Introduction

Poster: Overlap integrals of di-neutron cluster state and shell model state
Authors: M. Ito, R. Nakamoto, E. Uedal and S. Shimizu (ID #246)

Clustering is fundamental and interesting correlation in quantum many-body systems.
Recently, we can see studies of cluster correlations in the following articles.

・α cluster correlation

α-cluster correlation in Sn-isotopes：S. Typel, PRC89, 064321 (2014).

・Di-neutron cluster correlation

2n-cluster correlation in N-rich system：
H. J. Cook et al., PRL124, (2020).
Y. Kubota et al., PRL125, (2020).

Cluster configuration ⟺ NON-orthogonal ! ⟹ jj-coupling shell model

There must be a probability of cluster formation in jj-coupling shell model
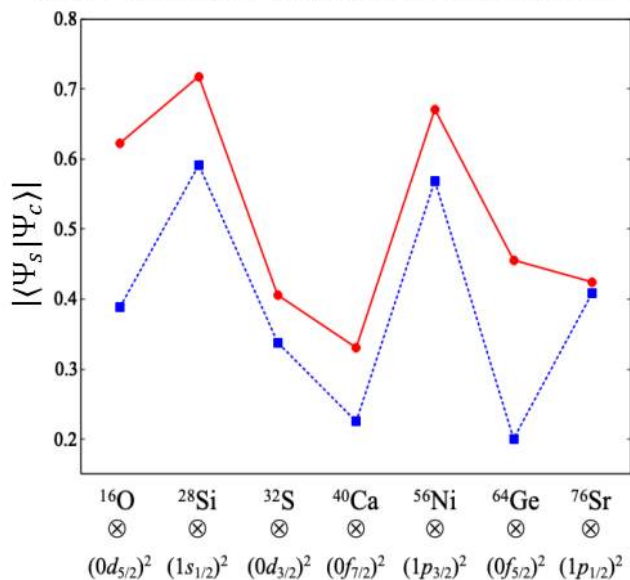
Present report

Overlap integral of jj-coupling shell model and cluster (2n and α) configurations is evaluated

Shell model   Cluster

$$\langle \Psi_s | \Psi_c \rangle = \left\langle \quad \middle| \quad \right\rangle$$

Overlap in core + n + n system

We have evaluated overlap amplitude of shell model and cluster wave functions based on Fourier transformation (Submitted to Prog. Theor. Exp. Phys. (PTEP))

$|\langle \Psi_s | \Psi_c \rangle|$

$^{16}O \otimes (0d_{5/2})^2$ $^{28}Si \otimes (1s_{1/2})^2$ $^{32}S \otimes (0d_{3/2})^2$ $^{40}Ca \otimes (0f_{7/2})^2$ $^{56}Ni \otimes (1p_{3/2})^2$ $^{64}Ge \otimes (0f_{5/2})^2$ $^{76}Sr \otimes (1p_{1/2})^2$

Blue: J=0 pair
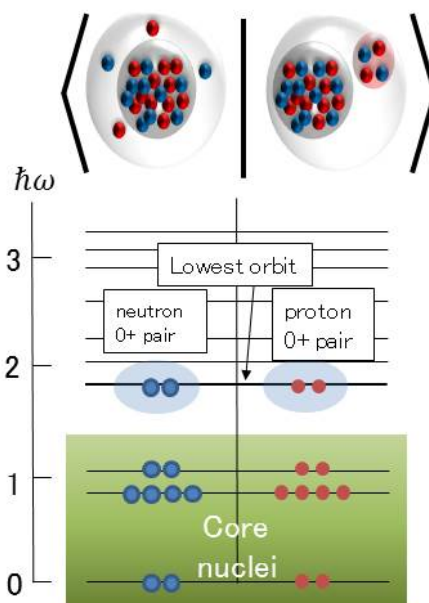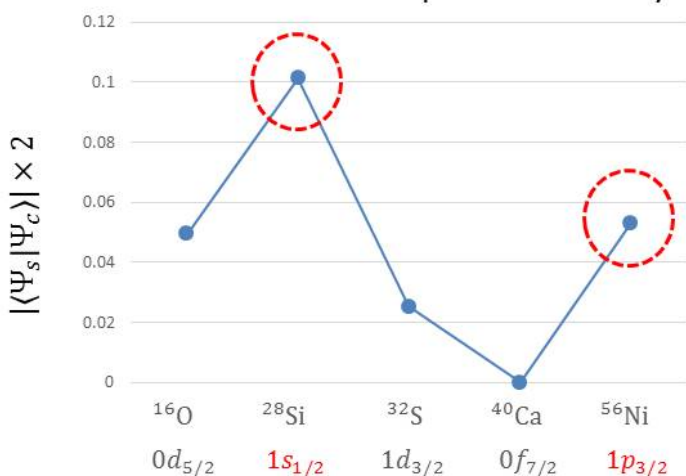2n total spin is coupled to J=0

Red: CI calculation
Configuration interaction is performed for shell model state

CI effect enhances overlap amplitude by a factor of 1.3 ~ 3

Overlap is enhanced if 2n occupy 1s or 1p orbit

Overlap in core + n + n + p + p

We have calculated overlap of Core + 4N systems

$|\langle \Psi_s | \Psi_c \rangle| \times 2$

^{16}O $0d_{5/2}$ ^{28}Si $1s_{1/2}$ ^{32}S $1d_{3/2}$ ^{40}Ca $0f_{7/2}$ ^{56}Ni $1p_{3/2}$

$\hbar\omega$

3

Lowest orbit

neutron 0+ pair   proton 0+ pair

2

1

Core nuclei

0

When four nucleons occupy 1s or p1 orbit, overlap is enhanced！
⇒ Enhancement of overlap with occupation of s or p orbit may be a general feature！