反応断面積と核子密度分布

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^{12}C ビームを用いた
中間エネルギー反応断面積

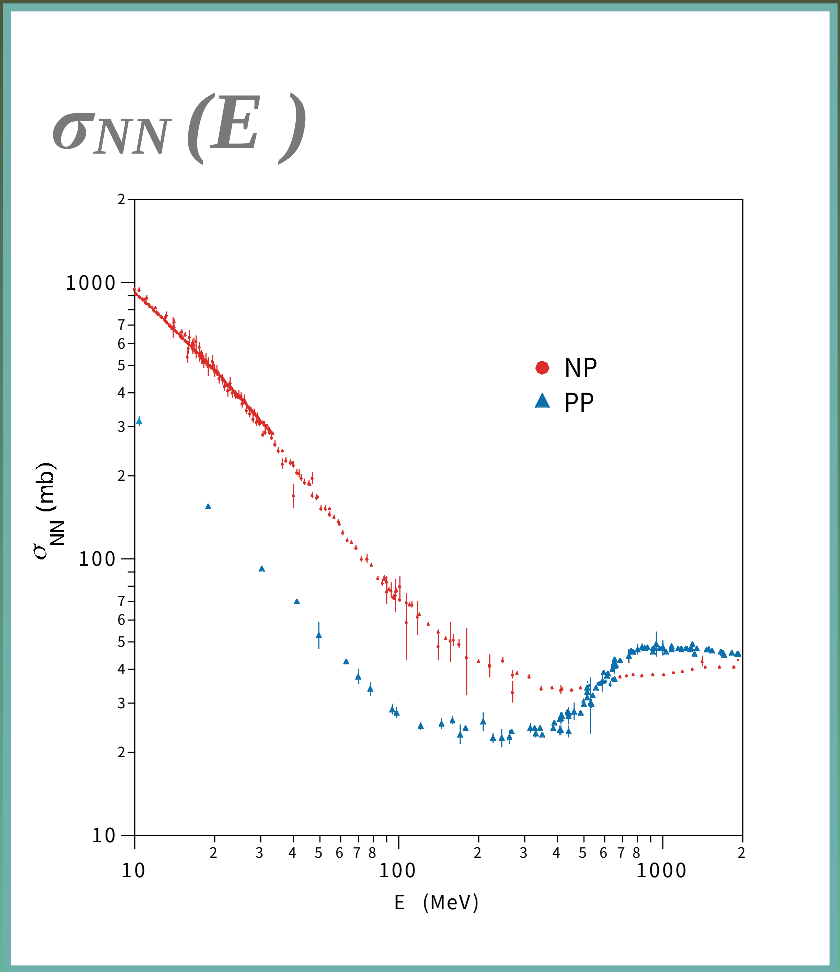
$\sigma_R(E)$ からの 核子密度分布の導出

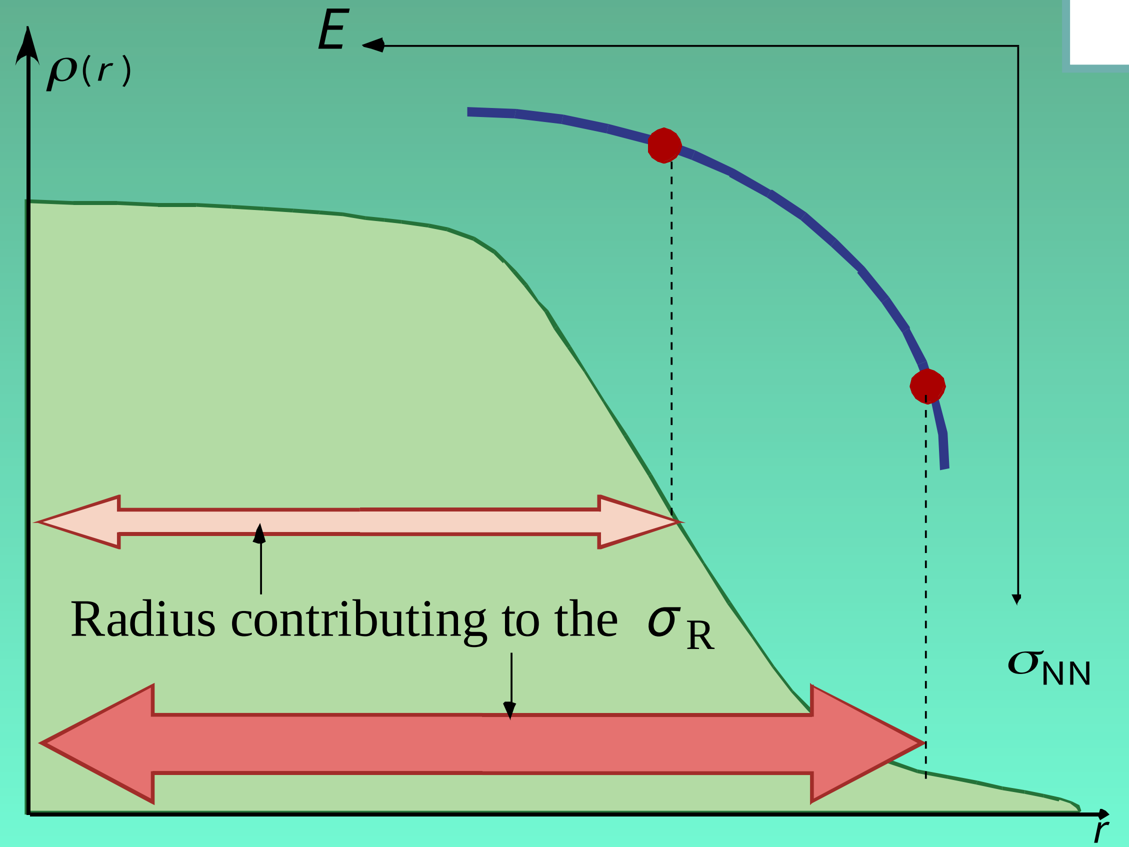
Glauber Calculation

$$\sigma_I = \int d\boldsymbol{b}\left[1-\exp\left(-\int d^2\boldsymbol{r}\sum_{i,j}\sigma_{NN}(E)\,\rho_Z^{P_i}(\boldsymbol{r})\,\rho_Z^{T_j}(\boldsymbol{r}-\boldsymbol{b})\right)\right]$$

σ_I can be uniquely calculated by 3 quantities

- ρ^P Projectile Density
- ρ^T Target Density
- σ_{NN} Nucleon- Nucleon Total Cross Section





問題点

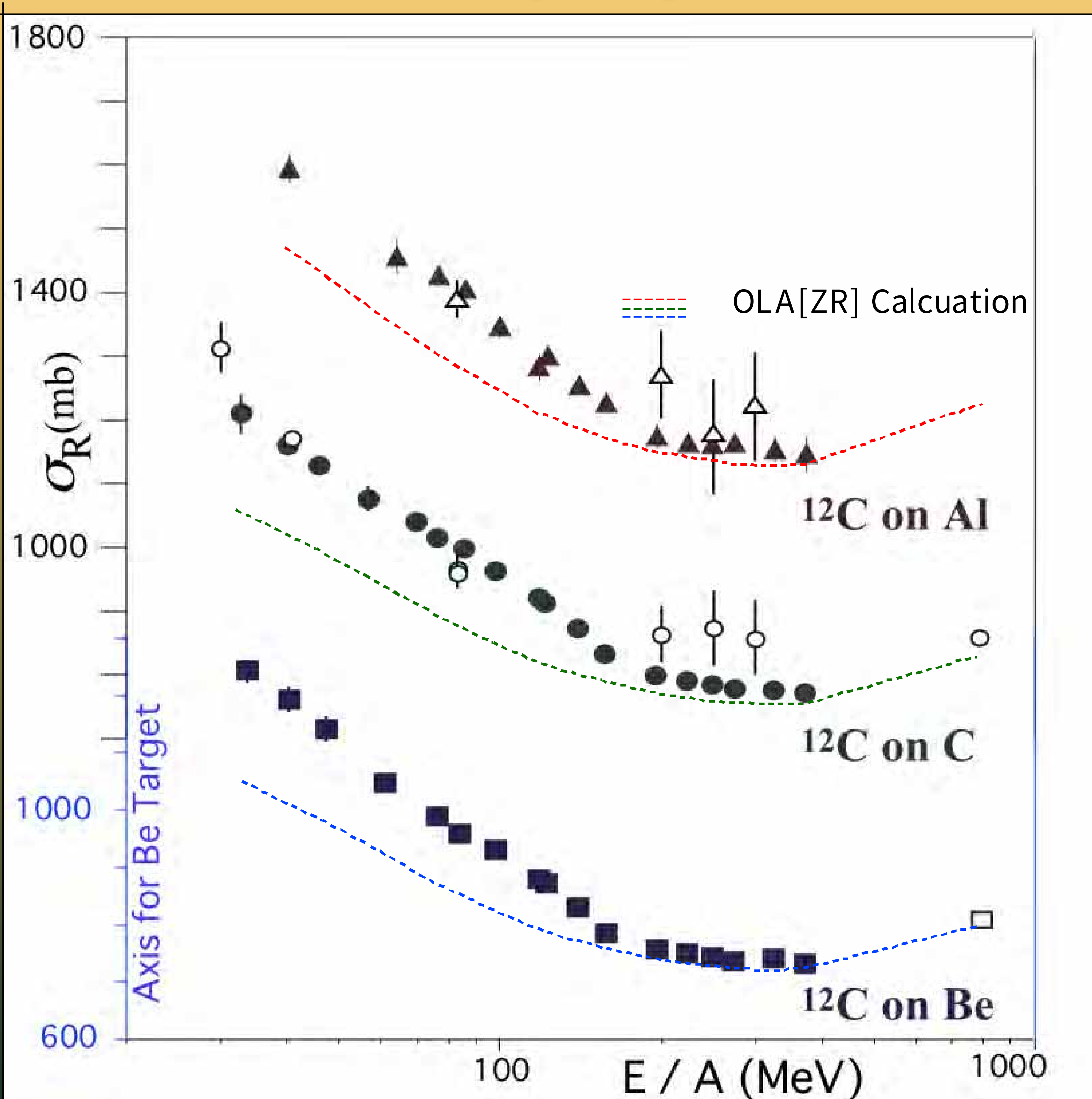
中間エネルギー領域で

σ_R (Exp) ＞ σ_R (Glauber Calc.)

Investigation

Measurements of σ_R for ^{12}C and ^{11}Be, ^{8}B

Measurements of σ_R for ^{12}C at intermediate energies

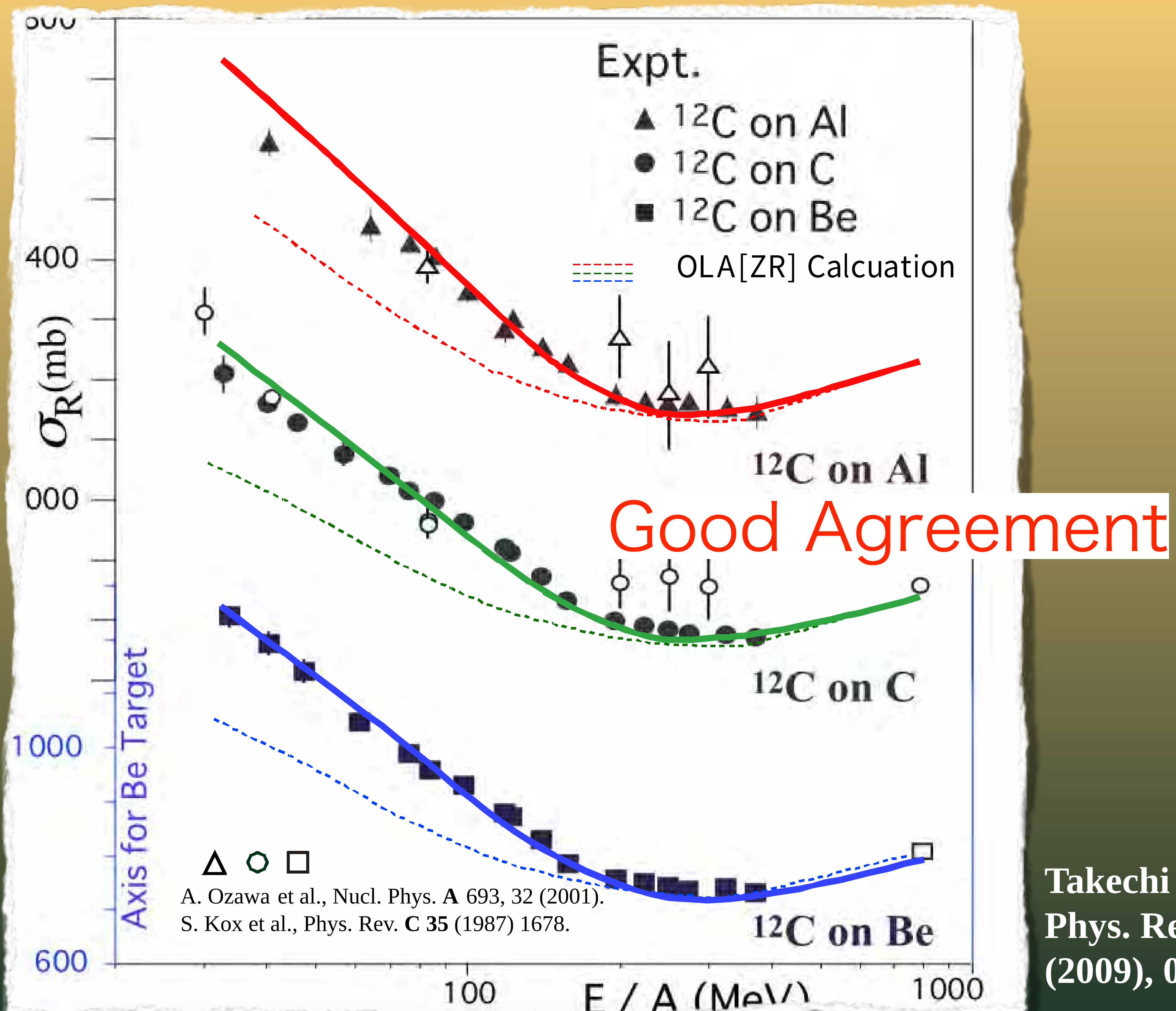


Experiment@
HIMAC, NIRS

Data are compared
with Glauber Calc.

Expt. > Calc.

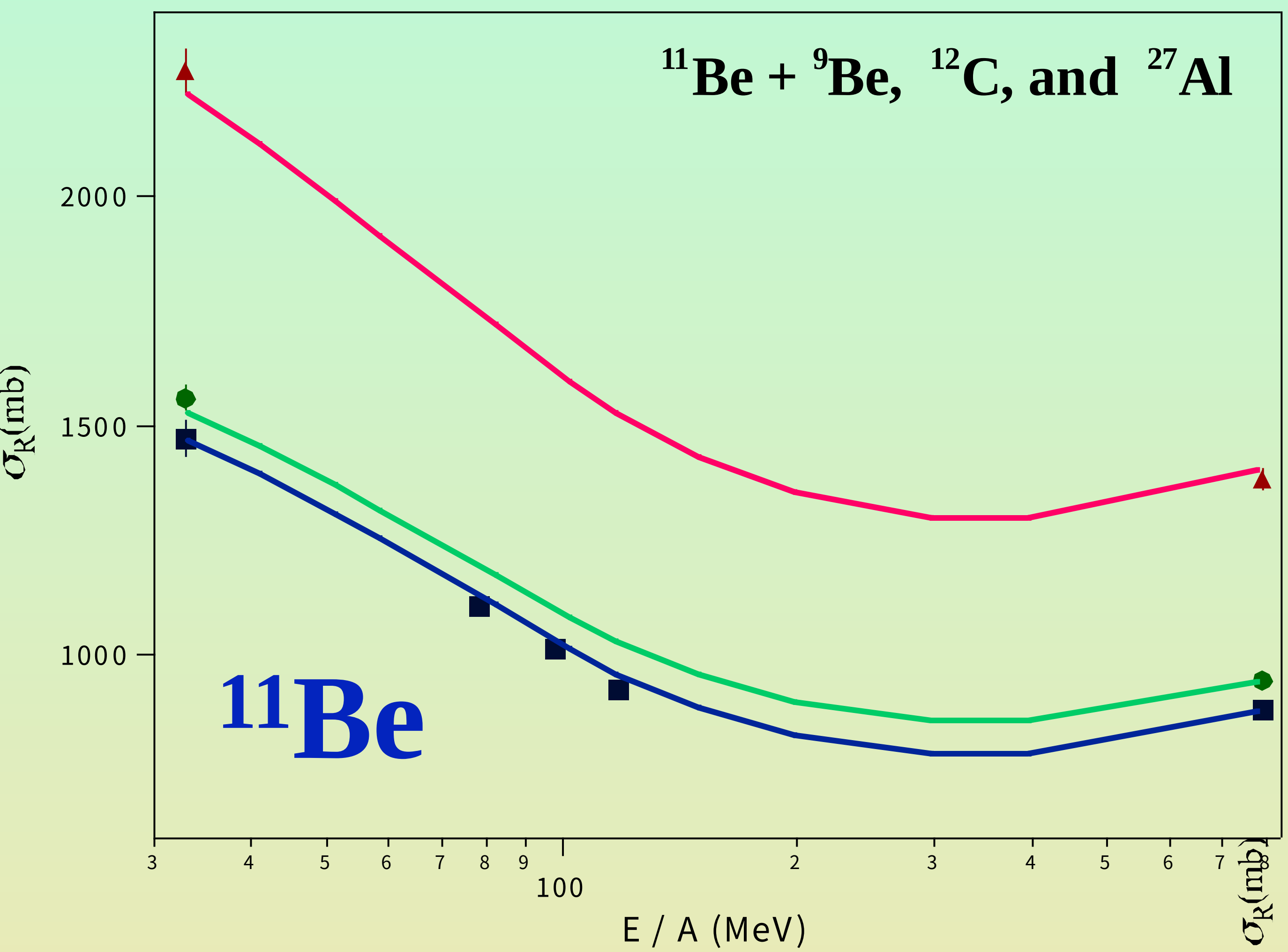
Fermi運動効果＋多重散乱効果の取り込み

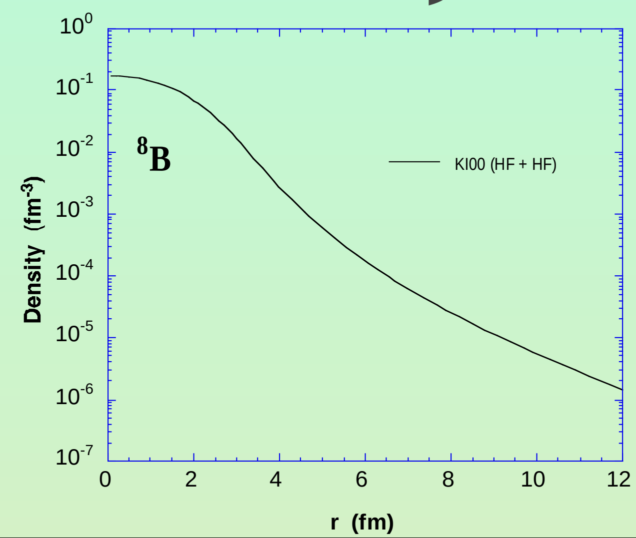


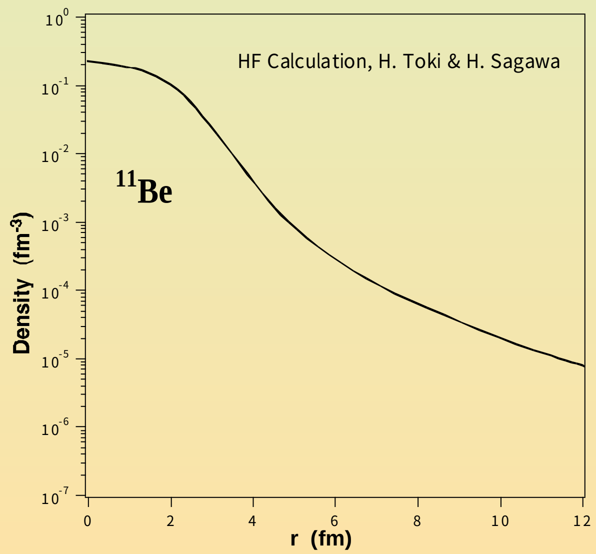
Takechi et al., Phys. Rev. C79 (2009), 061601(R)

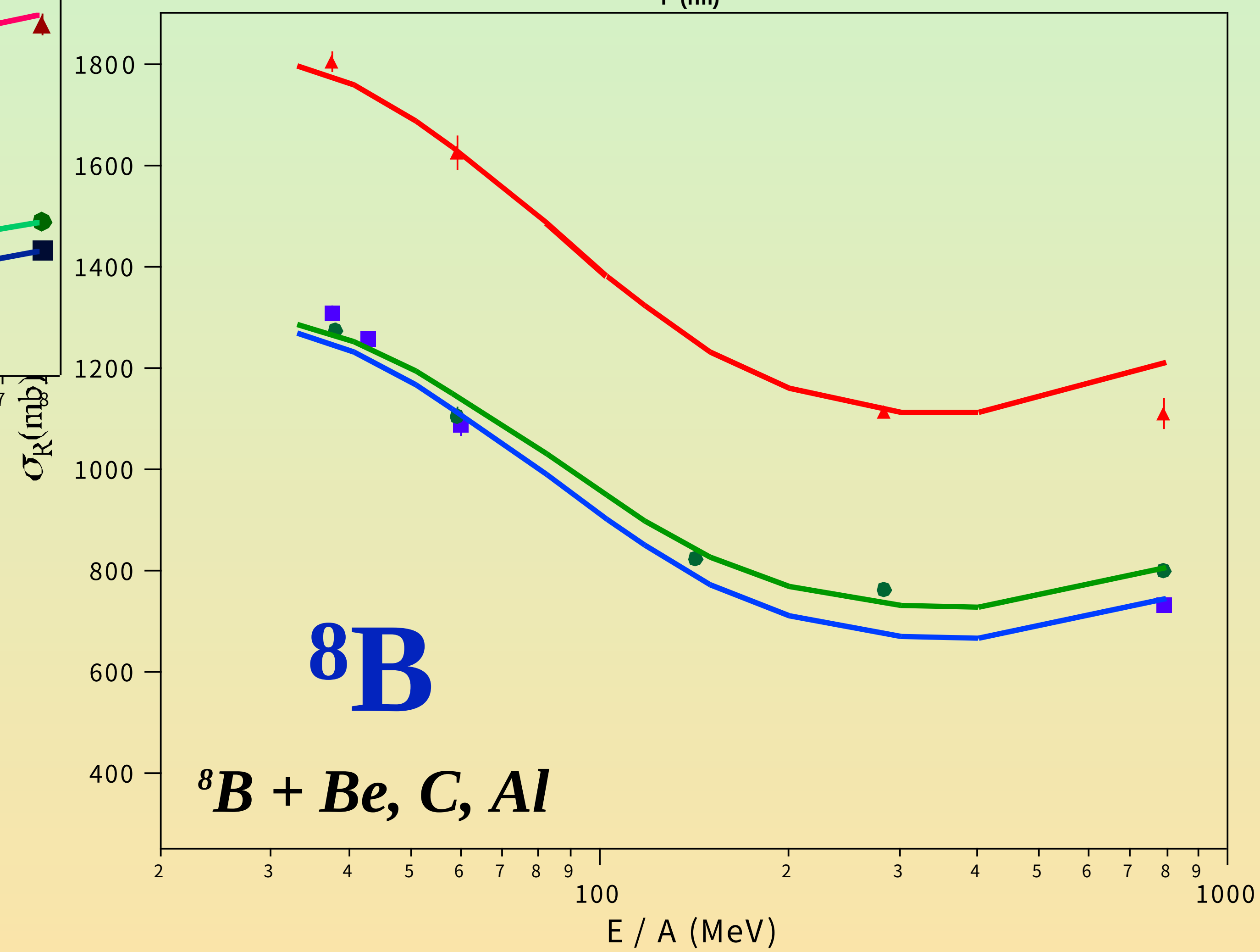
Comparison with the Data for Unstable Nuclei

Well-Known Halo Nuclei ^{11}Be, ^{8}B









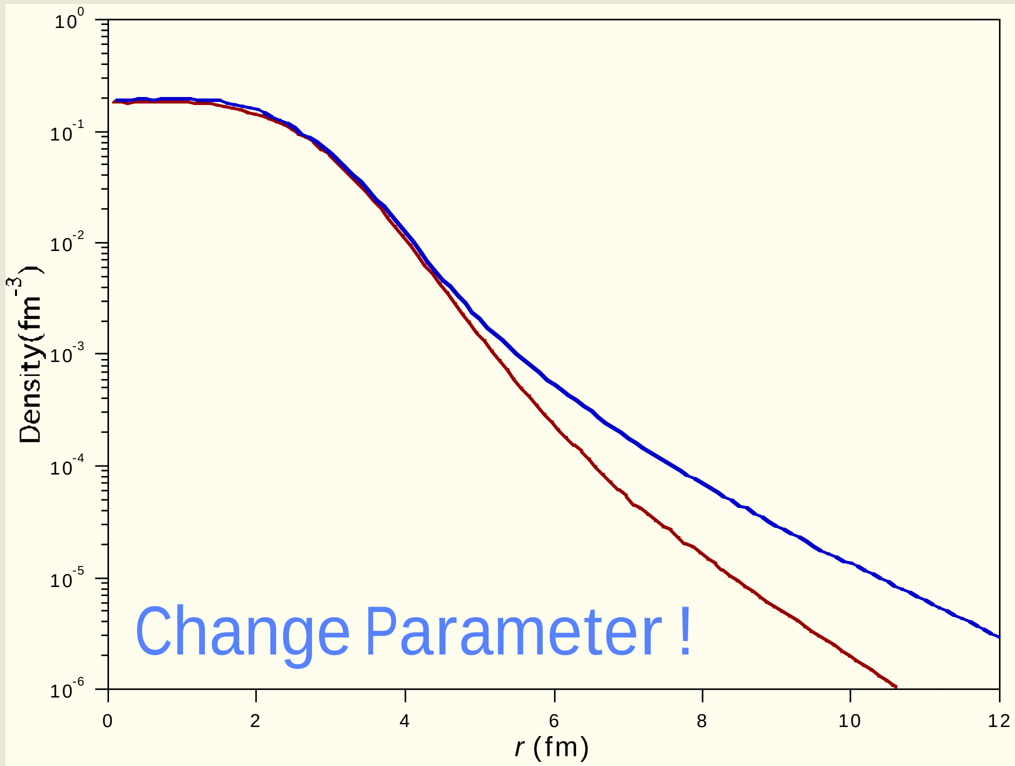
M. Fukuda et al., Nucl. Phys. **A 656** (1999) 209.
I. Tanihata et al., Phys. Lett. **206B** (1988) 592
B. Blank et al., Nucl. Phys. **A 624** (1997) 242.
M. Obuti et al., Nucl. Phys. **A609** (1996) 74.

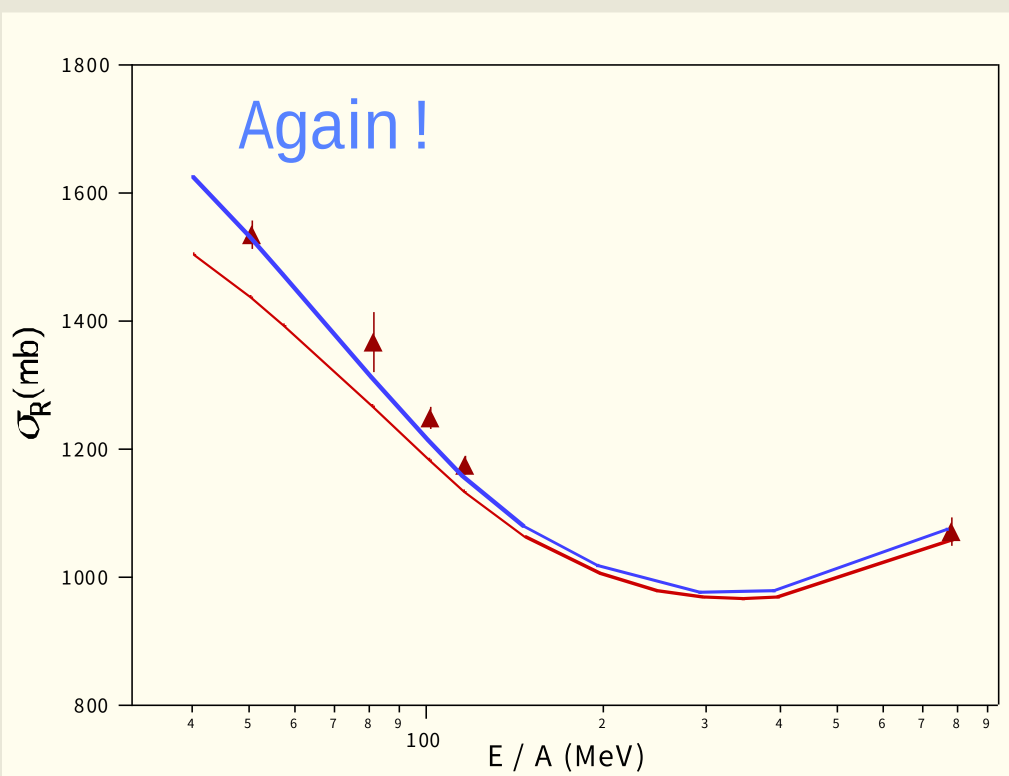
HF Densities ・・・H. Sagawa and H. Toki, J. Phys. G **13**, 453 (1987). and Private Communications

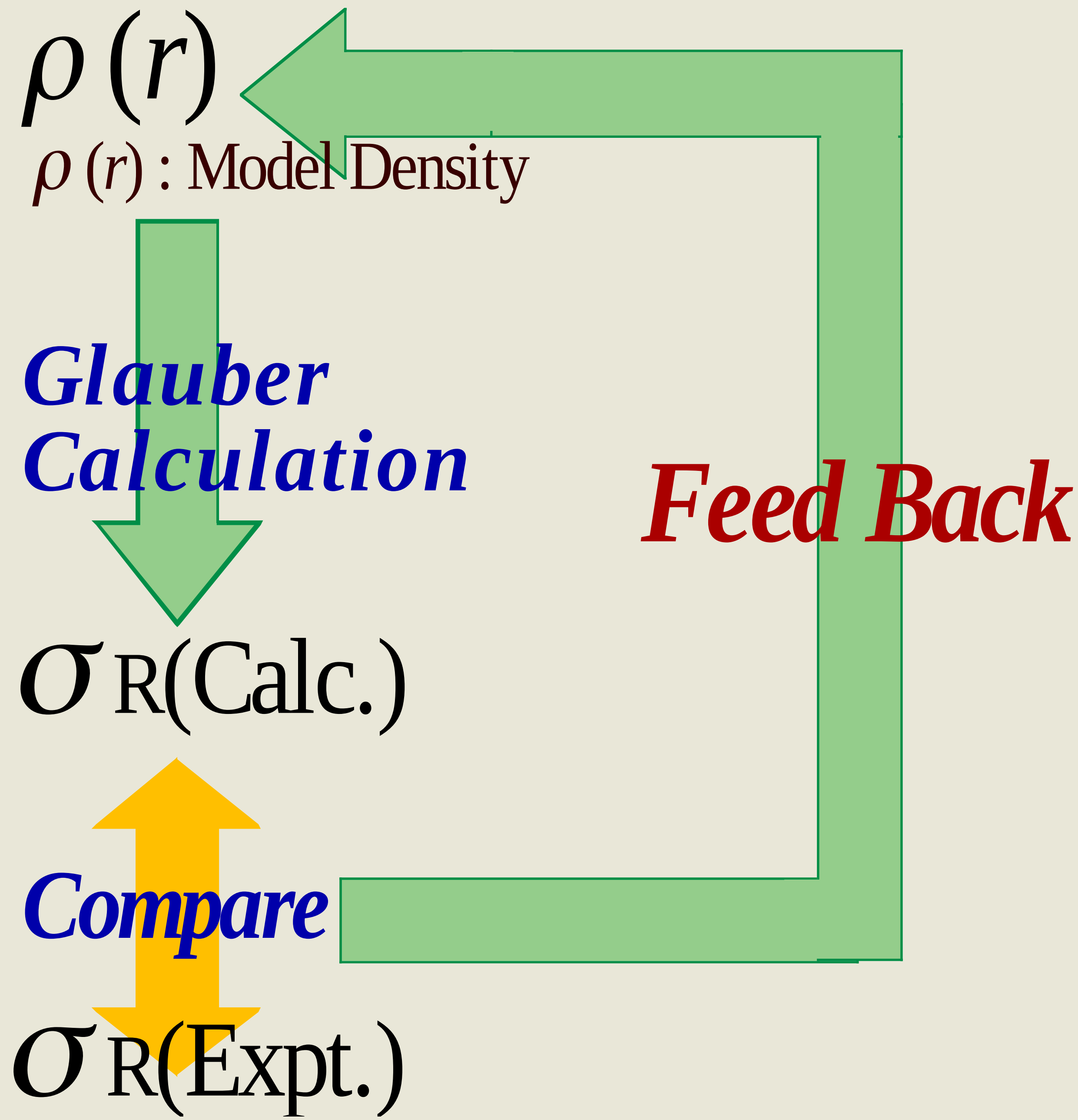
不安定核核子密度分布導出への応用

How to Deduce Nucleon Density

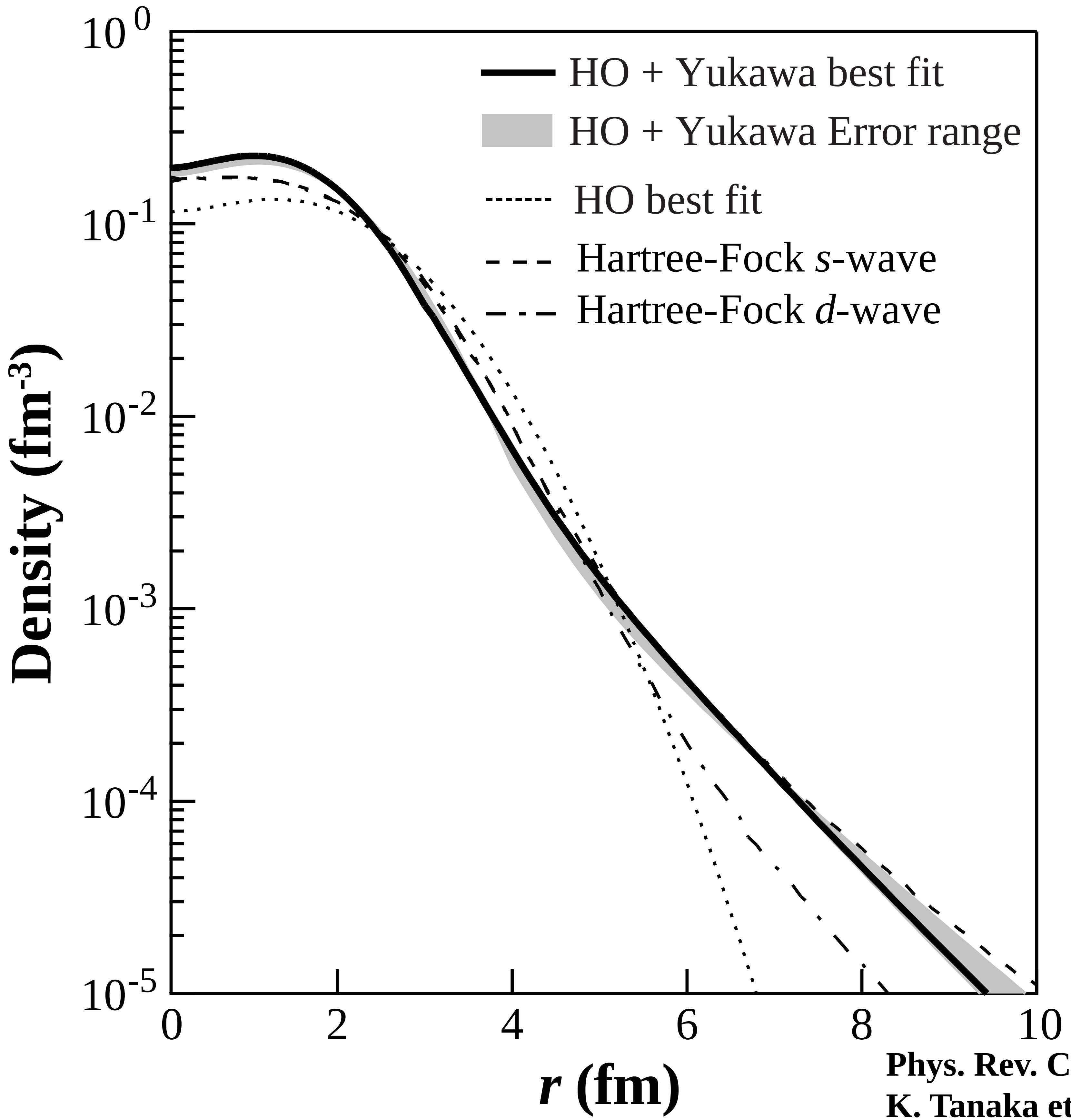
~ χ^2 fitting procedure ~





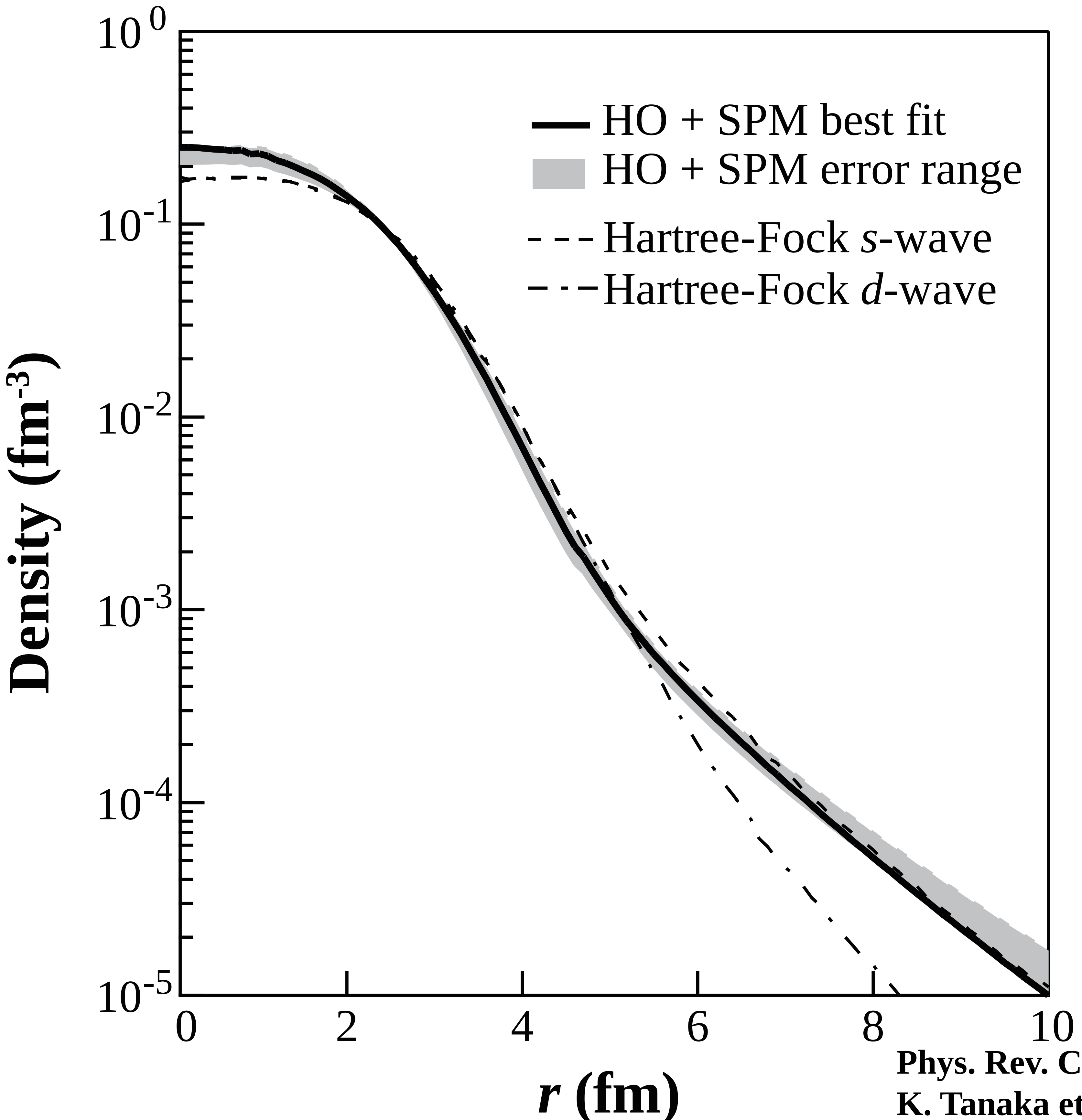


Nucleon Density Distribution of ^{17}Ne



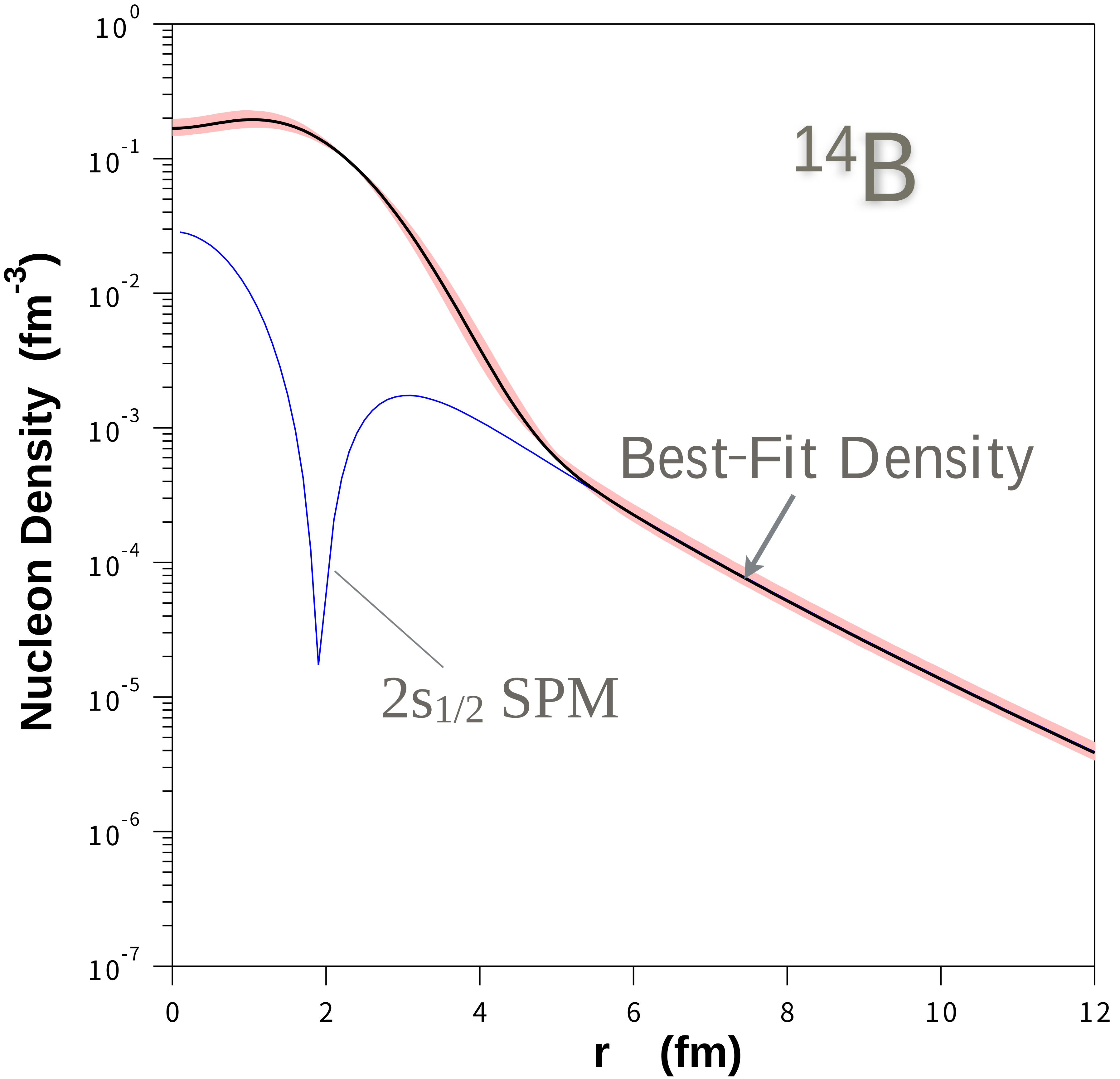
Phys. Rev. C82 (2010) 044309
K. Tanaka et al.

Nucleon Density Distribution of ^{17}Ne



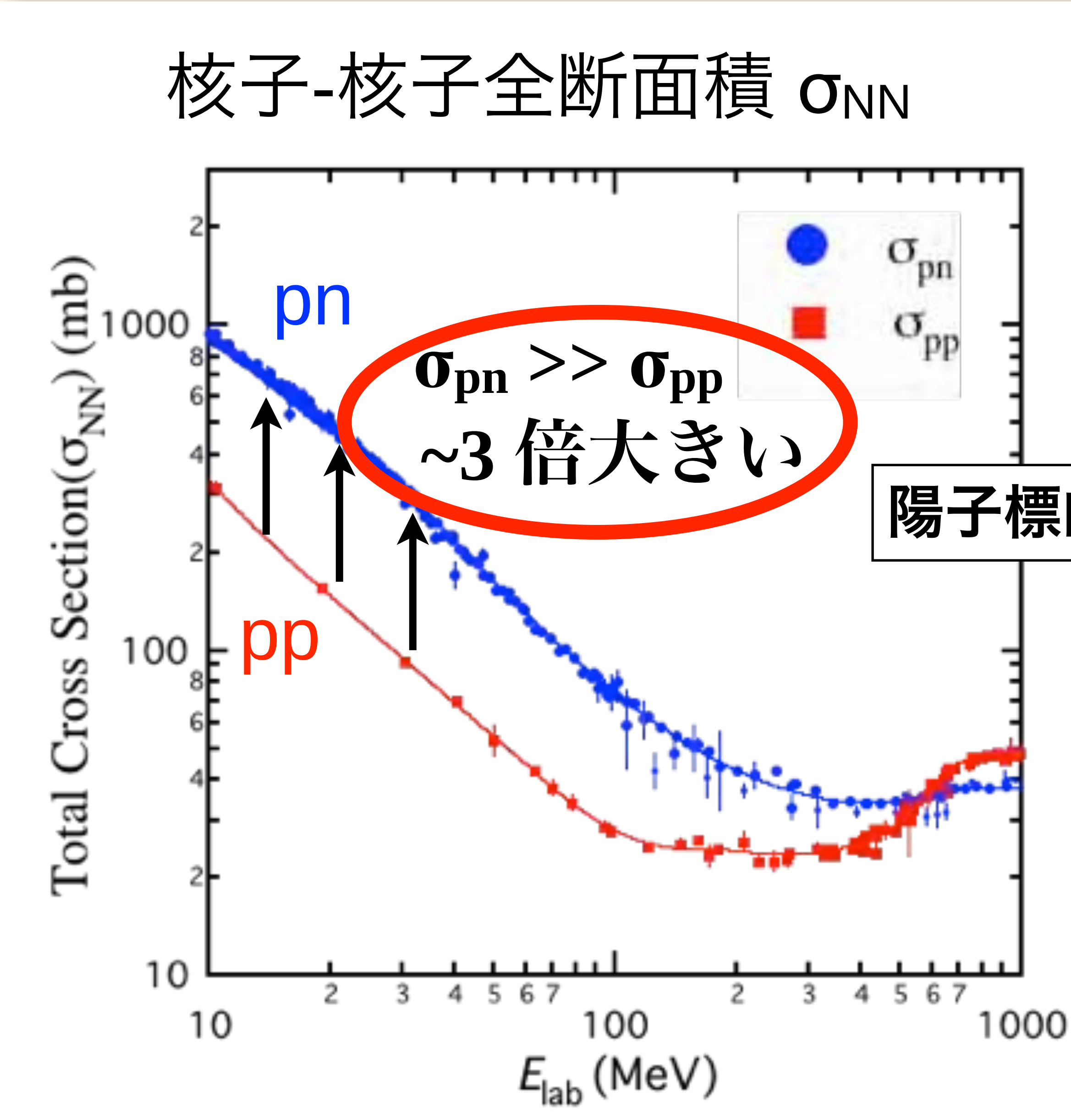
Phys. Rev. C82 (2010) 044309
K. Tanaka et al.

Deduced Density using $2s_{1/2}$ with S_{1n}=0.97MeV

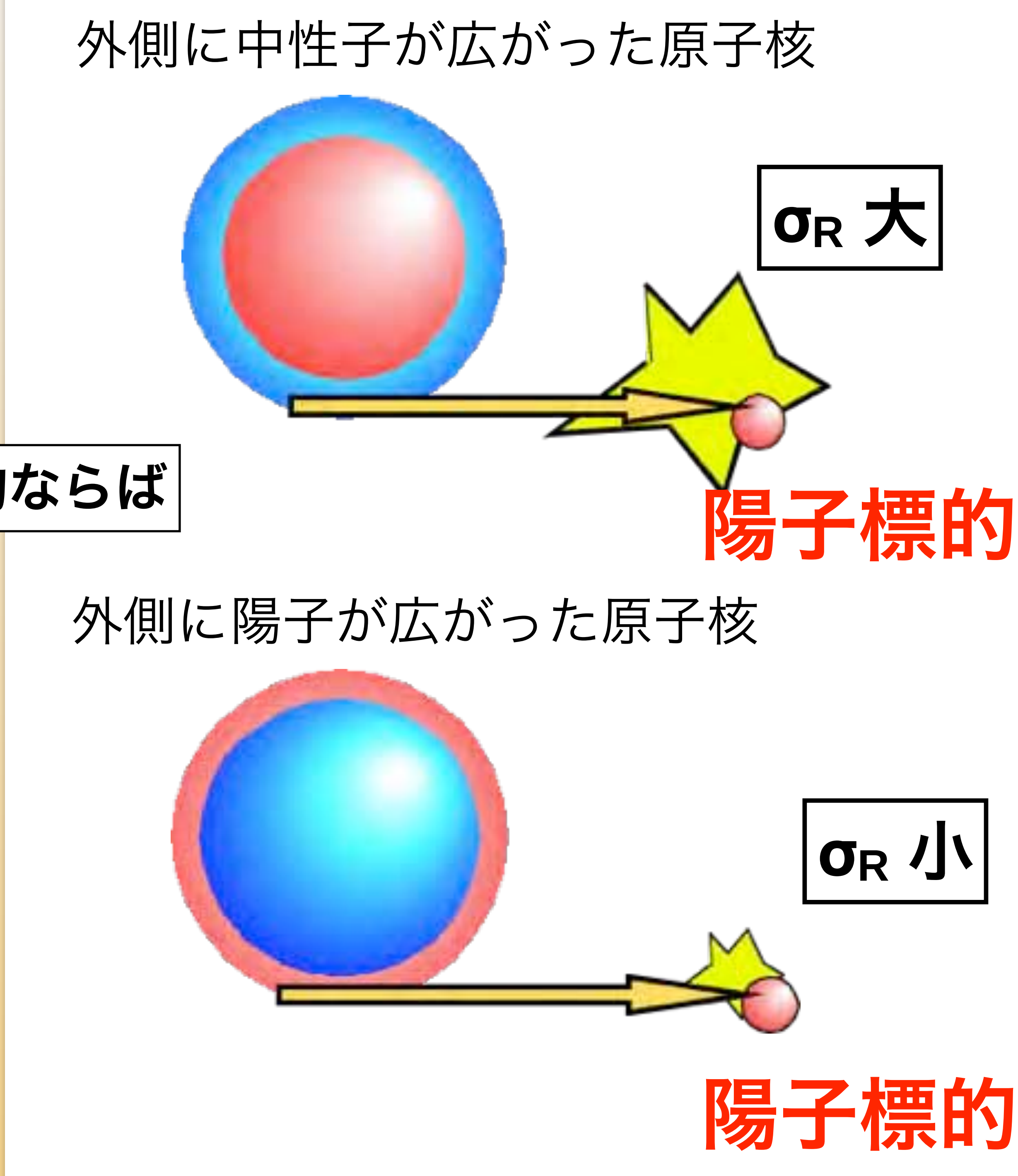


陽子分布・中性子分布の分離

核力の性質(σpp と σpn の違い)



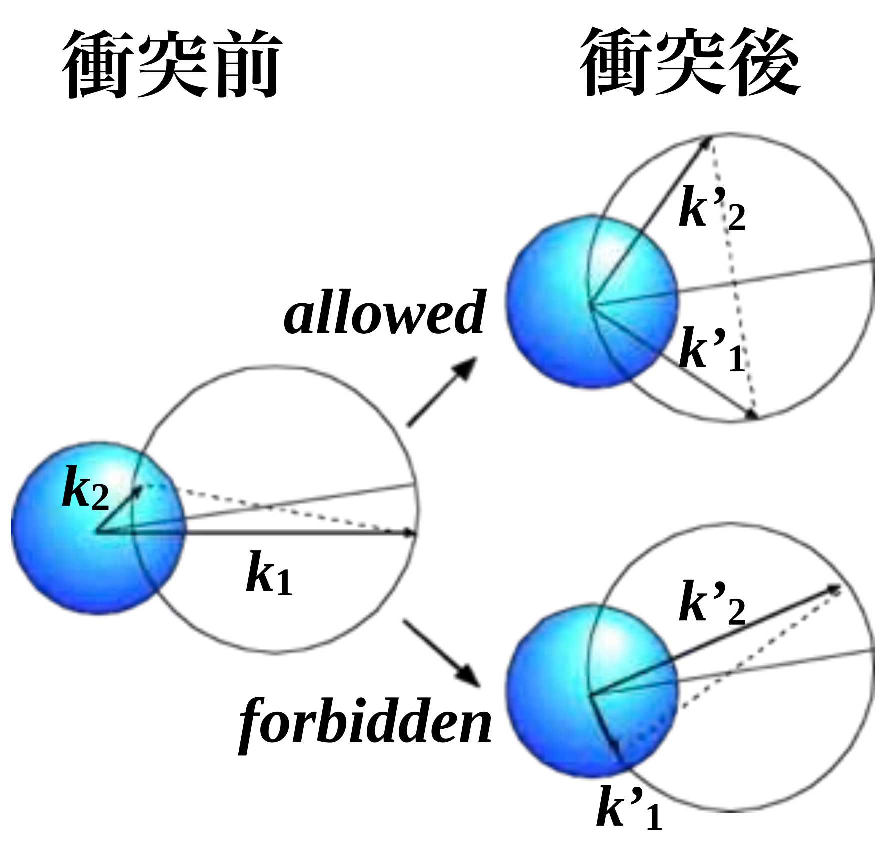
陽子標的ならば

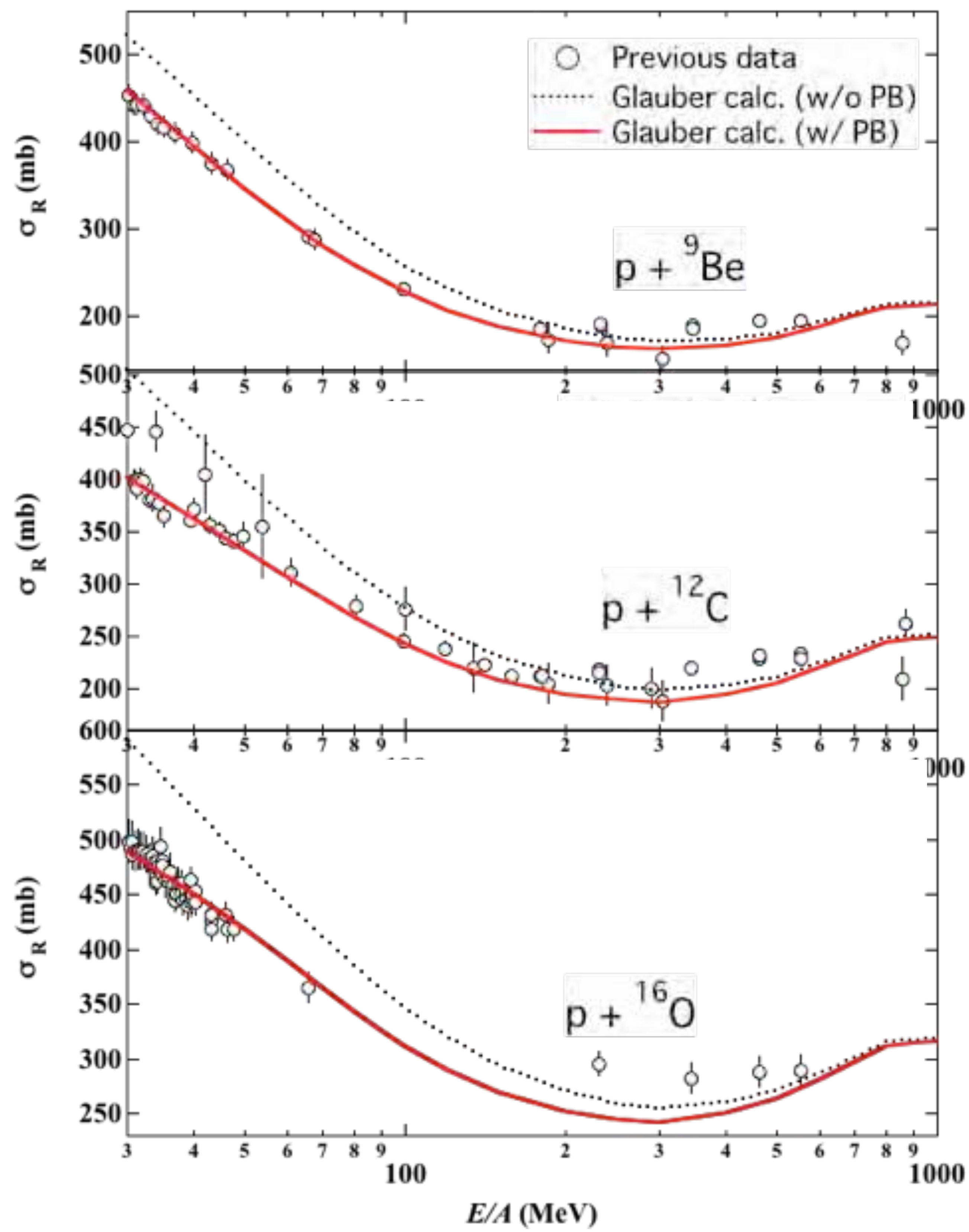


陽子-原子核σRから陽子･中性子分布を分離可能

パウリブロッキングの効果

運動量空間でのPauli Blocking





密度依存

$$k(r) = [3\pi^2\rho(r)]^{1/3}$$

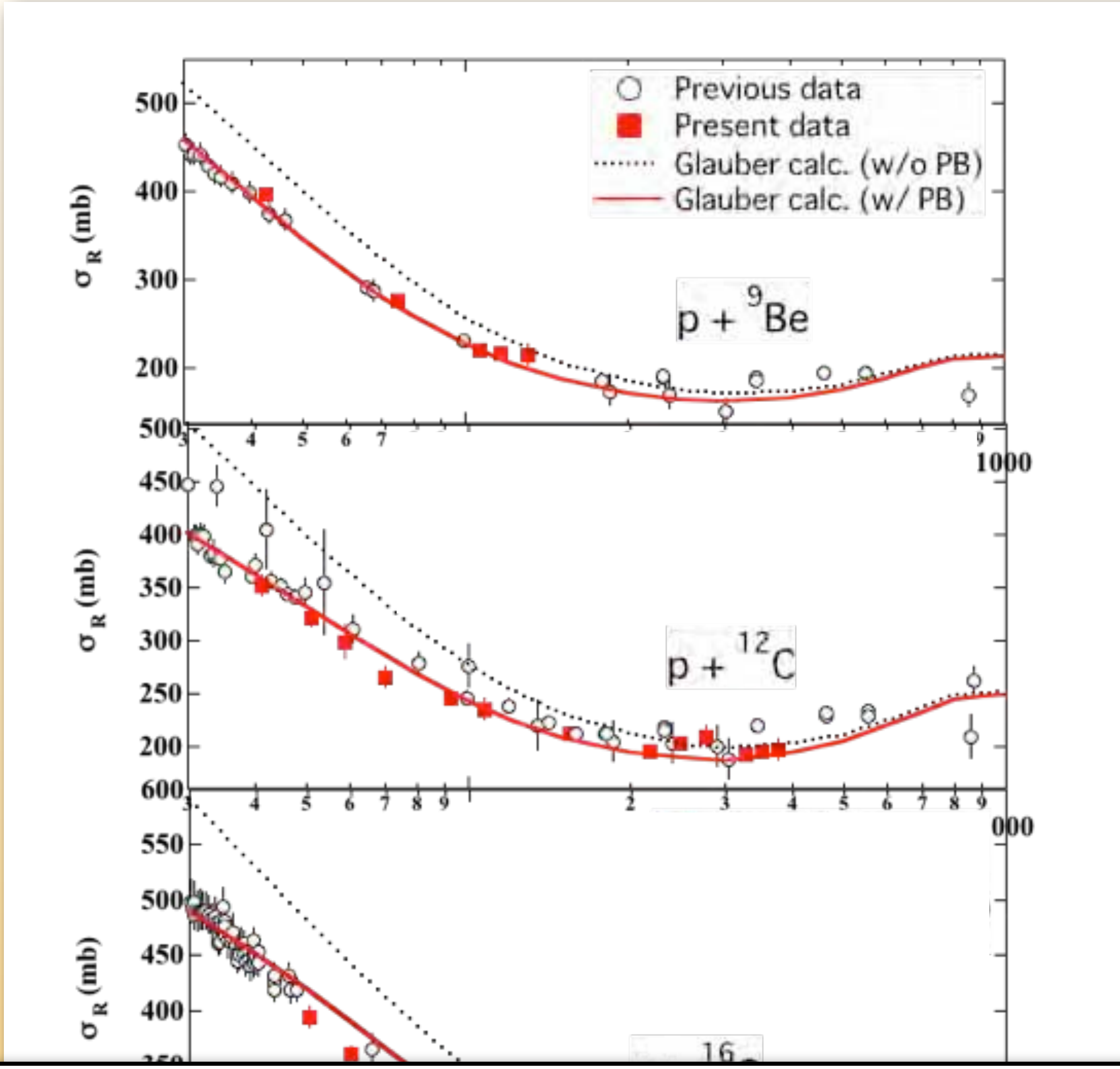
R. E. Warner et al., PRC 65 (2002) 044617

アイソスピン依存

$$k_p(r) \neq k_n(r)$$

L.W.Chen et al., PRC64(2001)064315.

陽子-安定核σR実験結果

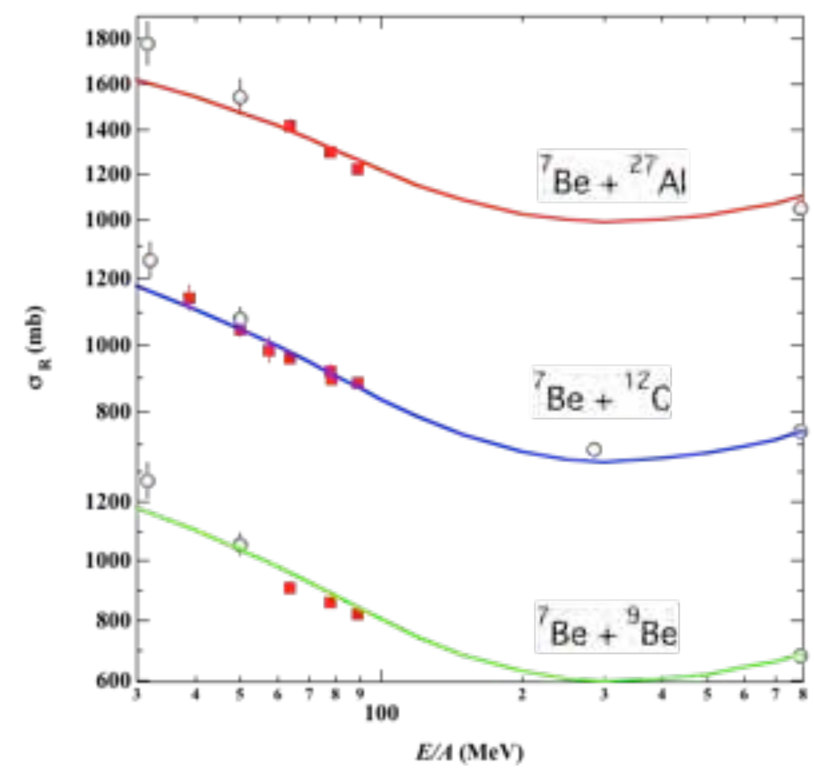


パウリブロッキングを考慮した

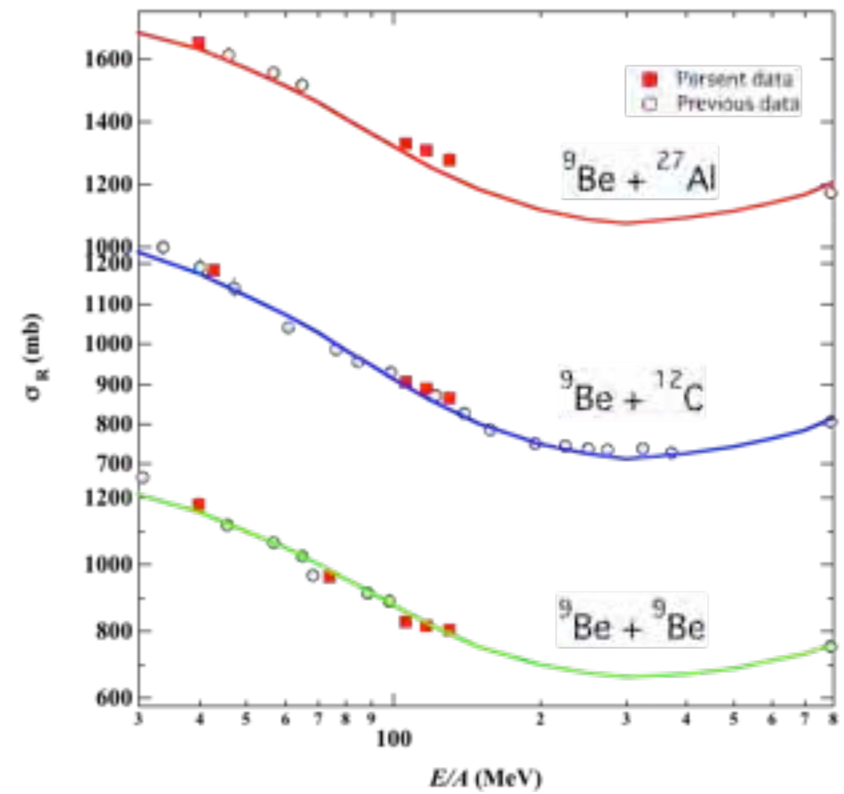
グラウバー計算が実験値を良く再現する。

Be同位体-原子核のσ_R実験結果

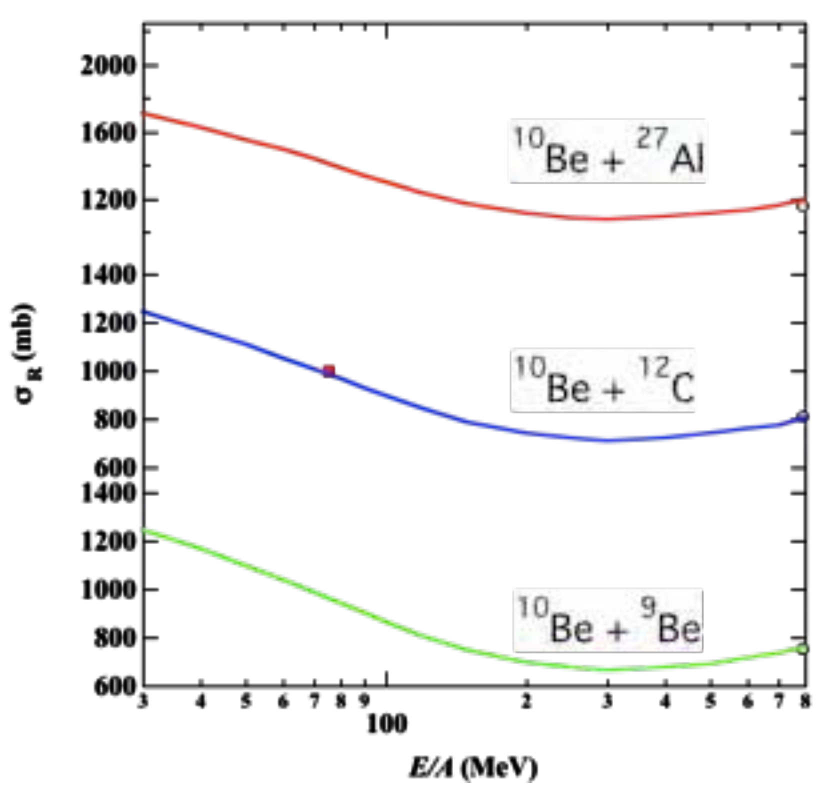
^{7}Be



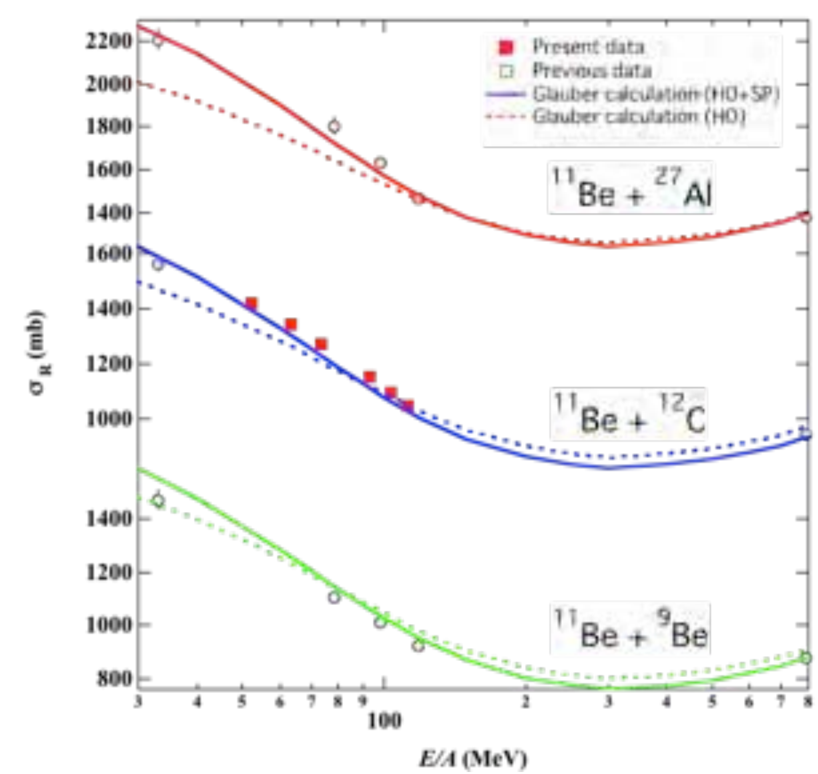
^{9}Be



^{10}Be

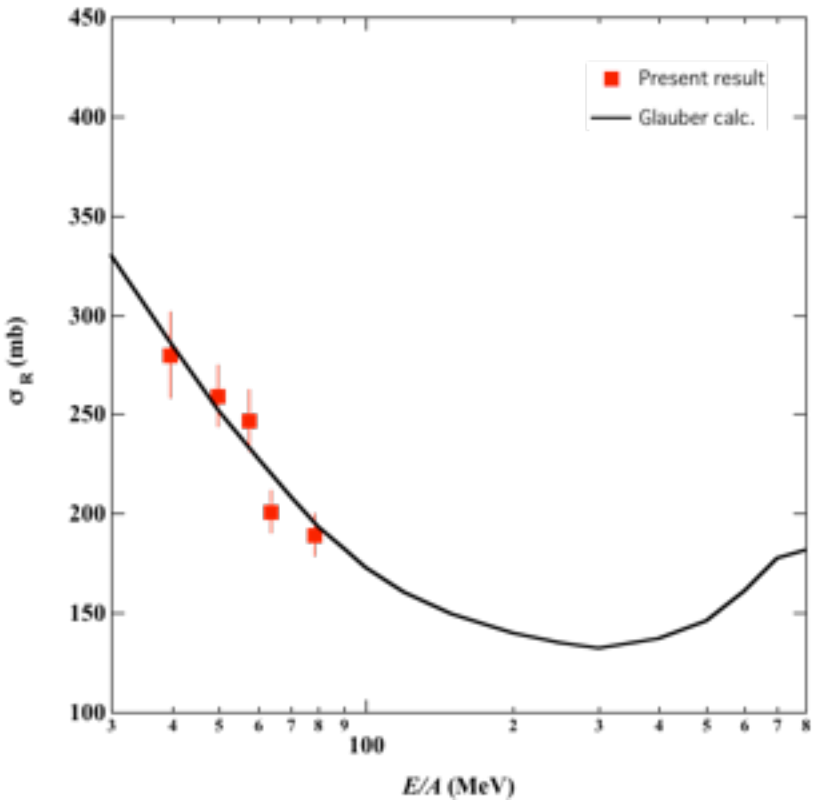


^{11}Be

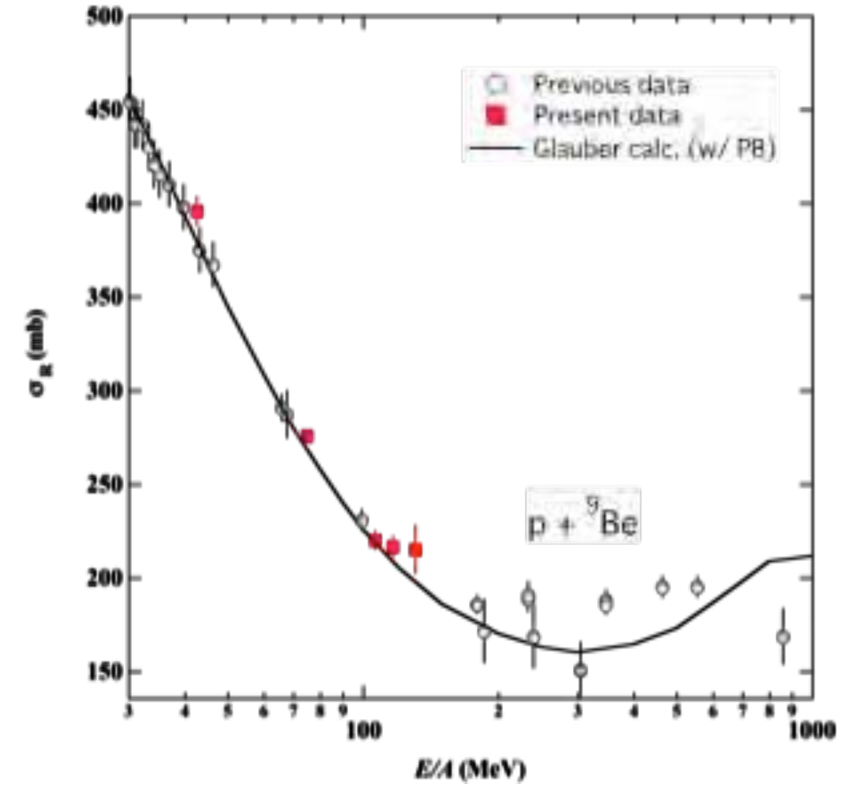


陽子-Be同位体σ_Rの実験結果

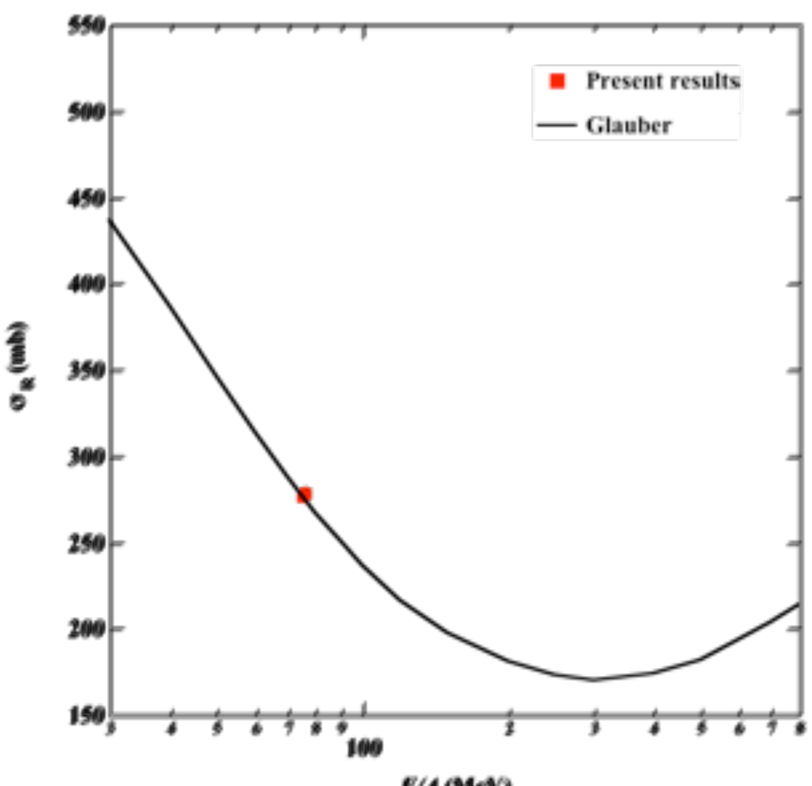
^{7}Be



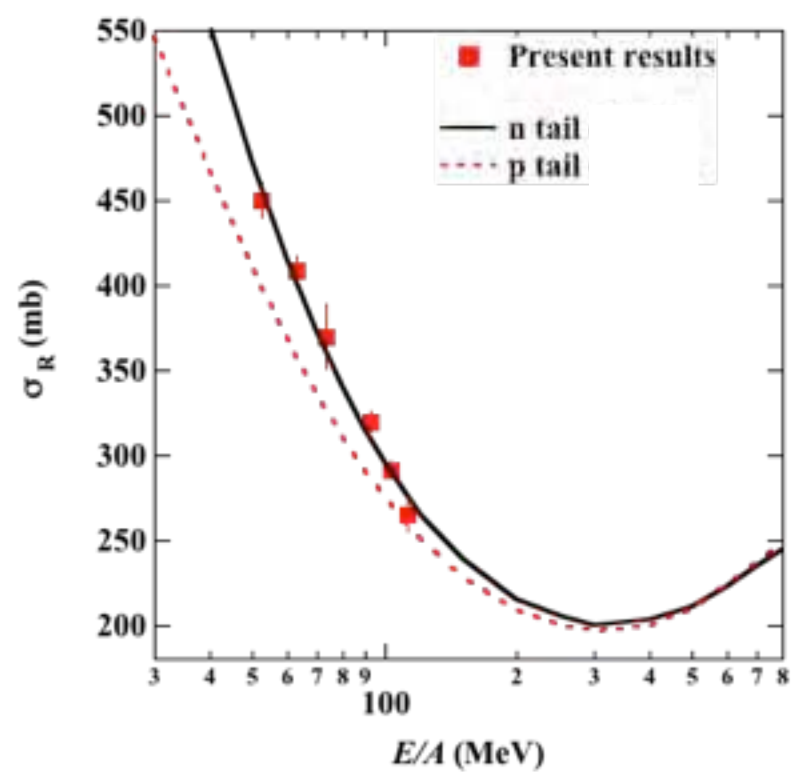
^{9}Be



^{10}Be

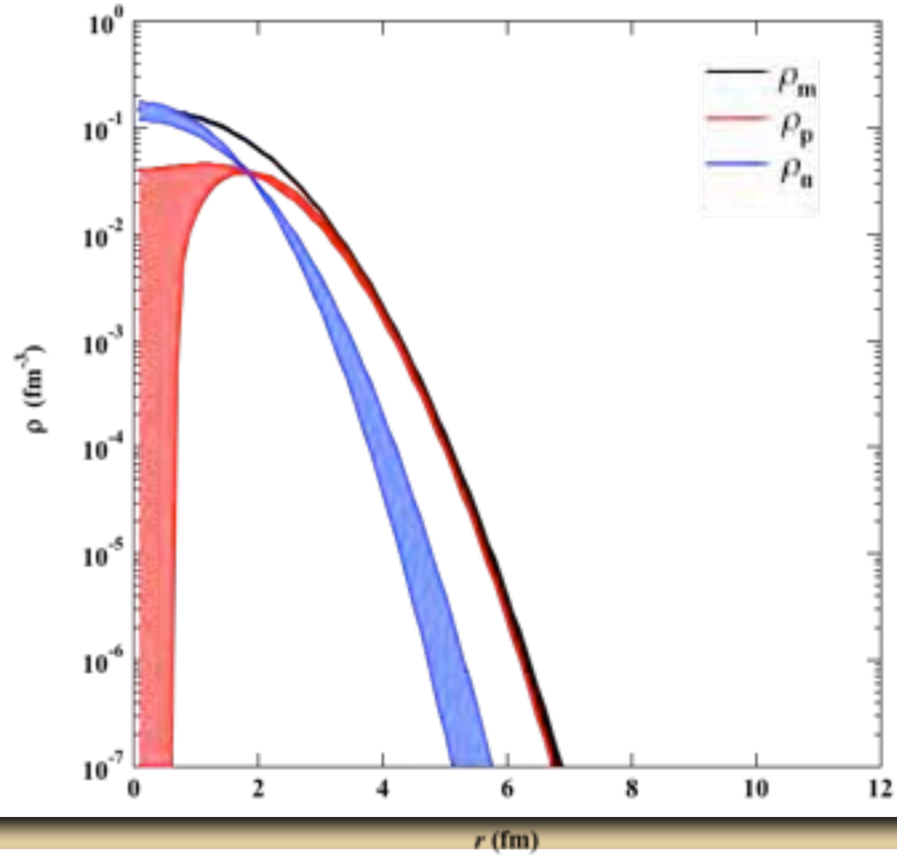


^{11}Be

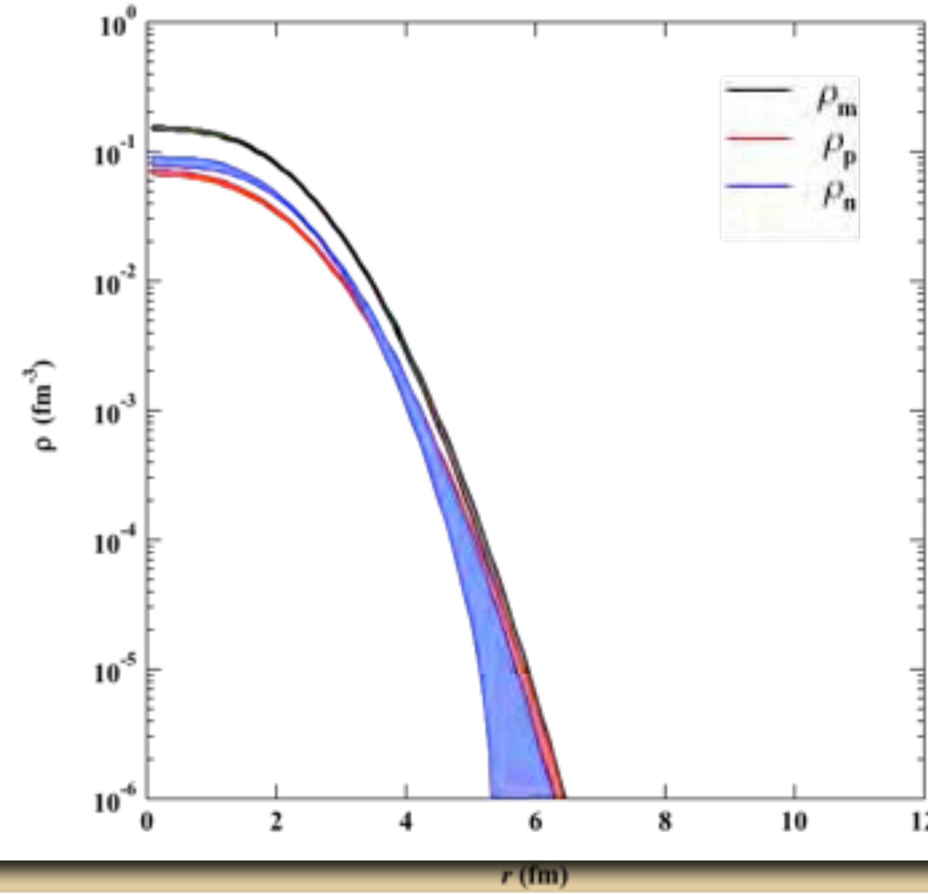


Be 同位体の陽子・中性子密度分布

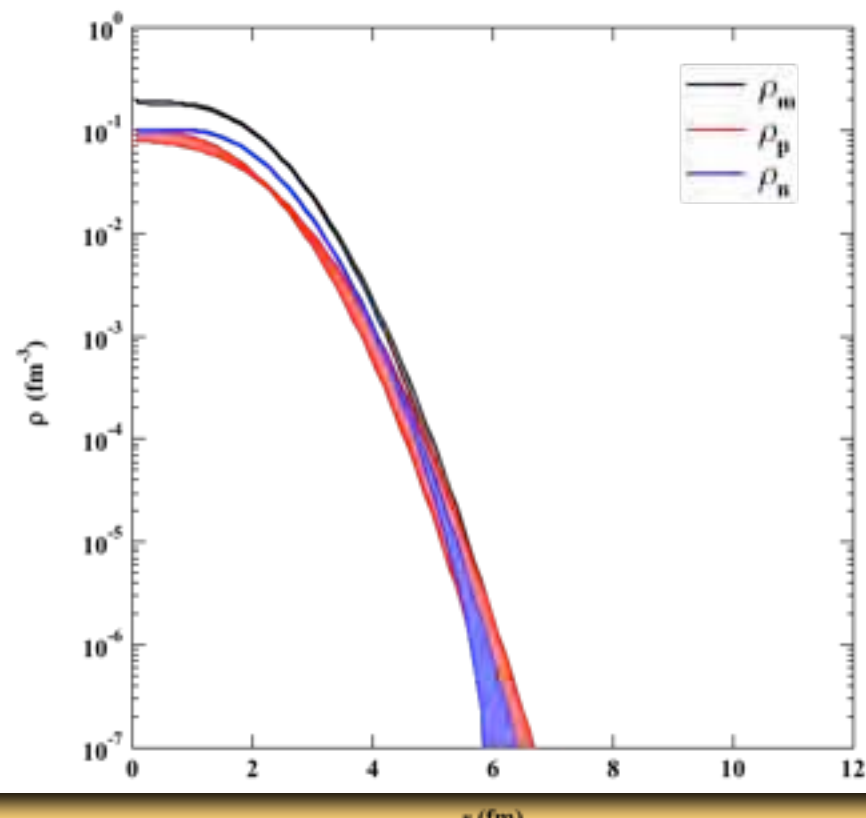
^{7}Be



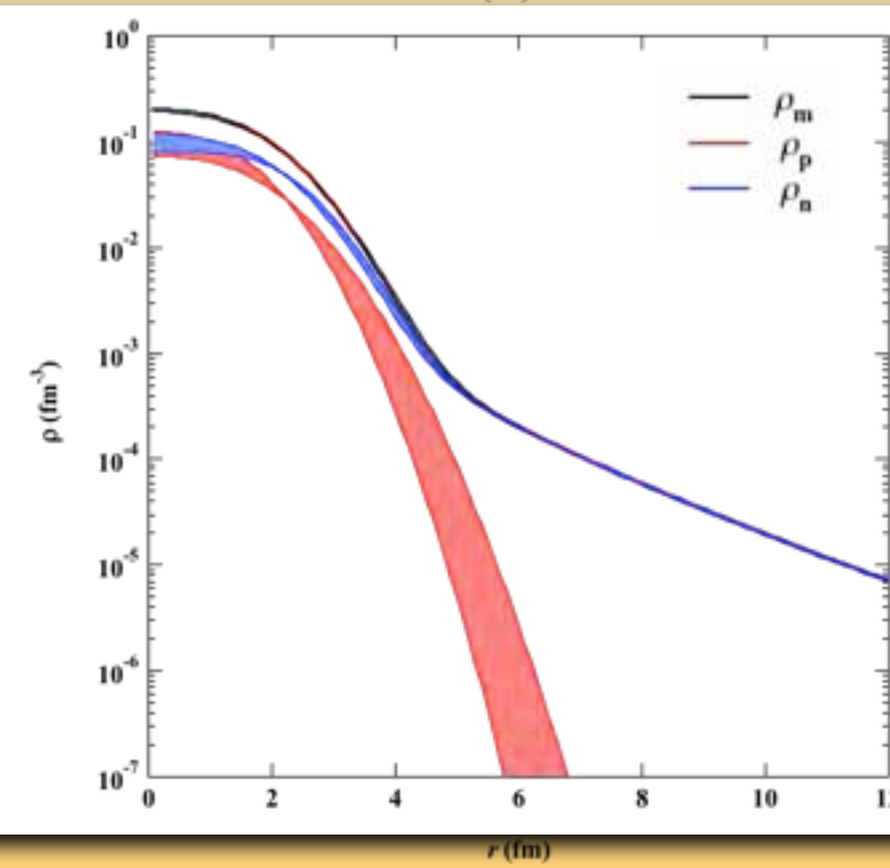
^{9}Be



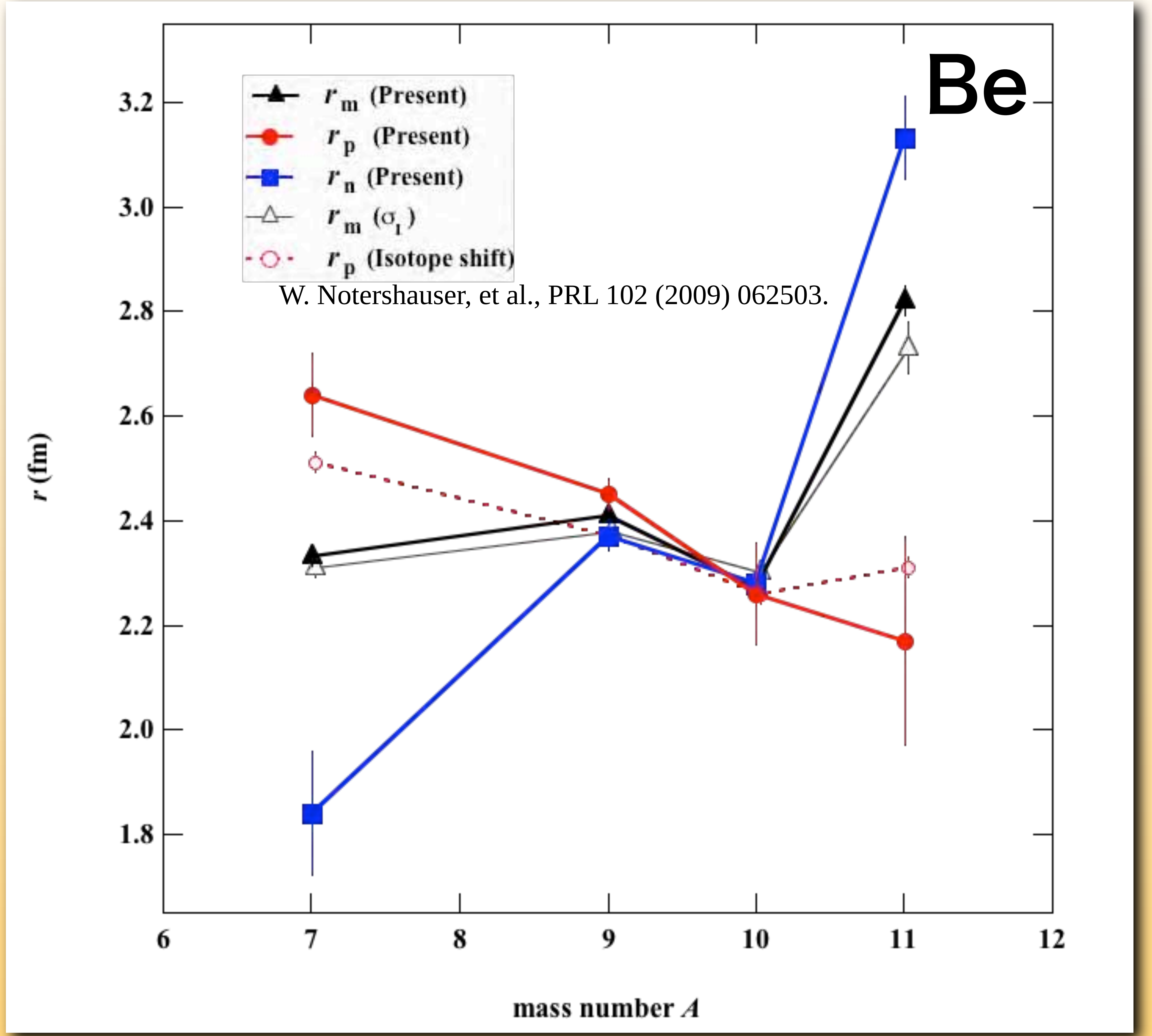
^{10}Be



^{11}Be

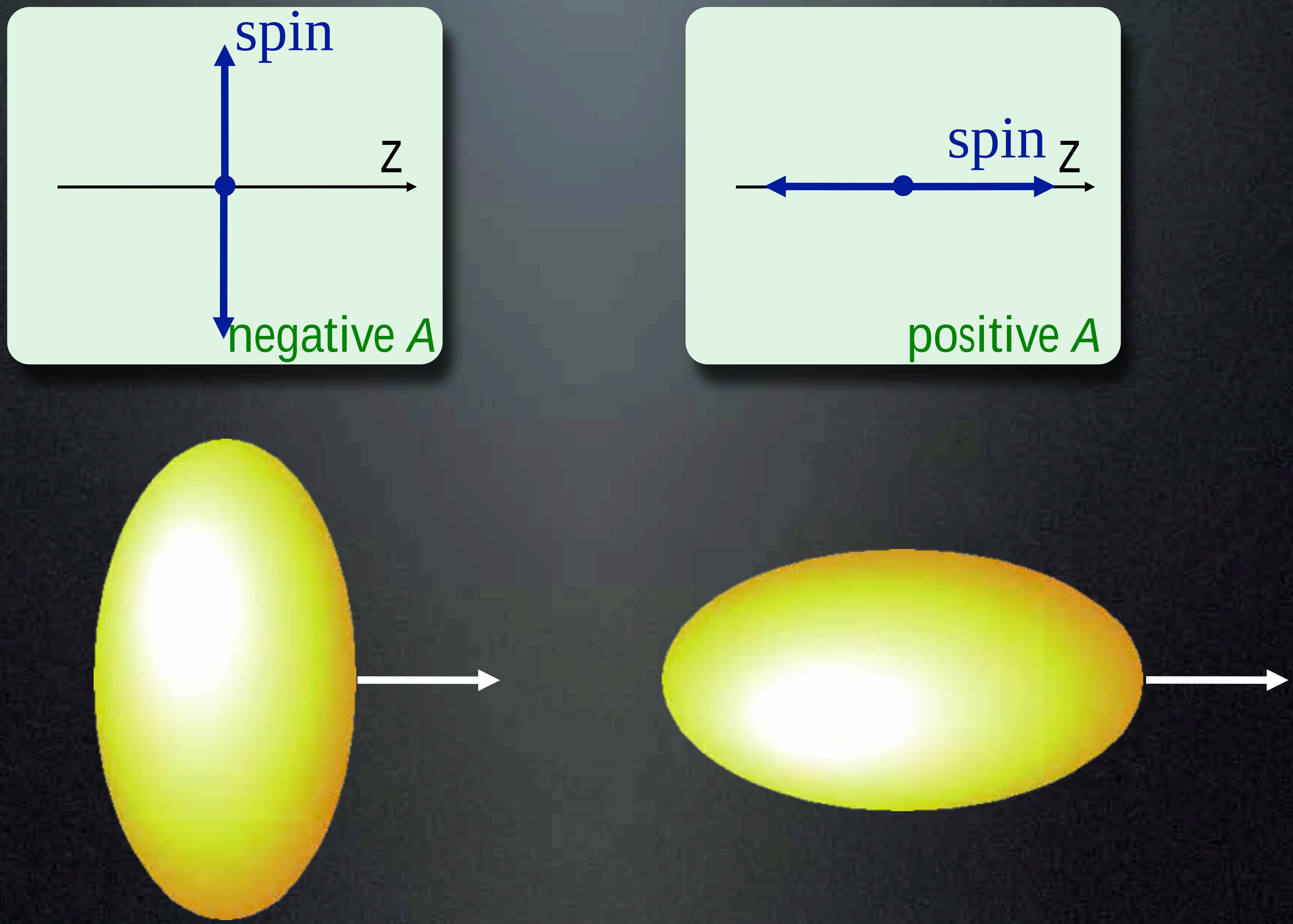


Be同位体の平均２乗半径の比較

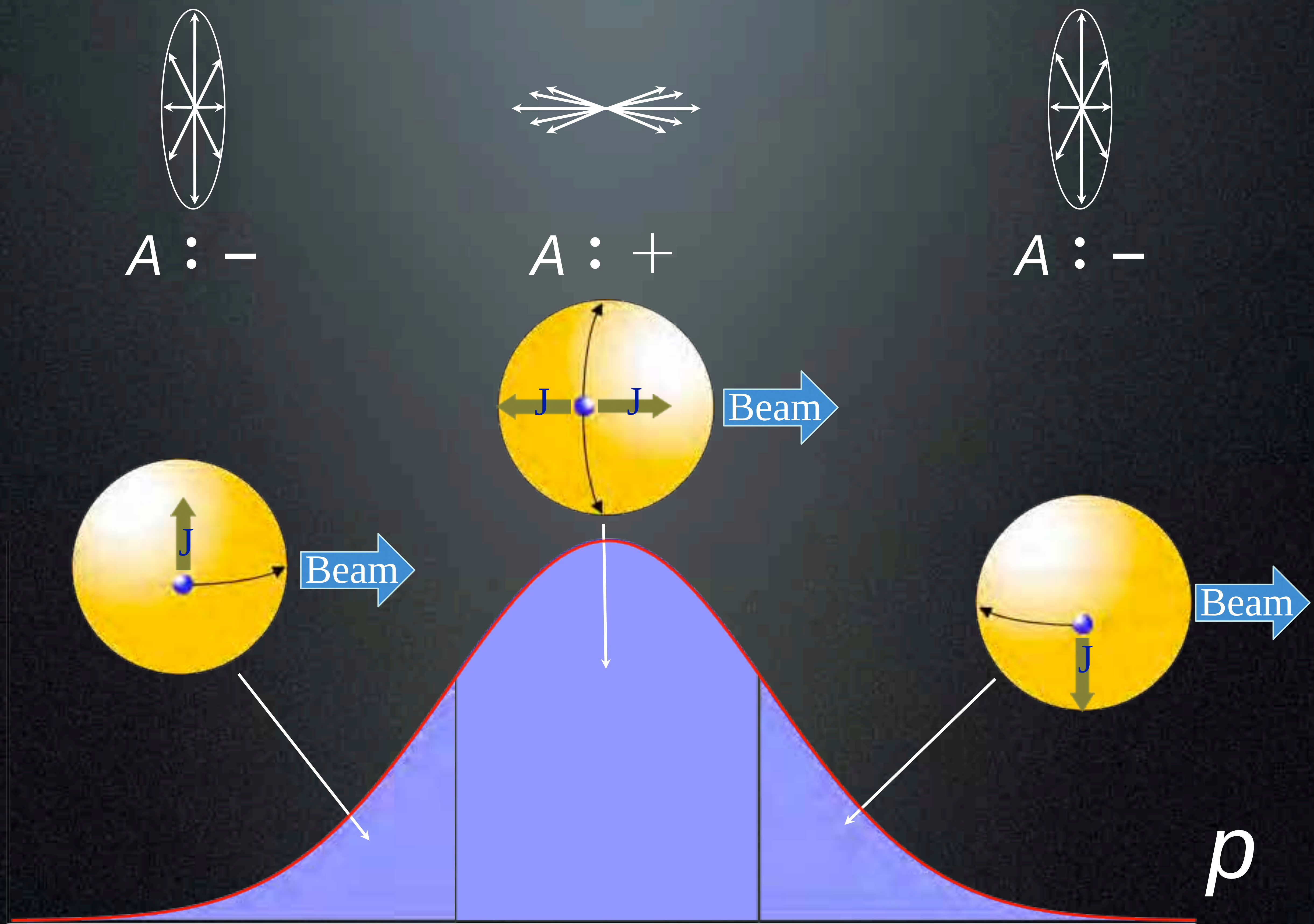


変形整列核の方位異方性

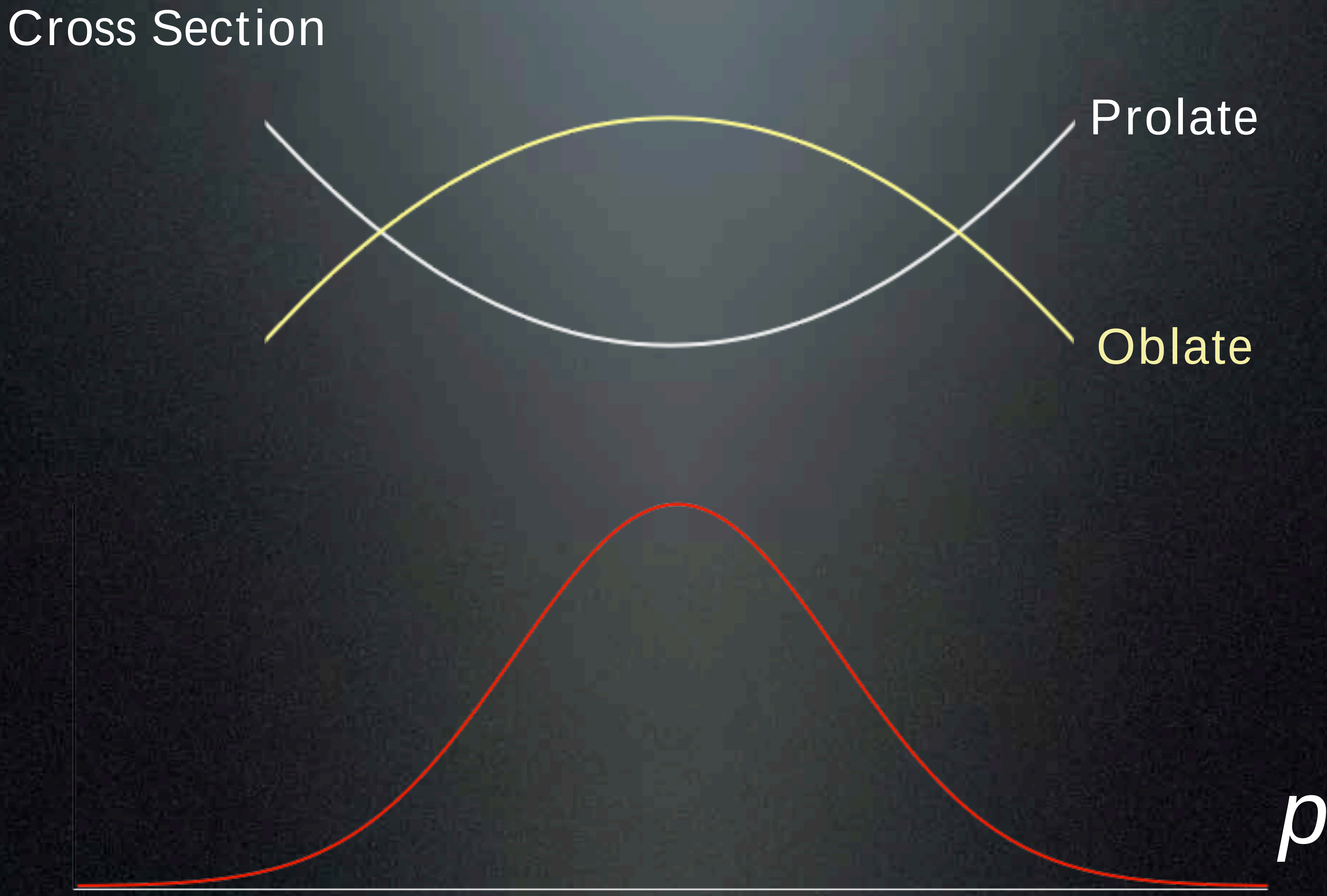
Beam, Spin, and Deformation Directions



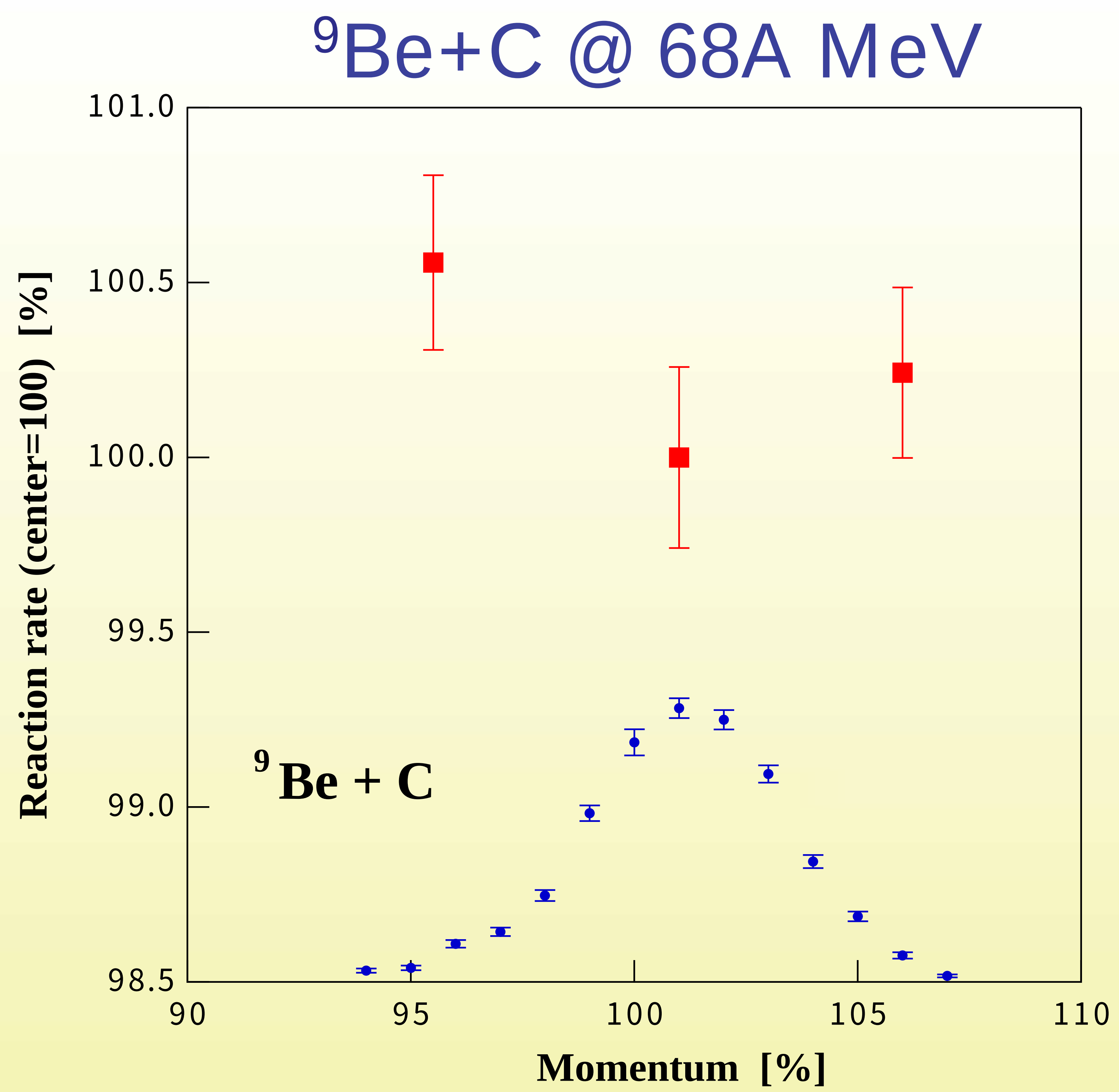
Creation of Nuclear Spin Alignment



Cross Section (*p*)



$^{11}B \rightarrow {}^{9}Be$



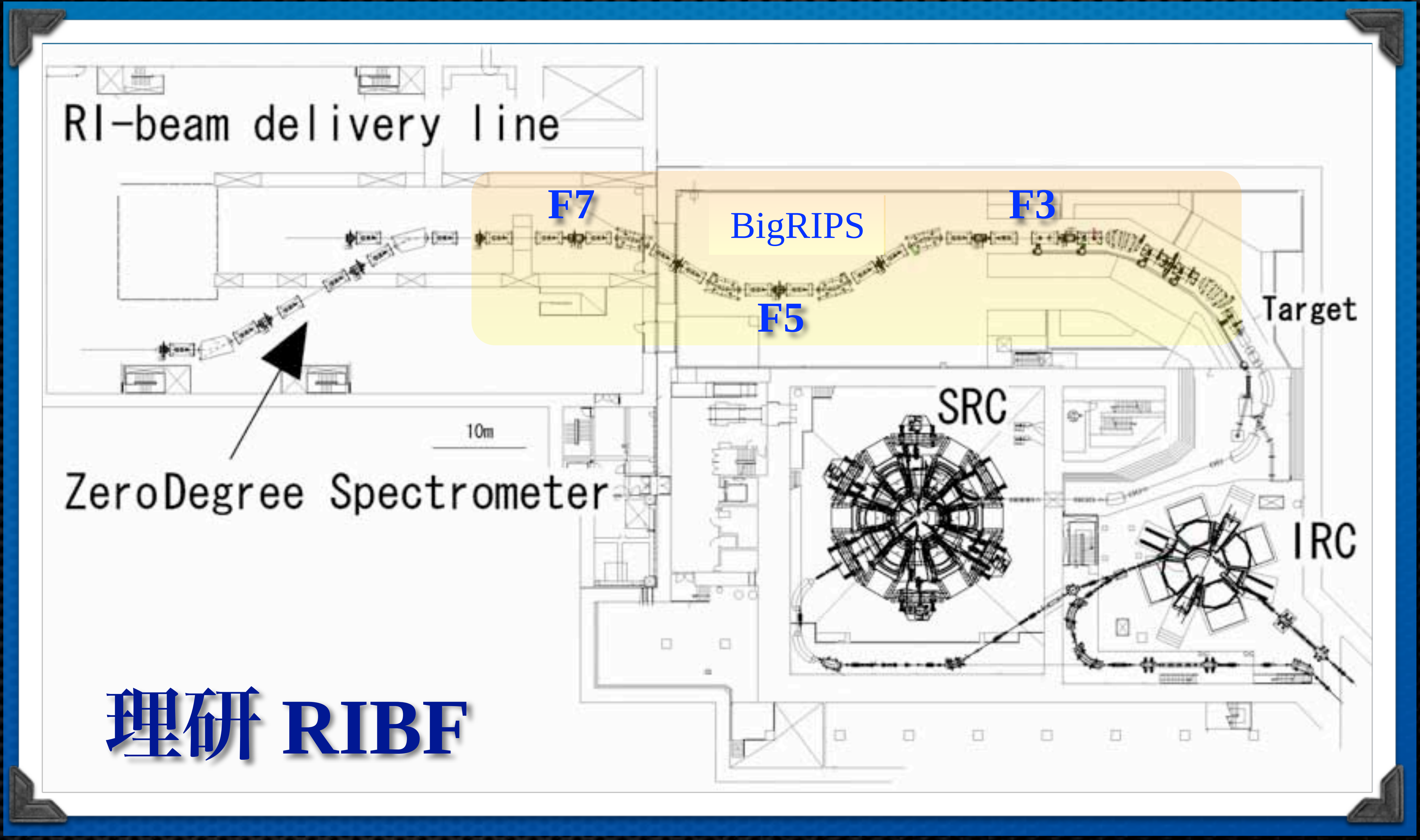
理研RIBFにおける

中性子過剰 Ne, Mg 同位体の研究

Primary Beam ^{48}Ca 345A MeV, ~10^2 pnA

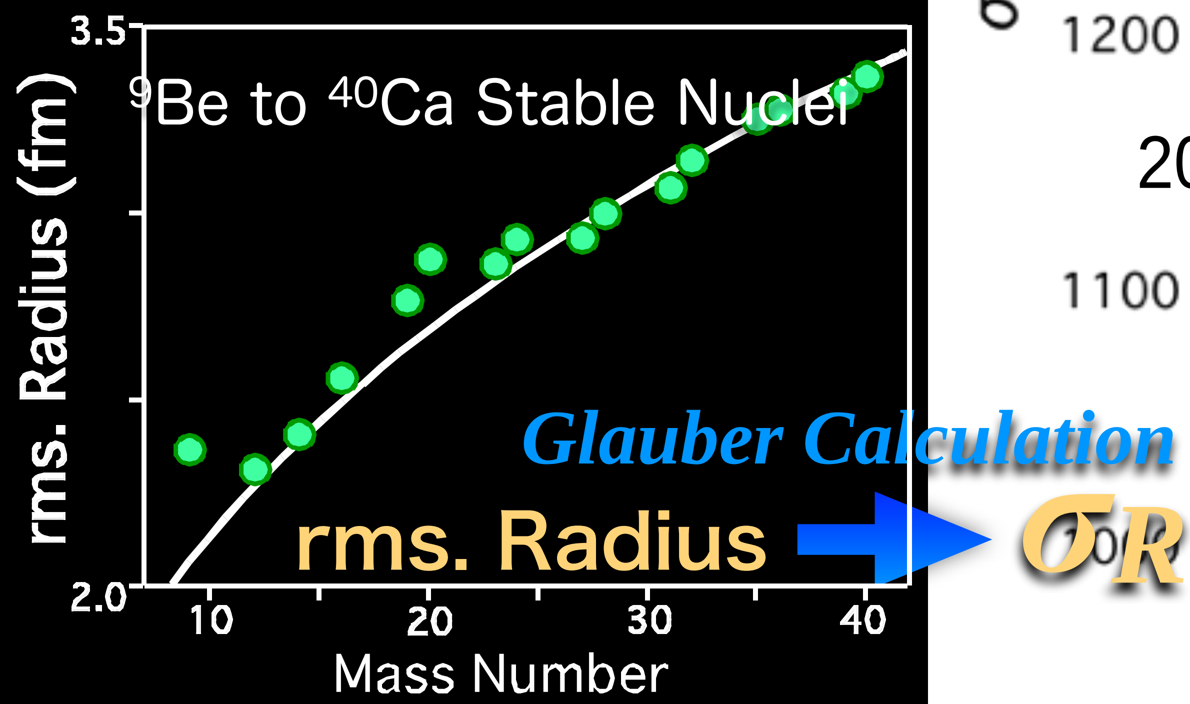
Secondary Beam $^{20\text{-}32}$Ne, $^{24\text{-}38}$Mg **Island of Inversion**

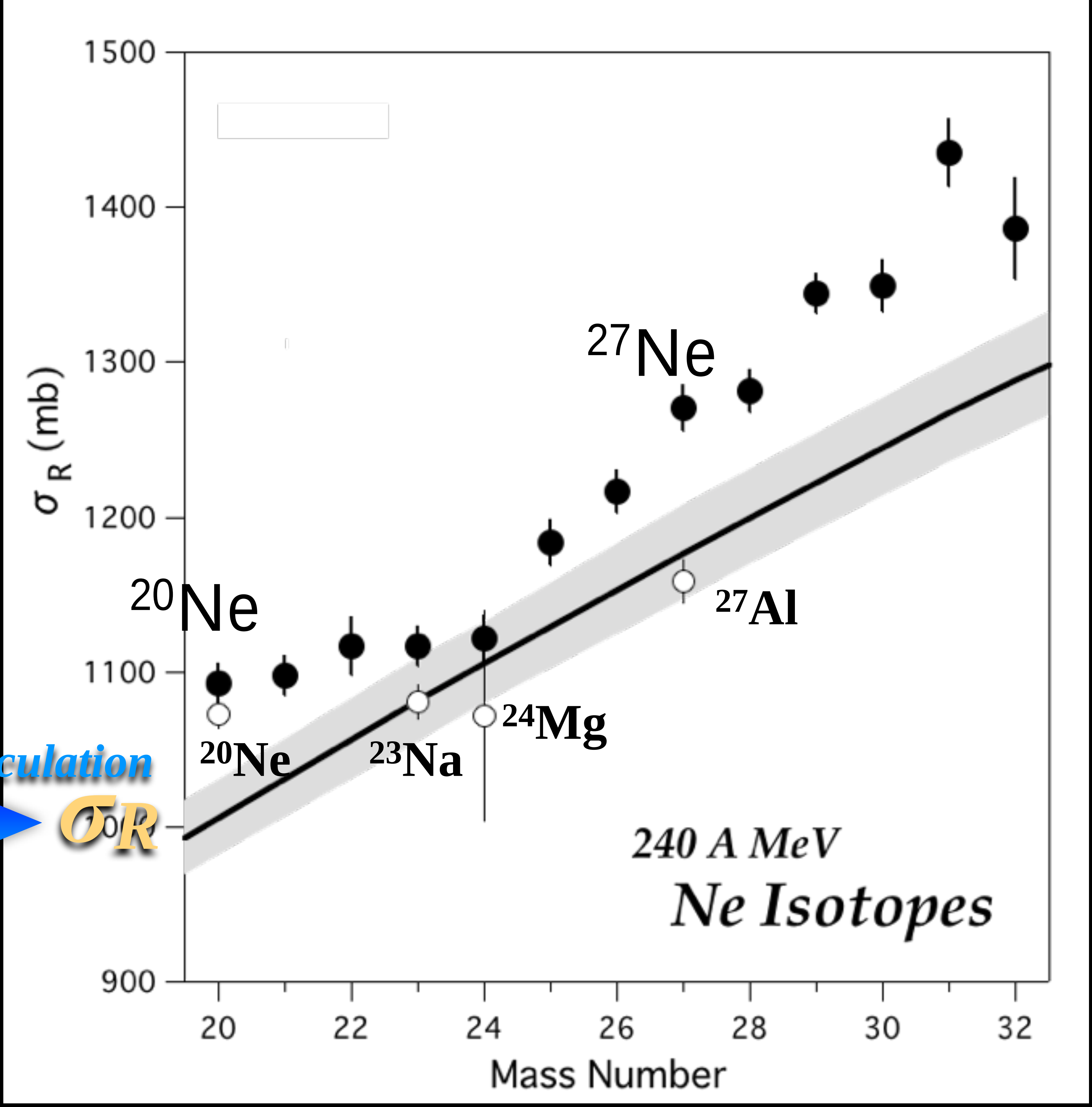
σ_R were measured using BigRIPS (F3 - F7)



Ne

M. Takechi et al., Phys. Lett. **B 707** (2012) 357.



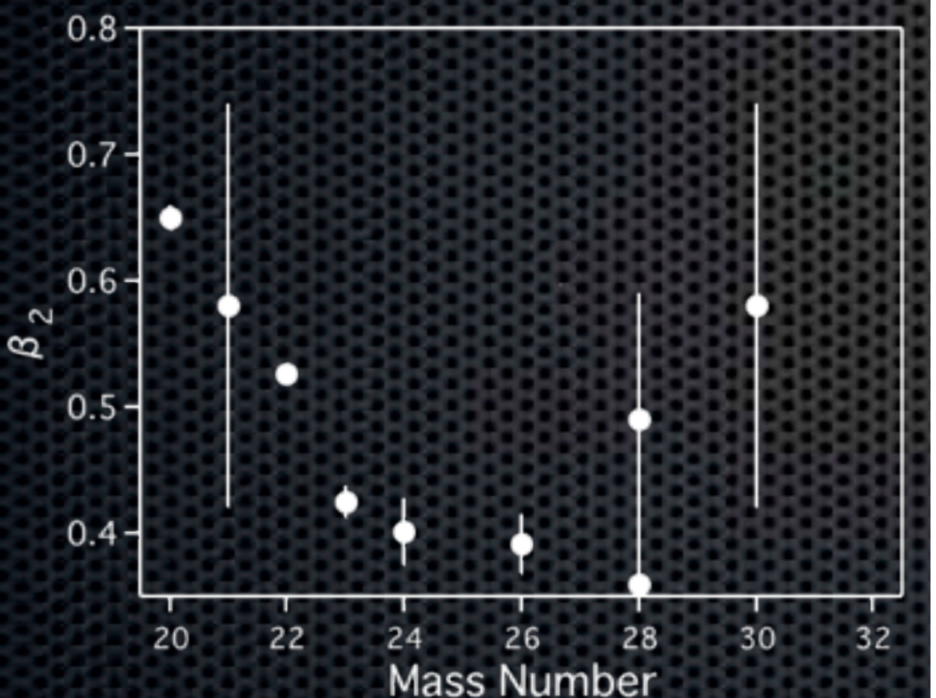


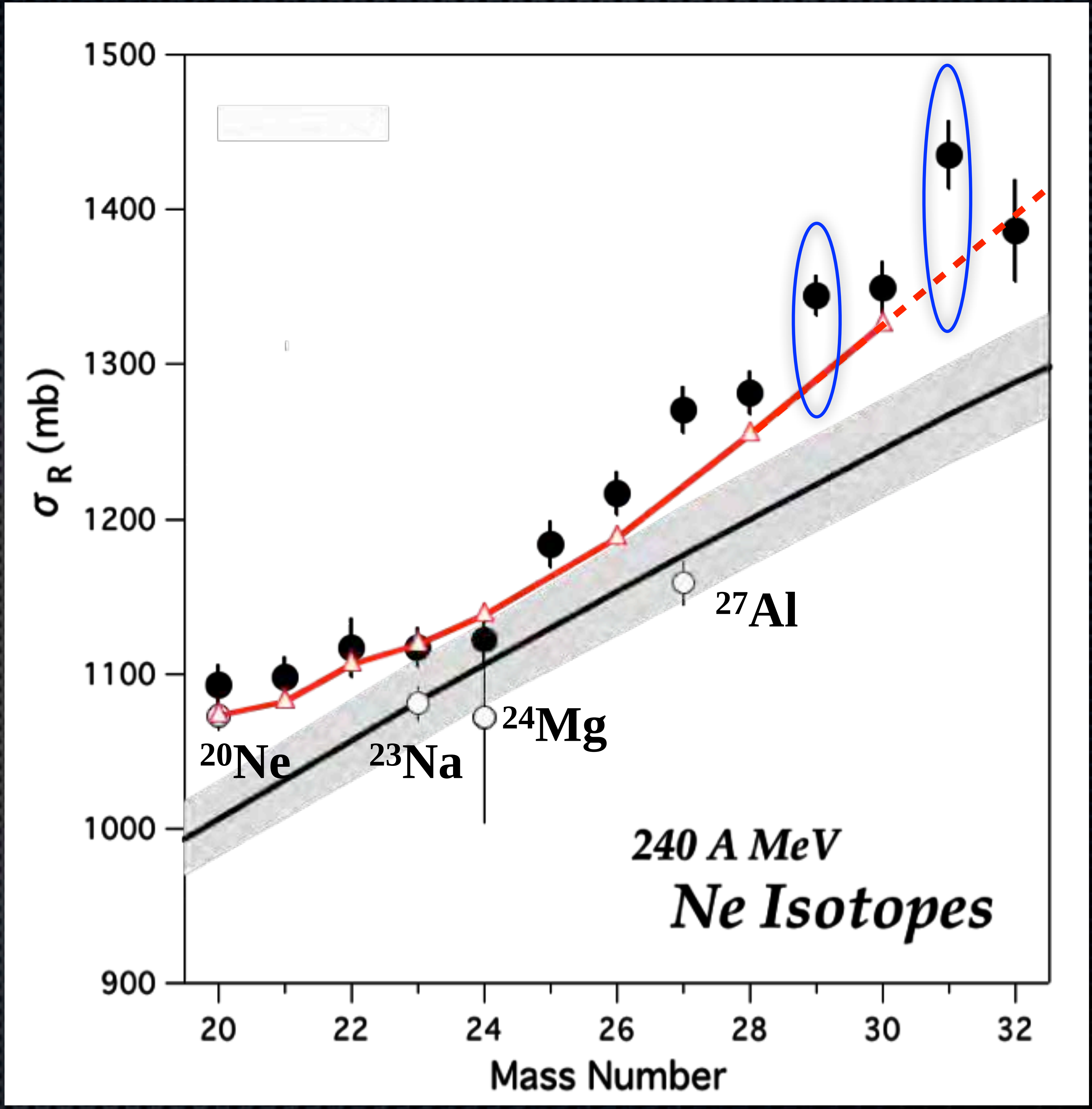
M. Takechi et al., Phys. Lett. **B 707** (2012) 357.

Radius : $r_0 A^{1/3}$

$$r_0 A^{1/3}(1 + 5/4\pi \cdot \beta^2)^{1/2}$$

β_2 deduced from experimental B(E2) and Q moment

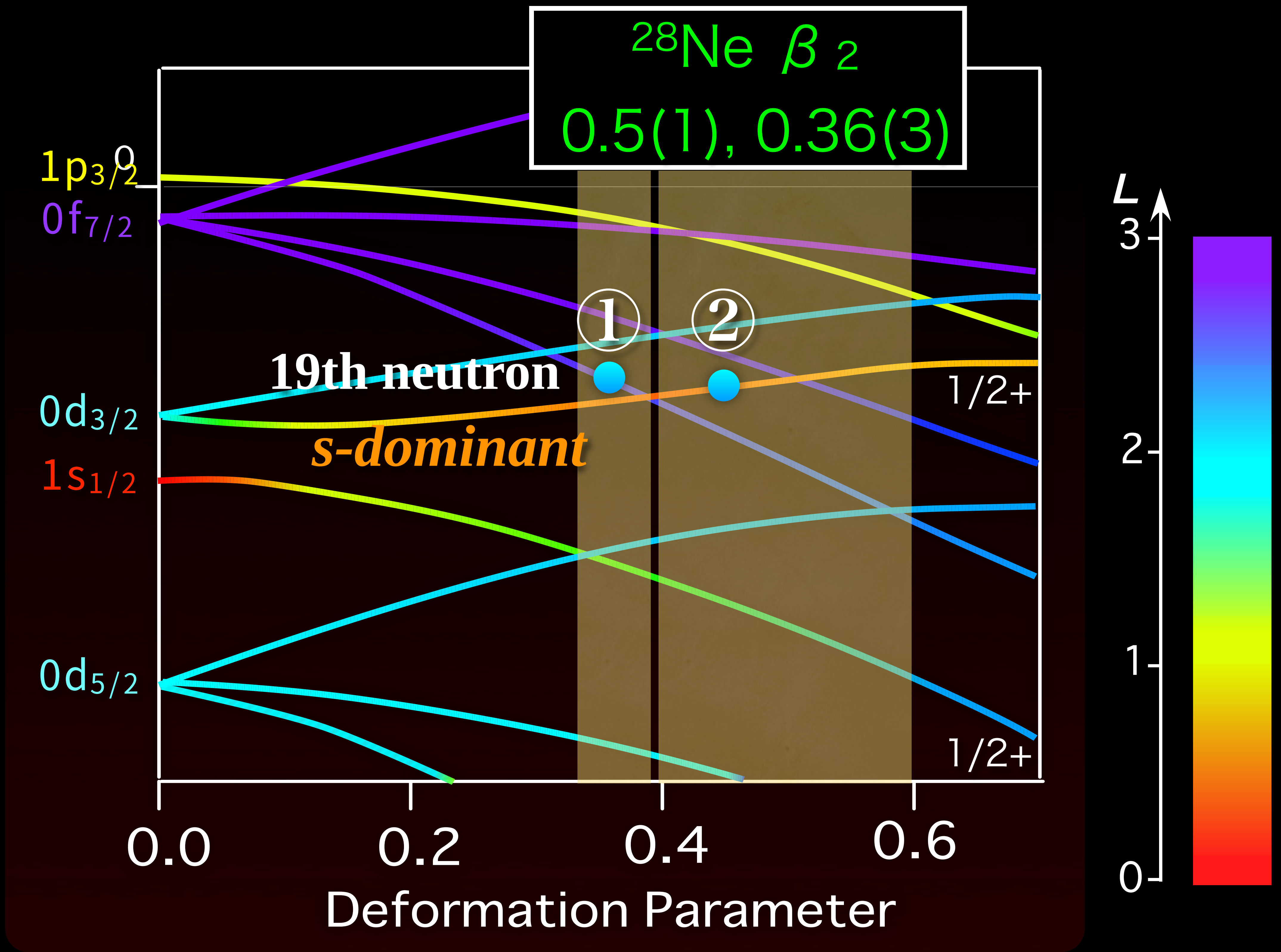




Halo Effect in ^{29}Ne

M. Takechi et al., Phys. Lett. **B 707** (2012) 357.

^{28}Ne + 1n model



^{28}Ne : H. Iwasaki et al., Phys. Lett. B 620 (2005) 118

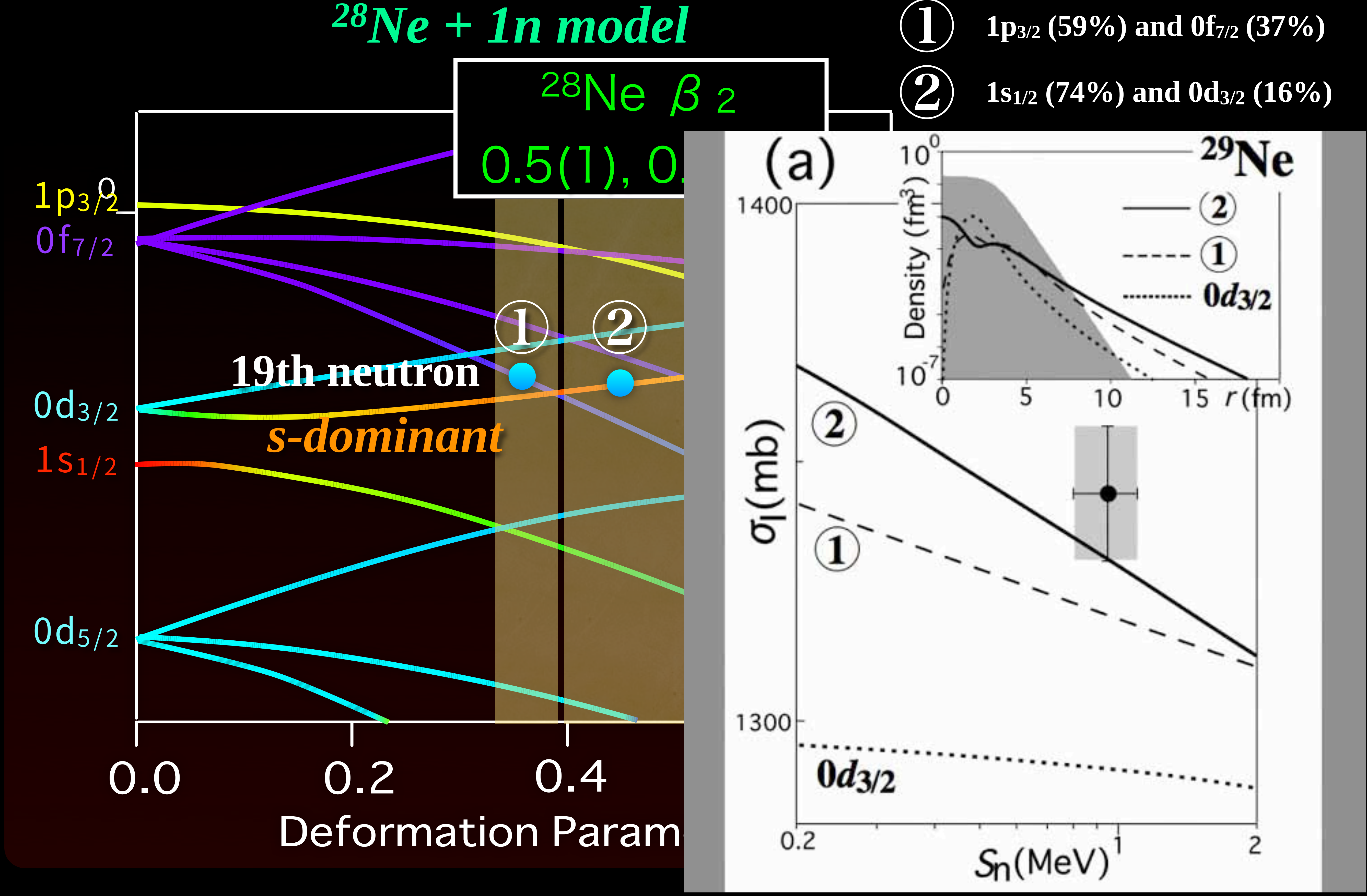
^{28}Ne : B. V. Pritychenko et al., Phys. Lett. B 461 (1999) 322.

Halo Effect in ^{29}Ne

M. Takechi et al., Phys. Lett. **B 707** (2012) 357.

① $1p_{3/2}$ (59%) and $0f_{7/2}$ (37%)

② $1s_{1/2}$ (74%) and $0d_{3/2}$ (16%)

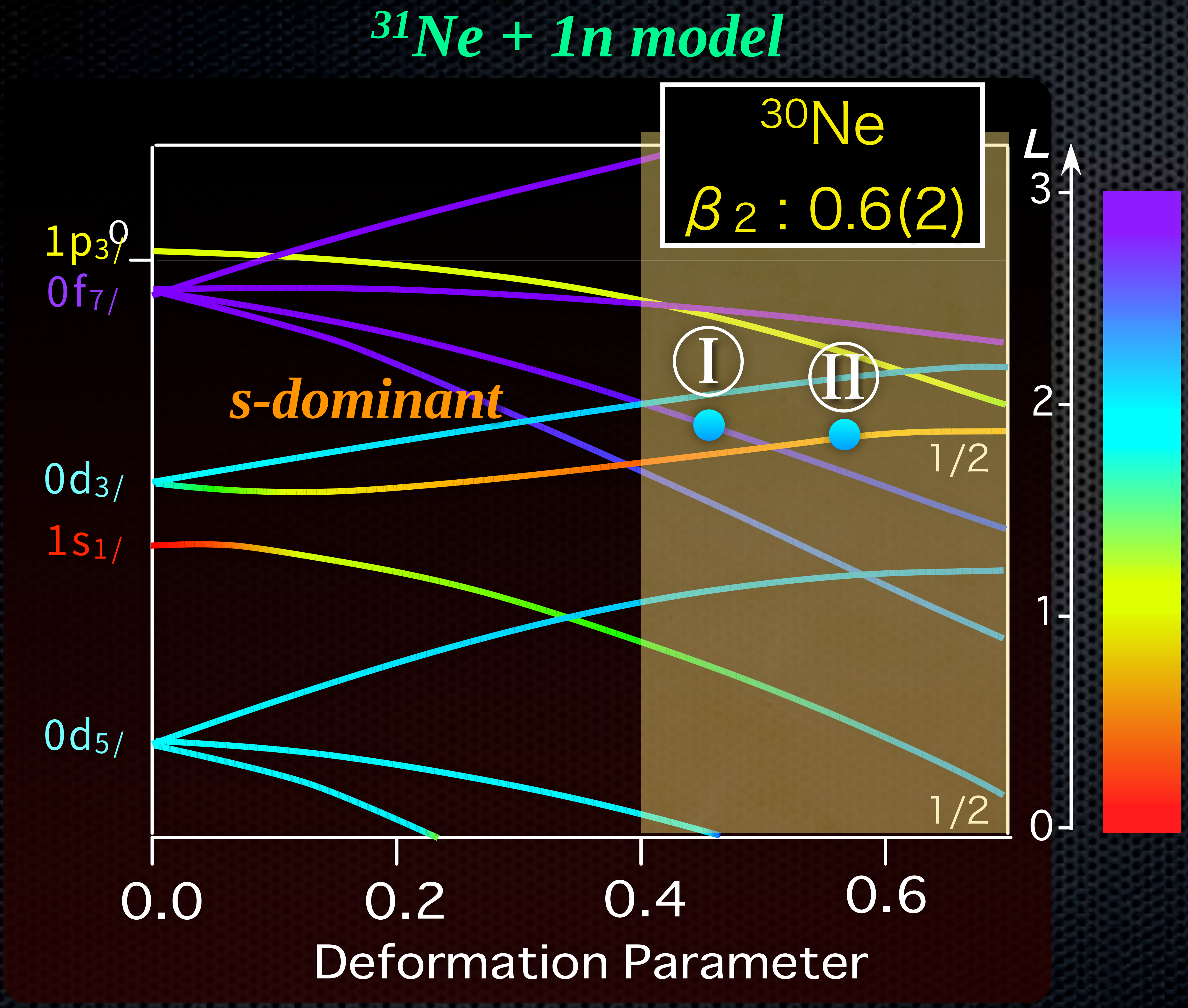


^{28}Ne : H. Iwasaki et al., Phys. Lett. B 620 (2005) 118

^{28}Ne : B. V. Pritychenko et al., Phys. Lett. B 461 (1999) 322.

Halo Effect in ^{31}Ne

M. Takechi et al., Phys. Lett. **B 707** (2012) 357.

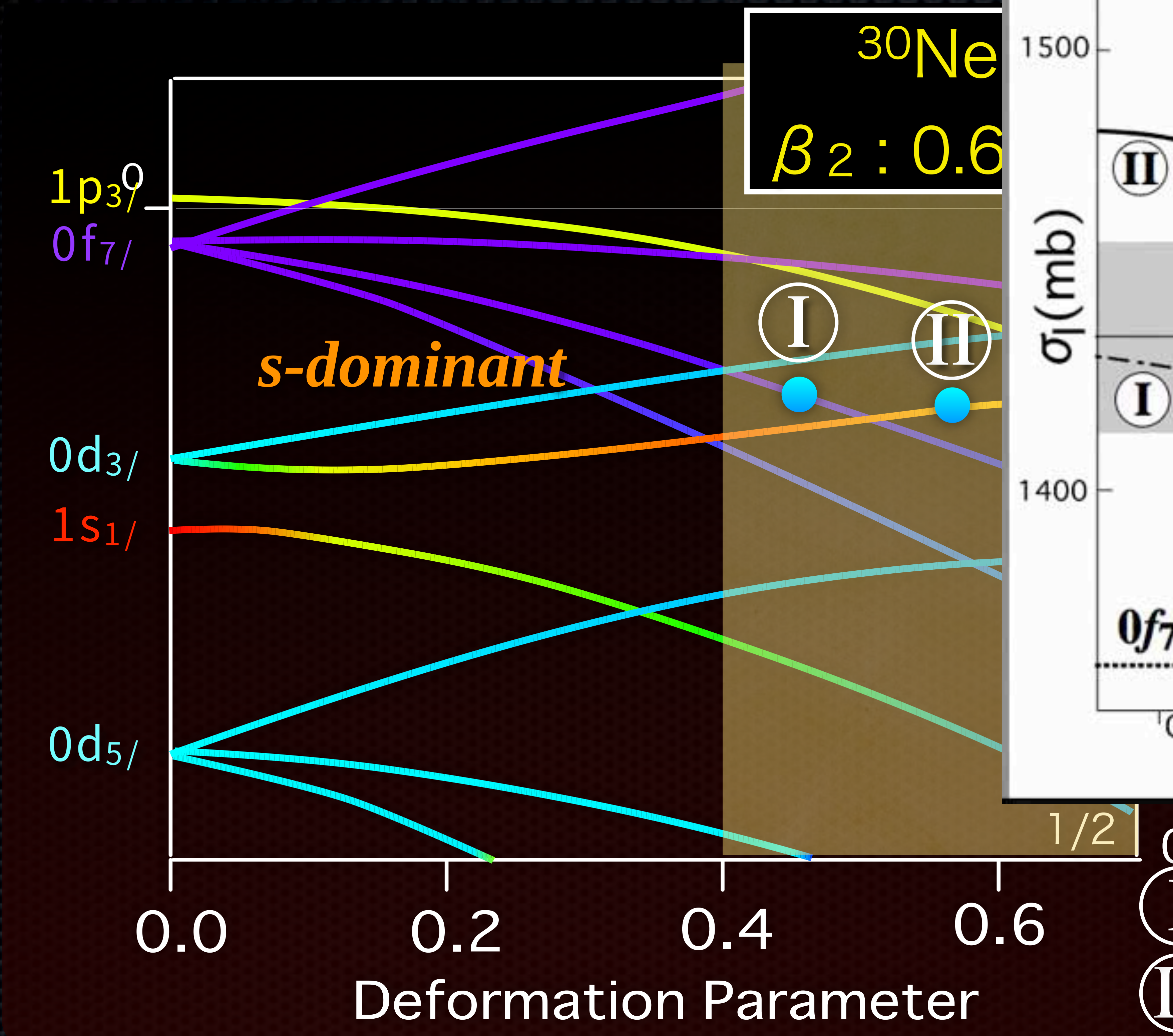


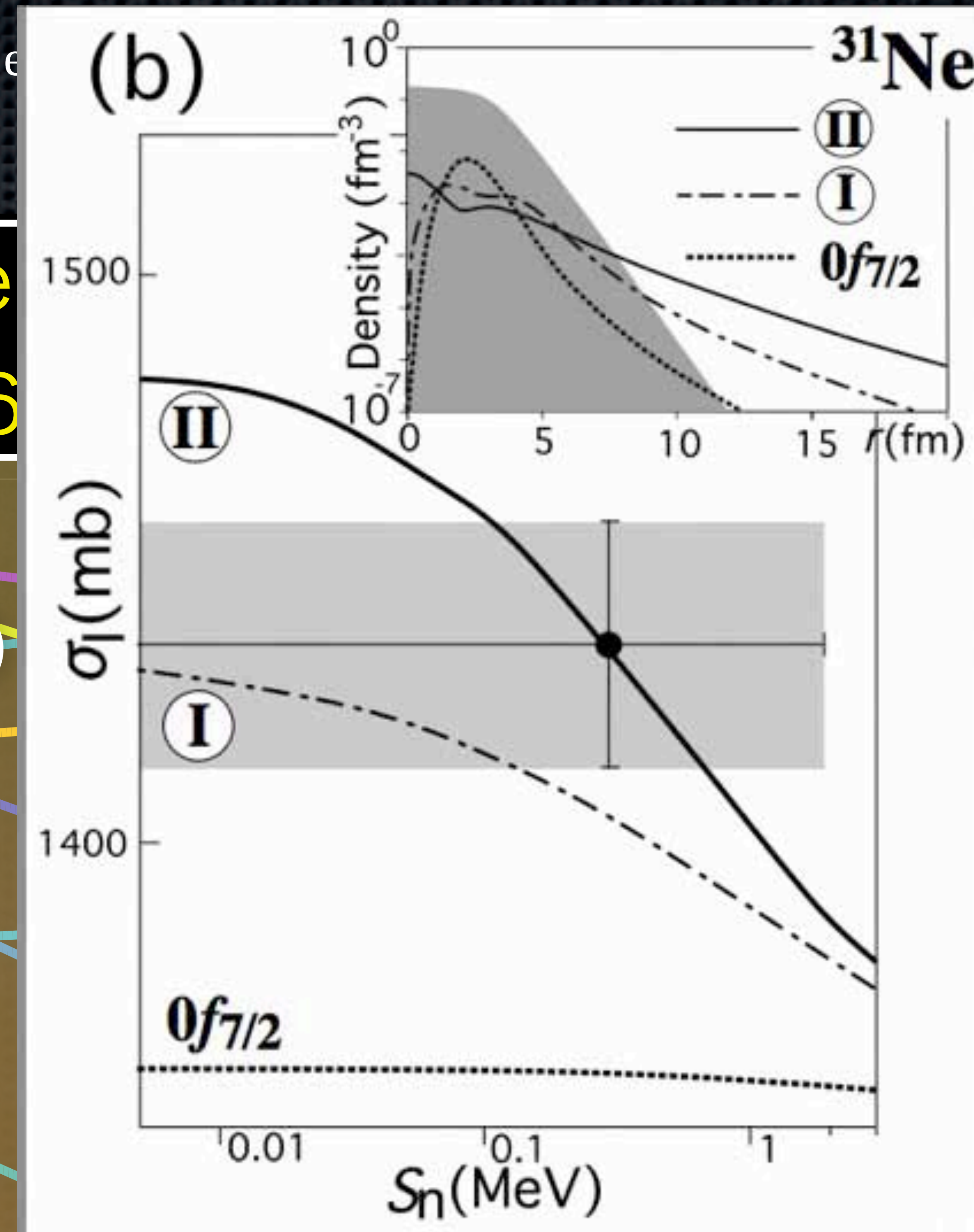
^{30}Ne : Y. Yanagisawa et al., Phys. Lett. **B 566** (2003) 84.

Halo Effect in ^{31}Ne

M. Takechi e

^{31}Ne + 1n model





I 0 $f_{7/2}$ (70%) and $1p_{3/2}$ (22%)

II $1s_{1/2}$ (82%), $0d_{3/2}$ (9%)

^{30}Ne : Y. Yanagisawa et al., Phys. Lett. **B 566** (2003) 84.

Summary

- σ_R (^{12}C) の高精度系統的測定
  →中間エネルギー領域での σ_R をGlauber+Fermi運動効果+多重散乱効果で極めて良く再現

- この解析法　→　不安定核への応用(^{17}Ne, ^{14}B)

- 陽子標的の利用→陽子分布・中性子分布の分離

- 変形核の方位異方性の観測

- RIBF における Ne, Mg 同位体の σ_R 測定