interactions with nuclei and atomic electrons in DBD detectors are serious BGs

- **Solar ν unavoidable.**
- **BG rate need to be < ββ signal rate**
- **E-resolution is a key element**

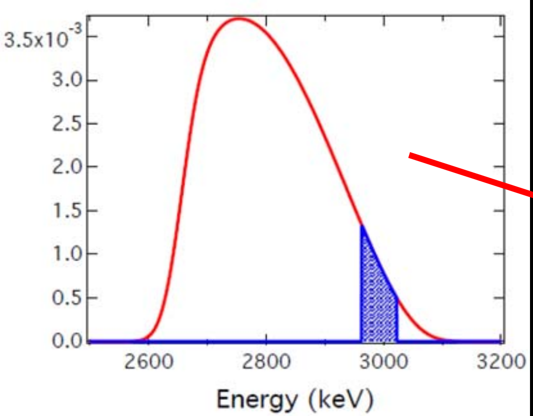
Solar ν response by CERs

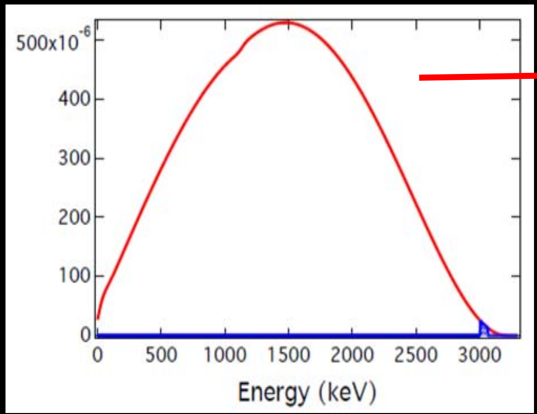


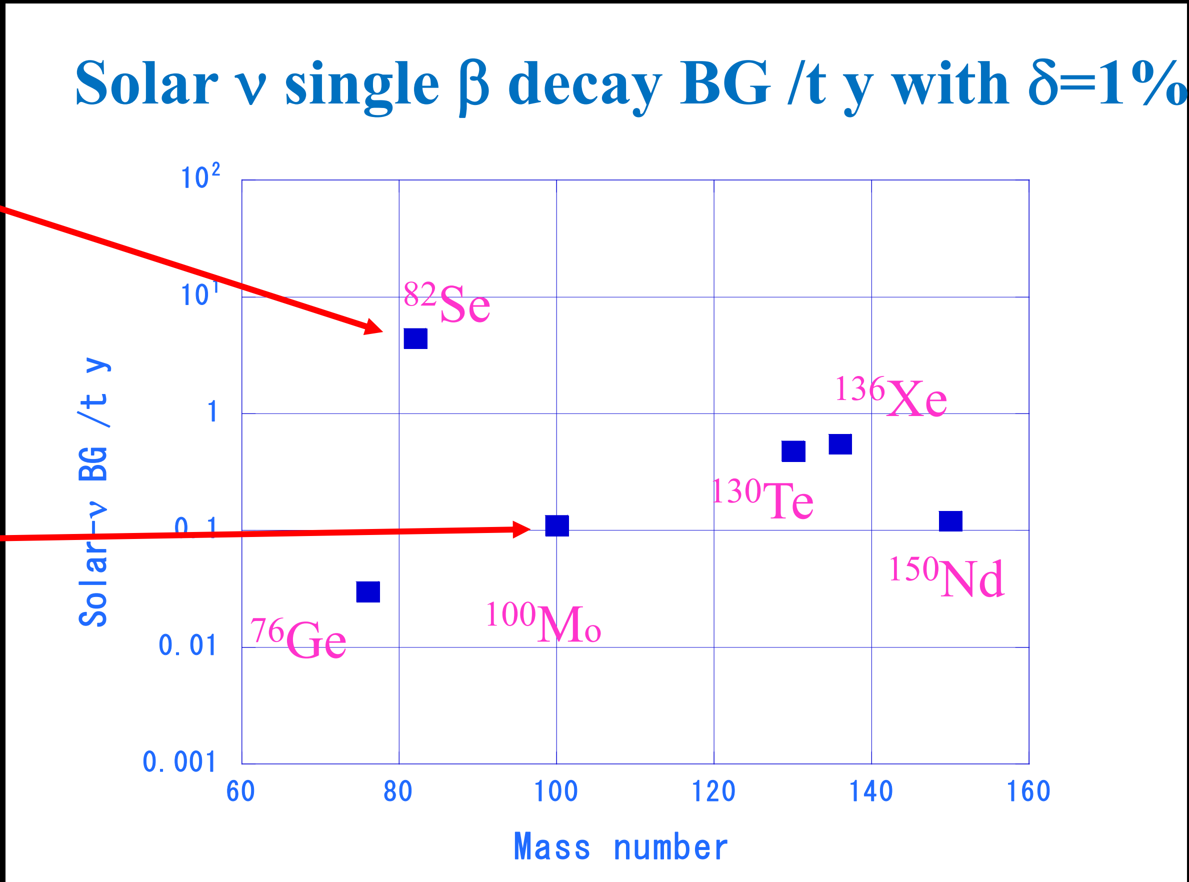


DBD rates for IH mass are 0.5-0.9 / t y except 0.2 for ^{76}Ge

Thus solar ν BG should be <0.2-0.3 /ty except <0.1 for ^{76}Ge







^{82}Se detector δ <0.1 % , and ^{130}Te ^{136}Xe δ <1% bolometers.

No plastic , liquid , ionization chambers.

H. Ejiri and S. Elliott PR C 89 055501 2014, PRC 95 055501 2017

Remarks

1. CER: High resolution (^{3}He,t) CERs, μ CER (μ,ν_μxn βγ) with P~60 MeV/c provide M(β^-, ν) and M(β^+, $\overline{\nu}$), to help theories for DBD $g_A{}^2$M(ββ) and astro g_AMν
2. M_{EXP} (β, 2νββ q~0) are reduced from M_{QP} by k^{eff}~ 0.25, $k_{\tau\sigma}$ ~ 0.4-0.5 by nucl. τσ, k_m ~ 0.5-0.6 by others ($g_A{}^{eff}/g_A$).
3. M_{EXP}(CER q=20-100 MeV/c) for 1^+, 2^- for low states are reduced from M_{QP} by the same k^{eff}~ 0.25 as M(β), suggesting the severe reductions for M(ββ) and M(SN-ν)
4. ^{71}Ga response for ^{51}Cr ν was measured, support missing of 87% . Solar ν BG for DBD IH is serious if δ>1%


Thank you for your attention
Sun set from the Ejiri-weekend house at Shounan