Determination of $^{8}B(p,\gamma)^{9}C$ Reaction Rate from ^{9}C Breakup

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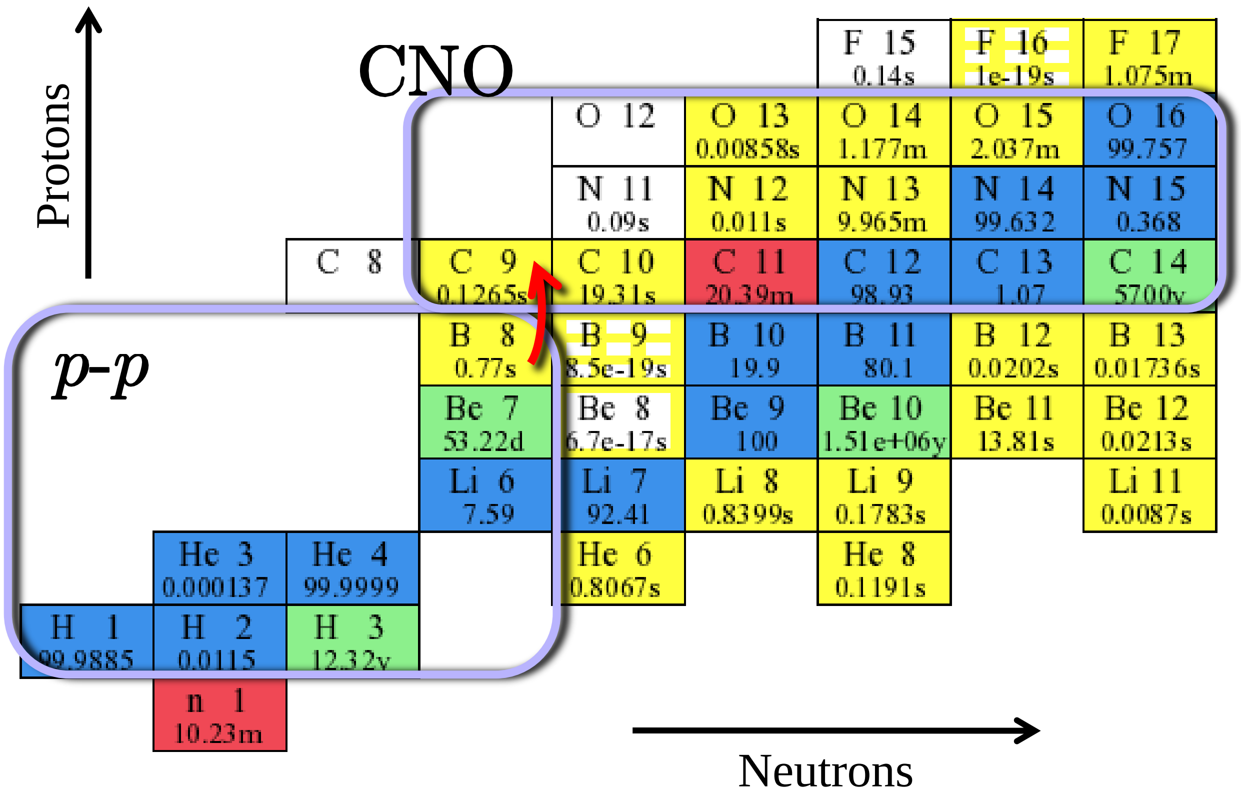
Introduction



$^{8}\mathrm{B}(p,\gamma)^{9}\mathrm{C}$

↓

$^{208}\mathrm{Pb}(^{9}\mathrm{C},p\,^{8}\mathrm{B})^{208}\mathrm{Pb}$

Hot p-p chain

$$p(p,\beta^{+}\nu)d(p,\gamma)^{3}\mathrm{He}(\alpha,\gamma)^{7}\mathrm{Be}(p,\gamma)^{8}\mathrm{B}(p,\gamma)^{9}\mathrm{C}(\beta^{+},\nu)^{9}\mathrm{B}(p)^{8}\mathrm{Be}(\alpha)\alpha$$

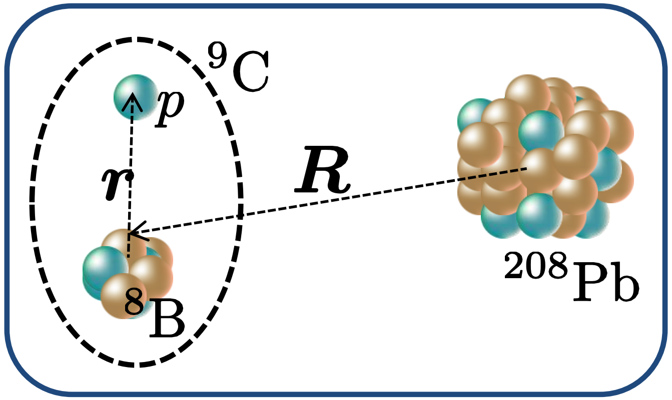
$$^{8}\mathrm{B}(p,\gamma)^{9}\mathrm{C}(\alpha,p)^{12}\mathrm{N}(p,\gamma)^{13}\mathrm{O}(\beta^{+}\nu)^{13}\mathrm{N}(p,\gamma)^{14}\mathrm{O}$$

Formulation CDCC (Continuum Discretized Coupled Channels) method

3-body Schrödinger eq.

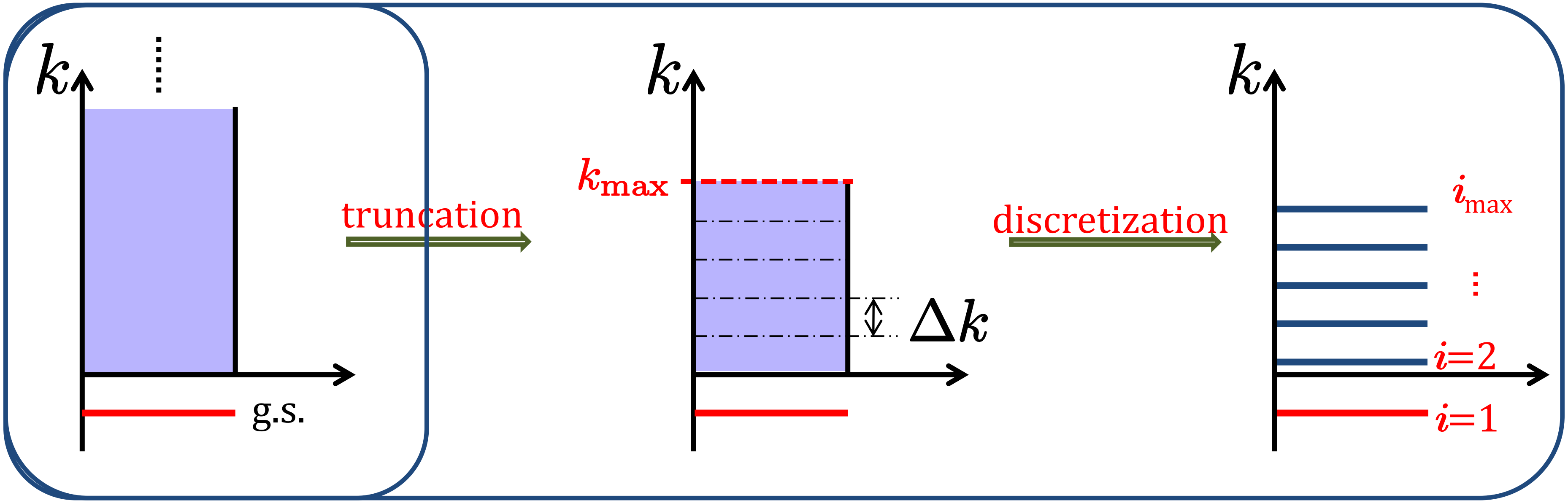
$$(H_{3b} - E)\Psi(\boldsymbol{r}, \boldsymbol{R}) = 0$$

$$H_{3b} = T_r + V_{p\mathrm{B}} + T_R + U_{p\mathrm{Pb}} + U_{\mathrm{BPb}}$$

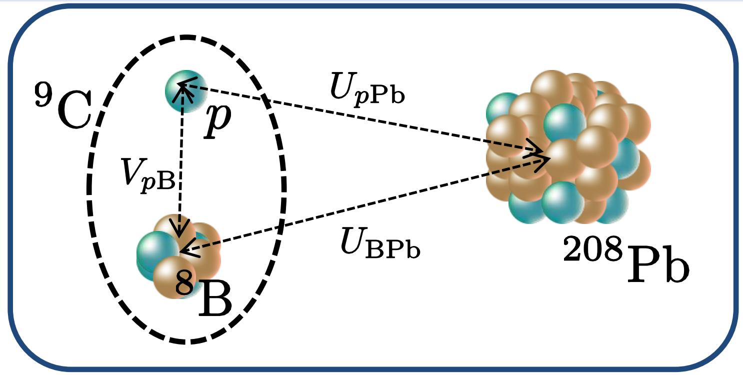


CDCC wave function

$$\Psi(\boldsymbol{r}, \boldsymbol{R}) = \phi_0\chi_0 + \int_0^\infty \phi_k\chi_k dk \longrightarrow \Psi^{CDCC}(\boldsymbol{r}, \boldsymbol{R}) = \sum_i^{i_{\max}} \hat{\phi}_i\hat{\chi}_i$$



Numerical Setting



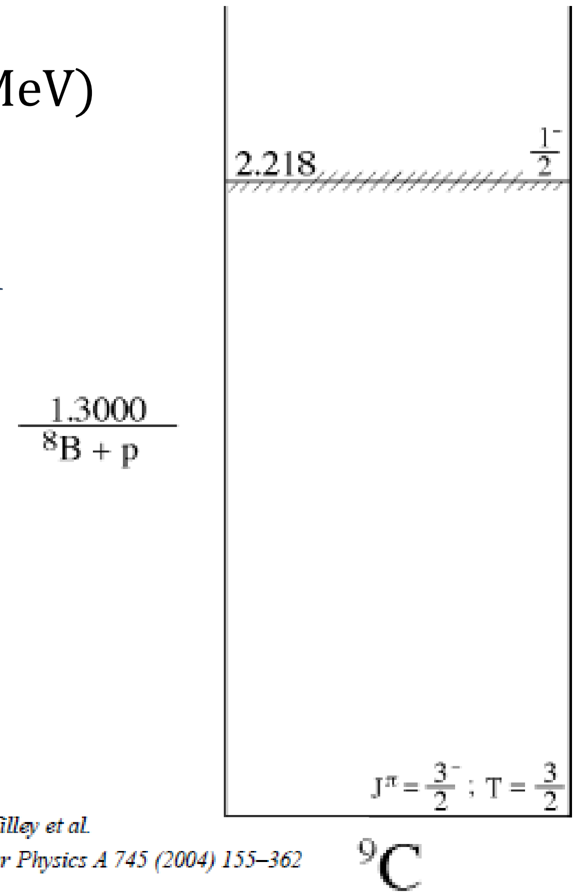
^{9}C

- *s, p, d, f* - waves
- $\boldsymbol{k}_{\max}$=1.0 [fm^{-1}] ($E_{\text{rel-max}}$~25 [MeV])
- $\Delta\boldsymbol{k}$=1/20 [fm^{-1}] → N_{ch}=323
- $V_{p\mathrm{B}}$: Woods-Saxon pot. reproducing B.E.(-1.3 MeV)

Distorting pot. : full microscopic folding model

- $U_{p\mathrm{Pb}} = \int \rho_{\mathrm{Pb}}(\boldsymbol{r}_2) \sum_{j\in\mathrm{Pb}} t_{pj} d\boldsymbol{r}_2$
- $U_{\mathrm{BPb}} = \int \rho_{\mathrm{B}}(\boldsymbol{r}_1)\rho_{\mathrm{Pb}}(\boldsymbol{r}_2) \sum_{i\in\mathrm{B},j\in\mathrm{Pb}} t_{ij} d\boldsymbol{r}_1 d\boldsymbol{r}_2$

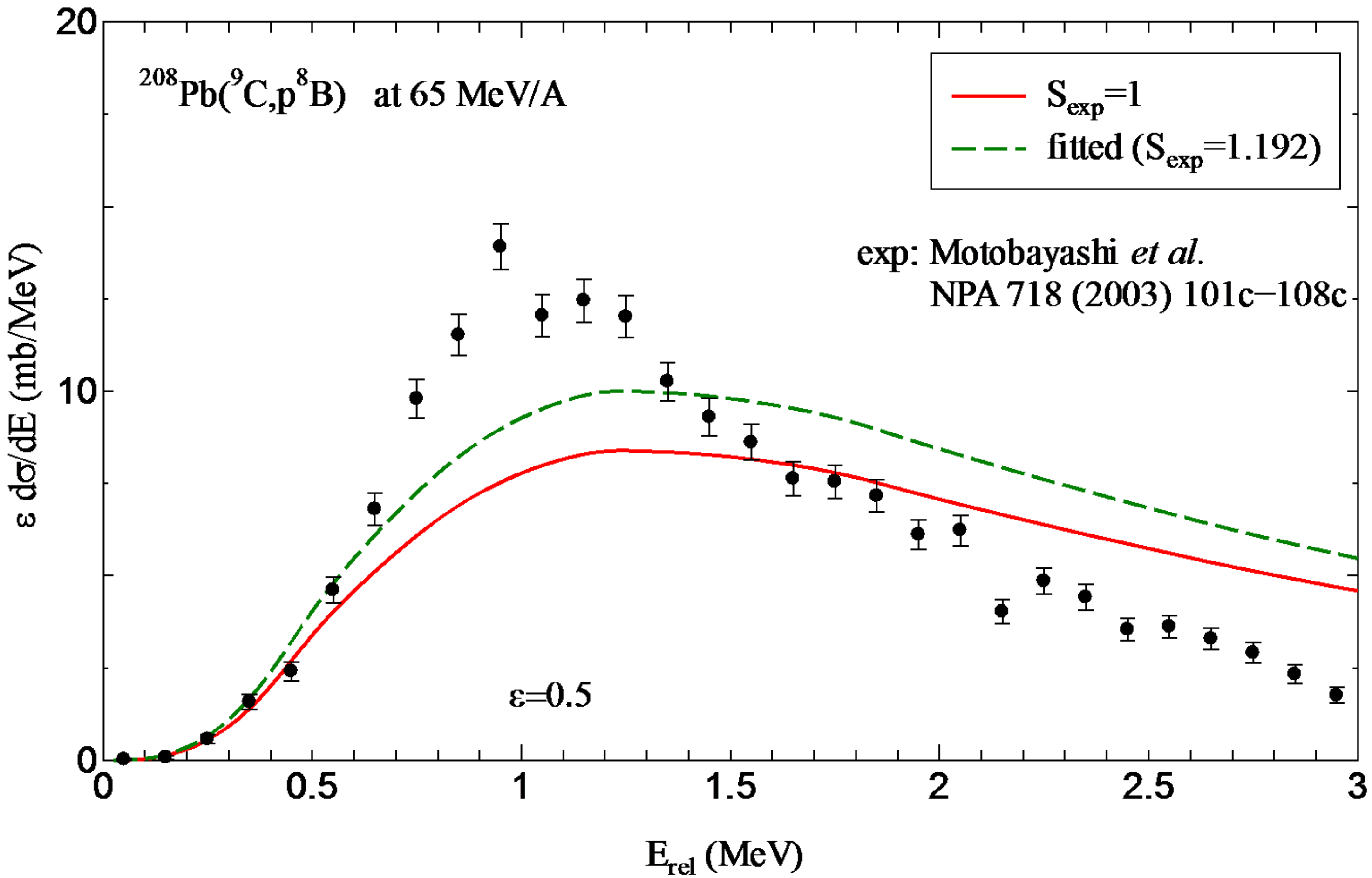
(NN interaction t_{ij} : Franey-Love *t*-matrix
$\rho_{\mathrm{B}}, \rho_{\mathrm{Pb}}$: Hartree-Fock calc. with Gogny D1S)



D.R. Tilley et al.
Nuclear Physics A 745 (2004) 155–362

Result

E_{rel} Distribution



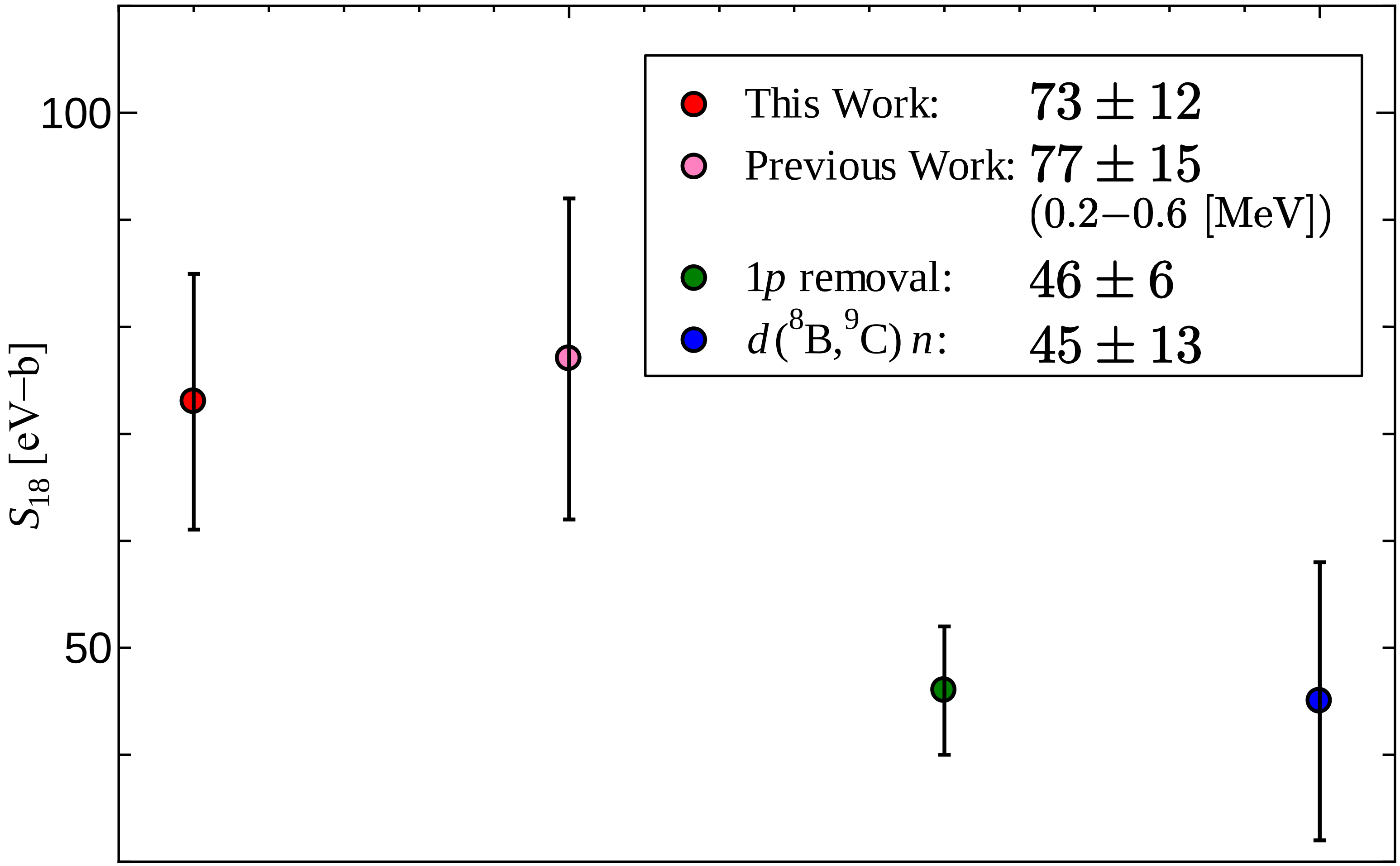
$$S_{\rm exp} = 1.192$$

$$(C_{\rm sp})^2 = 1.622 \quad [\mathrm{fm}^{-1}]$$

$$C^2 = 1.933 \quad [\mathrm{fm}^{-1}] \qquad (C^2 = S_{\rm exp}(C_{\rm sp})^2)$$

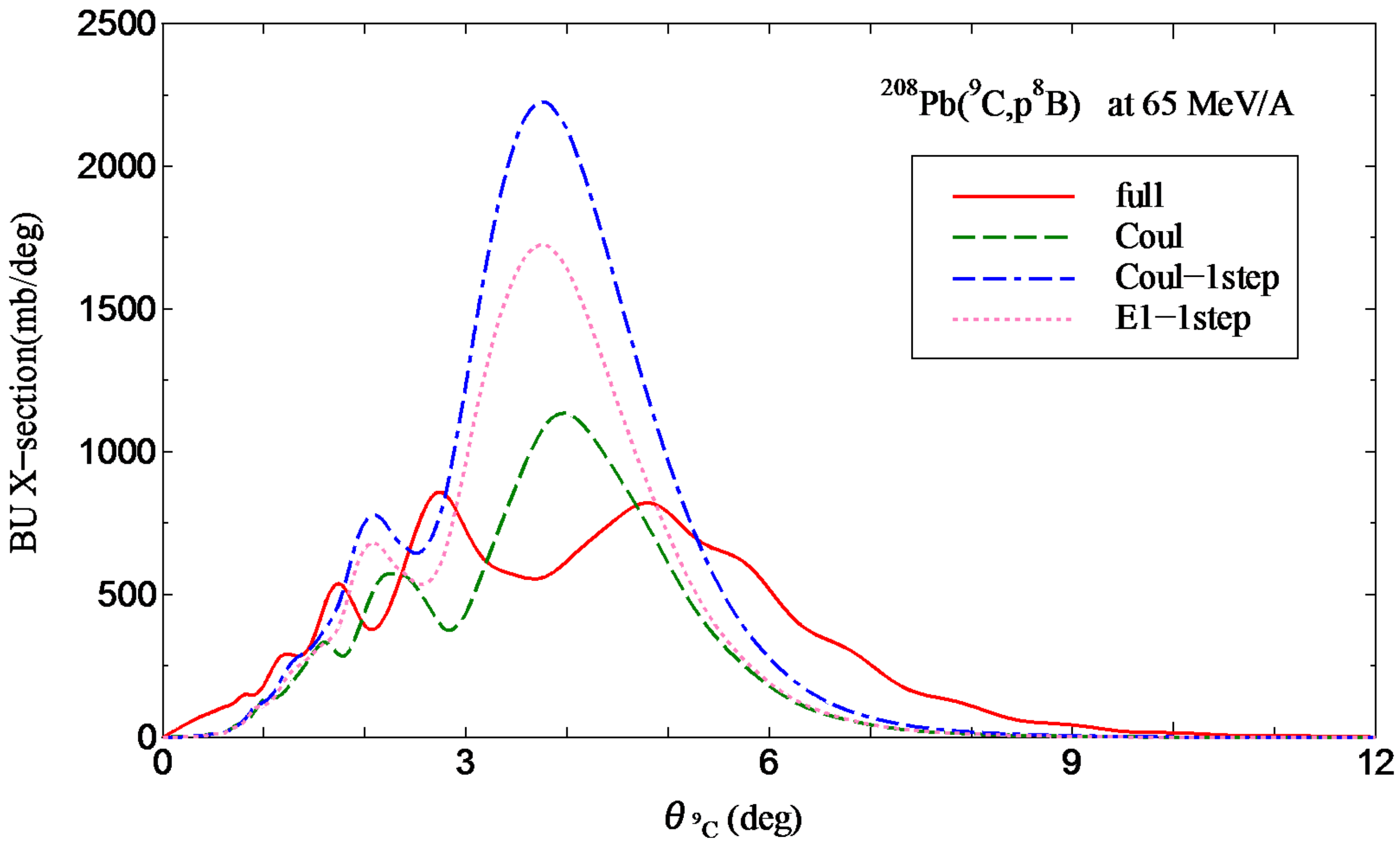
Result

Comparison S_{18} with previous values



- one proton removal reaction:
  -- L. Trache *et al.*, PRC66, 035801 (2002)
- $d(^{8}\mathrm{B},^{9}\mathrm{C})n$ reaction:
  -- D. Beaumel *et al.*, PLB514, 226 (2001)

Result Nuclear/Coulomb BU & Multistep Effects



Summary

$^{208}\mathrm{Pb}(^{9}\mathrm{C},p^{8}\mathrm{B})^{208}\mathrm{Pb}$ at 65 MeV/A
is analyzed by CDCC.

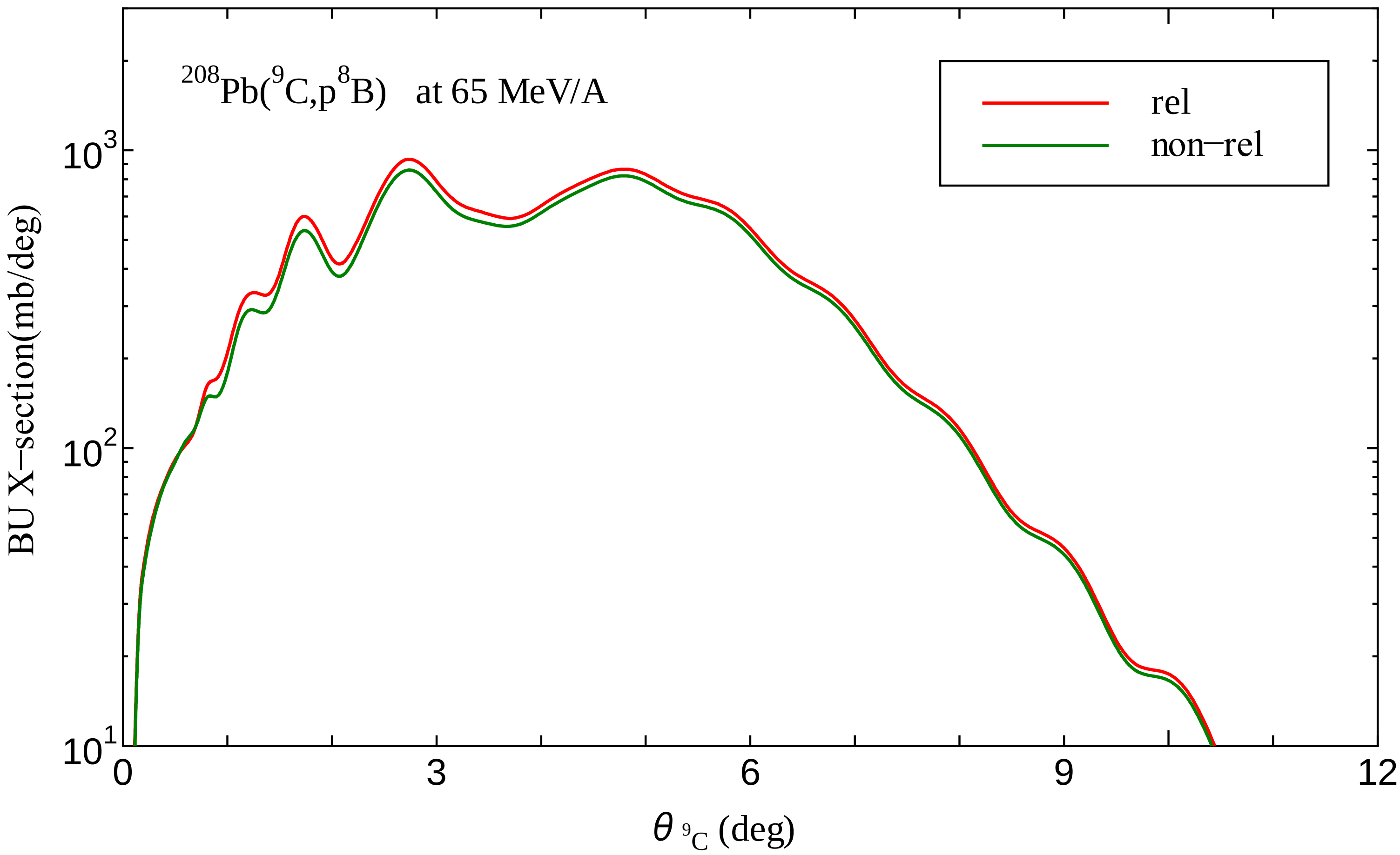
- Our CDCC calculation reproduces well the shape of breakup energy spectrum in low energy region.

- ANC: C^2=1.933±0.317 [fm^{-1}] → S_{18}=73±12 [eV-b]

- The simplification of the reaction mechanisms change a result rather drastically.

Backup

Relativistic Effect



Backup Nuclear/Coulomb BU & Multistep Effects