Delta–isobar (Δ) resonances and isospin-spin (τσ) couplings for weak (ν,β,ββ), electromagnetic (γ) and nuclear interactions.

Hiro Ejiri, RCNP, Osaka Univ.

- Nuclear matrix elements (NMEs) for neutrinoless ββ decays (DBD) and inverse β decays are crucial for studying ν properties beyond the standard model and astro-ν nuclear interactions. The NMEs consist mainly of the isospin spin (τσ) component. The τσ strength (square of the τσ NME) for DBD nuclei is studied experimentally by charge exchange reactions (CERs). The summed Gamow-Teller (GT τσ) and spin-dipole (SD $\tau\sigma Y_1$) strengths measured by CERs are shown to be reduced by half with respect to the nucleon-based sum rule limits. The τσ NMEs are shown to be quenched due to the non-nucleonic Δ-isobar giant resonance effect on the basis of the measured summed strength and the QRPA analysis with the NN and NΔ τσ interactions. The quenching effect is incorporated by using an effective τσ coupling of $g_{\tau\sigma}^{\Delta}/g_{\tau\sigma} \sim 0.7$ with $g_{\tau\sigma}$ being the τσ coupling for a free nucleon. The quenching coefficient is applied for the τσ components of weak, electromagnetic and nuclear interaction NMEs. Impact of the Δ giant resonance effect on ν studies in nuclei is discussed.

Refs. H. Ejiri, Phys. Rev. C 112 045505 2025.

- H. Ejiri, T. Fukuyama and T. Sato Phys. Rev. C 111 065501 2025

A brief note on Prof. Hiro Ejiri since 1936-2-21.

1. Born in the same 1930's as the nucleus with n & p by Heisenberg et al.
2. Start nuclear exp. of β rays in 1958 at Univ. Tokyo being inspired by the coherent nuclear excitations by Bohr Mottelson in 1953-54, the Delta resonance, the discovery of neutrinos by Reines and Cowan in 1956, and
- the P-violation of the weak force in 1956 by Lee Yang Wu
3. The first paper in 1960 on nuclear resonances.
4. PhD in 1963 at Univ. Tokyo by nuclear coherent excitations of sd-nuclei.
5. Works: Univ. Tokyo INS, Univ. Washington NPL, Univ. Copenhagen NBI, Univ. California LBL, Osaka-Univ. Phys. & RCNP (Director), SPring -8, Univ. Washington CENPA, ICU Tokyo, IIAS Kyoto, CTU Prague, others.
6. Subjects: Nuclear and hyper nuclear structures and reactions, weak(ν), EM and nuclear interactions and β–γ spectroscopy for NEWS, and others.
7. DBD with ELEGANT since 1982 and CERs for ν response since 1993.
8. Supervisor for ~40 PhD's in 4 countries.
9. Today's talk in NEWS is mainly on the recent works of Δ giant resonances and τσ couplings for Neutrinos, Weak and Electromagnetic interactions and Symmetries..

Delta–isobar (Δ) resonance and isospin-spin (τσ) coupling for weak (ν,β,ββ), electromagnetic (γ) and nuclear interactions.

Hiro Ejiri RCNP Osaka-U 2026-2-26

Thanks Prof. T. Shima and Prof. A. Tamii

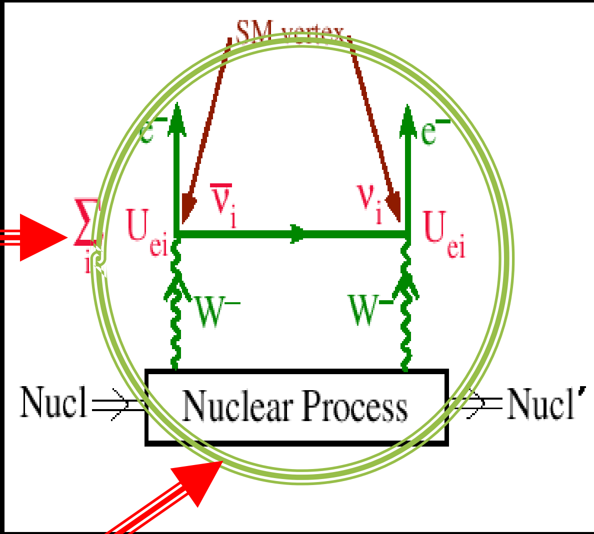
The present subject is concerns with Nuclear Interaction involved in ν and Weak NMEs

In case of 0νββ $A = B + \beta + \beta$

Lepton number ΔL=2 beyond SM.

•

Particle astro physics
Majorana ν, m_ν CP, RHC



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

EXP

NME : Nucl. phys.
g_A Delta (Δ) GR ,
τ σ correlation

ββ Review Doi Kotani Takasugi PTP 1985,
ROPP 2012 J. Vergados, H. Ejiri, F. Simkovic, .

Subjects to be discussed

- 1. Spin isospin NMEs and NN and NΔ GRs (Giant Resonances.)
- 2 GT and SD summed strengths and $g_{\tau\sigma}^{eff}(\Delta)$
- 3. NEWS (Neutrino, Electromagnetic, Weak and
- Symmetries) with NΔ GR
- 4. Concluding remarks

- For question, indicate the page number

PHYSICAL REVIEW C **112**, 045505 (2025)

Δ-isobar resonance effects studied by $\tau\sigma$ summed strengths and nuclear matrix elements for β and $\beta\beta$ decays

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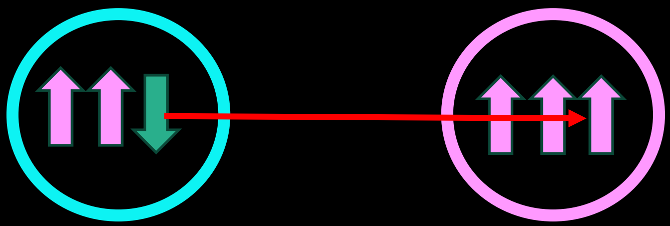
(Received 13 February 2025; revised 30 August 2025; accepted 26 September 2025; published 20 October 2025)

Nuclear matrix elements (NMEs) for neutrinoless $\beta\beta$ decays and inverse-β decays are crucial for studying ν properties beyond the standard model and astro-ν nuclear interactions. The NMEs consist mainly of the isospin (τ) spin (σ) component, and the $\tau\sigma$ strength (square of the $\tau\sigma$ NME) is studied experimentally by charge exchange reactions (CERs). The summed Gammow-Teller ($\tau\sigma$) and spin dipole ($\tau\sigma Y_1$) strengths measured by CERs are shown to be reduced half with respect to the nucleon-based sum-rule limits. The $\tau\sigma$ NMEs are shown to be quenched due to the non-nucleonic Δ-isobar resonance effect on the basis of the measured strengths and the quasiparticle random-phase approximation analysis with effective nucleon-nucleon and $N\Delta$ $\tau\sigma$ interactions. The quenching effect is incorporated by using an effective $\tau\sigma$ coupling of $g^{\Delta}_{\tau\sigma}/g_{\tau\sigma} \approx 0.7$ with $g_{\tau\sigma}$ being the coupling for a free nucleon. The quenching effect is applied to the $\tau\sigma$ components of the weak, electromagnetic and nuclear interaction NMEs. Impact of the Δ-resonance effect on ν studies in nuclei is discussed.

1. Nuclear Physics with nucleons /baryons/Δ



Nucleon τ σ flip Δ

Quark uud udd τ=σ=1/2 uuu, uud, udd, ddd τ=σ=3/2

1. Nucleus = A baryon interacting system : A=10 -200 (baryon number A) and Z (charge Z) and S=0 strangeness.
with strong τ σ r dependent nuclear (meson) field $V_N \sim 30$ MeV

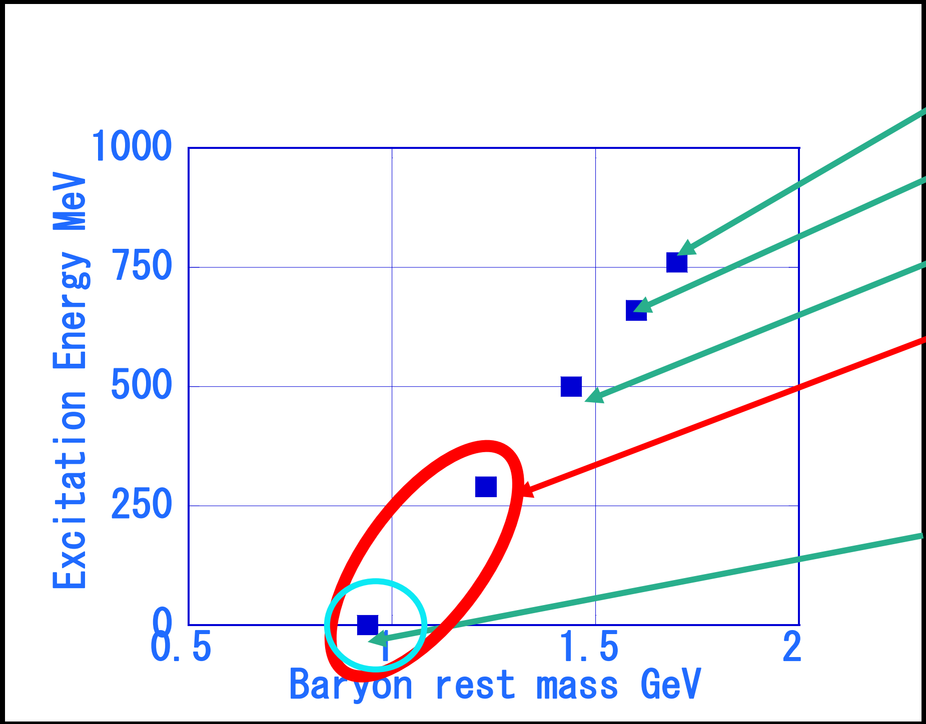
Photo-disintegration of a nucleus yields A baryons and many mesons and photons, but not Z protons , N neutrons.
A-interacting nucleon system is Ok in some cases, but not in many others like weak, EM and nuclear transitions.

2. The present talk is on nuclear matrix element NMEs for
low-E = a few MeV : β–γ, DBD-ν, SN-ν, nuclear reaction
<< non-nucleon baryon mass excess E~0.3-0.5 GeV.
Nucleon model with nucleons and nucleon interactions ???? No
Non-nucleonic baryon effects $V/E_\Delta \sim 0.01$ negligible ??? No

Baryons in low-energy (1-01 MeV) Nuclear Physics

Nucleons n, p (constituent udd, uud) with σ=1/2 τ=1/2 0.94 GeV

Delta Δ^{++} Δ^{+}, Δ^{0}, Δ^{-}, with uuu,udu,udd,ddd σ=3/2, τ=3/2



ΣK (uds s-bar u) Hyperon K

Λk (uds s-bar u) Hyperon λ

N*1440 ud, one radial excited d

Δ^{++} Δ^{+}, Δ^{0}, Δ^{-} τσ quark excitation Nπ Present

N (n,p) ud quark ground state & low-E nuclear physics with n/p in a 30 MeV well.

Low-E state (single QP (quasi-particle state) with mixings of nuclear state b and Δ state as |i>=|a> + k|b> +k'|Δ>

k=v/E (a few MeV) , k'=MeV/0.3 GeV : Not neg.

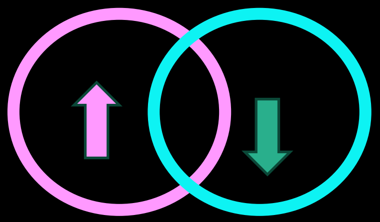
Giant resonances in nuclei and core polarization

Ground state |0> in the shell model potential (frozen nucleus T~0)
QP excitation to higher (MeV) shell. $|i\rangle = \alpha^{+}|0\rangle$ single QP state.
Giant resonance (vibration/photon)

T|0> T-phonon:GR

$V = \chi\, T \cdot T$ Interaction

[H,T]~ET commutator relation



$T = \tau$ Isospin GR IAS $= \Sigma\, \tau^-$ N-Z n↔p vibration

$T = \tau\sigma$ Isospin spin GT-GR

$T = \tau\sigma Y_1$ Isospin spin dipole SD –GR

$T = \tau_3 r Y_1$ EI –GR

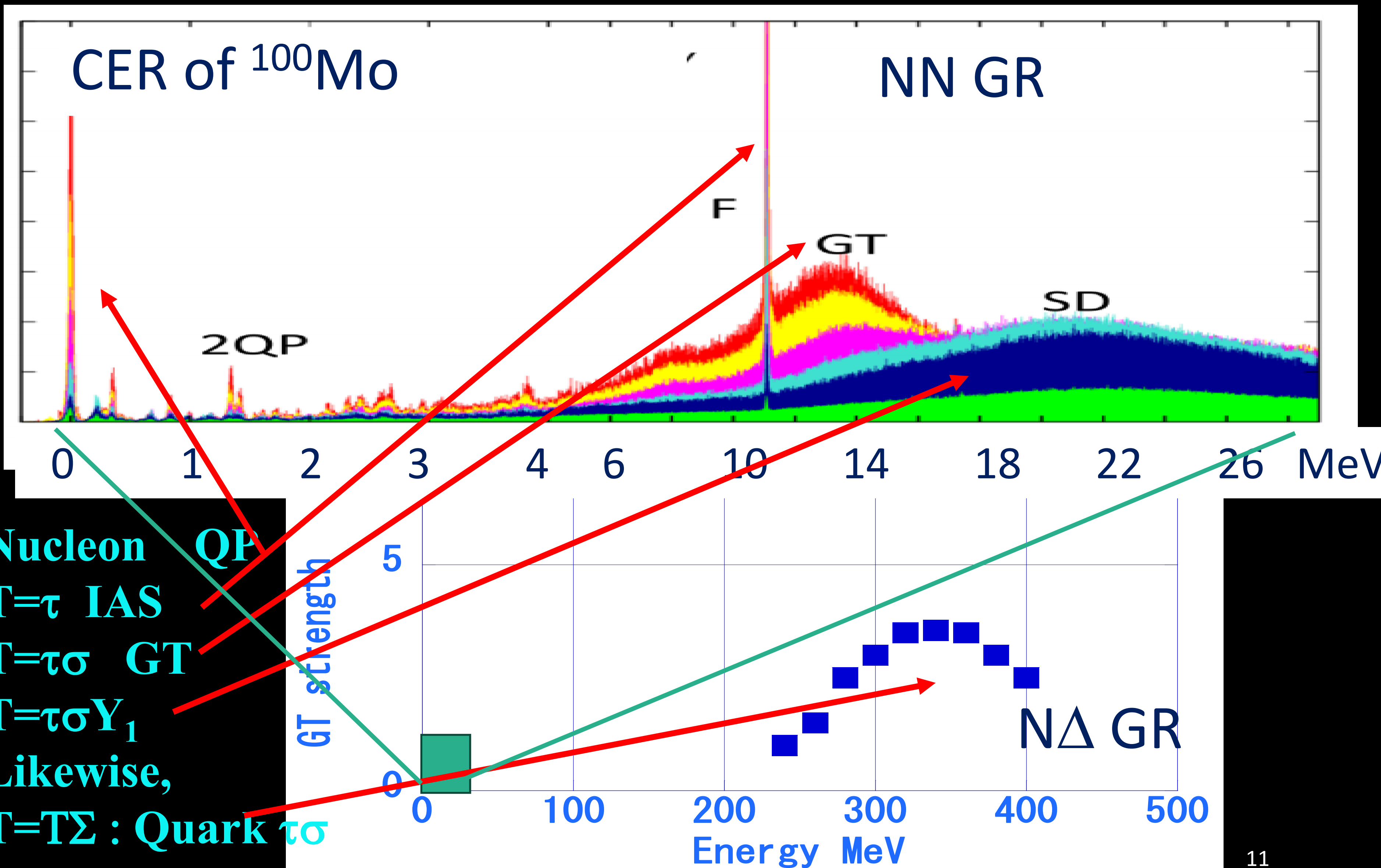
$T = \tau\sigma Y_n$ Iso-vector spin multipole GR

$T = r^2 Y_2$ E2 phonon

Spin Isospin repulsive interactions give rise to GRs at higher E.
EL attractive interaction pushes down the EL phonon states

This talk: extends to the quark $\tau\sigma$ Δ GR.

3. RCNP τσ CER. GT and SD summed στ strengths shift to NN GR and NΔ GR , leaving only ~ a few % in QP. Region.



Nucleon QP

T=τ IAS

T=τσ GT

$T=\tau\sigma Y_1$

Likewise,

T=TΣ : Quark τσ

GR -NME absorbs most T-mode strength (NME=M)

$|GR\rangle = \Sigma c_k |f_k\rangle$

Coherent sum of QP states with $k \sim 20 \gg 1$ $c_k \sim 1/k^{1/2}$

GR NME $M(GR) = \Sigma c_k M_k \sim k^{1/2} M(QP)$

$S(GR) = |M(GR)|^2 \sim k\,|M(QP)|^2 \sim$ Total sum

IAS (Fermi GR) : $k=2T_z=N-Z$ sum of n-p QP-F states and absorbs full N-Z Fermi strengths (M(F)=1) .

GT GR : N-Z GT QP states, and absorbs most GT strengths , N-Z of [M(GT)=3]. IFF rule

Non-GR QP NME is reduced much because the strength is taken away by the GR, i.e. destructive interference with GR.

$|f\rangle \sim |f\rangle - \varepsilon|GR\rangle$ $M \sim M(QP) - \varepsilon M(GR)$ i.e.

$M \sim M(QP)/(1+\chi)$ with $\chi \sim \varepsilon\, M(GR)/M(QP)$ susceptibility

$\sim (g^{eff}/g) M(QP)$ with g^{eff}: effective (renormalized) coupling.

g being g_A in case of the axial-weak NME

$g^{eff}/g \ll 1$ in case of repulsive V, while $\gg 1$ like e^{eff} if attractive.

Effective couplings g^{eff} for β–γ transitions and NN-giant resonances

1978 PR38 H.Ejiri, J.I. Fujita

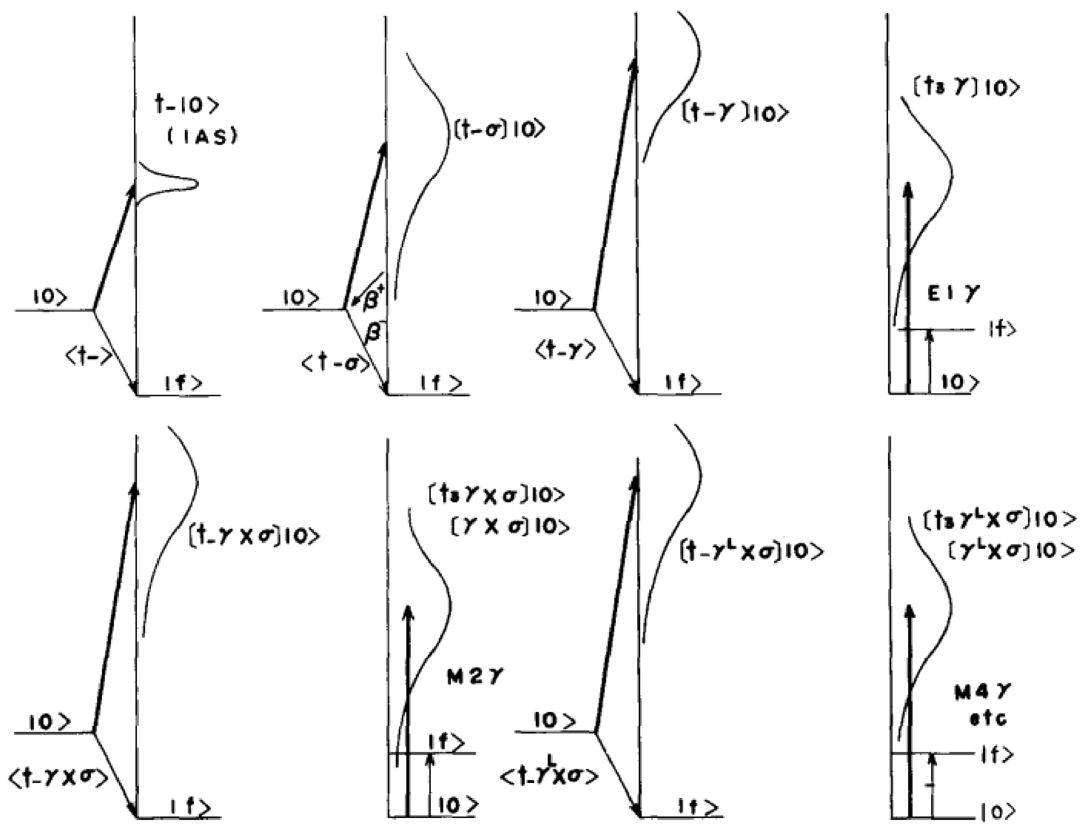


Fig. 2. Transition and level schemes showing schematically the (possible) giant resonance absorbing a large fraction of the transition strength, and the reduced single particle transition.

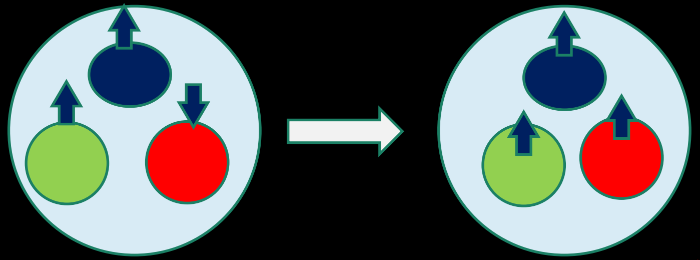
$g^{eff} = g/(1+\chi)$ has been used to incorporate NN τσ GR (GT, SD)

Present : extend to the Δ GR in DBD nuclei

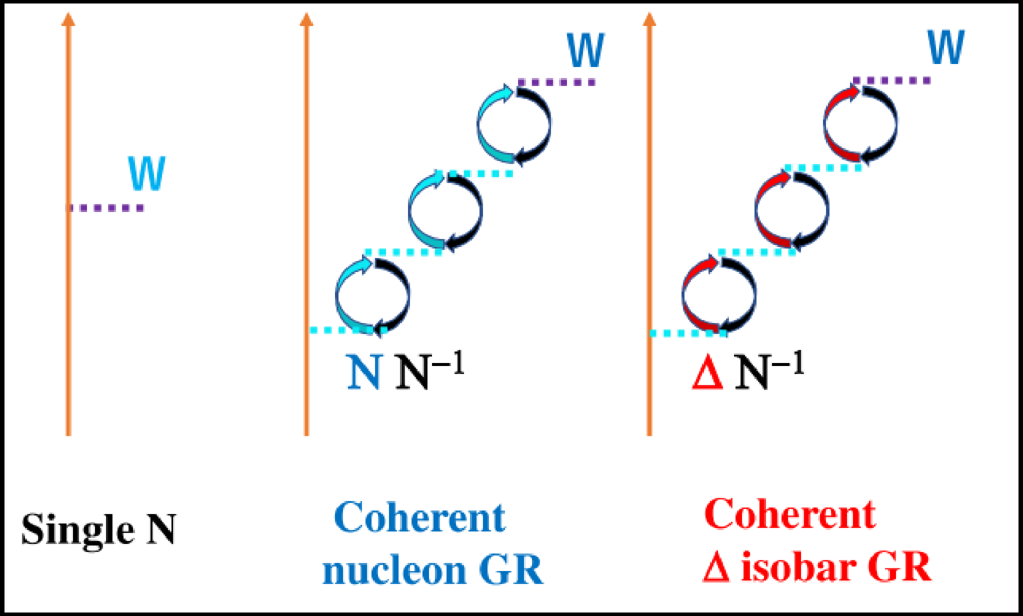
Nuclear physics with A

A = No of Baryons, p,n,Δ etc.

with interaction fields of π, ρ, τσ Y



Nucleon quark σ τ flip to Δ

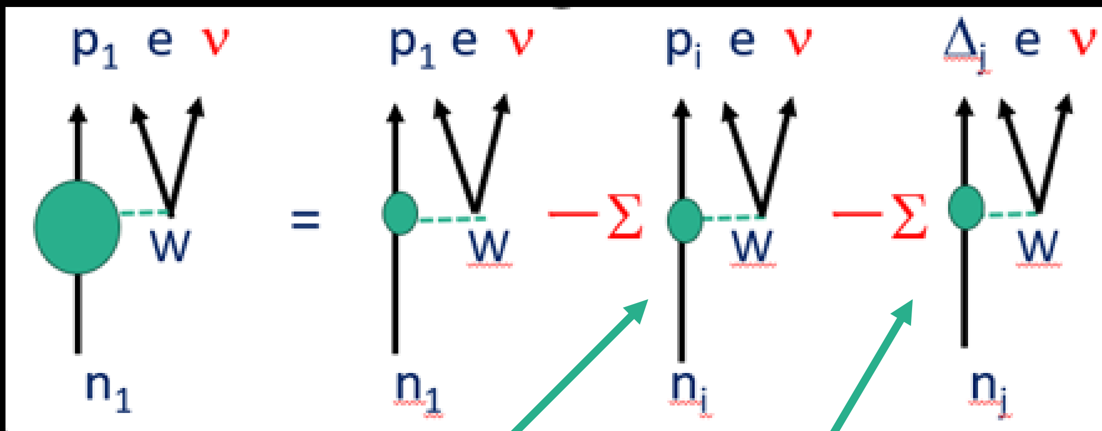


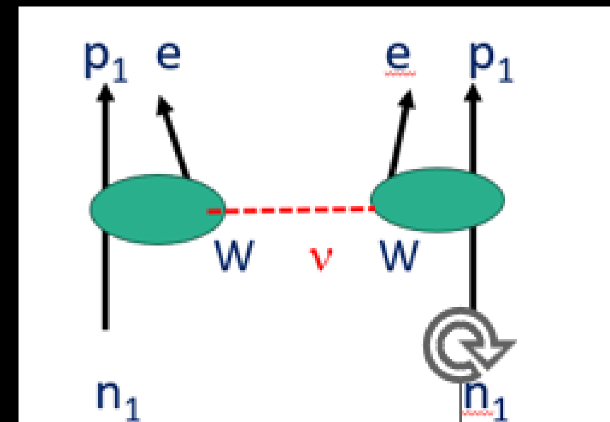
Baryons like Δ(1232) etc are effective in case of resonances, i.e

1. Amplitude : a_i=(V/(300 MeV) = 0.001,
2. No N ~ 100 in case of A=100 DBD nuclei.
2. Probability ~ N $(a_i)^2$=0.0001per nucleus.
3. NME= $\Sigma\, a_i \times M_i\,(\tau\sigma)$= 100 of 0.001 M ~ 0.1 effect

Weak $n^{-1}p$ with $n^{-1}p$ GR and $N^{-1}\Delta$ GR

$|i\rangle \Rightarrow |f\rangle = |f_1\rangle - \varepsilon||GR\text{-}N\rangle - \delta|GR\text{-}\Delta\rangle$





$M = M_0 - \varepsilon M(GR\text{-}N) - \delta M(GR\text{-}D)$ Tamm Dancoff

NN: $(V = 0.3$ MeV $)/10$ MeV = mixing amplitude $\sim 3\ 10^{-2}$

$(3\ 10^{-2}) \times$ (N-Z =20 coherent) =0.6 quench 0.4 .

NΔ: (V=0.3MeV/300 MeV mass difference

= mixing amplitude for A=100 is $\sim 10^{-3}$.

A -nucleons produce A Δ of Δ^0 Δ^- Δ^+ Δ^{++} coherent ~100

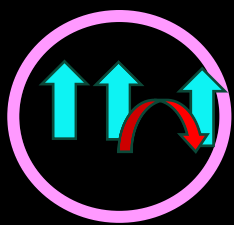
$10^{-3} \times A \times 2$ for f and b =0.2, reduce $K_\Delta = 0.8$ reduction

Δ probability in A nucleus $= (10^{-3})^2 \times 2A = 2\ 10^{-4}$

DBD with ν exchange in 2 quarks I

n N or Δ in 2 + DBD

Enhanced by $1/r_{ij}$



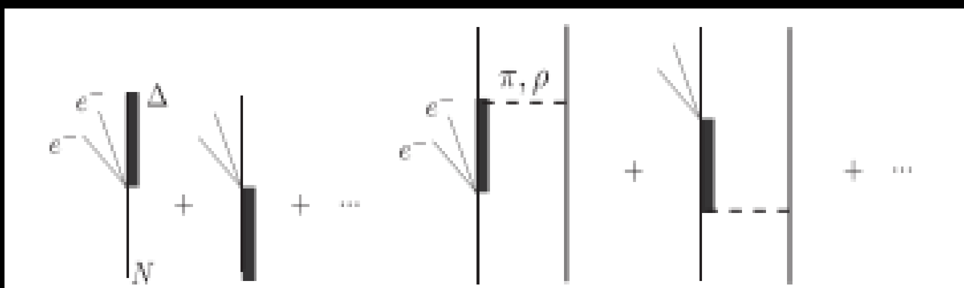
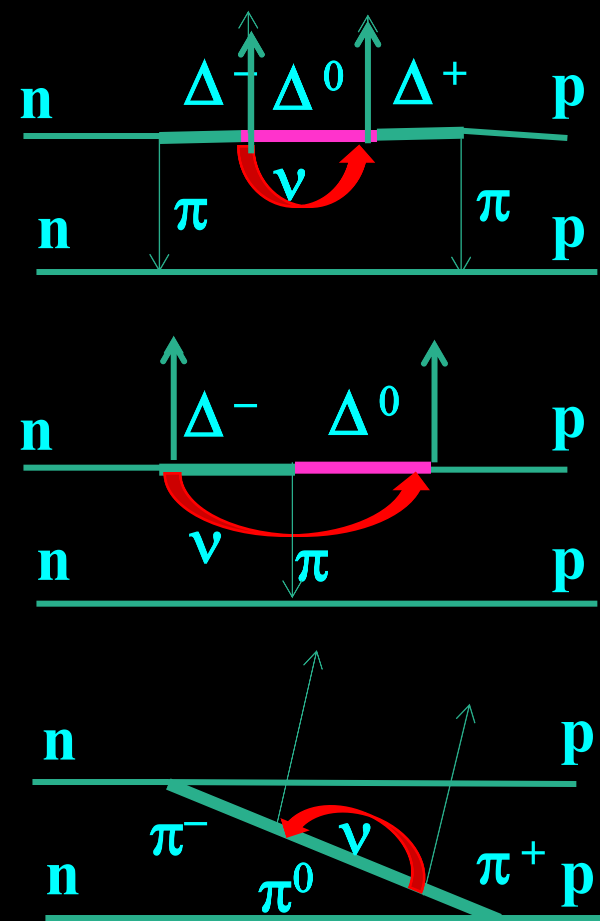
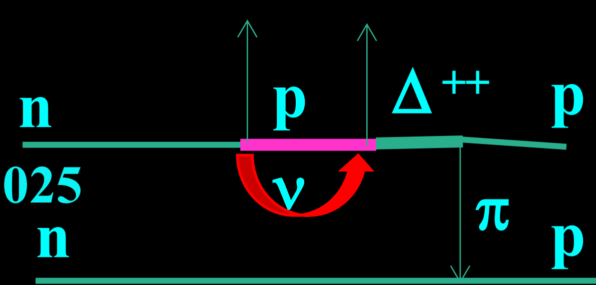


FIG. 2. Diagrams of neutrino exchange within a baryon. The left panel shows 0ν DBD of the N ↔ Δ transition. The right panel shows the Δ mechanism of DBD.



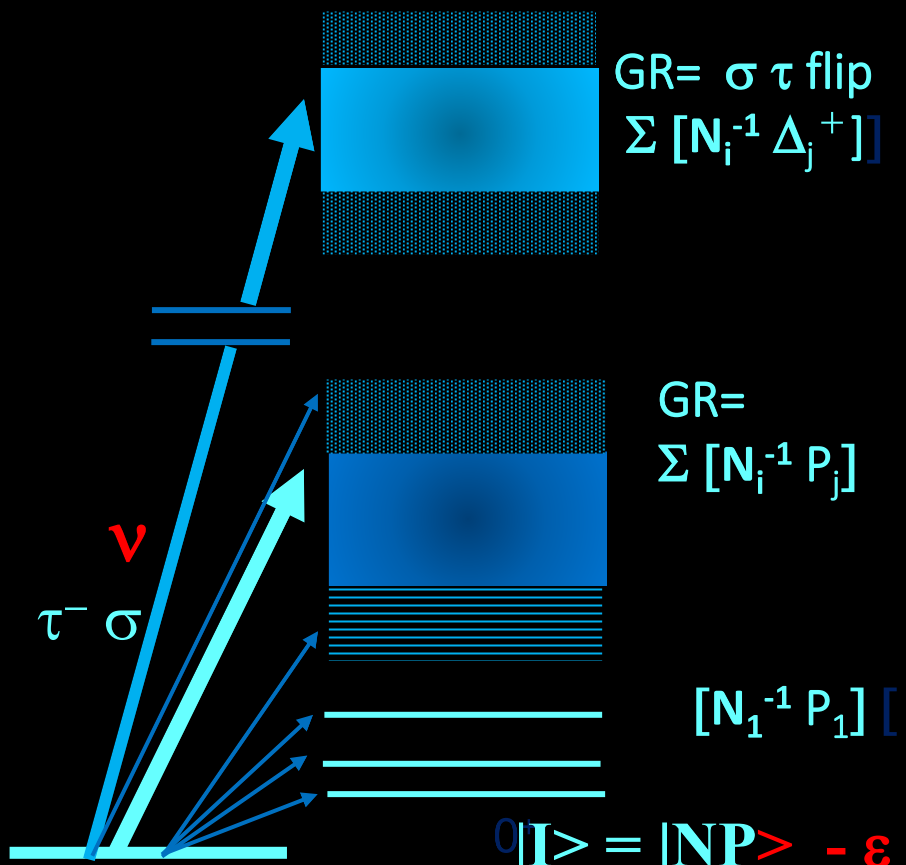


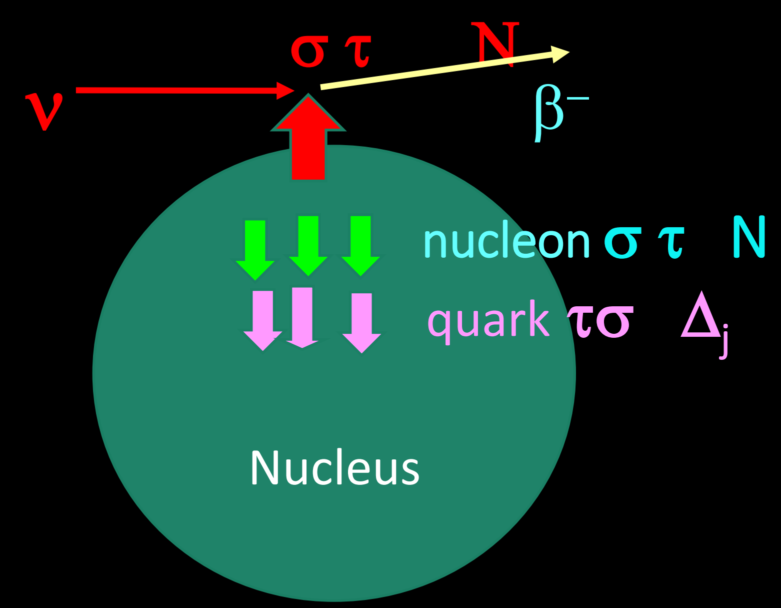
H.Ejiri, T. Fukuyama, T. Sato PR C 111 065501 2025

E. Hiyama , H. Suganuma for hadron physics.

N –GR and Δ-GR and τσ core polarization

Repulsive NN and NΔ correlations make negative τσ polarizations like an effective charge = true e_0 – pol charge e





0^+ |I> = |NP> - ε |GRn> - δ |GR Δ> 1^+ 2^-

Δ- τσ polarization effects

A. Bohr and B. Mottelson PL B 100 10 1981 GT

H. Ejiri Nucl. Phys. A 396 181 1983 SD

F. Oesterfeld RMP 64 49 1992 , E

D. Kirchuk et al., Phys. Scr. 59, 416 1999,

G. Cattapan, Review PR 362, 303, 2002 , and in others.

Exchange current =π+N~(Δ)=2B current effects

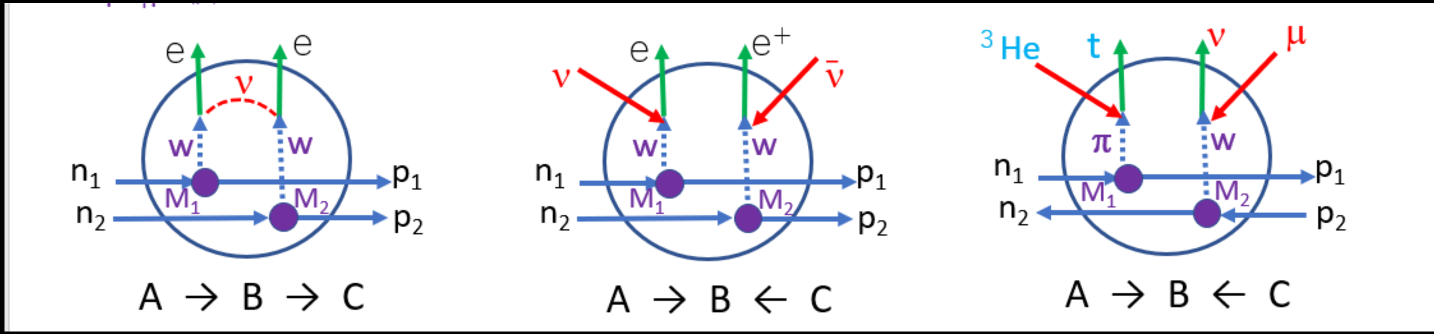
I.S. Towner PR 155 263 1987 Review

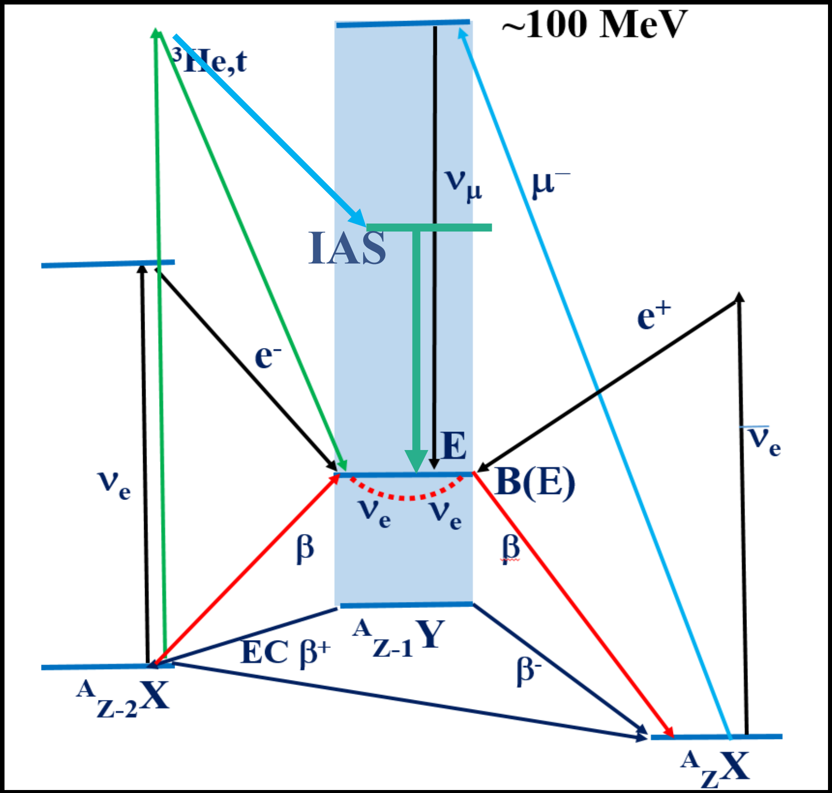
J. Menendez et al, for DBD PRL 107, 062501 2011,

P. Gysbergs et al, for β-decay Nat. Phys. 14, 428, 2019,

L. Corragio et al, Review PR C 109, 014301 2024

Weak (β, ββ, astro- ν) NMEs and CERs at RCNP





Weak ν cross sections:10^{-43}

Studied by
Nuclear reaction
with strong interaction
CER (^{3}He,t) RCNP
(present talk)

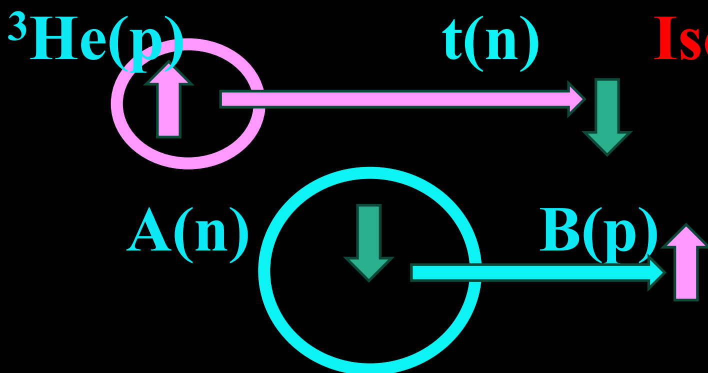
EM photon via IAS Ejiri
& μ,ν_μ capture
(Hashim Ejiri, Shima et al)

DCER NUMEN

2 GT and SD summed strengths by CERs .

Summed GT –SD $\tau\sigma$ strengths in nucleon region of E=0-30 MeV are reduced half, resulting in $\tau\sigma$ coupling $g^{eff}(\Delta)\sim 0.7$

Charge exchange reactions (CER) at RCNP are powerful for nuclear τ σ response studies



Isosoin spin flip

$$V^{\mathrm{eff}} = V^{\mathrm{C}} + V^{\mathrm{LS}} + V^{\mathrm{T}},$$

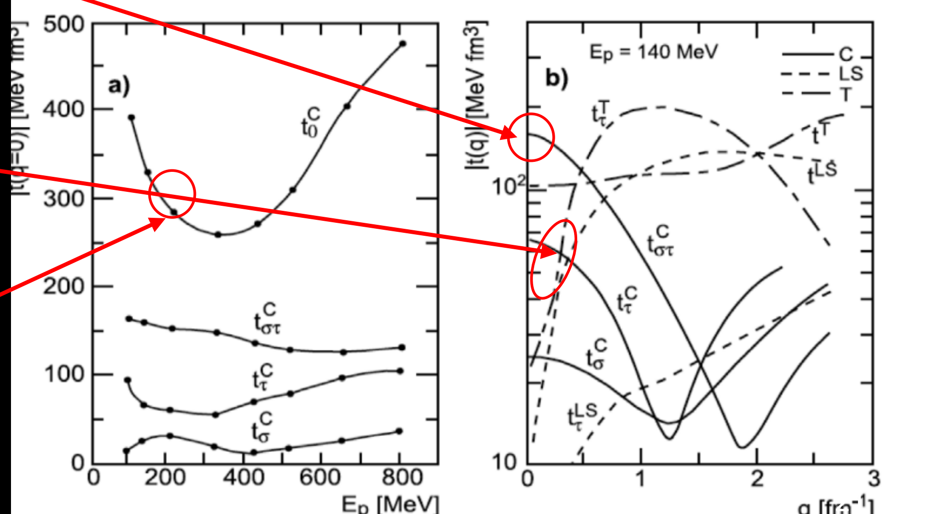
$$V^{\mathrm{C}} = V^{\mathrm{C}}(r_{ij}) + V^{\mathrm{C}}_{\sigma}(r_{ij})\boldsymbol{\sigma}_i \cdot \boldsymbol{\sigma}_j + V^{\mathrm{C}}_{\tau}(r_{ij})\tau_i\tau_j + V^{\mathrm{C}}_{\sigma\tau}(r_{ij})\boldsymbol{\sigma}_i \cdot \boldsymbol{\sigma}_j\tau_i\tau_j\,,$$

$$V^{\mathrm{LS}} = \left[V^{\mathrm{LS}}(r_{ij}) + V^{\mathrm{LS}}_{\tau}(r_{ij})\tau_i\tau_j\right]\mathbf{L}\cdot\mathbf{S}\,,$$

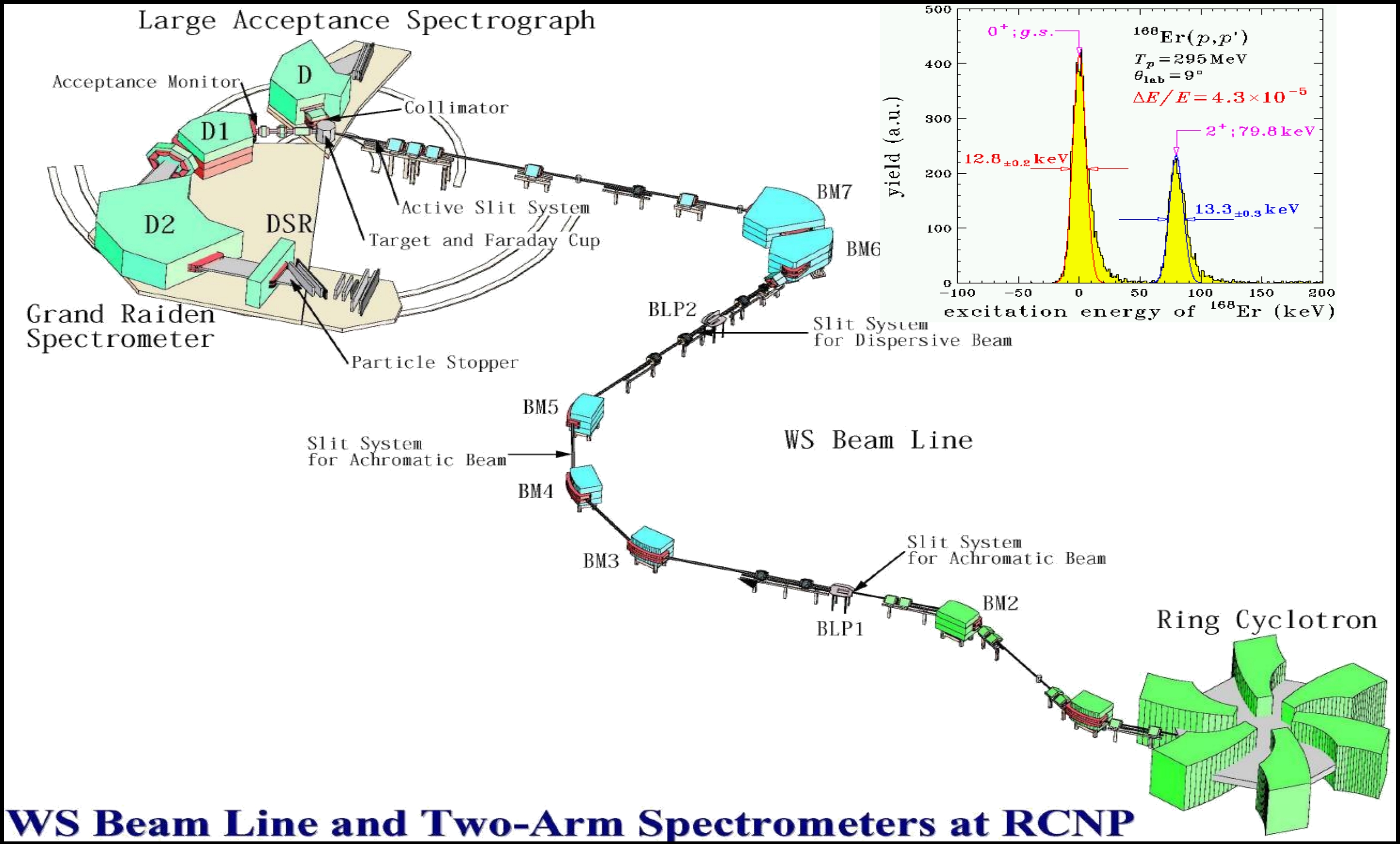
$$V^{\mathrm{T}} = \left[V^{\mathrm{LS}}(r_{ij}) + V^{\mathrm{LS}}_{\tau}(r_{ij})\tau_i\tau_j\right]S^{T}_{ij}\,.$$

1. Vστ interaction for GT,SD τσ response is dominant at RCNP E/A~0.15 GeV.
2. Tensor /LS interactions are small at q=0 − 0.5 /fm
   Tensor effect Y. Iwata, H. Ejiri, Sakar 2026
3. Distortion and multi-step process get minimum at E/A=0.2 - 0.4 GeV.

H. Ejiri, J. Suhonen and K. Zuber / Physics Reports 797 (2019) 1–102



RCNP cyclotron E/A= 0.15 GeV warrants one step CER. Spectrometer with energy resolution 30 keV is used to select individual F, GT, SD states up to 30 MeV of current interest.



H. Akimune, M. Fujiwara, D. Frekers, A. Tamii and others for CERs

CER nuclear interaction excites isospin (τ), spin (σ), l (angle), n (radial)

Select GT ($\tau\sigma$ $\Delta l=0$, $\Delta n=0$) (^{128}Te)

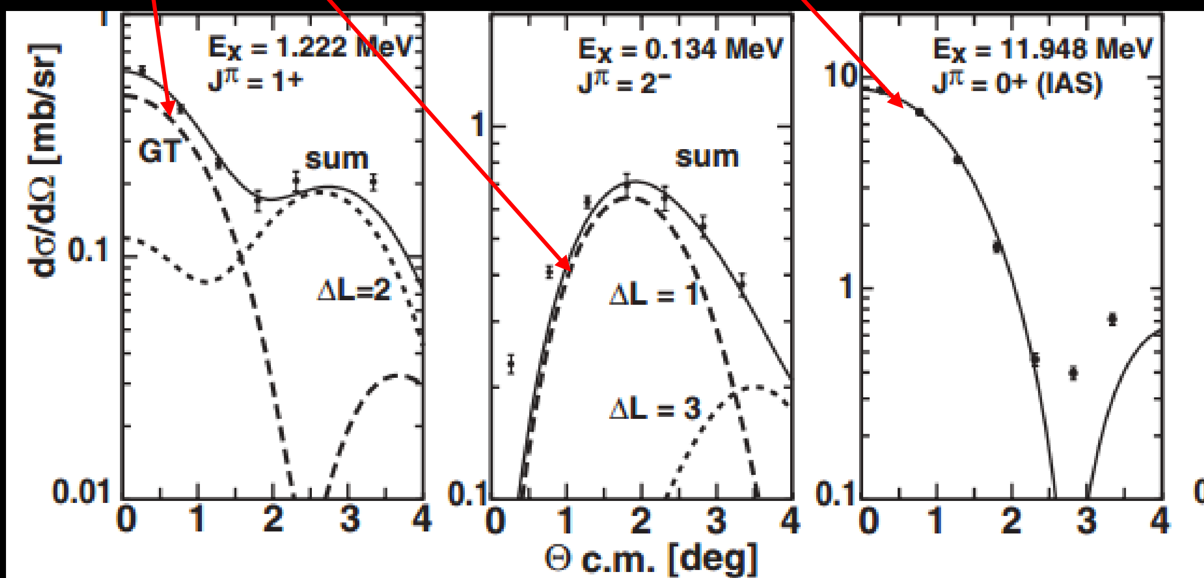
τ: CRE n ⇨ p reaction IAS

σ 1^+ s-wave $|j_0(qr)|^2$ 0+ neg. except IAS

$\Delta n=0$ radial node change = 0 low-excitation < 20 MeV

$\Delta n=2,4,6$ at higher 2-6 ħω are at high excitations = 20-60 MeV

σ r 2^- p-wave $|j_1(qr)|^2$



RCNP CERs with (^{3}He,t) reactions to select GT

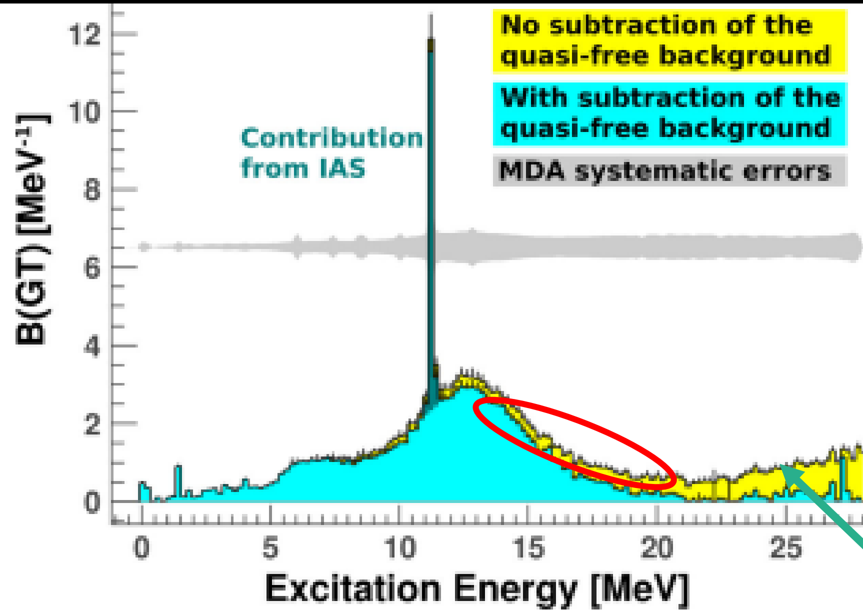


Fig. 14 Same as Fig. 13, but now for the ^{122}Sn(^{3}He, t)^{122}Sb reaction

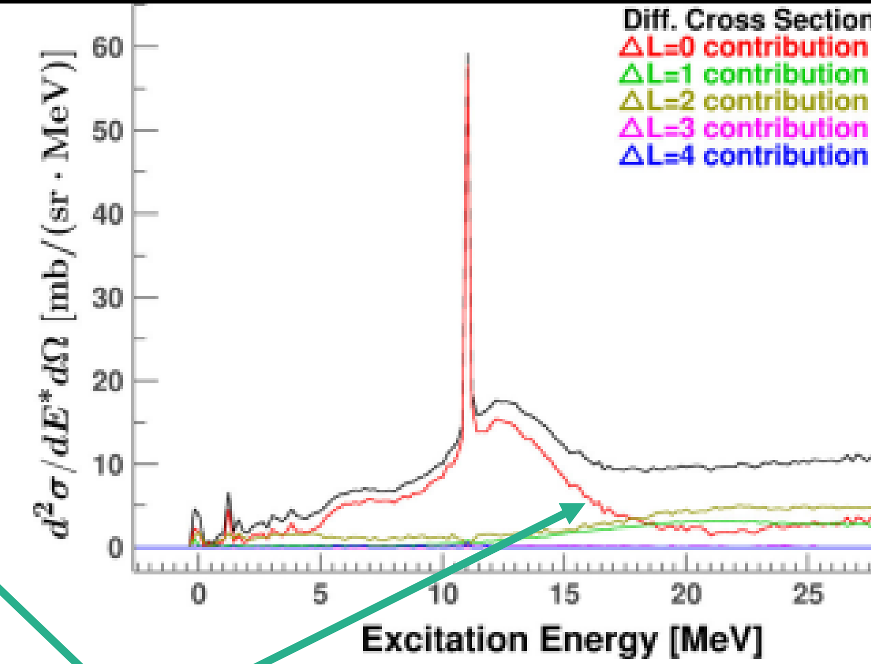


Fig. 16 Same as Fig. 15, but now for the ^{122}Sn(^{3}He, t)^{122}Sb reaction at 140 MeV/u

GT= τσ ΔL=0 (angular node =0), Δn=0 (radial node =0)

QF Quasi-free scattering (spreading to 2p-2h) with Δn=0 (GT)

and Δn=2, 4, 6 =Non GT , to be corrected for

from the observed and calculated ratio of the n=0 and n=2 GRs.

C. Douma et al, Ejiri RCNP Euro Phys 56 51 2020

DBD nuclei at RCNP

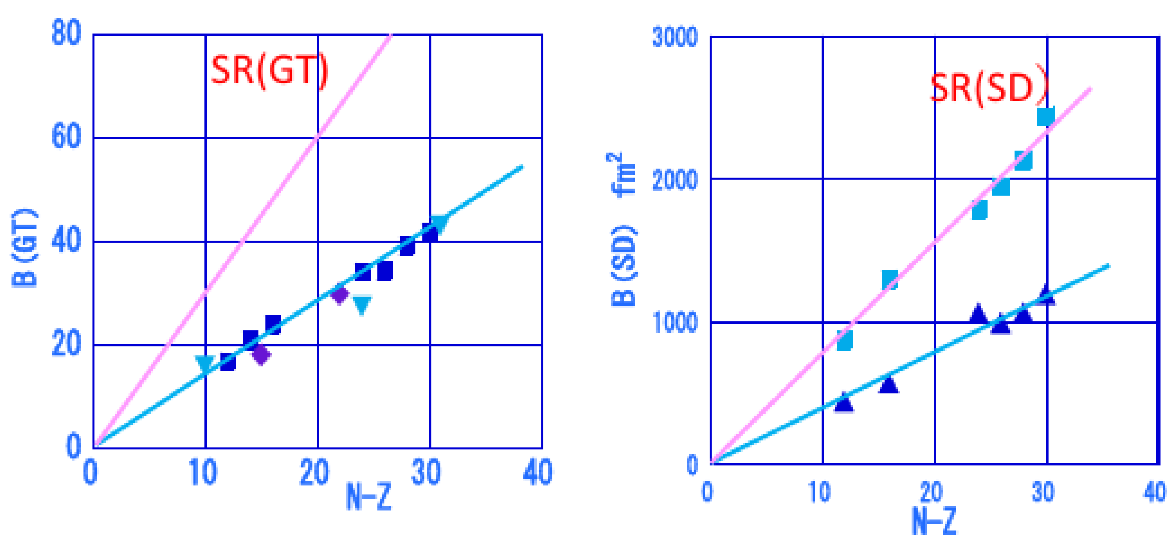


FIG. 3. Left panel: Summed GT strength of S^-(GT). Blue sqares: (^{3}He,t) on DBD nuclei. Blue diamonds: (^{3}He,t) on Sn isotopes. Light blue squares: (p,n). Solid thin line: S_N(GT). Thick line: 0.47 S_N(GT). Right panel: Summed SD strength of S^-(SD). Blue triangle: (^{3}He,t) on DBD nuclei. Light blue sqaure: sum rule limit of S_N(SD). Thick line: 0.50 S_N^-(SD).

IFF S(GT)=3(N-Z) $S^-(SD)=\Sigma(2l+1)(N^{eff}/2\pi) <r^2>$

$r^2=0.6\ R^2$ with $R \sim 1.35\ A^{1/3}$ for n to p effective radius

Experimental summed GT and SD strengths are a half of the nucleon-based IFF sum rule limits. First results on DBDs.

Comments on Sumed GT strengths ~ 0.5 of IFF sum rule Σ=3(N-Z) is based on the $t_z = \pm 1/2$ n,p model with no non-nucleons like Δ.

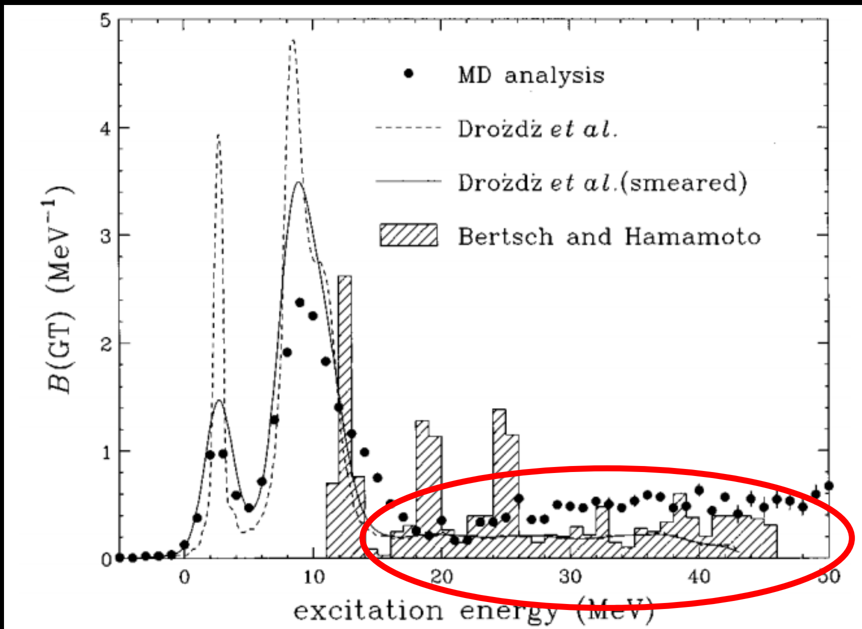
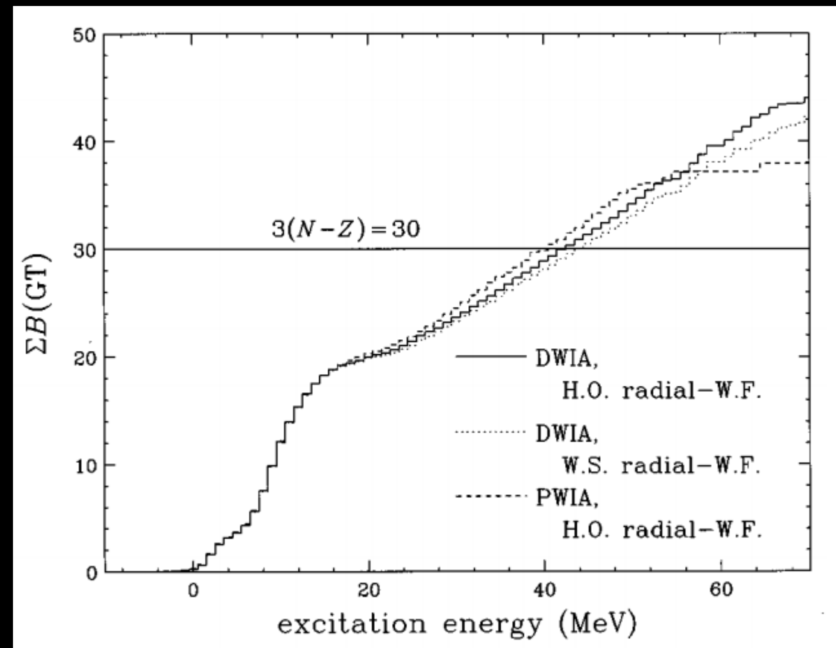


FIG. 13. Gamow-Teller strength distribution (filled circles) obtained from the 0° $L=0$ cross section which is deduced from the MD analysis. The dashed curves and hatched histogram represent the SRPA calculation by Drożdż *et al.* [22] and the perturbative calculation by Bertsch and Hamamoto [15], respectively. The

Berch Hamamoto PR C 26 1323 1082
B(GT) > 50 % of 3(N-Z) beyond GT-GR No Δ coupling , No n=2.4. hω



Gaarde and others <<3(N-Z)
Wakasa et al PR C 55 2909 1997
Full 3(N-Z) , mainly in n=2,4,6 hω

4. NEWS (Neutrino, Electromagnetic, Weak and Symmetries) with NΔ GR

- Nuclear states f>= |n> - δ|Δ GR> with $\delta \sim V/\Delta$-mass ~0.001. Weak, EM and nuclear $\tau\sigma$ –NMEs much quenched .

QRPA with NN and NΔ separable interactions

Quenching of τσ NMEs by Δ effects and exchange (2B) currents since 1980

A. Bohr and B. Mottelson

F. Osset Gaarde

Present QRPA for NN and ND separable interactions

$$V = g'_{NN} C V_{12} \sigma_1 \sigma_2 \tau_1 \tau_2 + g'_{N\Delta} C' V_{12} S_1 \sigma_2 T_1 \tau_2, \qquad (1)$$

where $V_{12} = \delta^3(r_1, r_2)$, C=392 MeV fm^3 and $C' = (f_{\pi N\Delta}/f_{\pi NN})C = 2C$ [22, 23, 48], and S and T are

$g'_{NN'} C V_{12} = \chi_N / A$ and $g'_{N\Delta} C' V_{12} = \chi_\Delta / A$. They are written as $\chi_N = 48\ g'_{NN'}$ MeV and $\chi_\Delta = 96\ g'_{N\Delta}$ MeV.

Interactions g'_{NN} =0.5 , $g'_{N\Delta}$ ~0.6 Julich Tokyo Potential

The same NN and NΔ τσ interactions for

GT weak, EM and strong τσ NMEs.

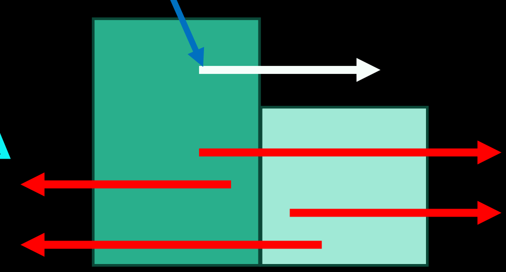
Dispersion equation with NN and NΔ interactions

$$\frac{\chi_N}{A}\Sigma_i \frac{|<\phi_i^-||\sigma\tau^-||0>|^2}{\epsilon_i-\epsilon} + \frac{\chi_\Delta}{A}\Sigma_j \frac{|<\psi_j^-||ST^-||0>|^2}{\epsilon_{\Delta j}-\epsilon}$$

$$+\frac{\chi_\Delta}{A}\Sigma_k \frac{|<\psi_k^+||ST^+||0>|^2}{\epsilon_{\Delta_K}+\epsilon} = -1 \qquad ($$

where ϕ_i^- stands for the $n_i^{-1}p_i$ state, ψ_j^- for the $n_j^{-1}\Delta_j^+$ and $p_j^{-1}\Delta_j^{++}$ states and ψ^+ for the $n_k^{-1}\Delta_k^-$ and $p_k^{-1}\Delta_k^0$

V=τσ, M=τσ, thus the product is |<στ>|^2 , all with the same phase,
NN for forward correlation because of blocking of backward
p ⇨ n in case of DBD nuclei with N>>Z No=N-Z~15



The NΔ terms of the dispersion equation.
NΔ for both forward and backward p,n ⇨ Δ
Number of GT N ⇨ Δ ~ 2 (N+Z)=2A ~200
since all n and p ⇨Δ^+ , Δ^{++} , Δ^- and Δ^0
Then the Δ effects get significant

NΔ contribution amounts to 30 %, very important effect on NME
Δ τσ susceptibility = V × Sum of NME^2/Energy gap

$$\kappa_\Delta \approx \frac{\chi_\Delta}{A}[\frac{2(A+0.33A)}{300}]/\mathrm{MeV} = 0.009\chi_\Delta/\mathrm{MeV}.$$

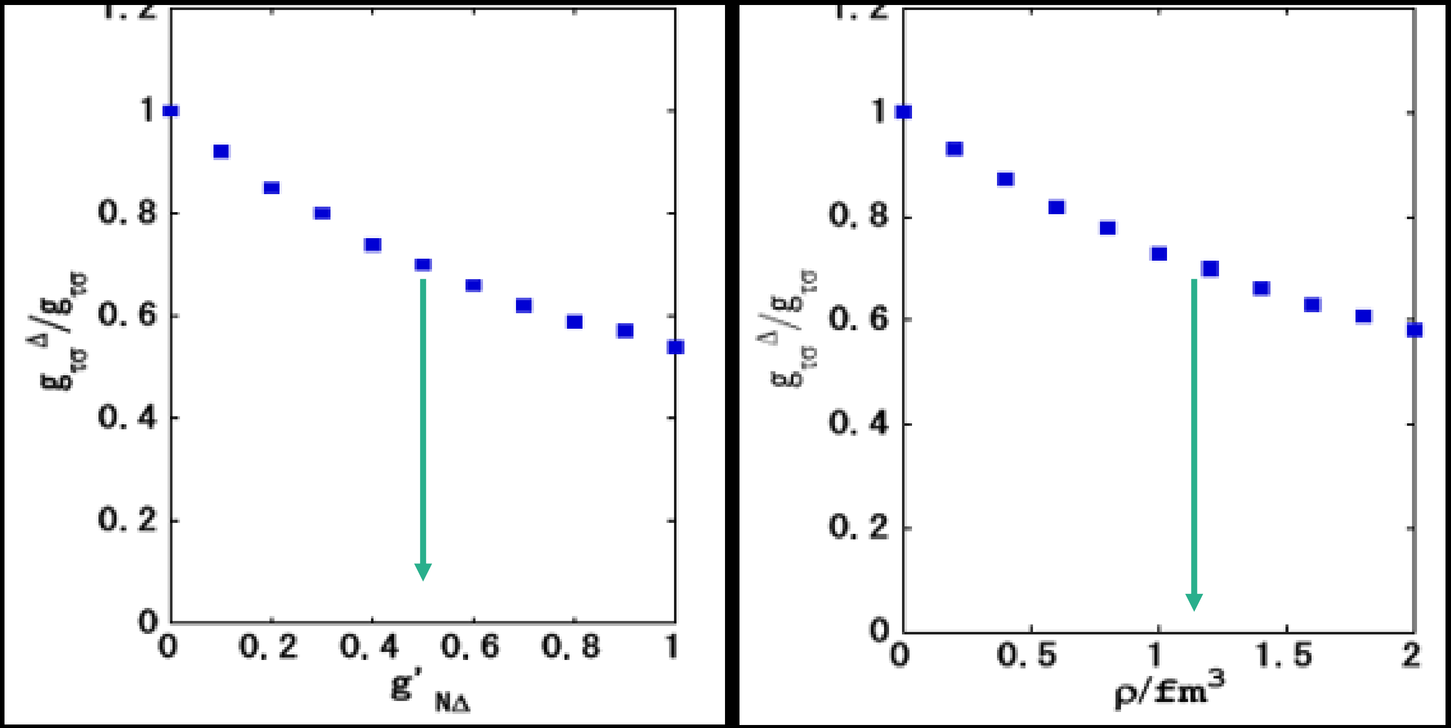
Using $g'_{N\Delta}$~0.5 and χ_Δ=48 MeV Julich Tokyo Potential,
Susceptibility for Δ τσ GR/correlations κ_Δ=0.43,

Nuclear part of the dispersion equation is expressed as

$$\frac{\chi_N}{A(1+\kappa_\Delta)}[\Sigma_i \frac{<|n_i^{-1}p_i||\sigma\tau^-||0>|^2}{\epsilon_i - \epsilon}] = -1,$$

Renormalized NN coupling by the coefficient
$1/(1+\kappa_\Delta)$=0.7
Renormalization (effective coupling) due to Δ
$K_\Delta = g^\Delta_{\tau\sigma} / g_{\tau\sigma} /=1/(1+\kappa_\Delta)$=0.7
in agreement with exp. summed strength.

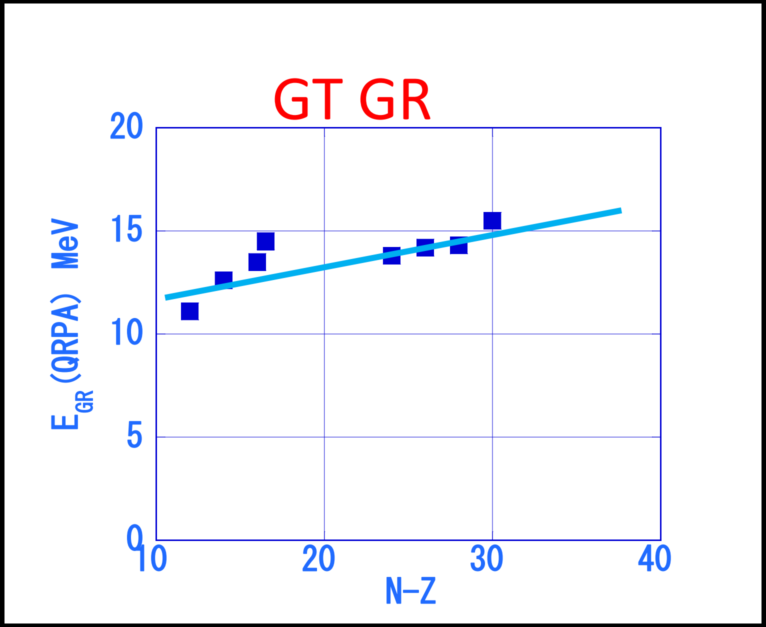
Effective τσ coupling $g^{\Delta}_{\tau\sigma}$ depends on the NΔ interaction and density.

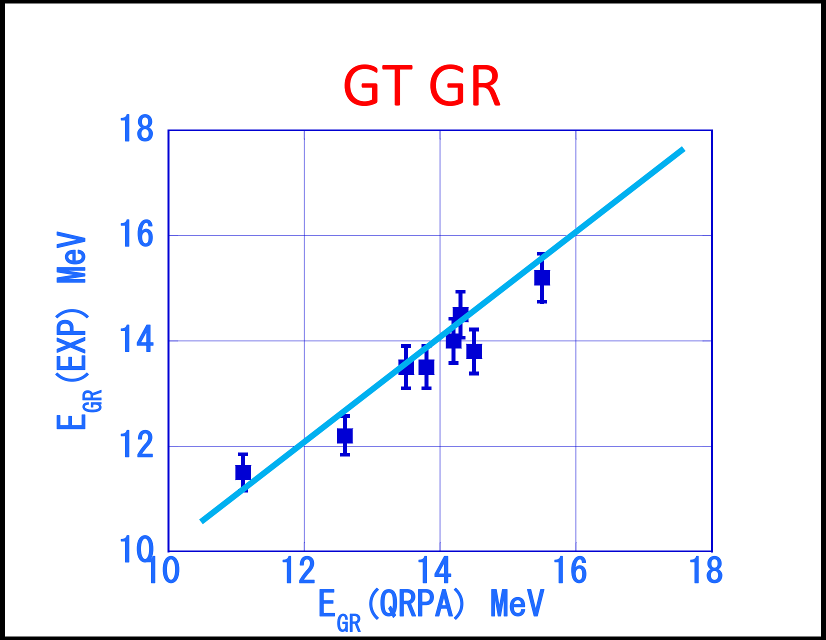


It is around 0.7
at the realistic interaction 0.5 and the density 1.2
Similar r dependence in 2B (Menendez PRL 107)

NN GR GT Energy and NN interaction

N-Δ interaction pushes down the NN GR(GT)
NN interaction pushes up the NN GR(GT).
Using NΔ $g'_{N\Delta}$=0.5 ((χ_{Δ}=48MeV) from the summed strength,
and the experimental N-GR GT energies,
one gets g'_{NN}=0.62 (χ_N=30 MeV), as Julich Tokyo potential





Δ GR energy and cross section

GR cross sections are proportional to A as observed in (γ,A)

Thus σ/A~ constant for all A

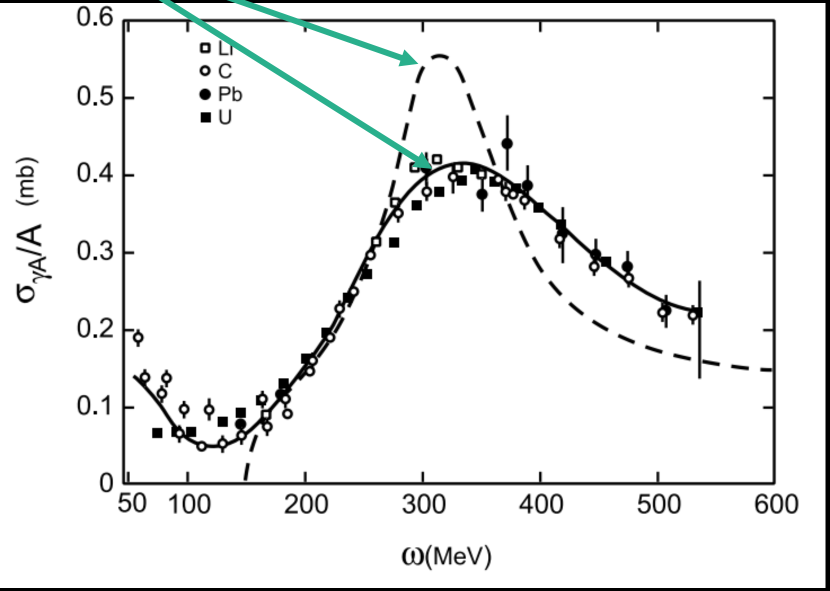
Recoil energy ~ 50 MeV for p and 0.5 MeV for A=100.

$$E(\mathrm{GR}_\Delta) = E_\Delta(0) + \frac{\chi_\Delta}{A}\frac{6Z+N}{3}$$

~ 335 MeV

284 MeV Δ in a nucleus ~294-10

48 MeV/A



Giorgio Cattapan[b,c], Lídia S. Ferreira[a,*]

PR 362 303 2002

J. Ahrens, L.S. Ferreira, W. Weise, Nucl. Phys. A 485 (1988) 621.

Low lying QP τσ (axial-vector) NME

M(QP)= UV M(SP) Vacancy-occupation corrected SP NME

Reduced(quenched) due to NN GR and NΔ τσ GR correlations

$$M = K_{\mathrm{N\Delta}} M_{\mathrm{QP}}, \quad K_{\mathrm{N\Delta}} = \frac{1}{1 + \kappa_{\mathrm{N}} + \kappa_{\Delta}},$$

$K_{N\Delta}$ = NN and NΔ τσ GR correlations /susceptibilities.

χ_{Δ}=48 MeV and the summed strength =0,7, one gets κ_{Δ} =0.43

$$\kappa_N = \frac{\chi_N}{A} \frac{N_f G^2}{\bar{\epsilon} - \epsilon_1},$$

κ_N=2.1 from NN τσ correlations χ_N=30 MeV

derived from experimental GR GT energy.

Then one gets $K_{\Delta N}$ =1/(1+2.1 + 0,43)=0.28,

The same quenching coefficient is derived as

$$K_{N\Delta} = K'_N \times K_{\Delta},$$

$K'_N = 1/(1 + \kappa'_N)$ and $\kappa'_N = \kappa_N K_{\Delta} \approx 0.7\kappa_N$.

NME(τσ) for low-states in DBD nuclei A=76-136

Spin isospin (axial-vector) NMEs are reduced by N-GR and Δ-GR

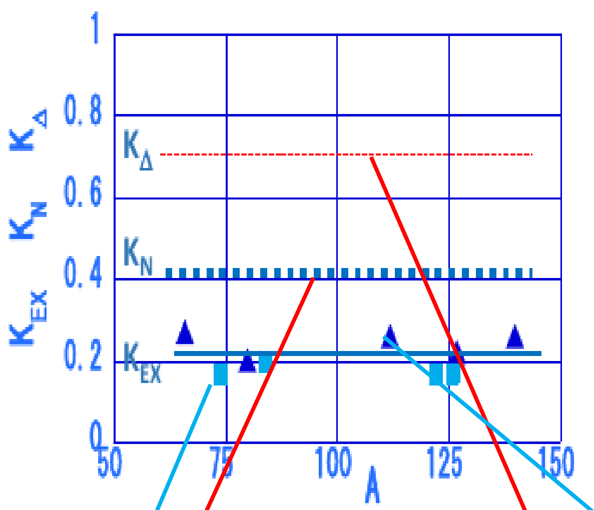
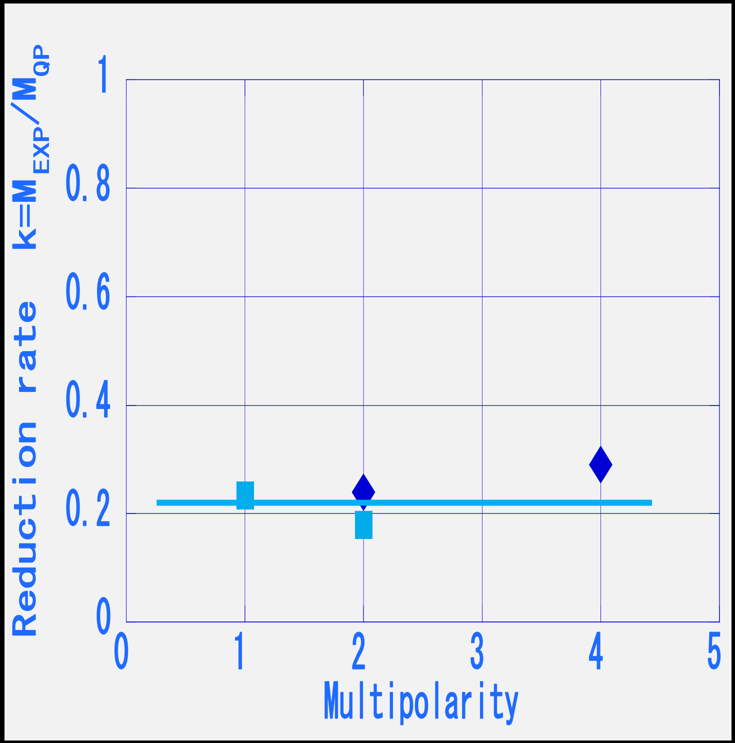


FIG. 4. Quenching coefficients. Blue triangles: K_{EX}(GT) and Blue squares: K_{EX}(SD). Thick blue line: K_{EX}=0.21. Thick dotted blue line: K_N. Thin dotted red line: K_Δ=0.7.



M(EXP) = K_{EX}M(QP) **K_{EX}~ 0.21 : Ejiri Suhonen G. Phys. 42 2015**

K_{EX}=K_{QR} K_m K_Δ **K_{GR} =0.4 (0.28/0.7) for NN τσ (NN GR)**

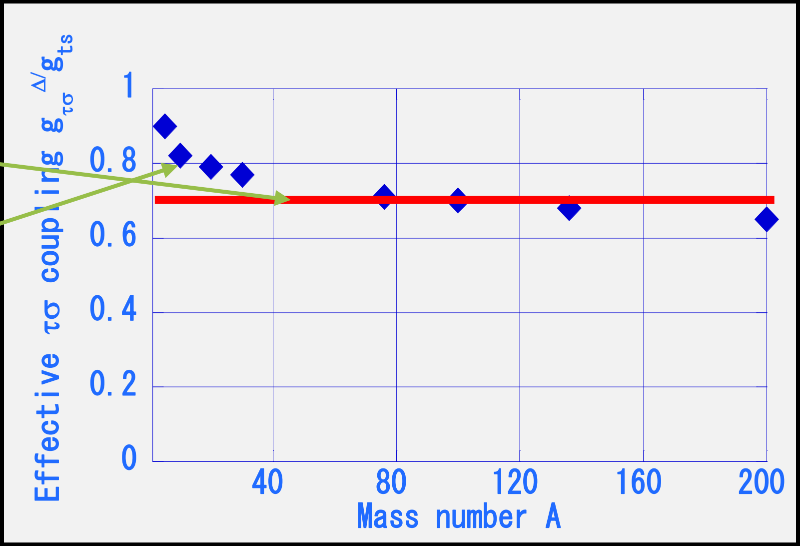
K_Δ=0.7 NΔ τσ correlations (NΔ GR)

Then K_m =0.8 2p-2h and others , not in QRPA.

1. A dependence

$g^{\Delta}_{\tau\sigma} / g_{\tau\sigma} = 0.7$ with constant V.

$A^{0.3}$ depend. (Honma PRC 54 2972)



2. Comments on g^{eff}_{A} DBD

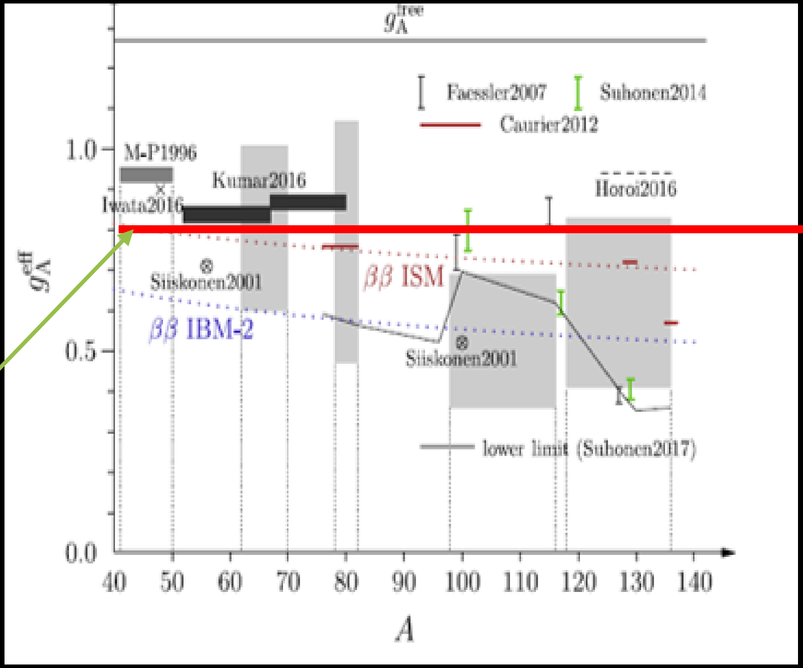
* $g^{eff}_{A} / g_{A} = (M^{2\nu}(exp)/M(model))^{1/2}$, reflect NN-GR, higher-shells, 2p-2h, NΔ- exchange-(2B), others, if not included in models. Thus they scatter much.

* If the M(model) includes all except the Δ GR,

$$g^{eff}_{A} / g_{A} = g^{\Delta}_{\tau\sigma} / g_{\tau\sigma} = 0.7$$

* In QRPA with N-GR,

$$g^{eff}_{A} = \Delta\text{–GR and } K_{m}$$
$$= 0.7 \times 0.8 \times 1.27$$

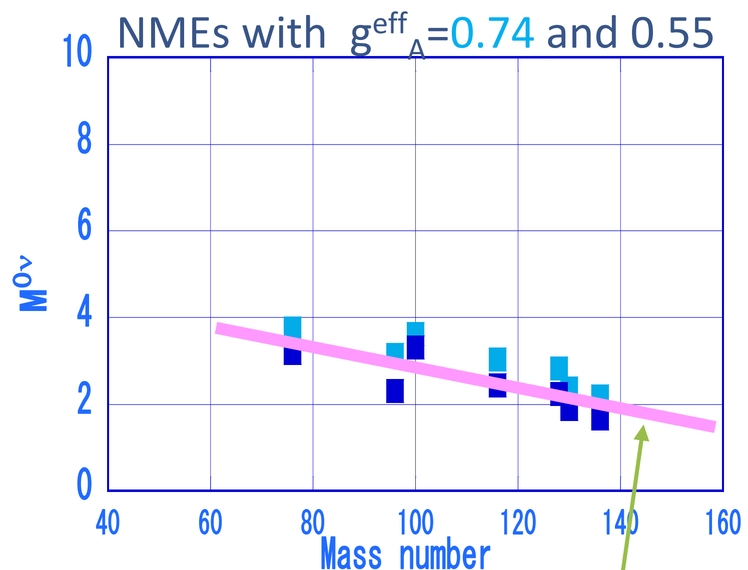


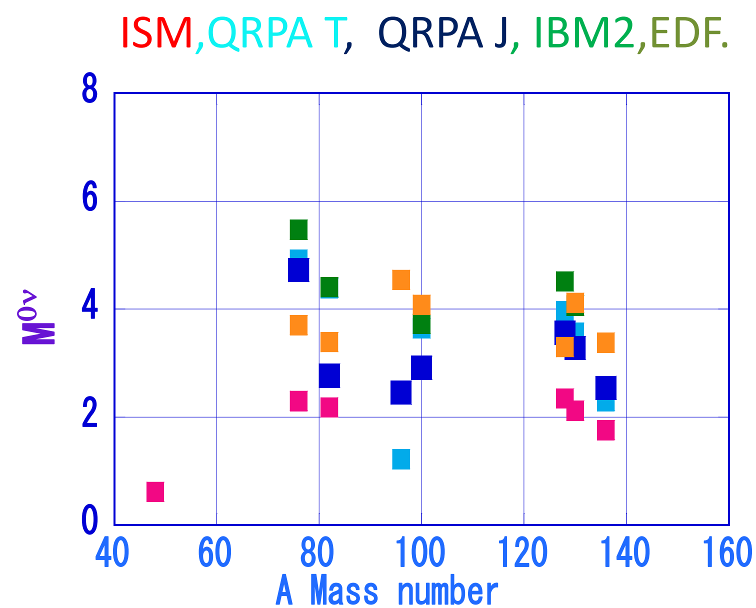
H. Ejiri J. Suhonen K. Zuber PR C 797 1 2019 H. Kosma QRPA

1. Exp. approaches to DBD and astro ν NMEs

Double –ν & astro-ν P~100 MeV τ σ *l*=0-6

NMES are sensitive to models and τσ correlations,





pnQRPA with experimental inputs

Ejiri Jokiniemi Suhonen PRC L 104 2022

Recommended NMEs with g_A=0.7x0.8=0.56

$M^{0\nu}$ ~5.2 - 0.023 A

$M^{0\nu}$~ depends on models

ROPP 2014 Vergados Ejiri Simkovic

5. Concluding Remarks

The spin isospin strength gets away by half from the neucleon world to the Delta world .

1. The summed GT and SD (spin dipole) strengths measured by (^{3}He,t) on DBD nuclei are quenched by $(g^{\Delta}_A/g_A)^2 \sim (0.7 \pm 0.07)^2$ with respect to 3(N-Z) IFF limit based on a simple N model. This indicates non-nucleonic $\tau\sigma$ Δ GR correlation.

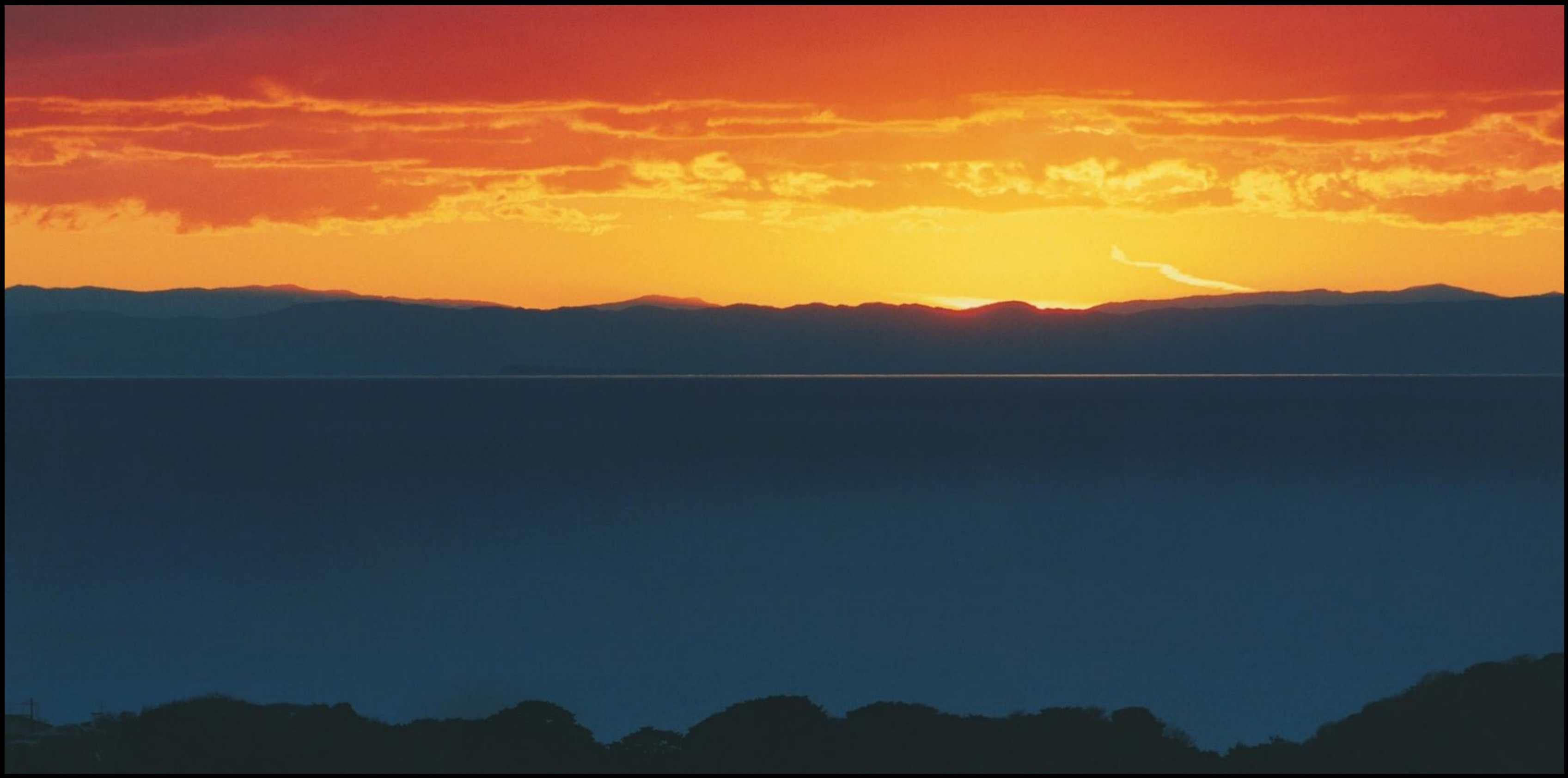
2. The experimental quenching coefficients are well reproduced by the QRPA with such NN and NΔ interactions of $g'_{NN} \sim 0.62$ and $g'_{N\Delta}=0.5$. that reproduce the experimental NN and NΔ GR (giant resonance) energies and the summed strengths.

3. Axial vector β QP NMEs for ββ nuclei are reduced by $K_{EX} \sim 0.21$, due to the NN GR correlations of $K_N \sim 0.4$ and the nuclear medium effect of $K_M \sim 0.8$ and the Δ GR effect of $K_{\Delta} = 0.7$.

4. The Δ GR effect, being due to the Δ mixture by the NΔ–$\tau\sigma$ nucl. interaction, quenches all weak, electro-magnetic and strong $\tau\sigma$ NMEs involved in Neutrino, EM, Weak, Strong interactions in nuclei . Thus the impact on particle -nuclear physics is great.

Thank you for your attention, and
all collaborators for the supports for the 0.9 century, including

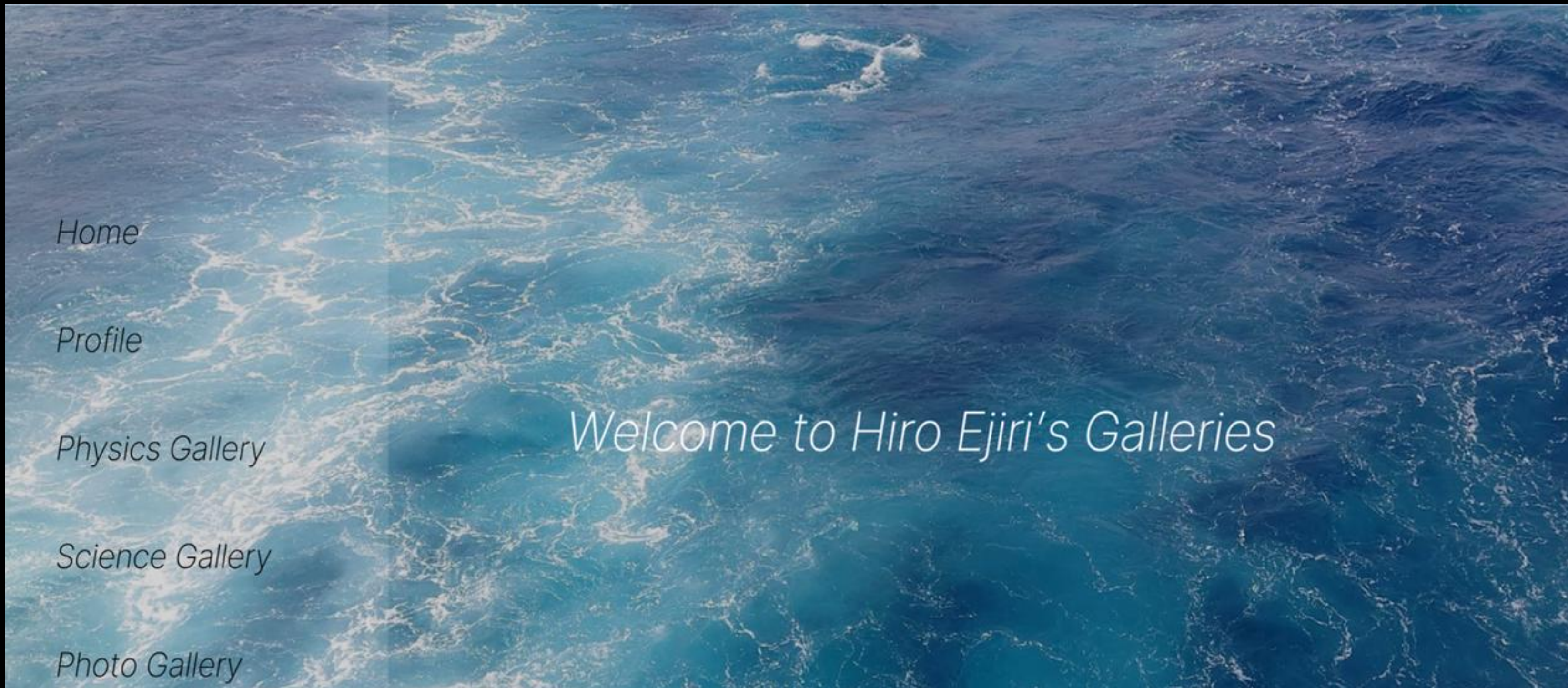
.

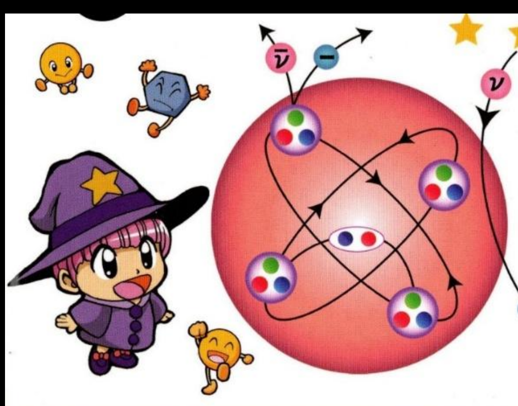


U Tokyo, INS, UW, NBI, LBL, Osaka-U, RCNP, CTU, Jyvaskyla, TUD, UOI, ELEGANTs, Majorana-Dem., UTM, and all other collaborations.

TABLE II: Calculated Landau parameters g'_0 and $g'_{N\Delta}$. The value of g'_0 is measured in units of $C_0 = 392$ MeV fm^3, while $g'_{N\Delta}$ is measured in units of $2 \times C_0 = 784$ MeV fm^3. Listed are results of *G*-matrix calculations performed by the Jülich group (Nakayama *et al.*, 1984) and by the Tokyo group (Cheon *et al.*, 1983). The various calculations were performed with different input and different approximations. Set I: Bare nonrelativistic *G* matrix based on the Bonn potential (Holinde *et al.*, 1972). Set II: Bare *G* matrix plus induced interaction. Set III: Bare *G* matrix plus induced interaction plus relativistic corrections. From Towner, 1987.

		g'_0	$g'_{N\Delta}$
Jülich	I	0.49	0.35
	II	0.58	0.56
	III	0.56	0.68
Tokyo	I	0.52	0.35
	II	0.61	0.45





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Hiroyasu Ejiri, PhD

Physicist, Researcher

Osaka, Japan

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Profile

Professor Hiroyasu Ejiri *graduated from* ***University of Tokyo (Physics course), e****arning his* ***B.S. in 1958*** *and* ***Ph.D. in 1963.***

He has held extensive academic appointments at research institutes and/or physics departments of leading universities, including ***University of Tokyo****,* ***University of Washington, University of California, University of Copenhagen, Osaka University, International Christian University, and Czech Technical University.***

He has played leading roles in nuclear physics research, serving as the professor and/or the supervisor at these universities, the chairperson of the Nuclear Physics Committee in Japan, ***the director of Research Center for Nuclear Physics Osaka Univ.****, and* ***the director General of Yamada Science Foundation.***


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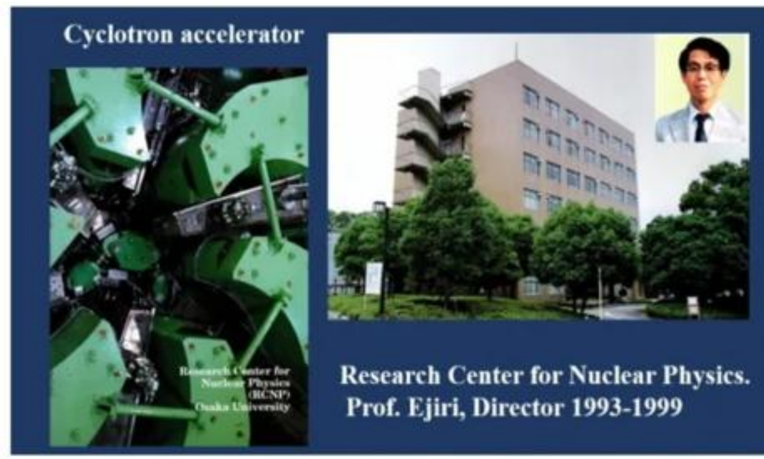
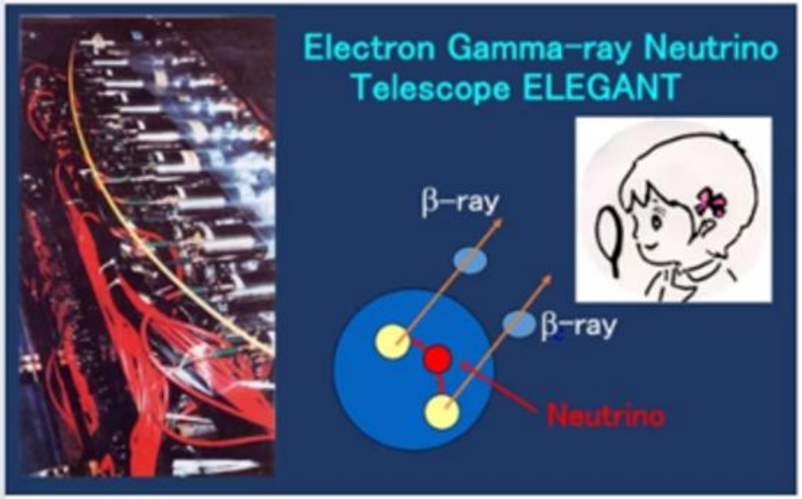

Cyclotron accelerator
Research Center for Nuclear Physics.
Prof. Ejiri, Director 1993-1999


Electron Gamma-ray Neutrino
Telescope ELEGANT
β-ray
β-ray
Neutrino


Ohto Underground Lab.
大塔コスモ観測所
1996 江尻教授開設
未使用廃線トンネル活用
空澄みて、
星のふる里
大塔の
隧道深く
宇宙を究む
江尻宏泰
図5-20A 大塔コスモ観測所とエレガント検出器(江尻研究室)
845m
西吉野村側
325m
大塔村側
439m
第二
観測室
第一
観測室
現在地
5039.5m
エレガントV号観測器
エレガントVI号観測器

Nuclear Structures – Nuclear vibrations and rotations.
Nuclear Reactions – Pre-equilibrium processes and charge-exchange reactions.
Hypernuclear Physics – Hypernuclear structures and reactions.
Electroweak Interactions – Nuclear beta and gamma decays.
Neutrino Nuclear Physics – Neutrino interactions and double beta decays.
Symmetry and Dark Matter – Fundamental symmetries and their implications for cosmology.

e experimental and theoretical research works were carried out at INSICU Univ. Tokyo, NPL iv. Washington, NBI Univ. Copenhagen, IBL Univ. California, RCNP Osaka Univ., KEK, Kamioka, oto, JASRI Spring8, IIAS Kyoto, ICU and others.

ough these studies, Professor Ejiri has developed ***advanced experimental frameworks*** *and* ***oretical frameworks*** *in nuclear particle spectroscopy, making significant contributions to* ***clear, hypernuclear, and neutrino nuclear physics****.*

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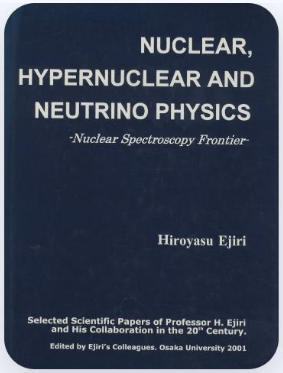

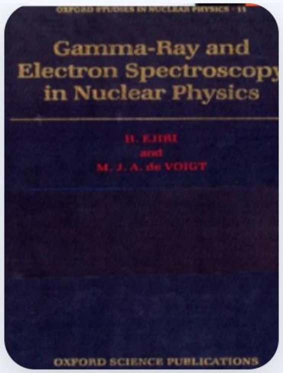

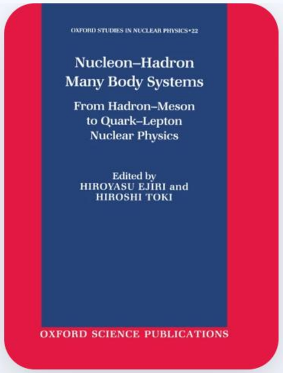

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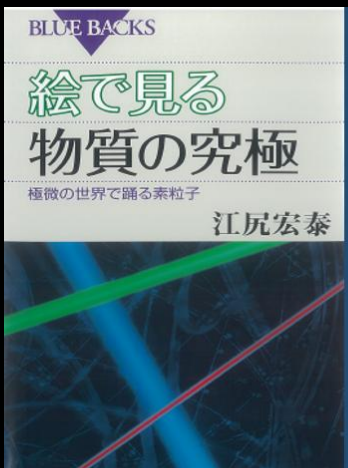

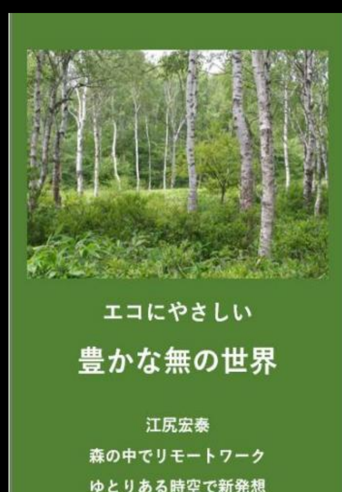


エコにやさしい
豊かな無の世界
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森の中でリモートワーク
ゆとりある時空で新発想

色即是空　空即是色


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日常の教育研究の
改善で必要とされる
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18才人口減、考える力不足、予算の不足、
研究力の低下、デジタルとAIの遅れで
大学の教育・研究が重大危機
欧米大学での研究教育の実績をもとに
教育研究の21改善法を提言


AI世紀のスキル
研究力UP
好奇心　新発想　探究
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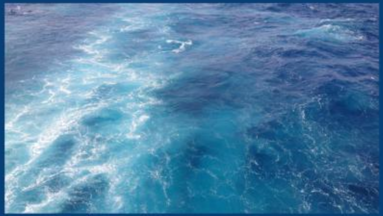
Poety of the Sea

海の詩

江尻宏泰

Ocean Light Serenade



潮洸
セレナーデ

1.潮光
2.潮様
3.照洋

江尻宏泰

Blue Light Sonata

水彩

水映
水彩
湖照
水相
水精

江尻宏泰

Flower Fragrance Melody

花香のメロディ

江尻宏泰

Rhythmic Light Sonata

彩律

翠の旋律
黄の旋律
緋の旋律
能の雅楽

江尻宏泰

Woods Light Sonata

樹想

梢影
樹様
樹精

江尻宏泰

Flower Light Serenade

花想
セレナーデ

江尻宏泰

Emerald Light Sonata

葉彩

葉光
翠風
葉映
照葉

江尻宏泰

Solemn Stone Sonata

粛石

粛
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江尻宏泰

Flower Color Cadenza

花彩
カデンツア

江尻宏泰

Thanks for collaborations,

Staff: T. Shibata, T. Itahashi, Y. Nagai, K. Okada,
T. Motobayashi, T. Fukuda, M. Sasao, K. Matsuoka, T. Nakano
Y. Kawashima, Y. Ohashi, S. Date, and others at Osaka/Spring8
T. Fukuyama, T. Sato, Y. Iwata and other theorists.

PhD, MD, S. Ferguson, S. Nakayama, T. Kishimoto, K. Maeda,
H. Masakawa, M. Nomachi, H. Ohsumi, R. Murayama,
T. Tsujita, Y. Adachi, N. Kamikubota, M. Fukuda, T. Watanabe,
T. Irie, T. Shima, H. Noumi, J. Tanaka,
A. Higashi, G. Choi, K. Fushimi, T. Ohshima, F. Nakamura, .
K. Nagata, N. Kudomi, K. Kume, N. Shinkai, H. Tazaki, R. Hazama,
R. Hayashi, S. Yoshida, S. Umehara, I. Hashim, and all others

All the best wishes for your productive own way.

3歩下がらず、向きを変えて 我が道拓く


Thank all for joining NEWS/party /contributions.
Thanks in advance for your continued encouragement
Family MEETS Dir. M. Ejiri, Prof. A. Ejiri, and Prof. K. Ejiri


無次元に　素核を究む　日々愉しく