~~Deformation and~~
Pairing correlation in neutron-rich halo nuclei

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1. Introduction: Borromean nuclei and di-neutron correlations
2. Pairing in two-neutron halo: Coulomb breakup of ^{22}C
3. Role of di-neutron correlation in E1 excitations
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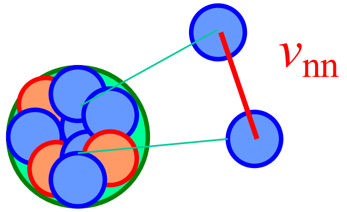
Borromean nuclei and di-neutron correlation

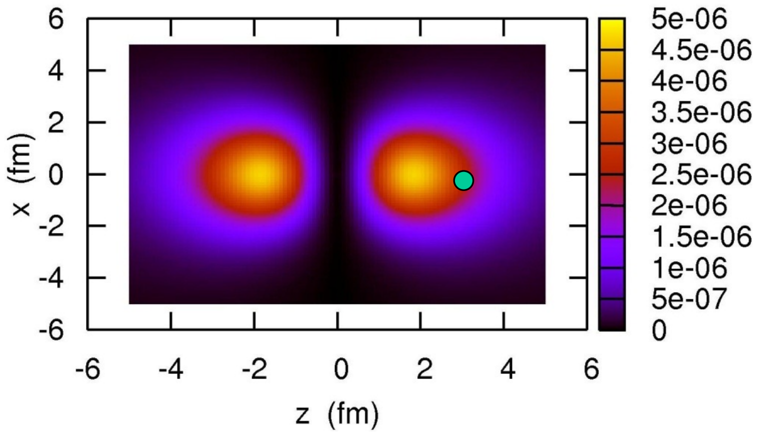


Di-neutron correlation

spatially compact configurations of two neutrons

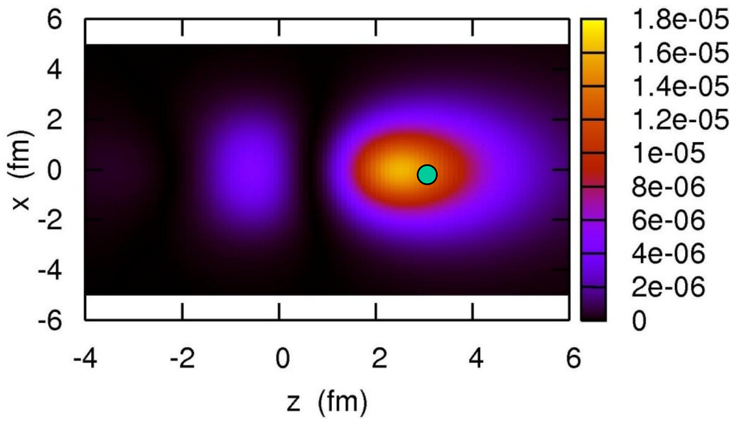
3-body model calculation for ^{11}Li

no *nn* interaction



v_{nn}

with *nn* interaction

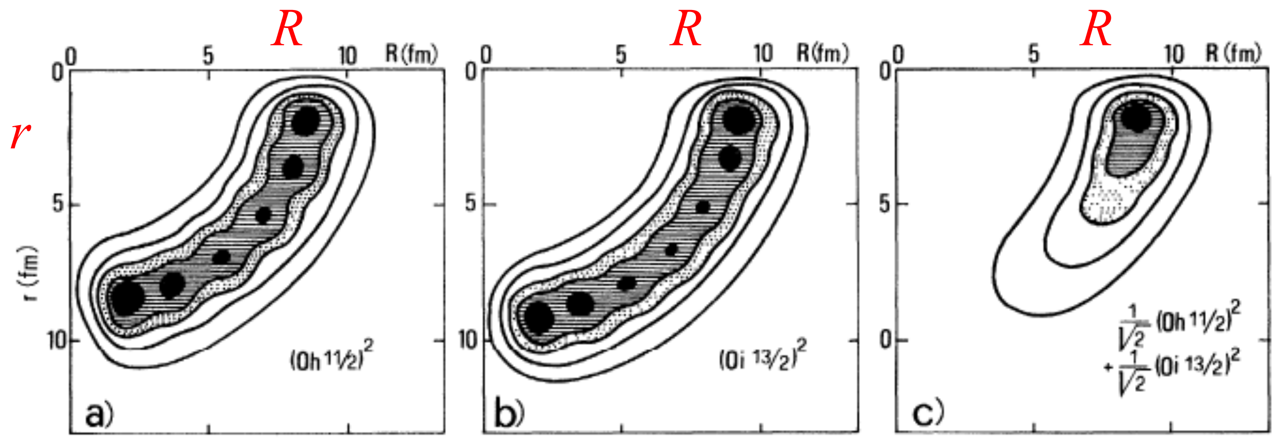


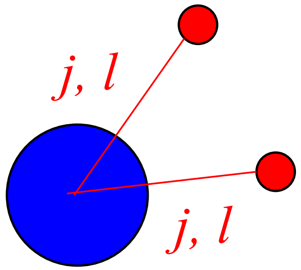
K. Hagino and H. Sagawa, PRC72 (2005) 044321

Borromean nuclei and di-neutron correlation

the essential ingredient:
admixture of configurations with
opposite parities

$$\boxed{\Psi(\boldsymbol{r}_1,\boldsymbol{r}_2)=\sum_{j,l}C_{jl}\left[\phi_{jl}(\boldsymbol{r}_1)\phi_{jl}(\boldsymbol{r}_2)\right]^{(00)}}$$

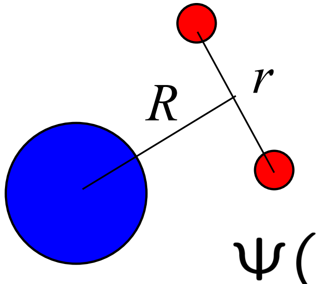




$(0h_{11/2})^2$ $l=5$

$(0i_{13/2})^2$ $l=6$

$\frac{1}{\sqrt{2}}(0h_{11/2})^2+\frac{1}{\sqrt{2}}(0i_{13/2})^2$



$$\Psi(\boldsymbol{r}_1,\boldsymbol{r}_2)\rightarrow\Psi(\boldsymbol{r},\boldsymbol{R})$$

F. Catara, A. Insolia, E. Maglione,
and A. Vitturi, PRC29 (1984) 1091

Analysis of the Coulomb breakup of ^{22}C

- ✓ Y. Togano et al., PLB761, 412 (2016)

  σ_R → rms radius = 3.44(8) fm
  $S_{2n} = 0.56\ ^{+0.27}_{-0.20}$ MeV

- ✓ N. Kobayashi et al., PRC86, 054606 (2012).

  momentum distribution → a large s-d mixture
  S_{2n} = 0.40-1.20 MeV

- ✓ N. Nakatsuka, T. Nakamura et al. in preparation

  exclusive Coulomb breakup cross sections ⇦

3-body model calculation

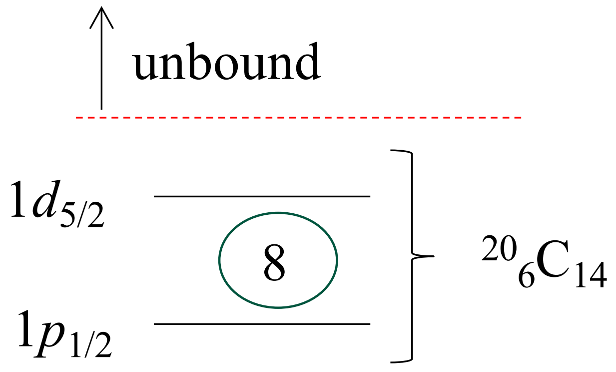
G.F. Bertsch and H. Esbensen, Ann. of Phys. 209 (1991) 327.
K. Hagino and H. Sagawa, PRC72 (2005) 044321.

V_{nn} : a density-dependent contact interaction

3-body model calculation for ^{22}C

$$^{22}_{6}\mathrm{C}_{16} = {}^{20}_{6}\mathrm{C}_{14} + \mathrm{n} + \mathrm{n}$$

spherical core

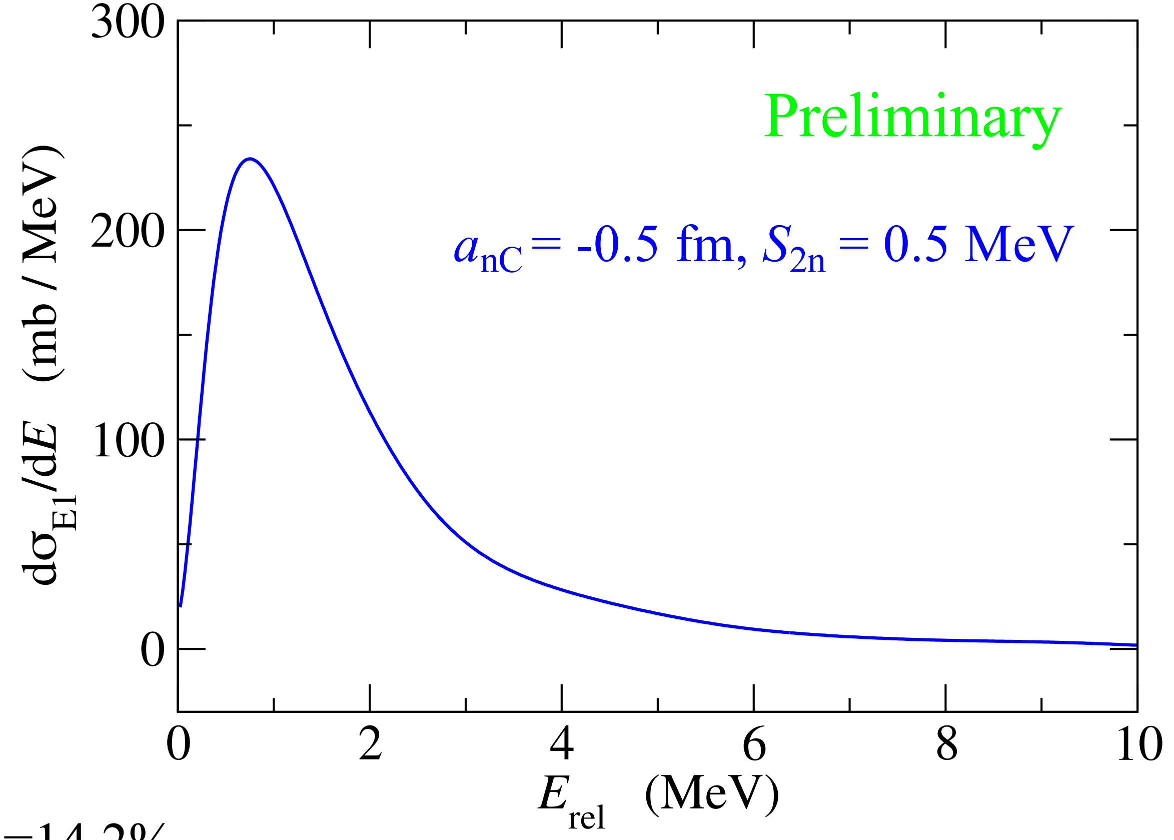


V_{nC} : Woods-Saxon

change V_0 for $l = 0$ to adjust a_{nC}

→ adjustable parameters: a_{nC} and S_{2n}

Analysis of the Coulomb breakup of ^{22}C



$P(s^2)$=14.2%
$P(d_{3/2}^2)$=63.9%

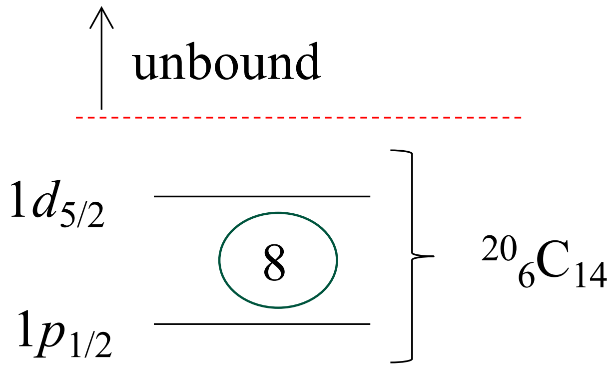
N. Nakatsuka, T. Nakamura et al. in preparation

rms radius = 3.20 fm [Exp.: 3.44 (8) fm]

3-body model calculation for ^{22}C

$^{22}_{6}C_{16} = {}^{20}_{6}C_{14} + n + n$

spherical core



V_{nC} : Woods-Saxon

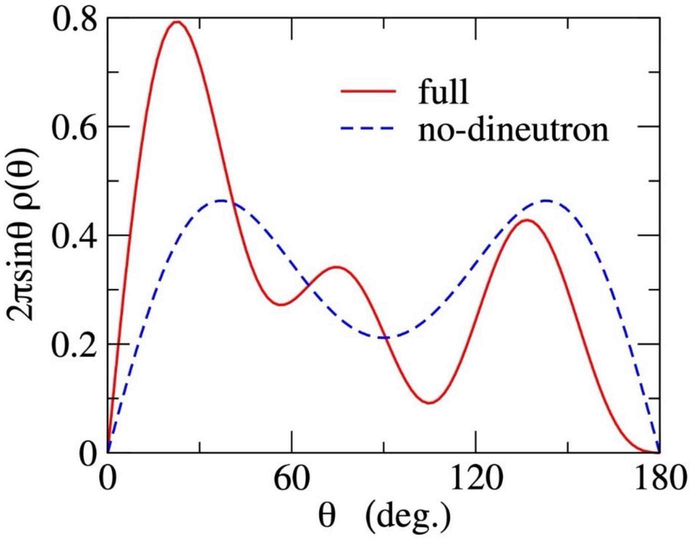
change V_0 for $l = 0$ to adjust a_{nC}

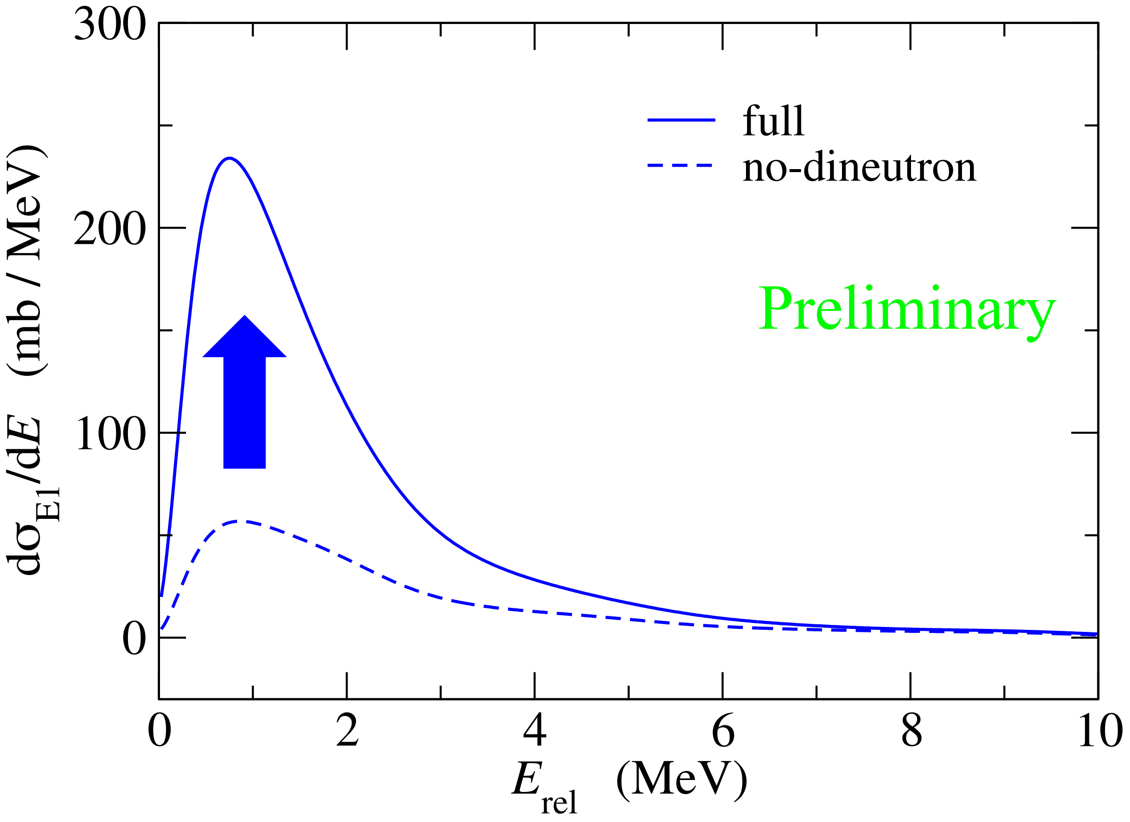
→ adjustable parameters: a_{nC} and S_{2n}

Role of di-neutron correlation

the ground state 0^+

full correlations vs no di-neutron
(even *l* only)

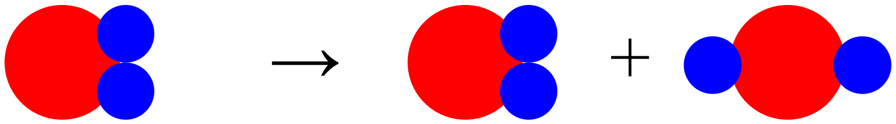




no dineutron in the ground state →a large hindrance in the *E*1 strengths

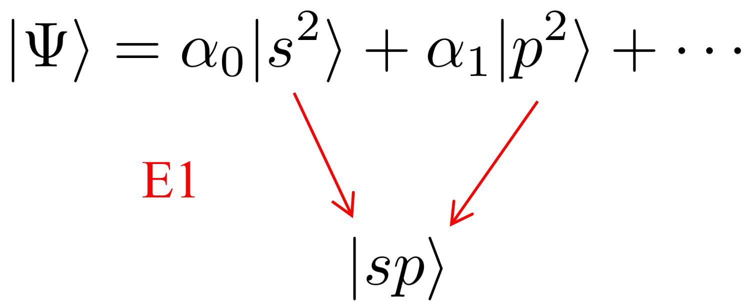
← due to a small $R_{c\text{-}2n}$ (4.25 → 3.01 fm)

$$B_{\rm tot}(E1) \propto \langle R^2_{\rm c-2n}\rangle$$



Role of di-neutron correlation

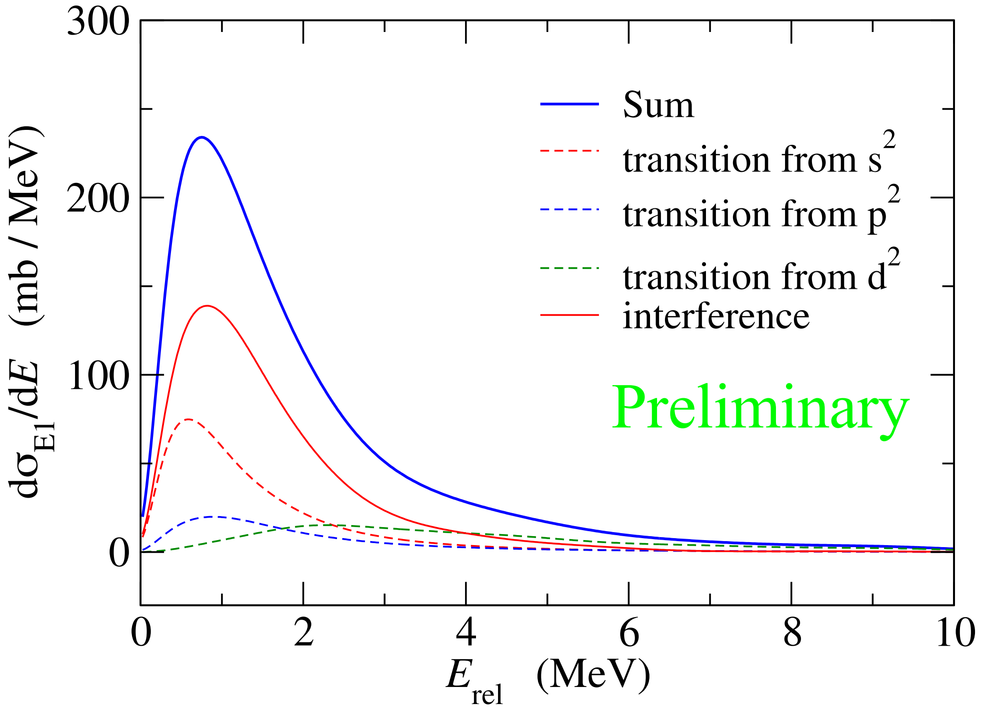
di-neutron correlation:



$$|\Psi\rangle = \alpha_0|s^2\rangle + \alpha_1|p^2\rangle + \cdots$$

E1

$$|sp\rangle$$



$$\begin{aligned}\rightarrow |\langle sp|T_{E1}|\Psi\rangle|^2 &= |\alpha_0|^2\,|\langle sp|T_{E1}|s^2\rangle|^2 \\ &+ |\alpha_1|^2|\,\langle sp|T_{E1}|p^2\rangle|^2 \\ &+ \alpha_0\alpha_1^*\,\langle sp|T_{\mathrm{E1}}|s^2\rangle\,\langle p^2|T_{E1}|sp\rangle + c.c. + \cdots\end{aligned}$$

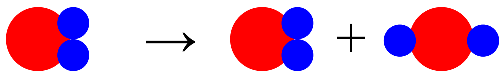
interferences

dineutron correlation: mixture of different parity states
→ the same final state for the E1 transitions
→ large interferences

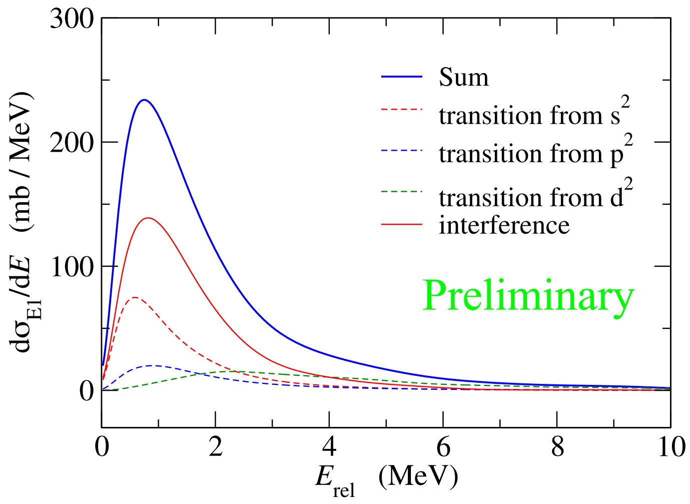
Summary

Coulomb breakup of ^{22}C

- 3-body model calculation
- Enhancement of E1 strengths due to dineutron correlation
  - ✓ cluster sum rule $B_{\mathrm{tot}}(E1) \propto \langle R^2_{\mathrm{c-2n}} \rangle$



  - ✓ interference



Future perspective

2n-halo nuclei with a deformed core → a rotor + 2 neutrons?

maybe important in ^{22}C (a deformed ^{20}C)