

Technical issues on EXFOR compilation at JCPRG

Hokkaido Univ.

Theoretical Nuclear Physics Lab.

Tetsuaki Tada



**Nuclear Reaction
Data Centre (JCPRG)**
Faculty of Science, Hokkaido University

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- Self-Introduction
- My research
 - Master course
 - Doctor course
- Compilation in JCPRG

Hokkaido Univ.



JCPRG : 2nd floor

Theoretical Nuclear Physics Lab. : 10th floor

Self-Introduction

Background

- Undergraduate:
Department of physics, Tokyo University of Science
- Master course:
Theoretical Nuclear Physics Laboratory, Hokkaido Univ.

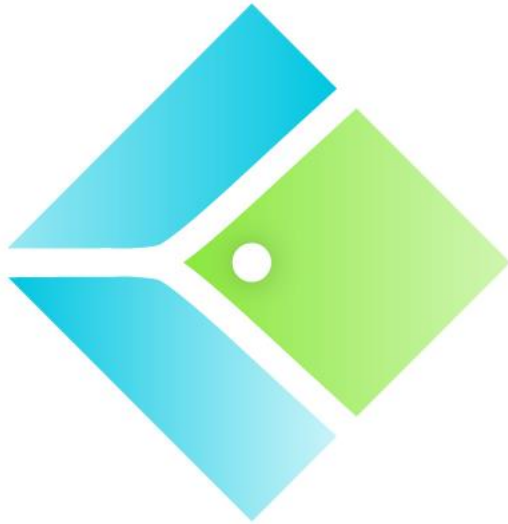
Current situation

- Doctor course(D1):
Theoretical Nuclear Physics Laboratory, Hokkaido Univ.
- Compiler in JCPRG



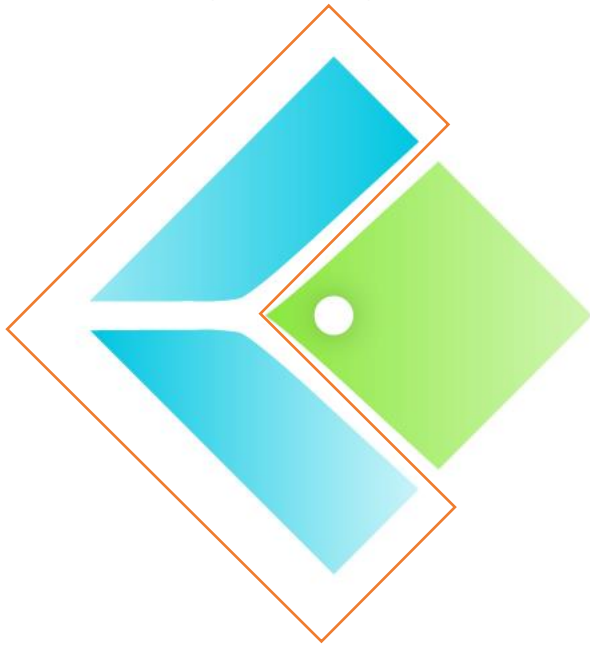
**Nuclear Reaction
Data Centre (JCPRG)**
Faculty of Science, Hokkaido University

The meaning of JCPRG logo



The meaning of JCPRG logo

The shape represents the orbit of nuclear reaction.



The meaning of JCPRG logo

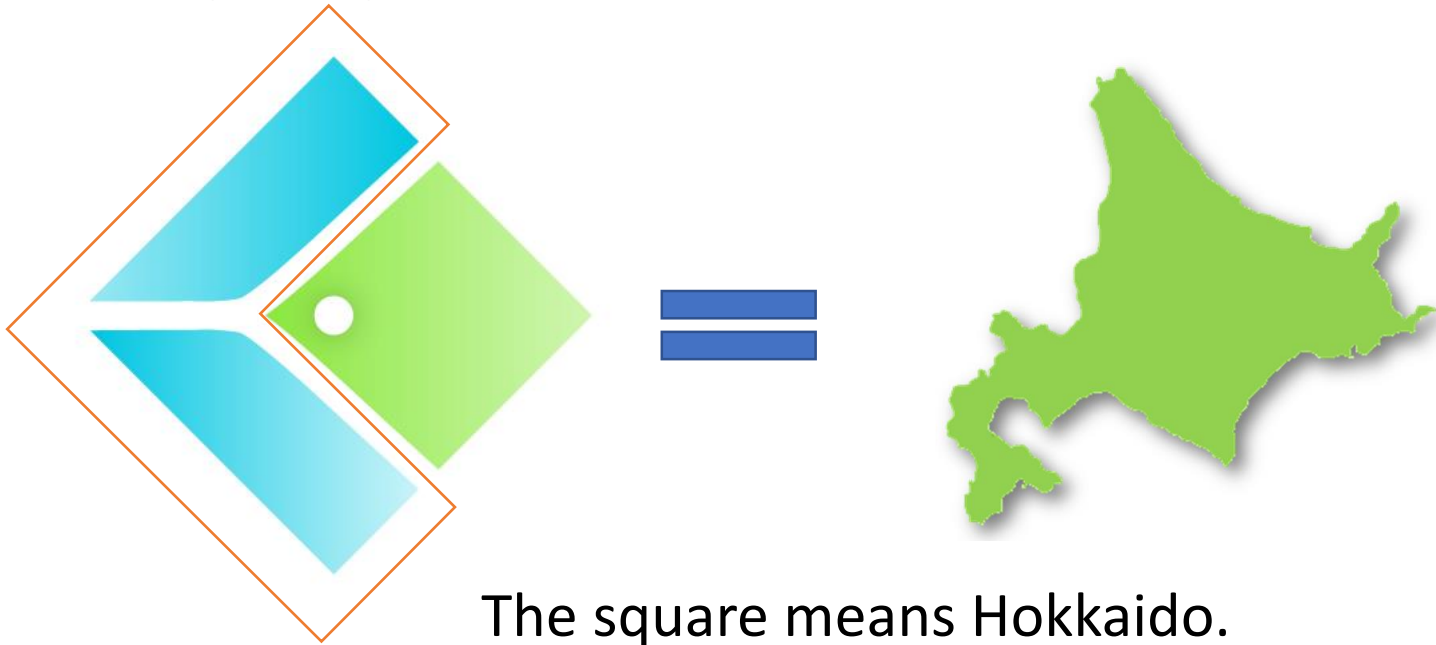
The shape represents the orbit of nuclear reaction.



White circle is Target.

The meaning of JCPRG logo

The shape represents the orbit of nuclear reaction.

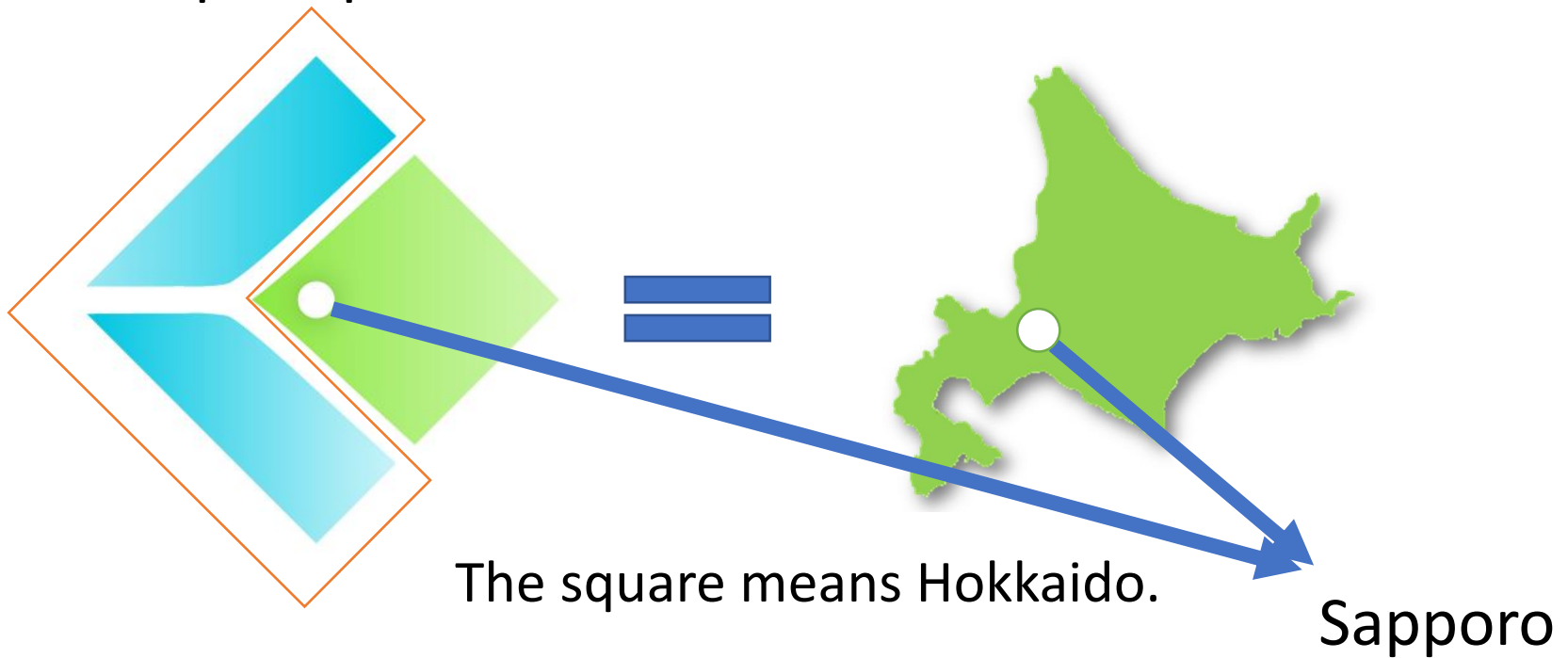


The square means Hokkaido.

The circle is Target.

The meaning of JCPRG logo

The shape represents the orbit of nuclear reaction.



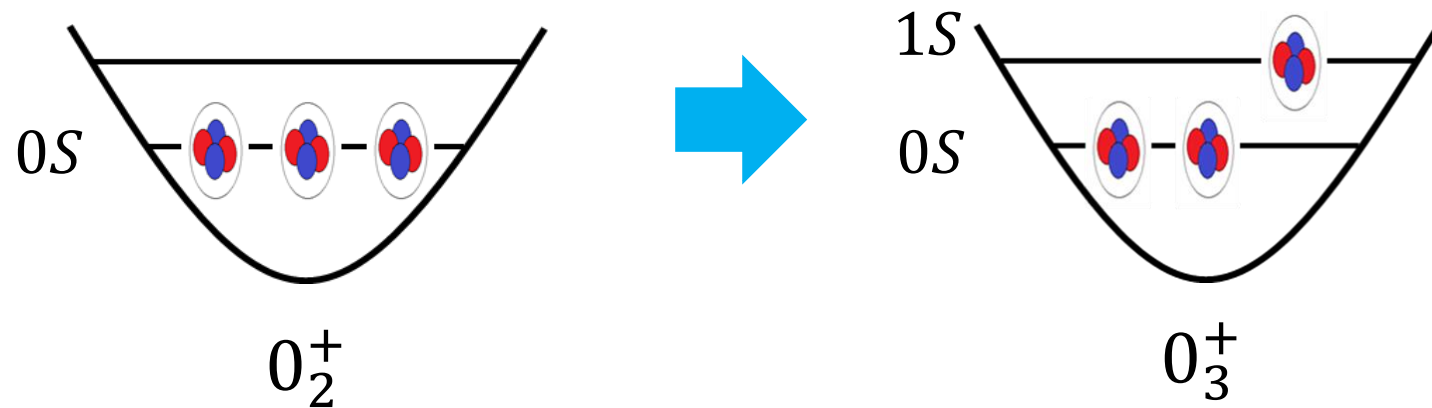
The circle is Target.

My research
in master thesis

Hoyle state and analog state in positive parity

The Hoyle state is dilute gaslike state composed of three α particles .

A. Tohsaki, et al., PRL 87, 192501 (2001)



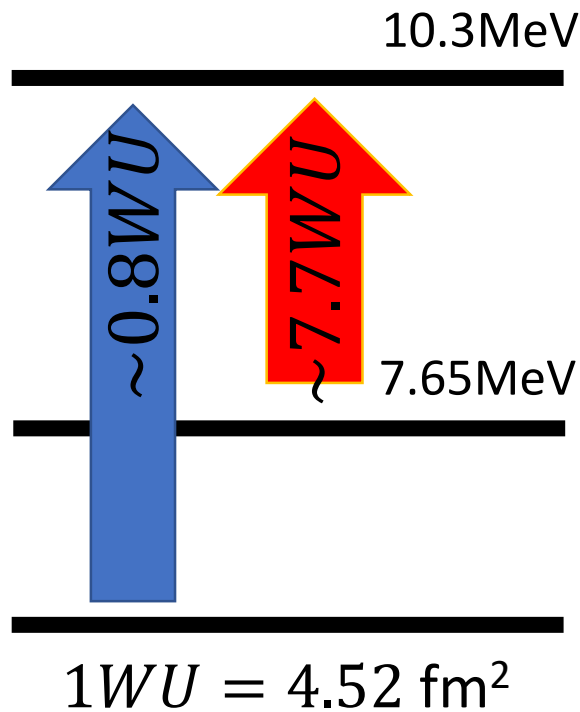
- The Hoyle state can be approximated by the three α particles trapped in the $0S$ state of harmonic oscillator.
- The 0_3^+ can be interpreted as the α particle excitation from $0S$ state to $1S$ state.

Y. Funaki, PRC 92,0211302(2015)

Y. Funaki, PRC 94,024344(2016)

Hoyle state and analog state in positive parity

- The 0_3^+ state has large radius and monopole transition from the Hoyle state.
- The 0_3^+ state is considered to be a family of the Hoyle state.



$$0_3^+ \quad \sqrt{\langle r^2 \rangle} = 4.7 \text{ fm}$$

$$0_2^+ \quad \sqrt{\langle r^2 \rangle} = 3.7 \text{ fm}$$

$$0_1^+ \quad \sqrt{\langle r^2 \rangle} = 2.4 \text{ fm}$$

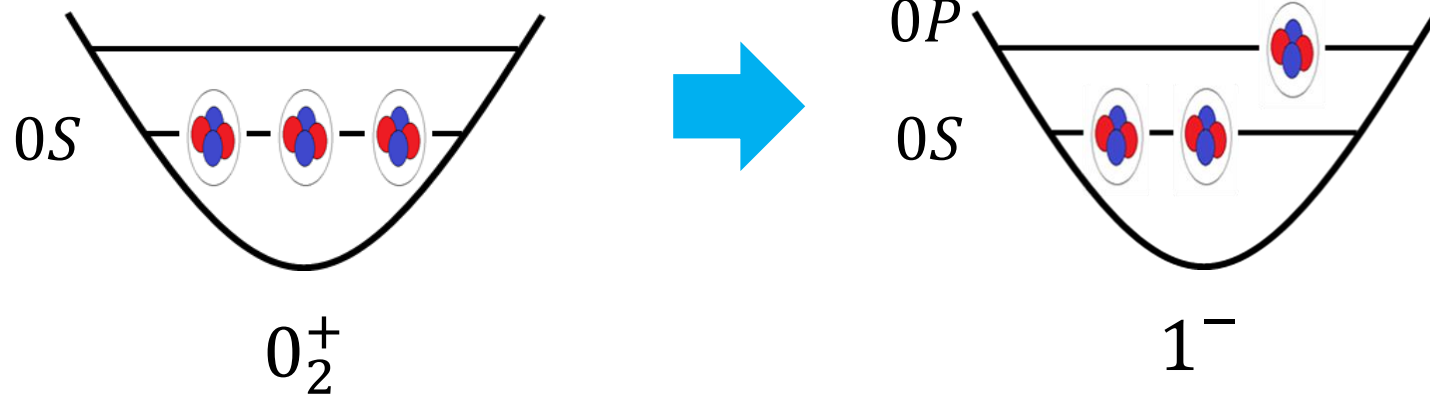
Y. Funaki, PRC 92,0211302(2015)

Y. Funaki, PRC 94,024344(2016)

Hoyle state and analog state in negative parity

Is there an excitation from the Hoyle state in **negative** parity?

In analogy to the 0_2^+ state



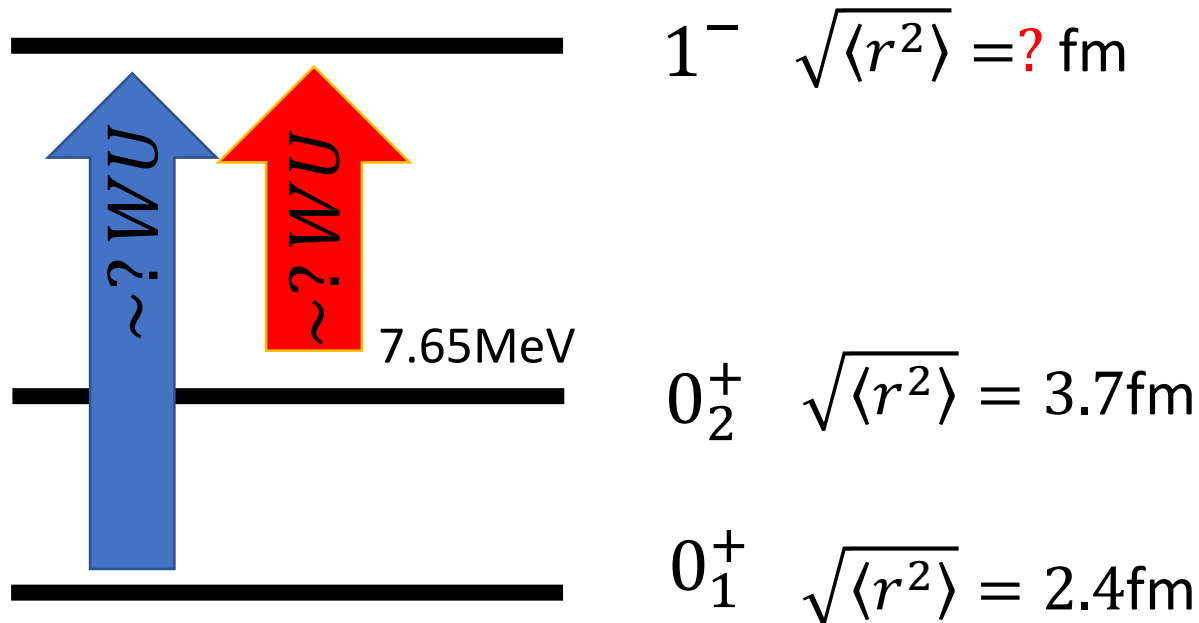
In same potential, we consider an α particle excitation from $0S$ to $0P$ which generate 1^- state.

Hoyle state and analog state in negative parity

Does the 1^- state have large radius?

1^- cluster state can be strongly excited from the ground state by the IS dipole transition.

Y. Chiba ,M. Kimura and Y. Taniguchi, PRC93, 034319(2016)



Y. Funaki, PRC 92,0211302(2015)

Y. Funaki, PRC 94,024344(2016)

Motivation

1^- has been studied by using cluster model, but the relation between the 1^- and alpha condensate state is unknown.

By using Real Time Evolution Method, we investigate the structure of the 1^- state.

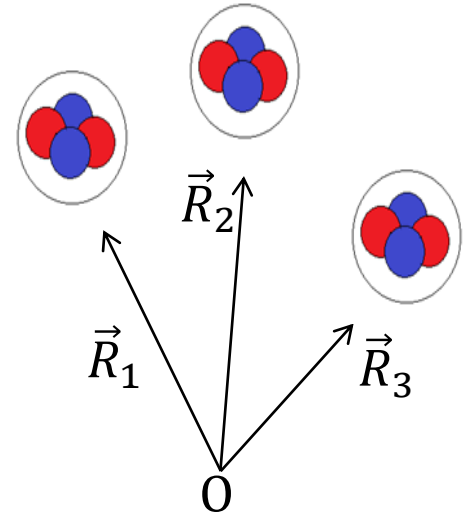
- Does the 1^- state has large radius?
- The 1^- state should have large isoscalar dipole transition to the state that has large radius.

Framework

Hamiltonian

$$H = \sum_i T_i - T_{c.m} + \sum_{i<j} V_{ij} + \sum_{\text{proton}} V_{cc}$$

• V_{ij} : Volkov No.2 potential



Wave function

$$\phi(\vec{R}_1, \vec{R}_2, \vec{R}_3) = \mathcal{A} \{ \phi_{\alpha 1}(\vec{R}_1) \phi_{\alpha 2}(\vec{R}_2) \phi_{\alpha 3}(\vec{R}_3) \}$$

$$\phi_{\alpha i}(\vec{R}_i) = \mathcal{A} \{ \varphi(\vec{r}_{4i-3} - \vec{R}_i) |n \uparrow\rangle \dots \varphi(\vec{r}_{4i} - \vec{R}_i) |p \downarrow\rangle \}$$

$$\varphi(\vec{r} - \vec{R}_i) = (\pi b^2)^{-\frac{3}{4}} \exp\left[-\frac{1}{2b^2} (\vec{r} - \vec{R}_i)^2\right]$$

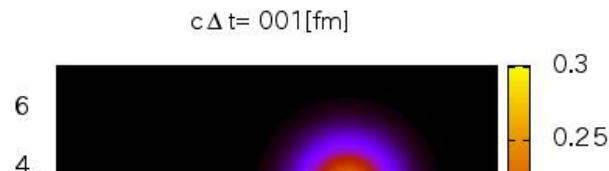
b : the size of α particle , R_i : the center of the i th cluster

$$\psi_{M,K}^{J\pi} = \sum c_K^{J\pi}(\vec{R}_1, \vec{R}_2, \vec{R}_3) \hat{P}_{MK}^J \hat{P}^\pi \phi(\vec{R}_1, \vec{R}_2, \vec{R}_3)$$

Framework Real Time Evolution Method

We generate basis function by solving equation of motion.

⊙time dep



$$\psi_{M,K}^{J\pi} = \sum_t F_K^{J\pi}(\vec{R}_1(t), \vec{R}_2(t), \vec{R}_3(t)) P_{MK}^{J\pi} \phi(\vec{R}_1(t), \vec{R}_2(t), \vec{R}_3(t))$$

Real time is generator coordinate.

$$H \equiv \frac{\langle \phi(\vec{R}_1, i) |}{\langle \phi(\vec{R}_1, i) |}$$

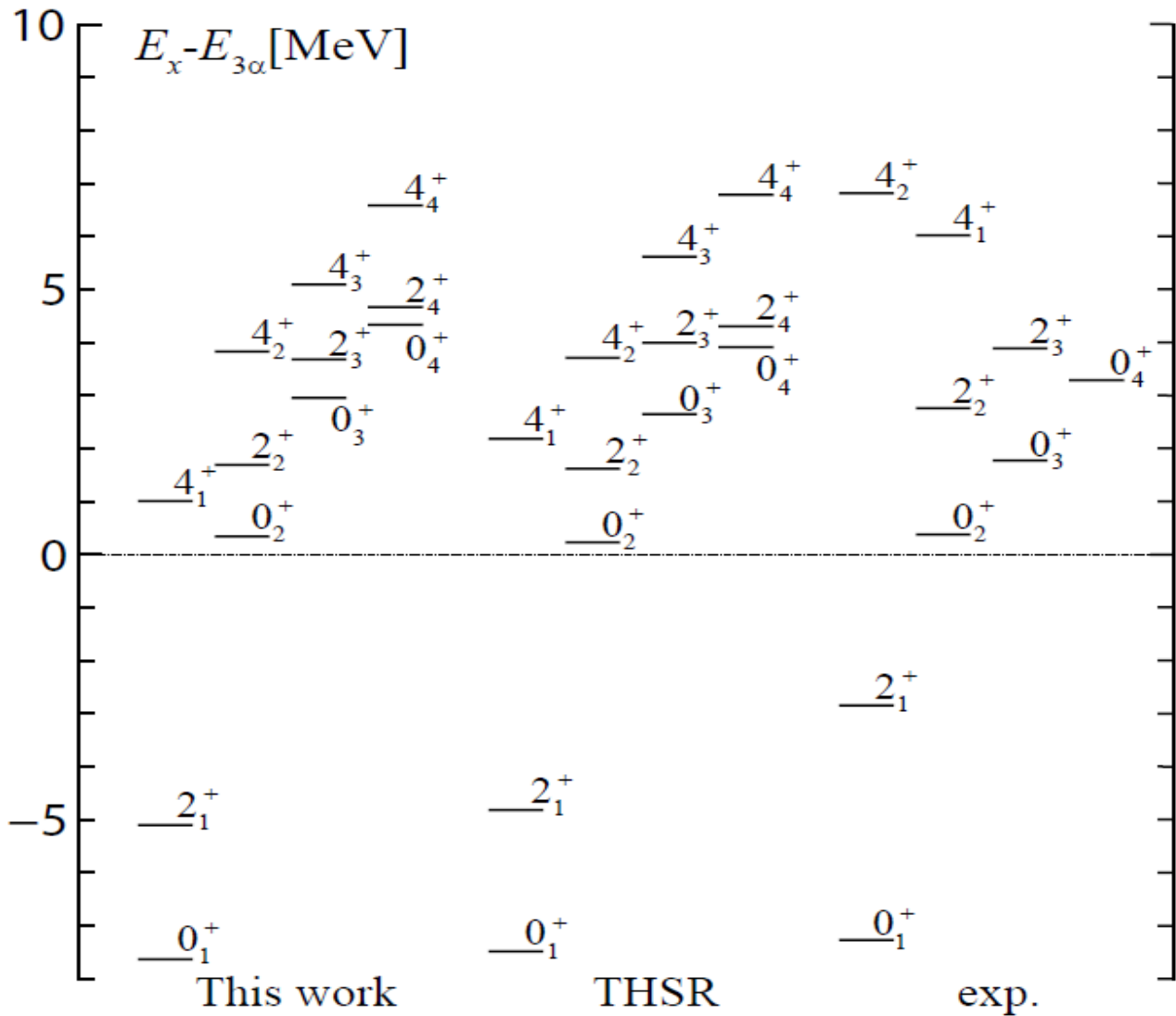


$$\frac{\partial^2}{i\tau \partial R_{i\sigma}^*} \ln N$$

If we evolve time long enough, all configurations will appear on constant-energy surface(ergodic hypothesis).

Result Spectrum of positive parity states

Y. Funaki, PRC 92,0211302(2015)
 M. Freer et al., PRC 83, 034314(2011)
 M. Itoh et al., PRC 84,054308(2011)



Result Radius of the 1_1^-

E. Uegaki, et al., PTP 57, 1262(1977)

M. Kamimura, NPA.351,456(1981)

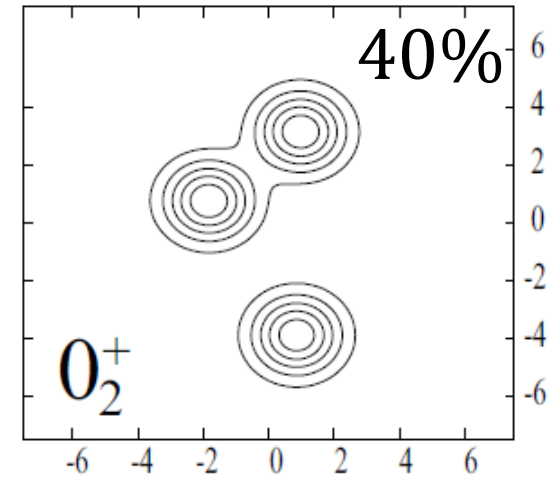
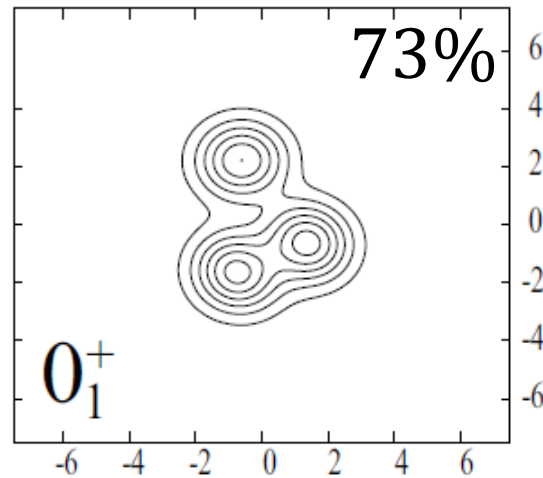
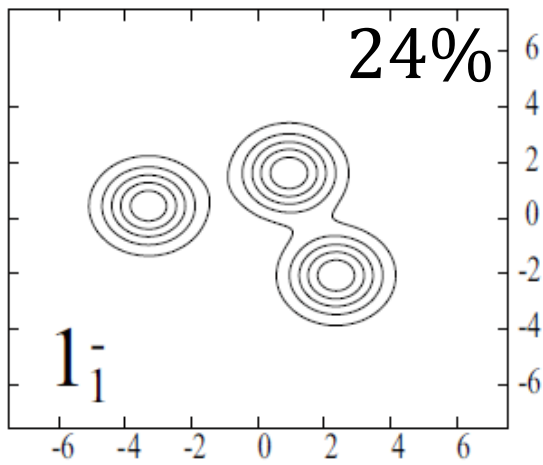
Y. Kanada-En'yo, PTP 117(2007)

Y. Funaki, Phys. Rev. C 92 021302(2015)

J^π	$\sqrt{\langle r^2 \rangle}$				
	This work	AMD	THSR	GCM	RGM
1_1^-	4.09	3.42		3.29	3.36
0_1^+	2.39	2.53	2.4	2.40	2.40
0_2^+	3.63	3.27	3.7	3.40	3.47
0_3^+	4.76	3.98	4.7	3.52	

1_1^- has larger radius than the Hoyle state.

Density distributions



1_1^- is so dilute that the state can't be described by single Slater determinant.

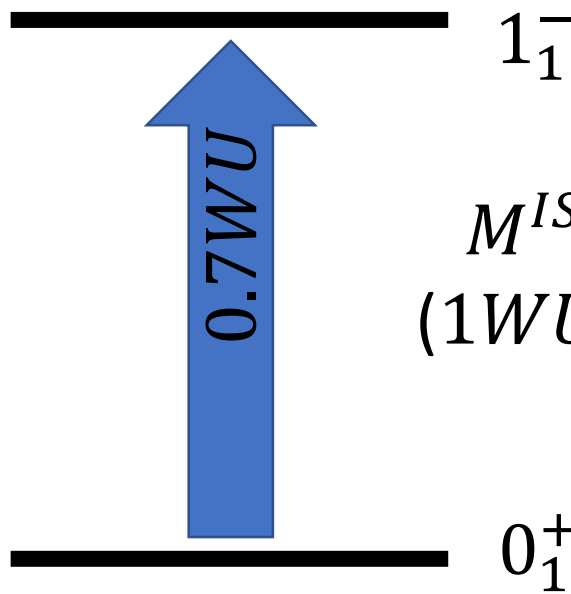
Result IS1

1^- cluster state can be strongly excited from the ground state by the IS dipole transition.

Y. Chiba, et al., PRC93, 034319(2016)

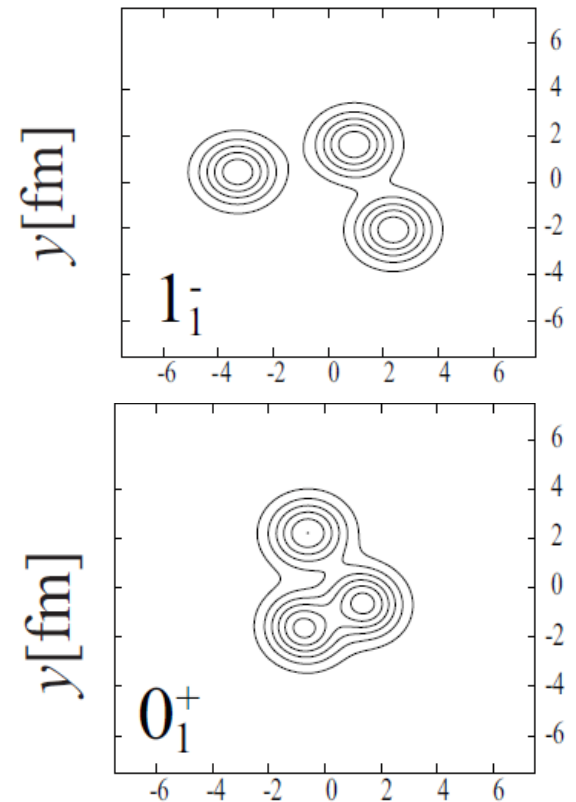
$$\mathcal{M}_{\mu}^{IS1} = \sum_{i=1}^A (\mathbf{r}_i - \mathbf{r}_{\text{c.m.}})^2 \mathcal{Y}_{1\mu}(\mathbf{r}_i - \mathbf{r}_{\text{c.m.}})$$

$$M^{IS1} = \langle 1^- || \mathcal{M}^{IS1} || 0_1^+ \rangle$$



$$M^{IS1} = 0.7WU$$

($1WU = 5.06\text{fm}^3$)



The transition strength is as strong as one particle estimate.

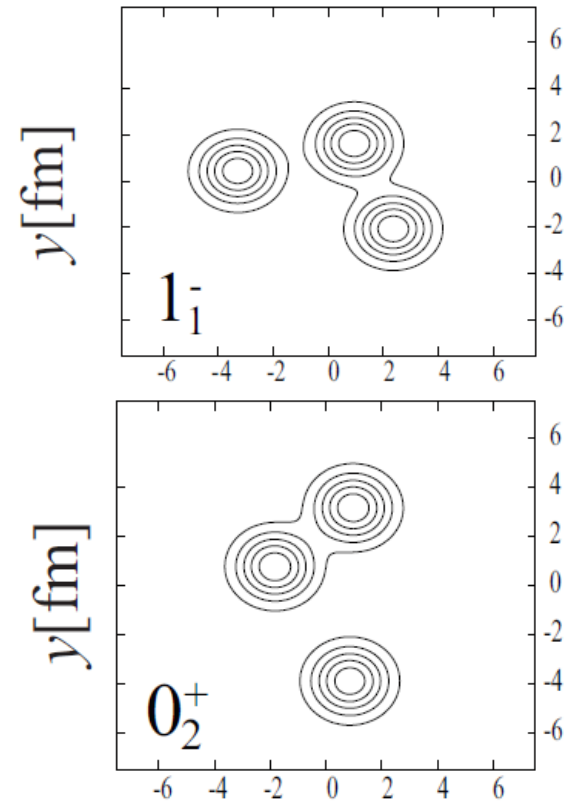
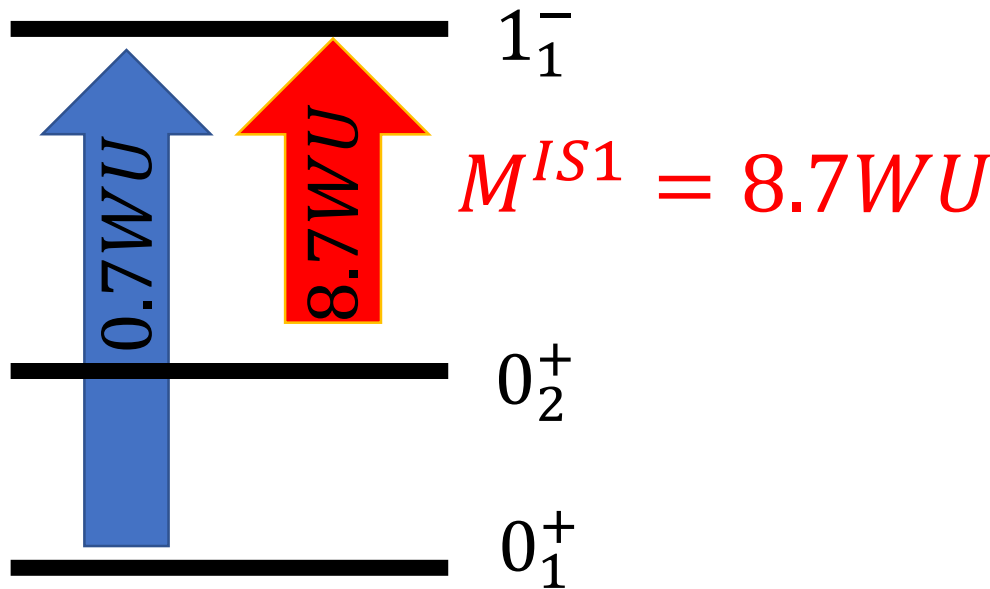
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$$\mathcal{M}_{\mu}^{IS1} = \sum_{i=1}^A (\mathbf{r}_i - \mathbf{r}_{\text{c.m.}})^2 \mathcal{Y}_{1\mu}(\mathbf{r}_i - \mathbf{r}_{\text{c.m.}})$$

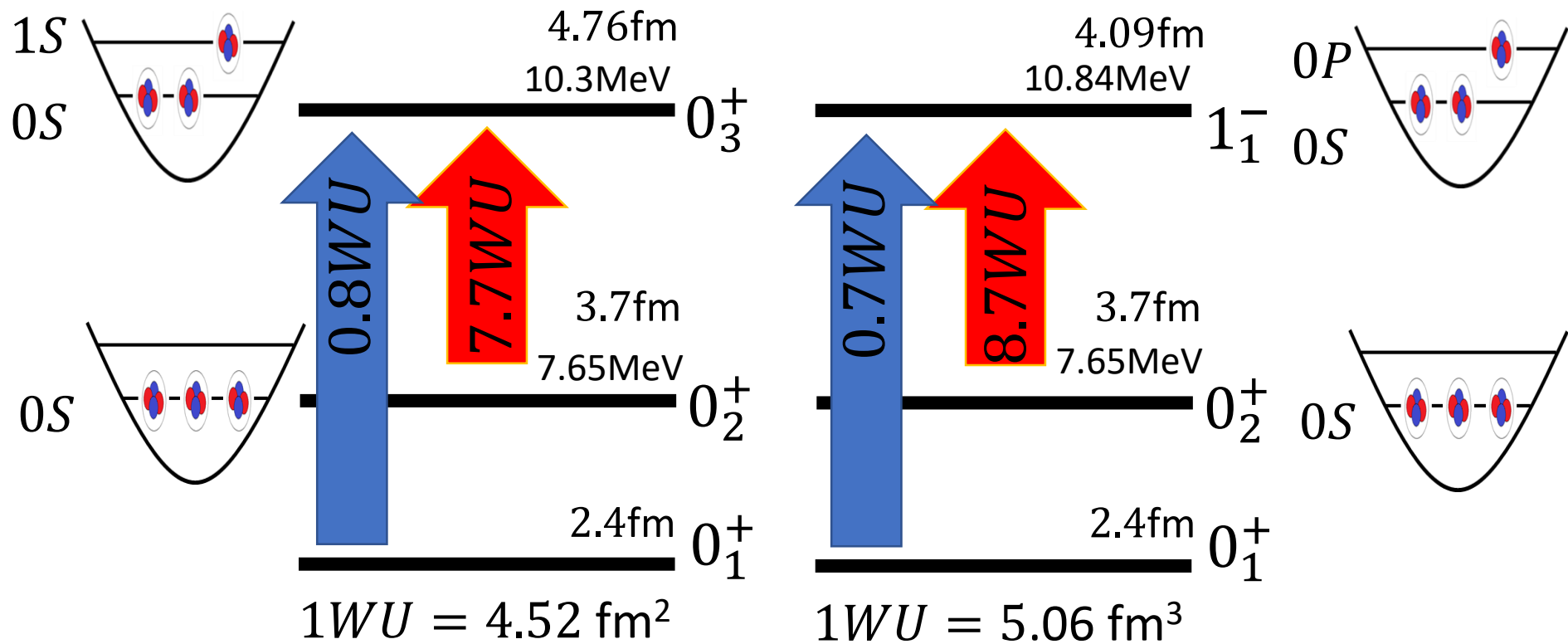
$$M^{IS1} = \langle 1^- || \mathcal{M}^{IS1} || 0_1^+ \rangle$$



The 1_1^- state has large IS1 transition to the Hoyle state.

Summary of master thesis

- We investigated the property of the 1_1^- state by using Real Time Evolution Method.



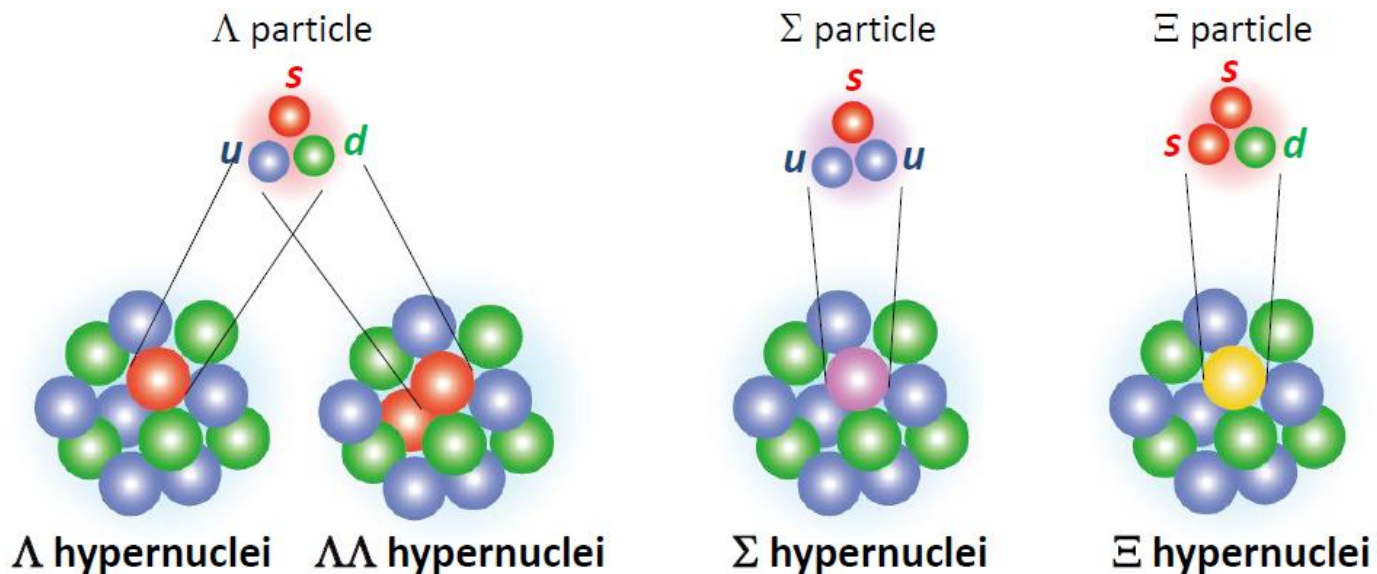
Future work

- We will research the orbit of the α particle to check that the description of the 1_1^- state is correct.

Rasearch
in doctor course

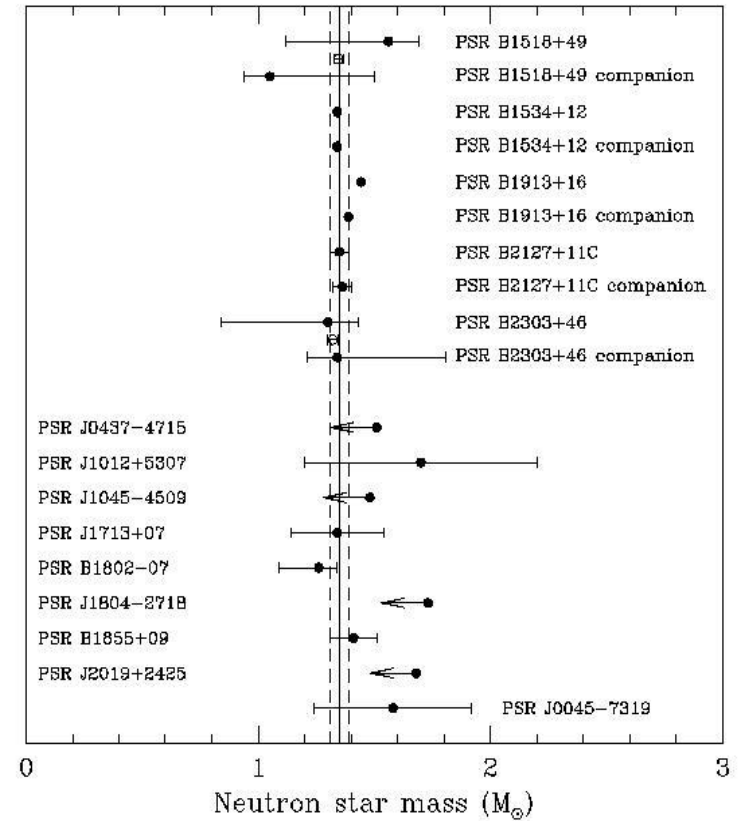
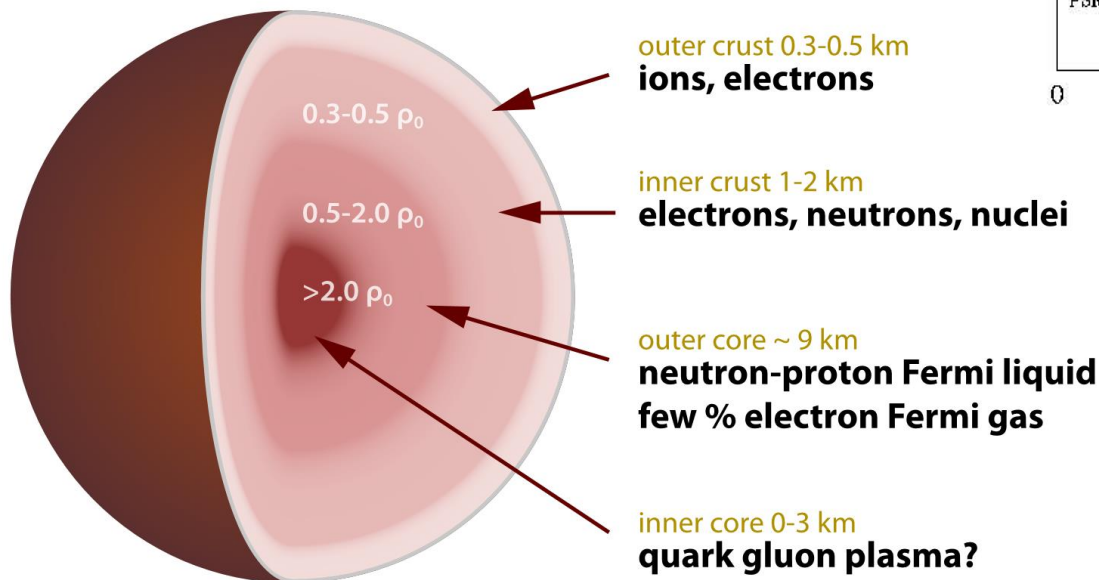
Hyper-nuclei

- Why the hypernuclei are interested in?
 - YN, YY interaction
 - Impurity effects



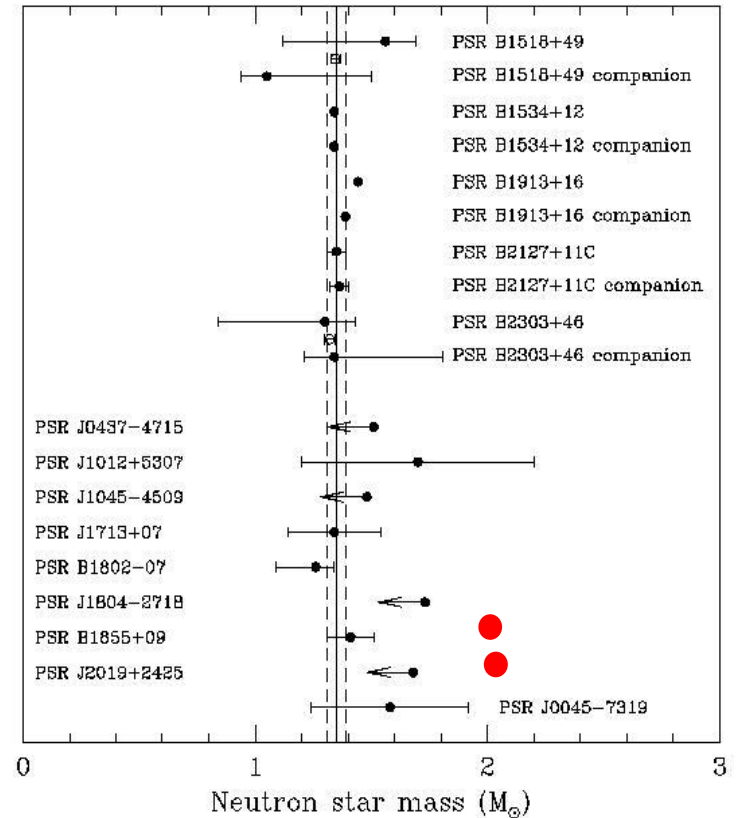
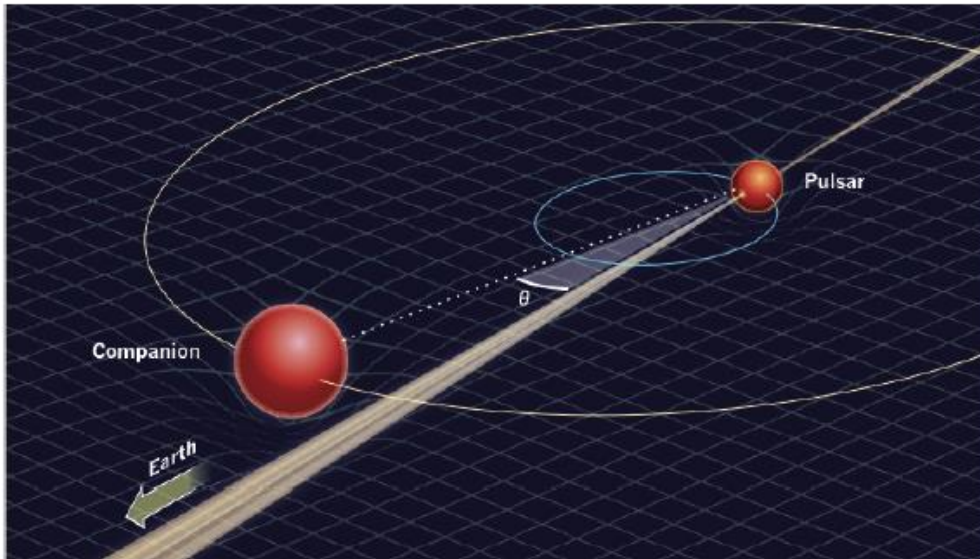
Background

- Neutron star
 - Mass is $1.1 \sim 1.4 M_{\odot}$.
 - Radius is about 10 km.
 - High density



Background

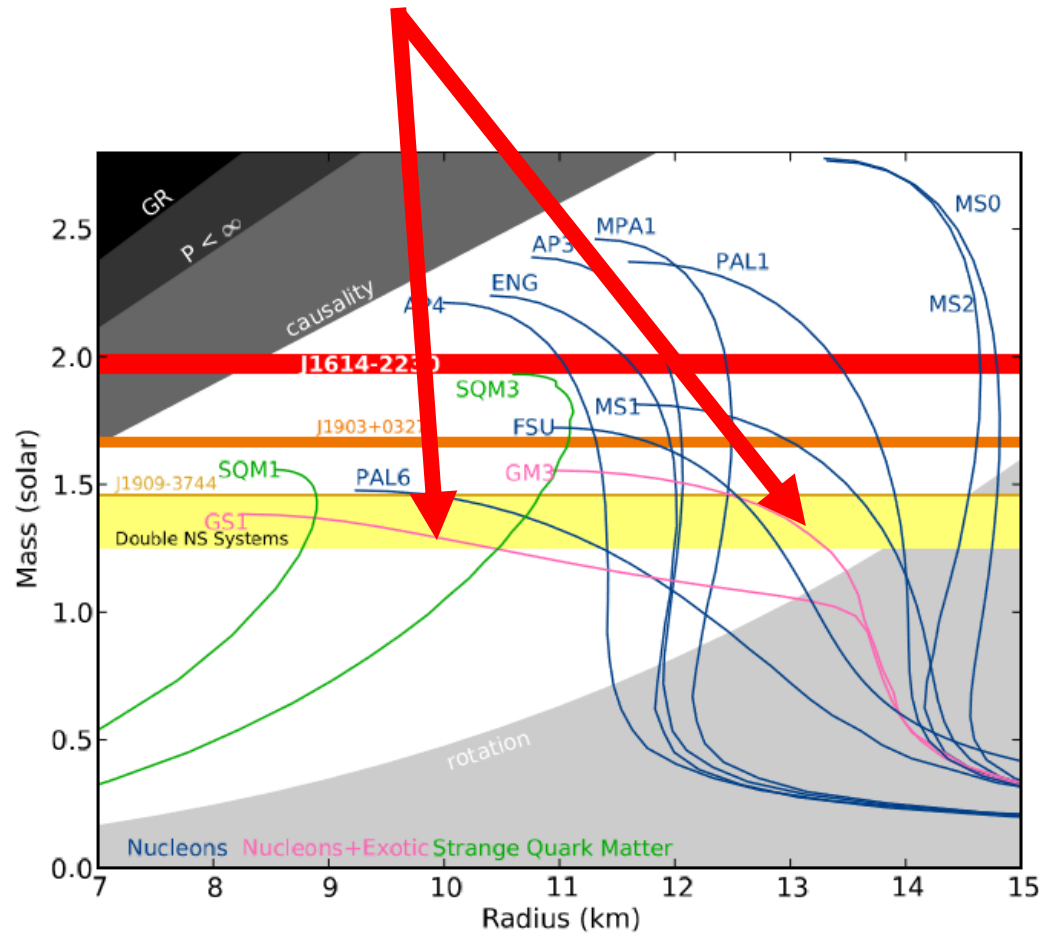
In 2010, PSR J1614-2230($1.97 \pm 0.04M_{\odot}$) and
 in 2013, PSR J0348+0432($2.01 \pm 0.04M_{\odot}$) were observed.



Hyperon puzzle

- But the calculations including hyperon cannot reproduce the large mass.
- How do the YN and YY interaction change for high density?
 - This is important to solve the Hyperon puzzle.
- Hypernuclei give us the information about the YN interaction.

EOS with hyperons or Kaons



P. Demorest, et al.,(2010)

Ξ hypernuclei

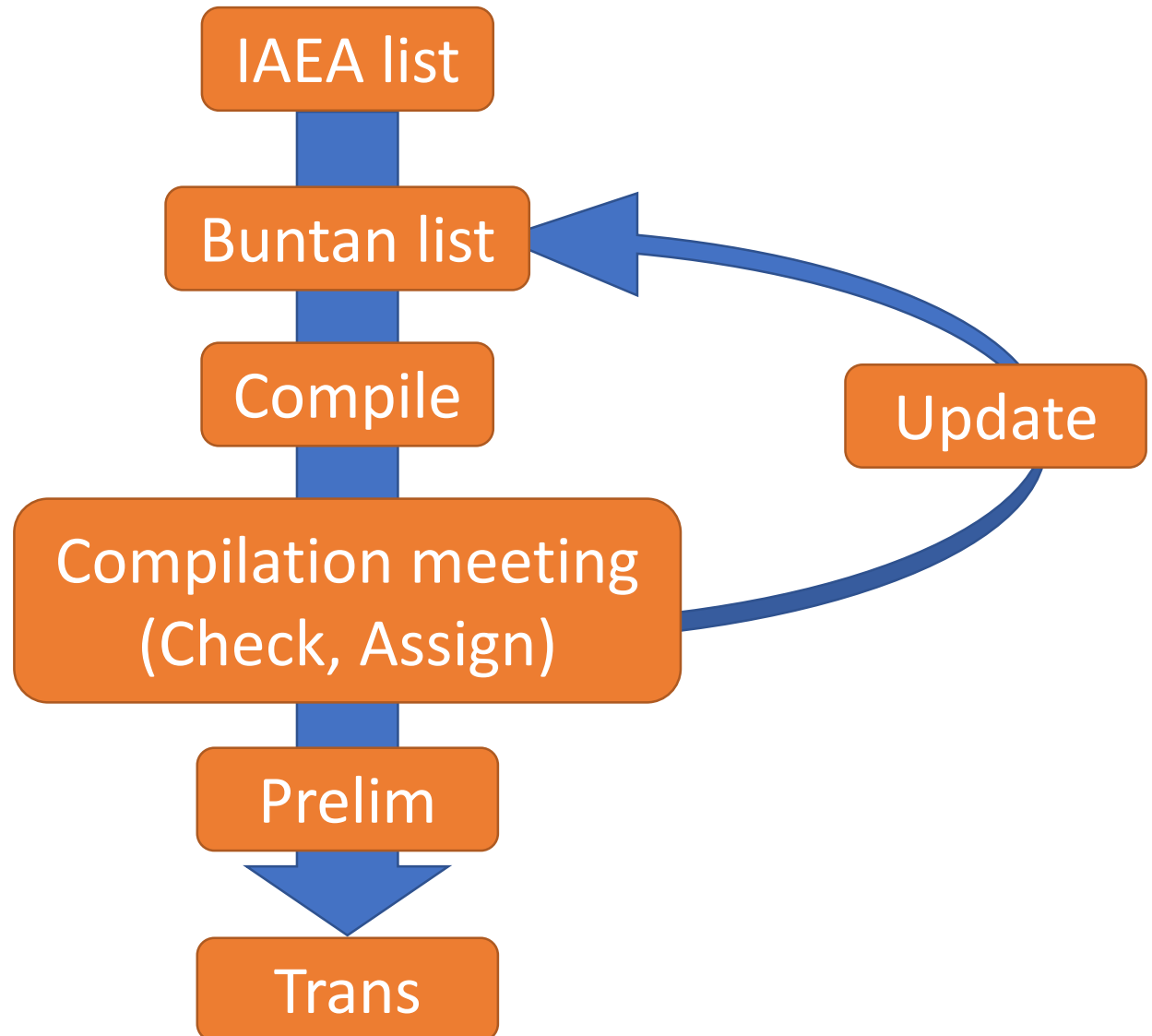
- I will calculate the spectrum of Ξ hypernuclei by AMD.
 - E05 experiment was planned. $^{12}\text{C}(K^-, K^+)$ reaction (T. Nagae et al.)
 - To observe Ξ hypernuclei
 - To observe Ξ hyper nuclear potential of $^{12}_{\Xi}\text{Be}$



Information about Ξ -N interaction

Compilation in JCPRG

Flowchart of Compilation in the JCPRG



Buntan(分担) list

I distributes the paper from the IAEA list to the “buntan list”.

2565	JPJ25(1968)901	Single particle strength of collective 3- state in medium mass nuclei	Tada (finished)	All (finished)
2564	JPJ25(1968)301	Inelastic alpha-particle scattering on copper 65 at 29 MeV	Tada (finished)	All (finished)
2563	JIN43(1981)1727	Production of 119mSn by alpha particle bombardment of 116Cd and its carrier-free separation	Saito (finished)	All (finished)
2562	JPJ87(2018)014203	Observation of new neutron-rich isotopes among fission fragments from in-flight fission of 345 MeV/nucleon 238U: search for new isotopes conducted concurrently with decay measurement campaigns	Jagjit (finished)	All (finished)
2561	JPJ87(2018)014202	Identification of new neutron-rich isotopes in the rare-earth region produced by 345 MeV/nucleon 238U	Jagjit (finished)	All (finished)
2560	PTEP2017(2017)083D01	Neutron production cross sections for (d,n) reactions at 55 MeV	Murata, Saito (finished)	All (finished)
2559	PRL119(2017)182503	Test of the Brink-Axel Hypothesis for the Pygmy Dipole Resonance	Tada	All
2558	PRL118(2017)252501	Electric Dipole Polarizability of 48Ca and Implications for the Neutron Skin	Ichinkhorloo	All
2557	PRL118(2017)202502	Gamma Decay of Unbound Neutron-Hole States in 133Sn	Jagjit (finished)	All (finished)
2556	PR/C96(2017)044604	Photoneutron cross-section measurements in the 209Bi(g,xn) reaction with a new method of direct neutron-multiplicity sorting	Jagjit	All
2555	PR/C96(2017)044316	Low-lying dipole strength in 52Cr	Tada	All
2554	PR/C96(2017)034604	Discovery of new isotopes 81,82Mo and 85,86Ru and a determination of the particle instability of 103Sb	Jagjit (finished)	All (finished)

Compile


- We compile by using tools hendel and Gsys.

Edit:
e2575
edit

Convert:
e2575
conv

[NRDF](#)
[w/o data](#)
[CHEN](#)
[EXFOR](#)
[w/o data](#)
[CHEX](#)
[JANIS](#)
[EXFOR+](#)
[Graph](#)

[Bib](#)
[Data 0A](#)
[Data 0B](#)
[Data 0X](#)
[Data 1](#)
[Data 2](#)
[Data 3](#)
[Data 4](#)
[Data 5](#)
[Data 6](#)
[Data 7](#)



Volume 426, 13

Nucl. Instrum. Methods in Physics Res., Sect.B

2018

Production cross sections of deuteron-induced reactions on natural palladium for Ag isotopes

N.Ukon^{1,2}, M.Aikawa¹, Y.Komori³, H.Haba³
¹Faculty of Science, Hokkaido University, Sapporo
²Fukushima Global Medical Science Center, Fukushima Medical University, Fukushima
³Nishina Center for Accelerator-Based Science, Inst.of Physical and Chemical Res. (RIKEN), Wakou

Add or Delete author(s), institute(s) or data section(s).
Add author(s) after th author

Input example --
=== Add 2 data sections after 5 th data section. ===
(1) Data section "Data 6", "Data 7" ... are renamed as "Data 8", "Data 9" ...
(2) Then 2 new data sections, named "Data 6" and "Data 7", are added successively.

Compile

Gsys is the Graph digitizing system.

The screenshot displays the GSYS software interface. On the left, a multi-panel plot shows the differential cross-section $(d\sigma/d\Omega)_{c.m.}$ in mb/sr versus the center-of-mass angle $\theta_{c.m.}$ in degrees. The plot is divided into four vertical panels, each representing a different energy level: 2,52 MeV ($\times 10^3$), 2,85 MeV ($\times 10^3$), 2,98 MeV ($\times 10^3$), and 3,08 MeV ($\times 10^3$). The y-axis is logarithmic, ranging from 1.0×10^{-5} to 10.0 . The x-axis ranges from 20.0 to 50.0 degrees. Data points are shown with error bars, and a solid line represents a fit or model. The top menu bar includes 'File', 'Edit', and 'View'. Below it are various tool buttons like 'Xa', 'Ya', 'Auto', 'Ad', 'Rm', 'X err(sy)', 'Y err(sy)', 'Magnify', 'Shrink', 'Loupe', 'Reset', 'Glass', and 'Shot!'. On the right, the 'Output Data' dialog box is open, showing settings for writing, saving, and sorting data. It includes fields for x and y ranges, scales (Linear and Log), point styles (Fixed and Floating), and digit precision (3 decimal places). The 'Format of Output Data' is set to 'NRDF' and 'Error notation' is 'Relative'. Below the dialog, a list of digitized data points is shown, including the date '9.Oct.2018, 17:42:27' and the number of data points '9'. An 'Axis Manager' dialog box is also visible, showing the current axis settings: X Axis (Start: 20.0, End: 50.0, Scale: Linear) and Y Axis (Start: 1.0E-5, End: 10.0, Scale: Log). At the bottom of the window, a status bar indicates 'Clicked (0, 0), Mouse (100, 5)'.

Output Data

Write Save Sort X Sort Y No Sort Close

x(start)= 20.0 , x(end)= 50.0 , Scale: Linear , Point: Fixed , Digit: 3 decimal

y(start)= 1.0E-5 , y(end)= 10.0 , Scale: Log , Point: Floating , Digit: 3 decimal

Format of Output Data: NRDF , Error notation: Relative

Separator: Space , X-err position: x dx y dy , Output Error: As Read

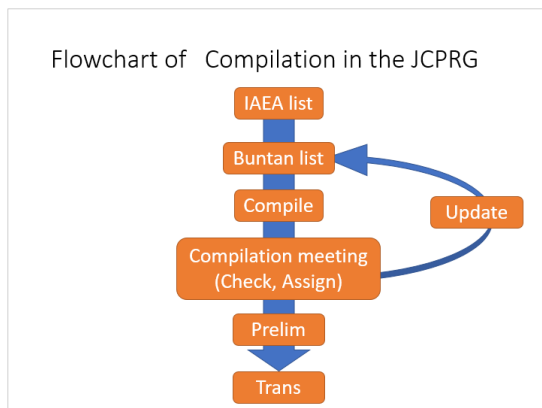
```
# Digitized by GSYS2.4.7
# Date = 9.Oct.2018, 17:42:27
# Number of data = 9
# set xrange[20.0, 50.0]
# set yrange[1.0E-5, 10.0]
# Set Logscale y
# MD5Fig : 892dbab0fd4e5bc02c4ee6f37df93a48
# Axis_X : 3fc8b3a766d653b53feb778f900df9ea3fe92c91a4091c7e3feb778f900df9ea
# Axis_Y : 3fc8a6dfc3518a6e3feb729c628b3f323fc8a6dfc3518a6e3f8c8ace7ffc19b5
# x y +-dy
26.519 1.912E-01 +-5.704E-02
29.170 1.815E-01 +-3.817E-02
31.822 1.815E-01 +-3.627E-02
34.403 1.162E-01 +-3.026E-02
37.055 1.162E-01 +-3.779E-02
42.358 5.720E-02 +-1.599E-02
44.939 6.783E-02 +-1.960E-02
47.591 6.107E-02 +-1.878E-02
52.751 2.929E-02 +-1.054E-02
```

	Start	End	Scale
X Axis :	20.0	50.0	Linear
Y Axis :	1.0E-5	10.0	Log

Clicked (0, 0), Mouse (100, 5)

Compilation meeting

- This meeting is held once a week.(member: Aikawa, Kimura, Jagjit, Ichinkhorloo and Tada)
- Agenda
 - Check(1 or 2 papers)
 - Correction
 - Next schedule (which entry, date)



Plan for my internship

- My task
 - Compilation of old E entry in the buntan list.
 - Correction for the IAEA comments.

Plan for my internship

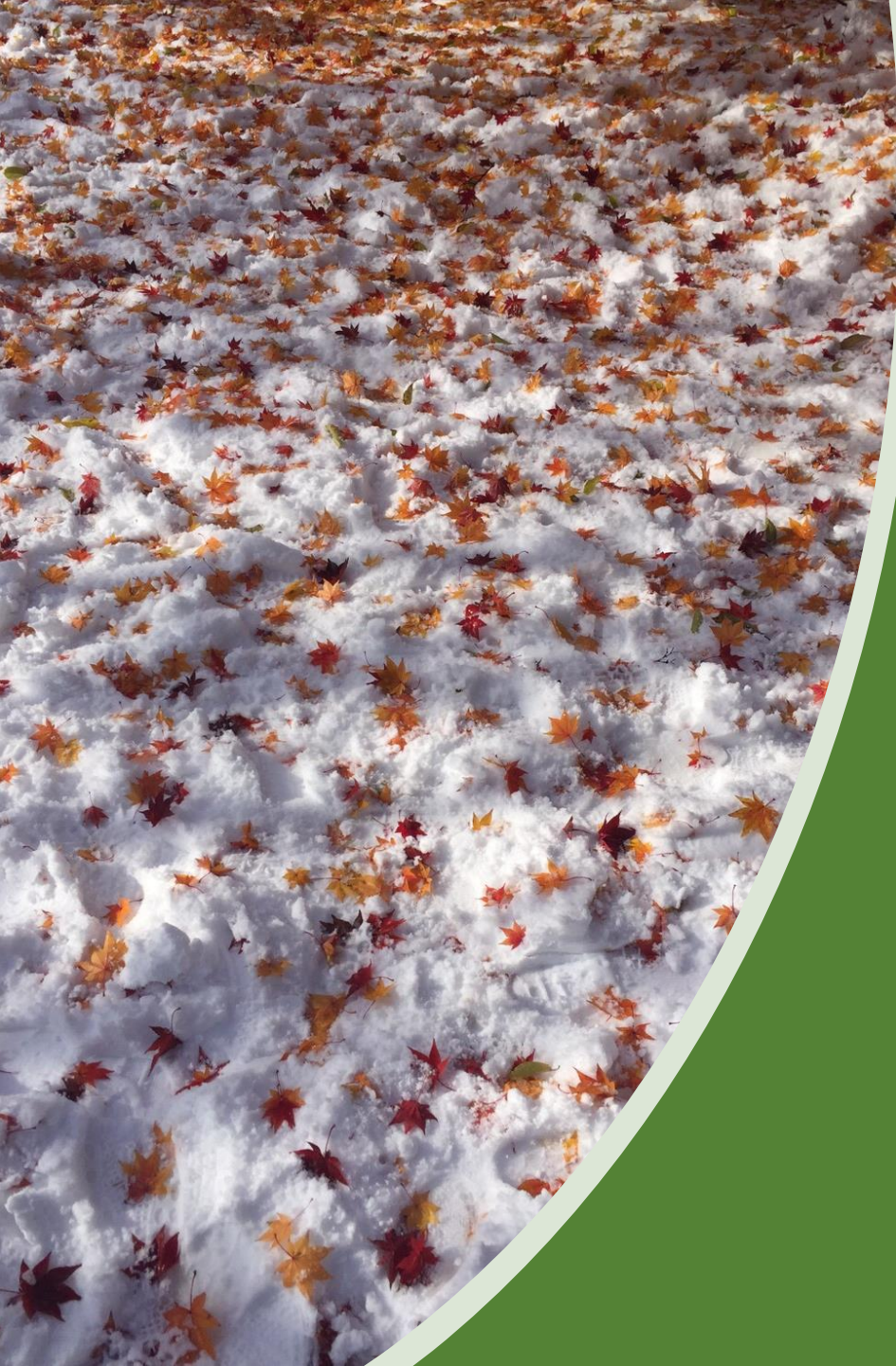
- My task
 - Compilation of old E entry in the buntan list.
 - Correction for the IAEA comments.

You must finish 65 corrections
for IAEA comments.



Technical Issue in JCPRG

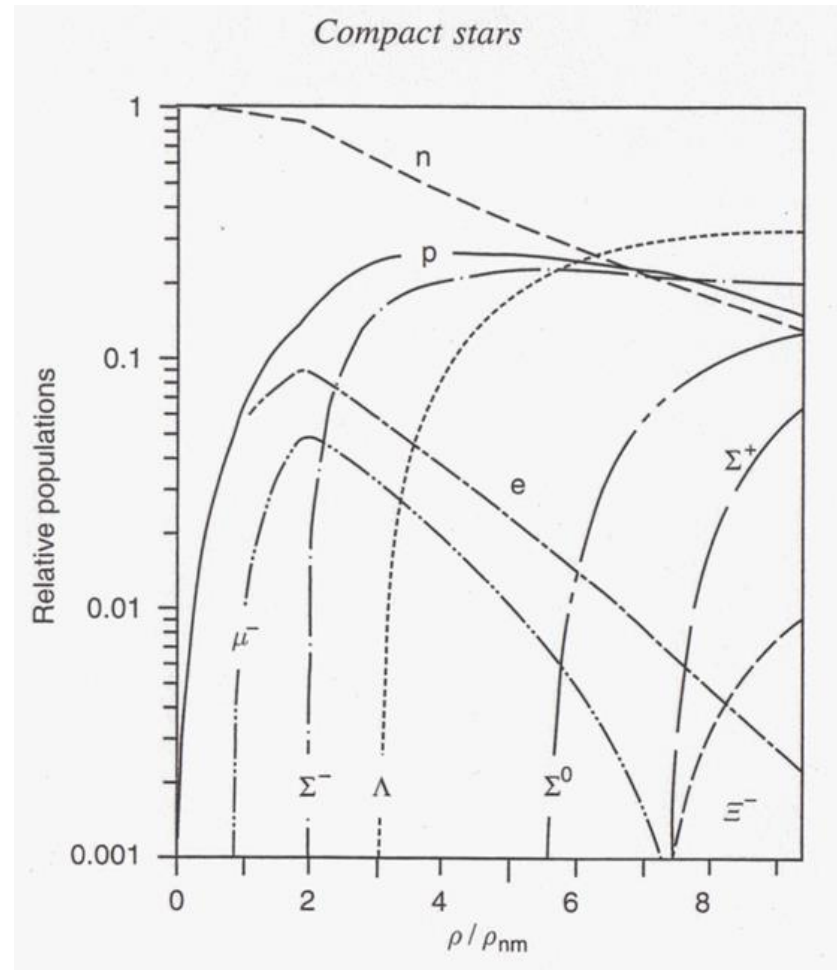
- We have a few members.
- Members are too busy, so that all members can't attend every compilation meeting.
- Members are not fixed in some years.



Thank
you!

backup

It is thought that hyperon appear in the neutron star.



$$\rho_{nm} = 1.6 \text{fm}^{-3}$$

Result

transitions [fm ²]	TGCM	THSR	exp.
$M(E0; 0_2^+ \rightarrow 0_1^+)$	6.57	6.3-6.4	5.4(2)
$M(E0; 0_2^+ \rightarrow 0_3^+)$	30.60	34-37	
$M(E0; 0_2^+ \rightarrow 0_4^+)$	1.37	0.5-1.4	

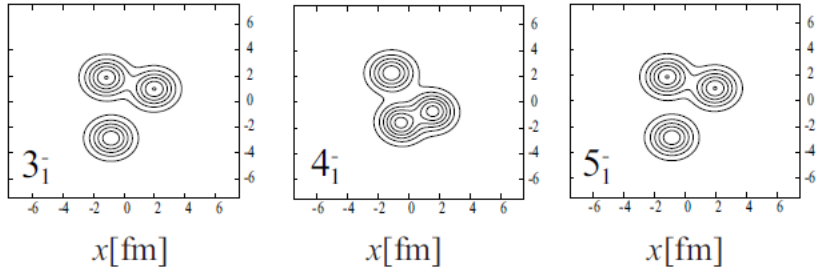
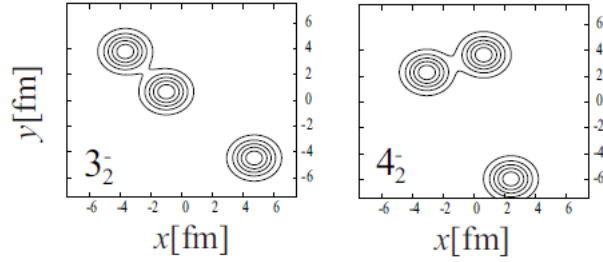
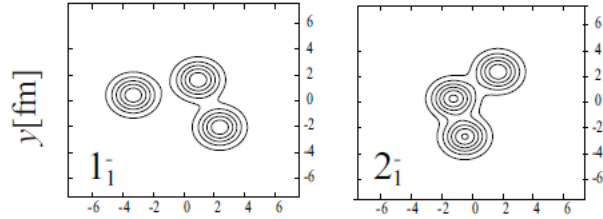
0^+ states has strong monopole excitation.

transitions [$e^2\text{fm}^4$]	TGCM	THSR	exp.
$B(E2; 2_1^+ \rightarrow 0_1^+)$	9.01	9.5	7.6(4)
$B(E2; 2_1^+ \rightarrow 0_2^+)$	0.84	1.0	2.6(4)
$B(E2; 2_2^+ \rightarrow 0_1^+)$	2.64	2.0-2.5	0.73(13)
$B(E2; 2_2^+ \rightarrow 0_2^+)$	270.20	295-340	
$B(E2; 2_2^+ \rightarrow 0_3^+)$	143.81	88-220	
$B(E2; 2_2^+ \rightarrow 0_4^+)$	11.49	22-31	
$B(E2; 4_2^+ \rightarrow 2_2^+)$	605.30	560-730	

This results consistent with the THSR calculation and reproduce tendency of exp.

B. Zhou et al., PRC 94, 044319(2016)

Y. Funaki, PRC 94, 024344(2016)



J^π	$\langle \psi_\alpha \tilde{\phi}_i \rangle$	J^π	$\langle \psi_\alpha \tilde{\phi}_i \rangle$	J^π	$\langle \psi_\alpha \tilde{\phi}_i \rangle$
1_1^-	24 %	2_1^-	37 %		
3_2^-	18 %	4_2^-	15 %		
3_1^-	53 %	4_1^-	50 %	5_1^-	46 %

