Dineutron-dineutron correlation in ^{8}He

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Purpose of this study

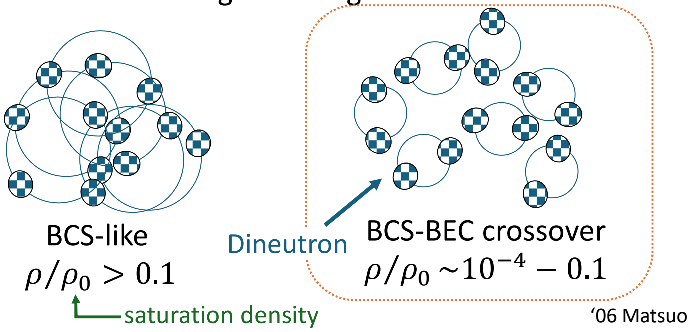
- to reveal the spatial correlations of dineutrons in detail especially in $^{8}\mathrm{He}(0_2^+)$, where the cluster structure is expected to develop as suggested by the recent experiment

Summary of Results

- Dominant contribution of 3-body cluster structure both in $0_1^+, 0_2^+$
- The developed cluster structure in 0_2^+ is a mixture of 2- & 3-body cluster configurations.

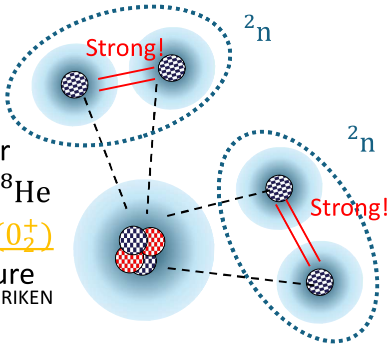
Introduction

n-n spatial correlation gets strong in dilute neutron matter.



Why ^{8}He ?

- ^{8}He : α cluster + 4n
→ dineutron formation on the surface of the α cluster
- Recent experiment about ^{8}He
  - first observation of $^{8}\mathrm{He}(0_2^+)$
  → developed cluster structure '23 Yang *et. al.* @ RIKEN
  - tetraneutron
  '22 Duer *et. al.* @ RIKEN

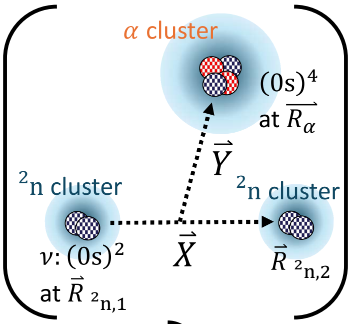


Model wave function of ^{8}He

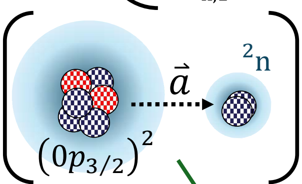
$\alpha +$ ^{2}n $+$ ^{2}n 3-body generator coordinate method
+ dineutron breaking induced by spin-orbit force
based on the microscopic cluster model

$$\Psi(^{8}\mathrm{He}) = \int d\vec{X}\, d\vec{Y}\, c_{\vec{X},\vec{Y}} \det [\ldots]$$

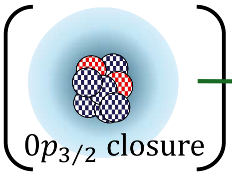
3-body cluster GCM



$$+ \int d\vec{a}\, c_{\vec{a}} \det [\ldots]$$



$$+ c_1 \det [\ldots]$$



Dineutron breaking by spin-orbit force

Results

Energy

units :MeV	This work	Expt.
B.E.	29.44	31.60
S_{2n}	1.47	2.14
S_{4n}	1.83	3.12
$E_x(0_2^+)$	5.20	6.66(6)
$Er(0_2^+)$	3.4	3.54

Radius & IS0 strength

	This work	Expt.
$R_{rms}(0_1^+)$(fm)	2.40	2.52
$R_{rms}^{p}(0_1^+)$(fm)	1.89	1.788
$R_{rms}(0_2^+)$(fm)	3.91	
$M(\mathrm{IS0})$ (fm^2)	7.75	$11^{+1.8}_{-2.3}$

- Hierarchy of B.E. of He isotopes can be reproduced.
- In 0_1^+, compact structure is seen while in 0_2^+, spatially developed structure appears.
- Large strength of isoscalar monopole(IS0) transition
→ Cluster structure is enhanced in the 0_2^+ state.

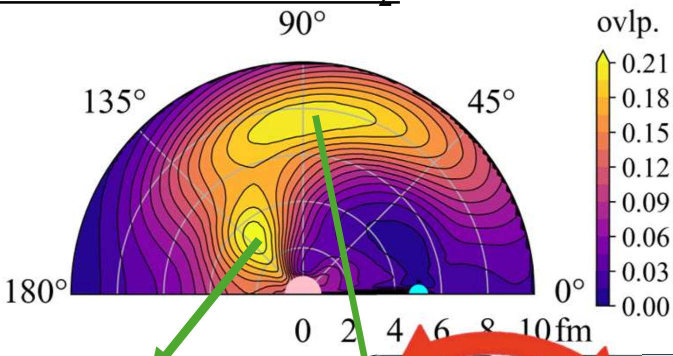
Detailed analysis of each component

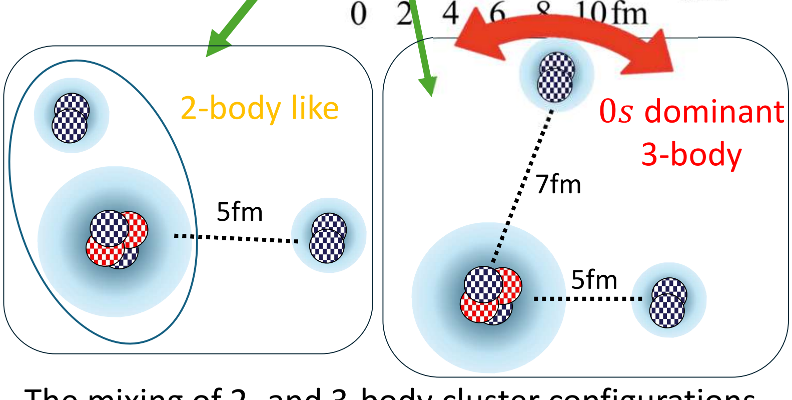
- 3-body structure is dominant
- Shell-model like $p_{3/2}$ closure config. is enhanced in 0_1^+.
- 2-body structure is still subdominant in $\mathbf{0_2^+}$

squared overlap

	0_1^+	0_2^+
$p_{3/2}$	48.7%	8.6%
3-body	84.1%	92.6%
2-body	88.2%	58.3%

Dineutron distribution in 0_2^+





The mixing of 2- and 3-body cluster configurations