微視的模型を用いた原子核散乱反応におけるエネルギー依存性

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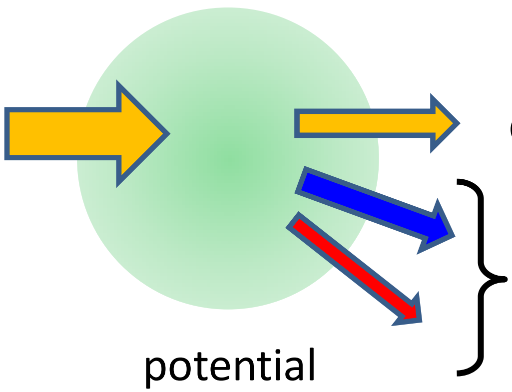
Introduction

- **Optical model potential (OMP)**

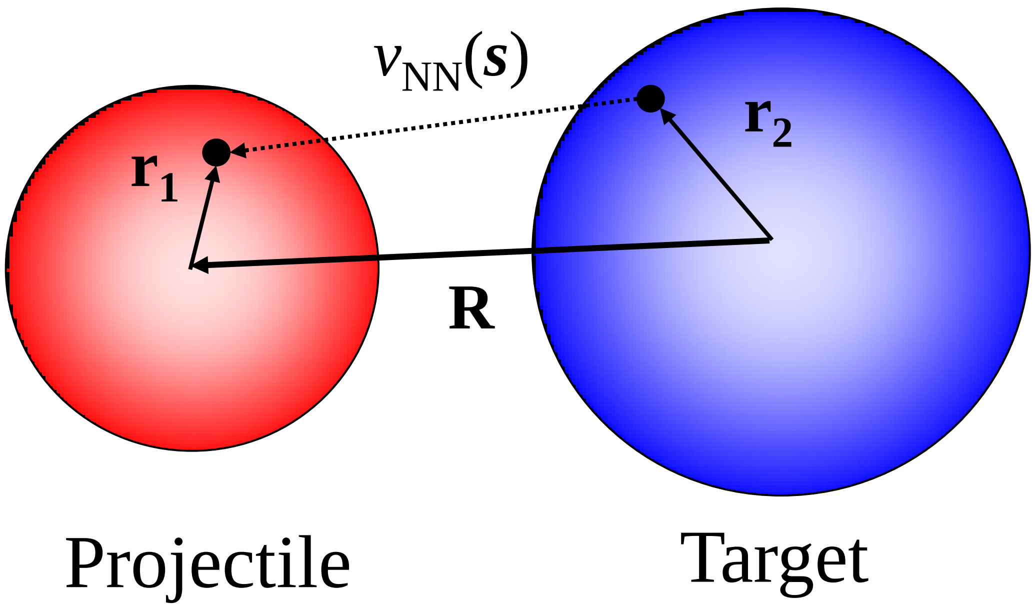
  - is complex potential

  - has the imaginary part that represents the loss of flux in elastic scattering



$$U_{opt}(r) = V(r) + iW(r)$$

Double-Folding Model (DFM)

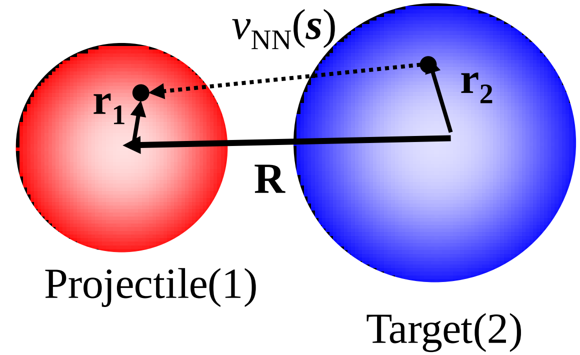


$$U_{opt}(\mathbf{R}) = \int \underline{\rho_1(\mathbf{r}_1)}\,\underline{\rho_2(\mathbf{r}_2)}\,\underline{v_{NN}(\mathbf{s};\rho,E)}\,d\mathbf{r}_1 d\mathbf{r}_2$$

nucleon density

effective *NN* interaction

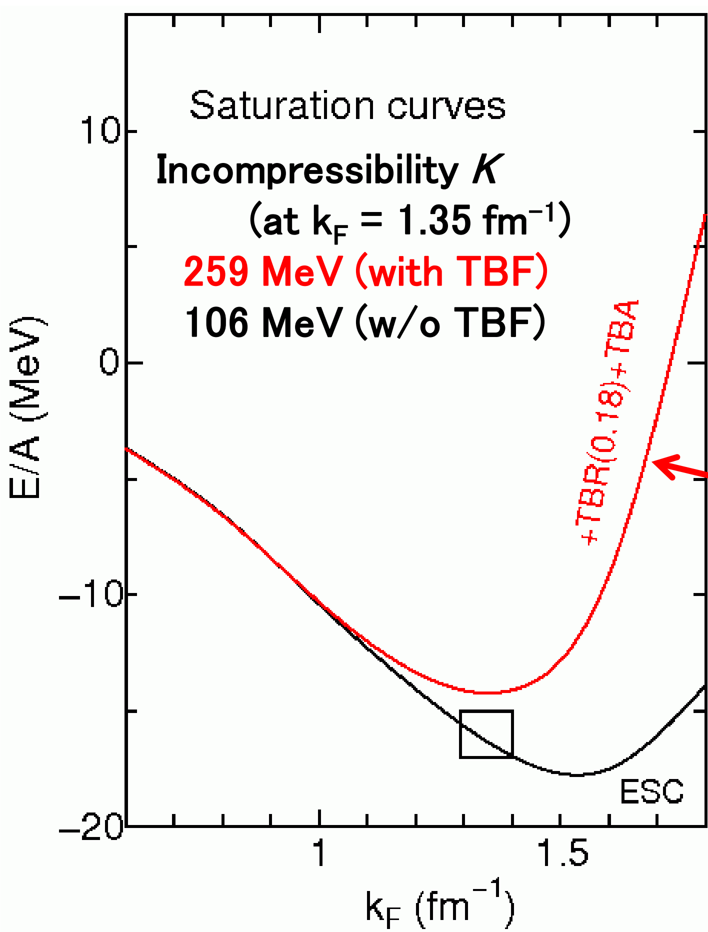
Double-Folding Model (DFM)
with complex G-matrix interaction



Folding model potential

$$U(\mathbf{R}) = V_{DFM}(\mathbf{R}) + iW_{DFM}(\mathbf{R})$$
$$= \int \rho_1(\mathbf{r}_1)\rho_2(\mathbf{r}_2)v_{NN}(\mathbf{s};\rho,E)d\mathbf{r}_1 d\mathbf{r}_2$$

Interaction
CEG07 (complex G-matrix interaction)



CEG07b (with TBF)
CEG07a (w/o TBF)

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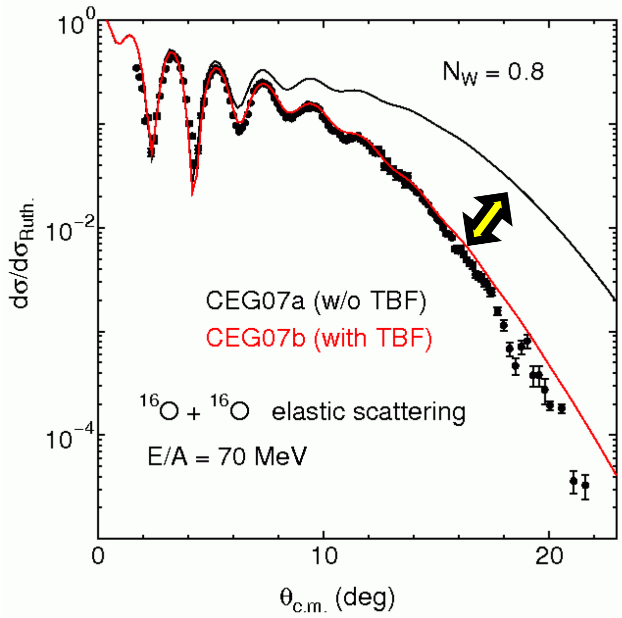
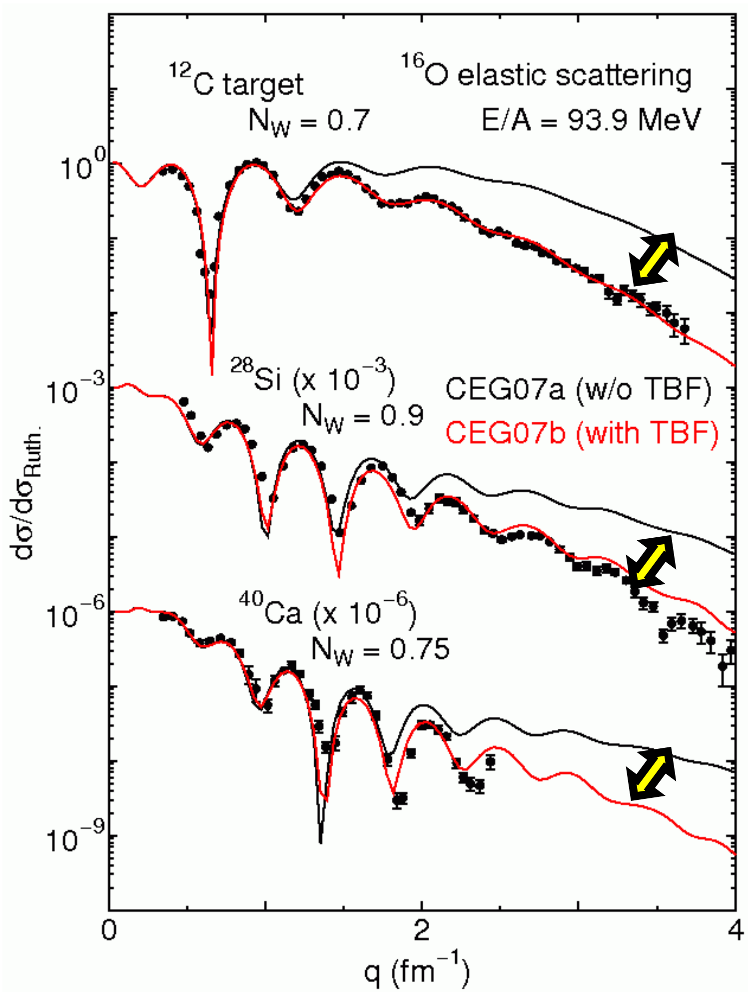
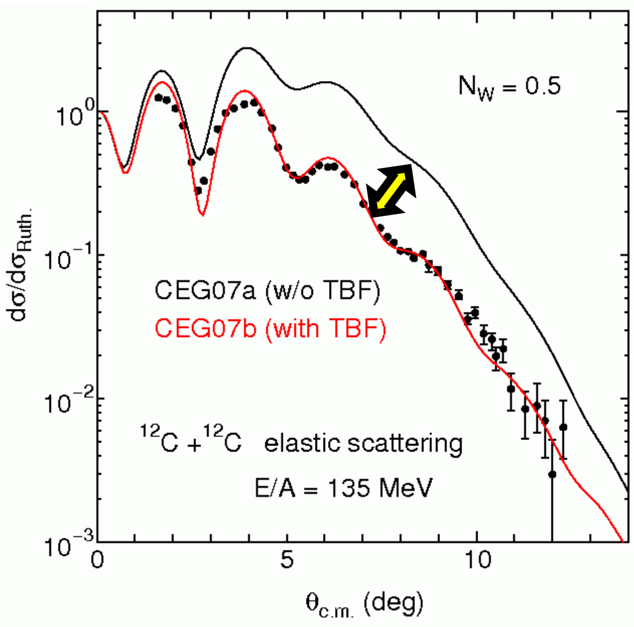
(Phys. Rev. C.79 (2009) 011601(R)), ibid. 80 (2009) 044614)

Heavy-ion elastic scattering



Important effect of three-body force





T. Furumoto, Y. Sakuragi and Y. Yamamoto,
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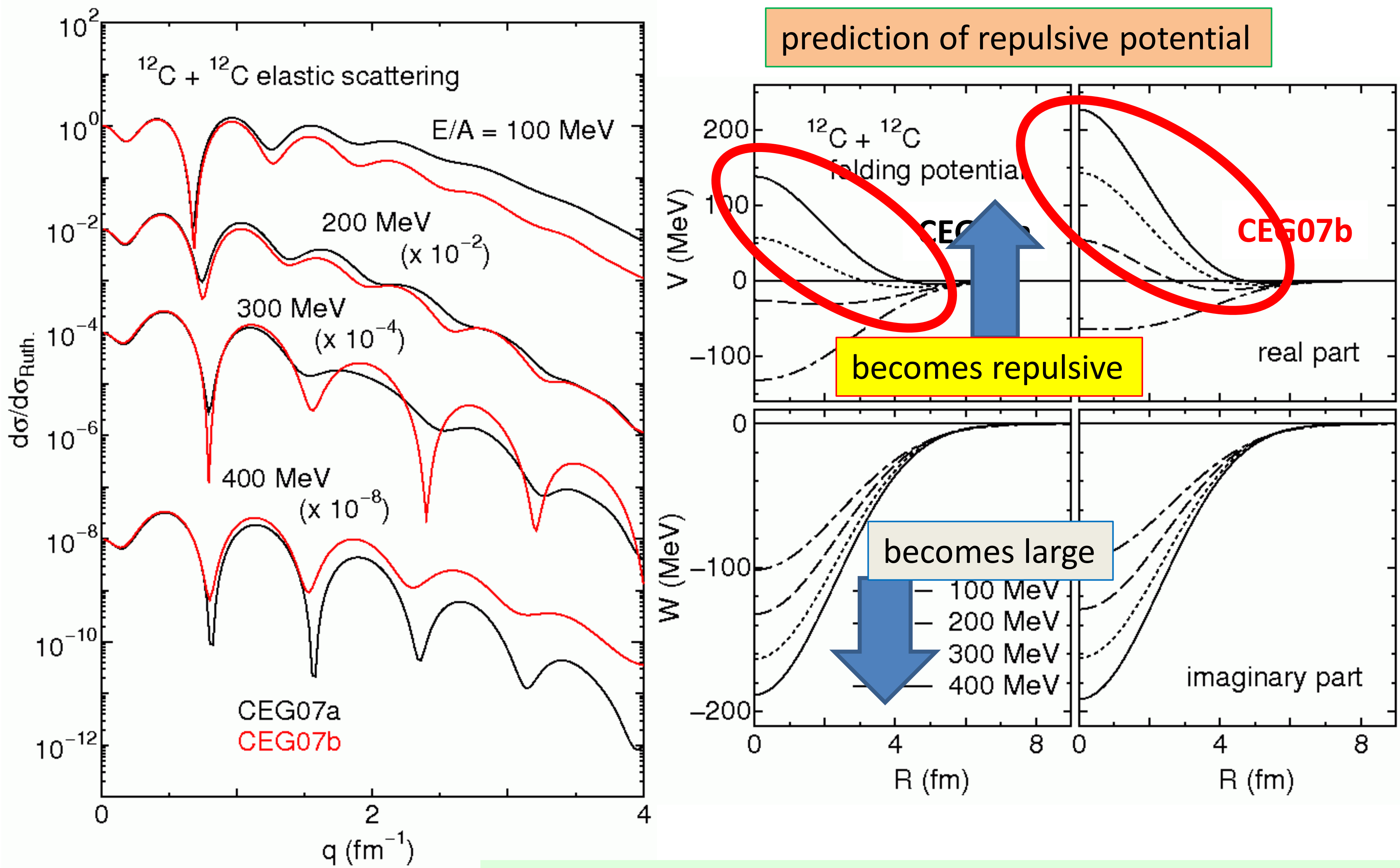
$^{12}C + ^{12}C$ elastic scattering at various energies



T. Furumoto, Y. Sakuragi and Y. Yamamoto, Phys. Rev. C82, 044612 (2010)

About repulsive potential

In general, nuclear interaction is attractive.

⇓

By several reasons, nuclear interaction becomes repulsive

- **medium effect (Pauli principle, three-body force)**
- **energy dependence**

⇓

The repulsive potential is obtained in the high-energy region.

Examples
- Dirac phenomenology (p-A, d-A)
- microscopic approach (p-A)
- phenomenological optical model analysis (α-A)

About repulsive pot

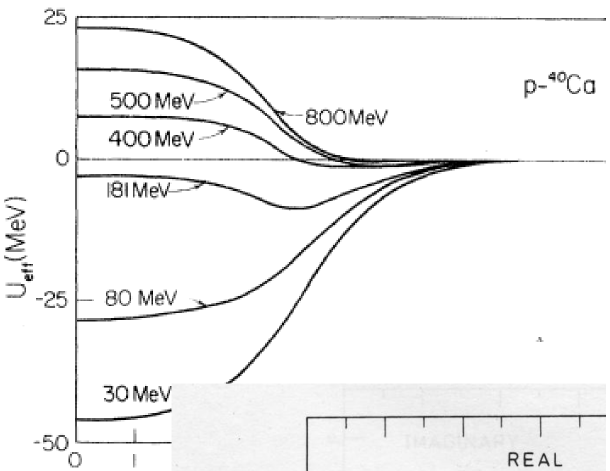


FIG. 2. The
central potential
tion based analy
ments (Refs. 1
omitted.

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Nguyen Van Sen et al. / $^{16}O(\vec{d}, d)$

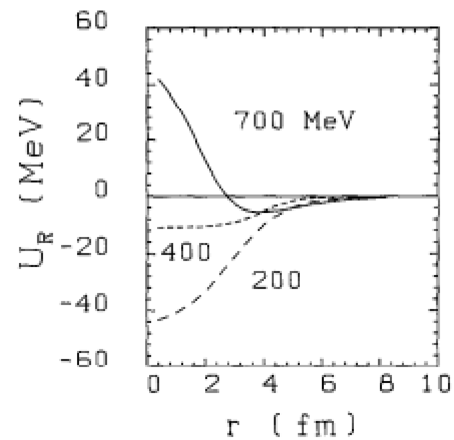
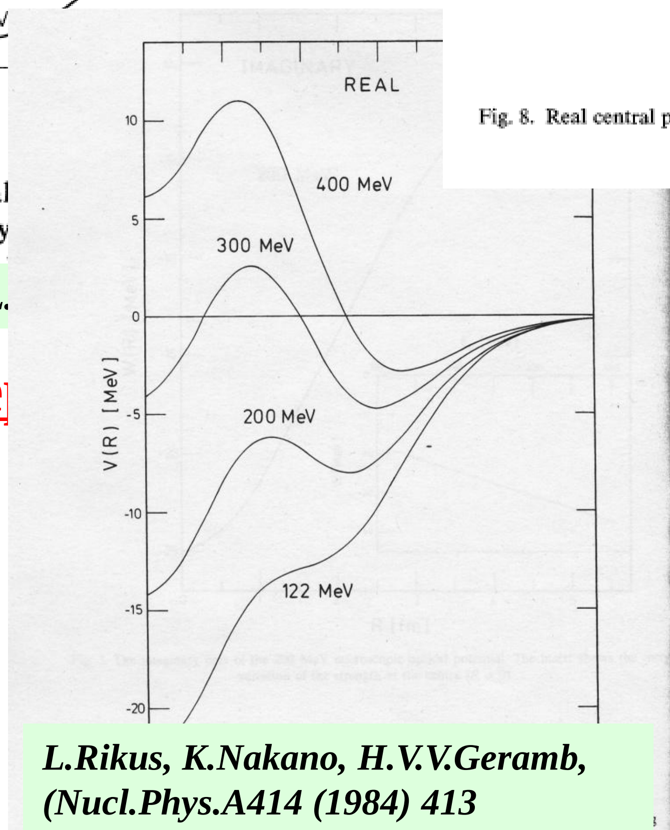


Fig. 8. Real central potential for d+^{16}O
(solid line), cal

N.V.Sen, (Nucl.Phys.A464 (1987) 717



from ^{12}C.

L.Rikus, K.Nakano, H.V.V.Geramb, (Nucl.Phys.A414 (1984) 413

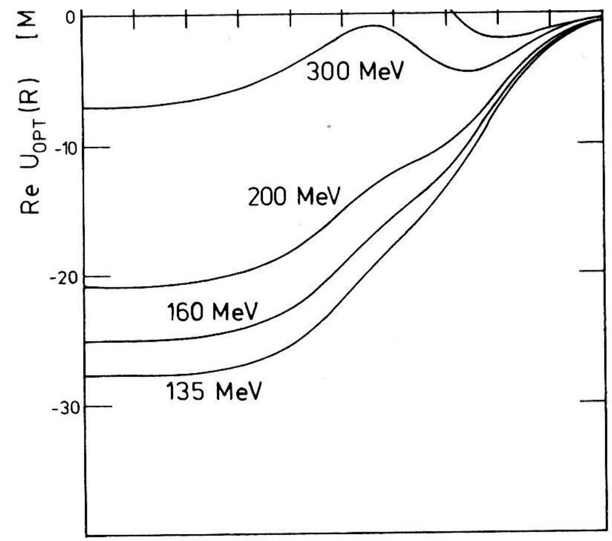


Fig.
^{208}Pb

L.Rikus, H.V.V.Geramb, (Nucl.Phys.A426 (1984) 496

The re ... ned i

d-A)

odel a

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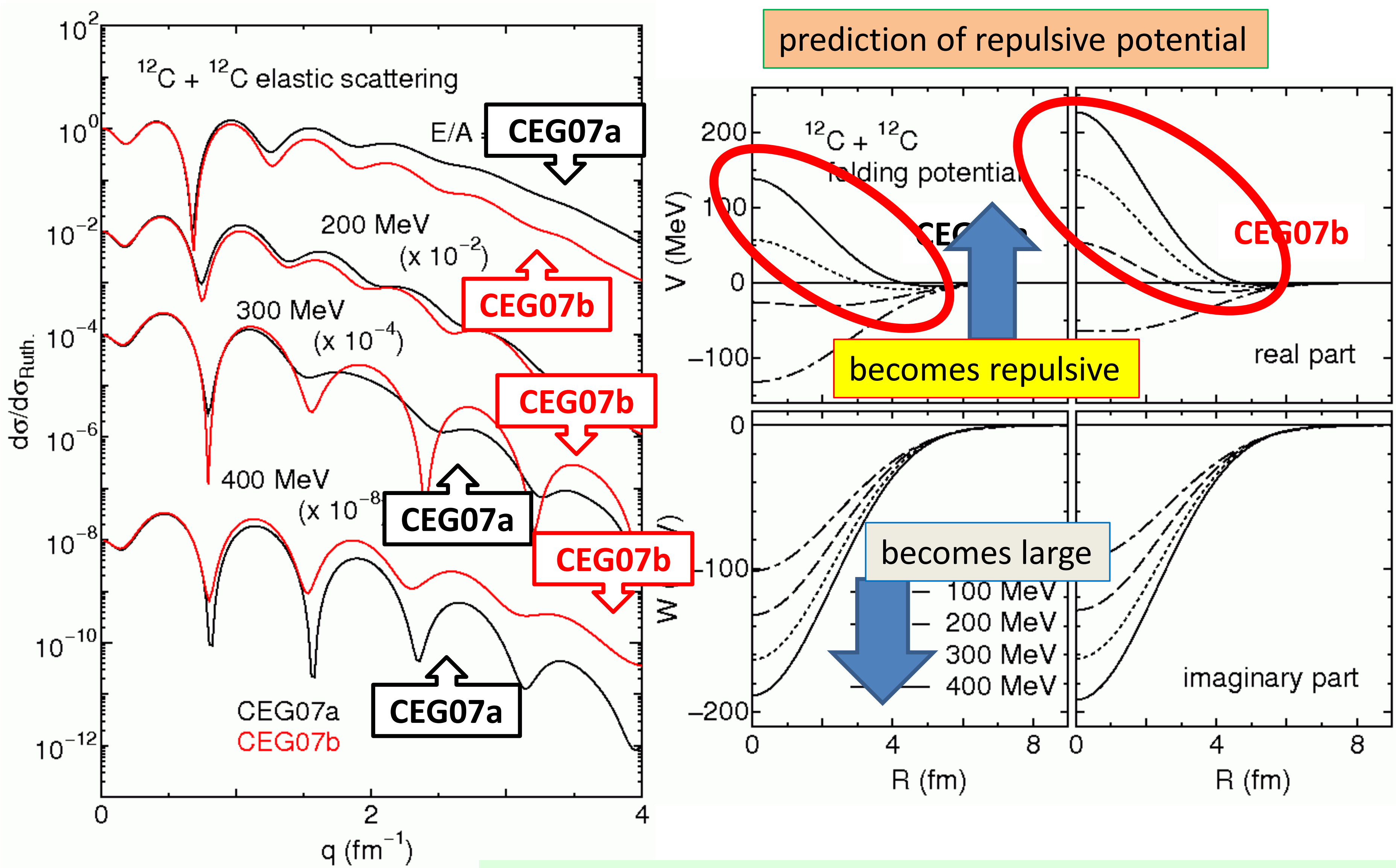

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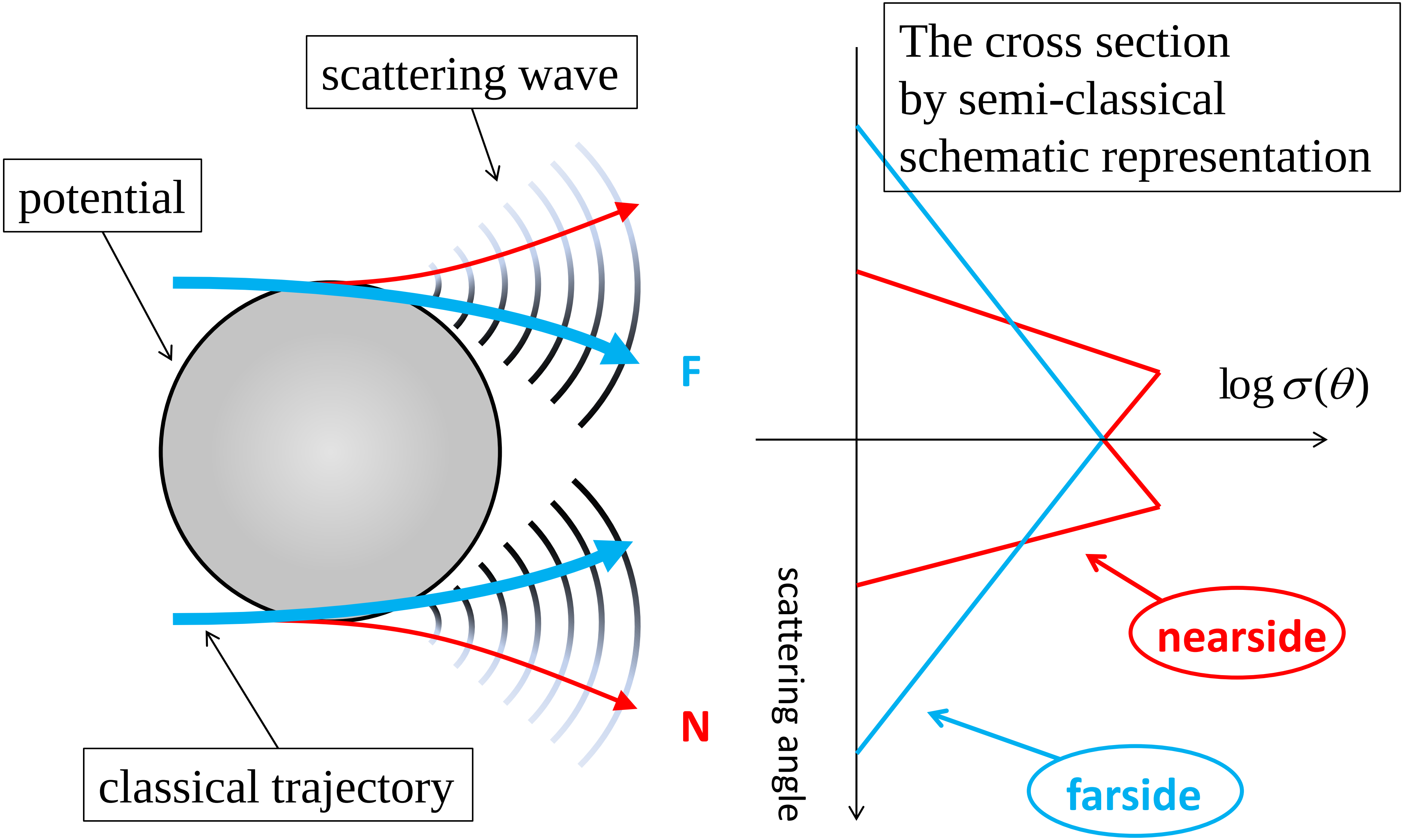
(a) Attractive potential (V < 0)



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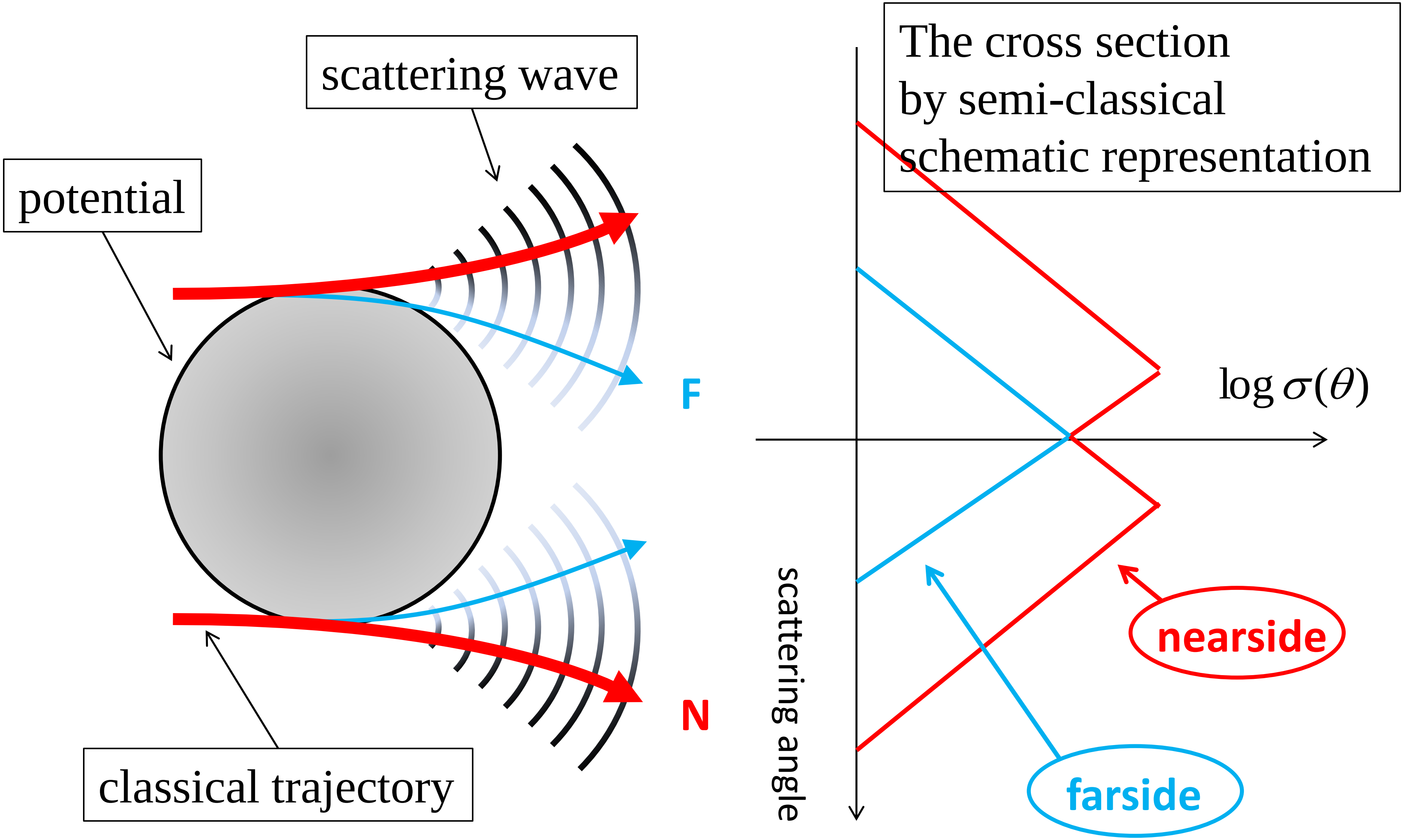
(b) Repulsive potential (V > 0)



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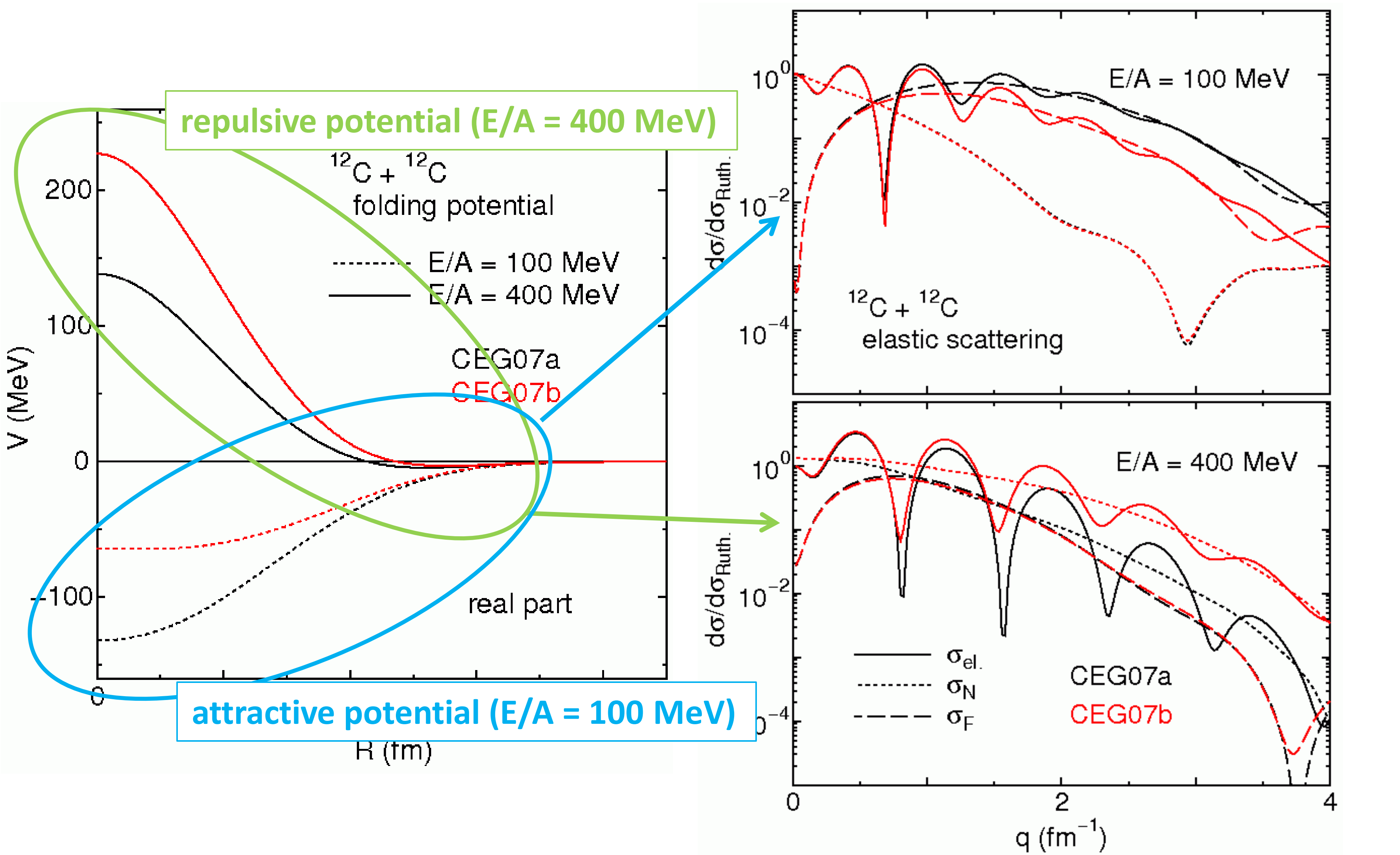
Nearside and farside (N/F) decomposition



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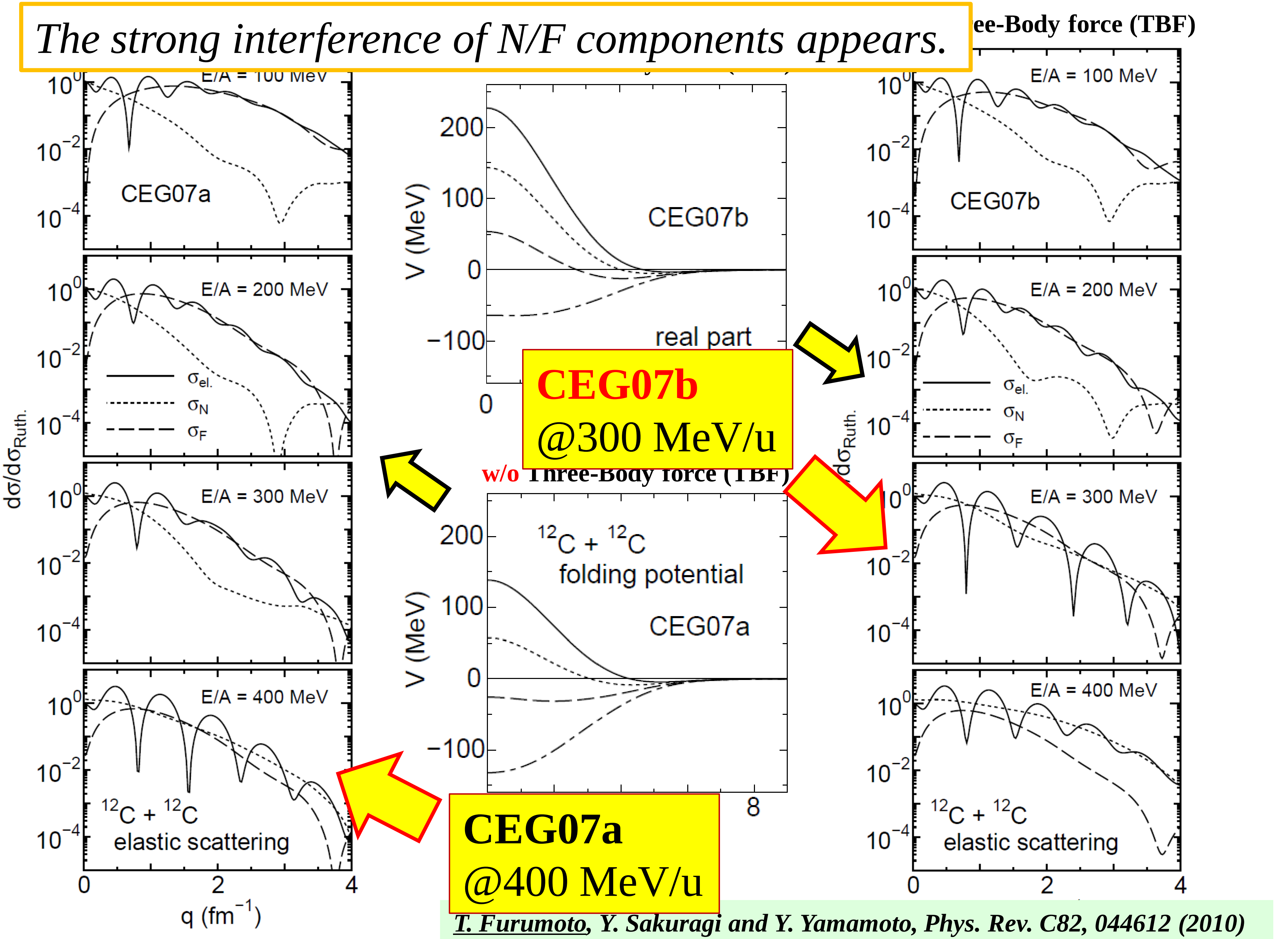
The strong interference of N/F components appears.



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Next step

- **Inelastic cross section**

  → Today

- **<u>Dynamical coupling effect</u> to elastic cross section**

  → JPS meeting (19pSF-4)

Microscopic Coupled Channel (MCC) with CEG07

Coupled Channel equation

$$\left[T_R + V_{\alpha\alpha}(R) - E_\alpha\right]\chi_\alpha(R) = -\sum_{\beta\neq\alpha}^{N} V_{\alpha\beta}(R)\,\chi_\beta(R)$$

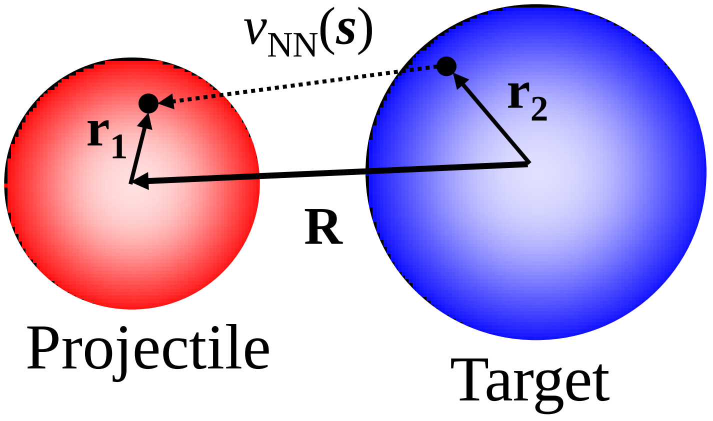
The diagonal and coupling potentials are derived from microscopic view point.

$$V_{\alpha\beta}(R) = \int \underline{\rho_{\alpha\beta}^{(P)}(r_1)}\,\underline{\rho_{\alpha\beta}^{(T)}(r_2)}\,\boxed{v_{NN}(\mathbf{s};\rho,E)}\,dr_1 dr_2$$

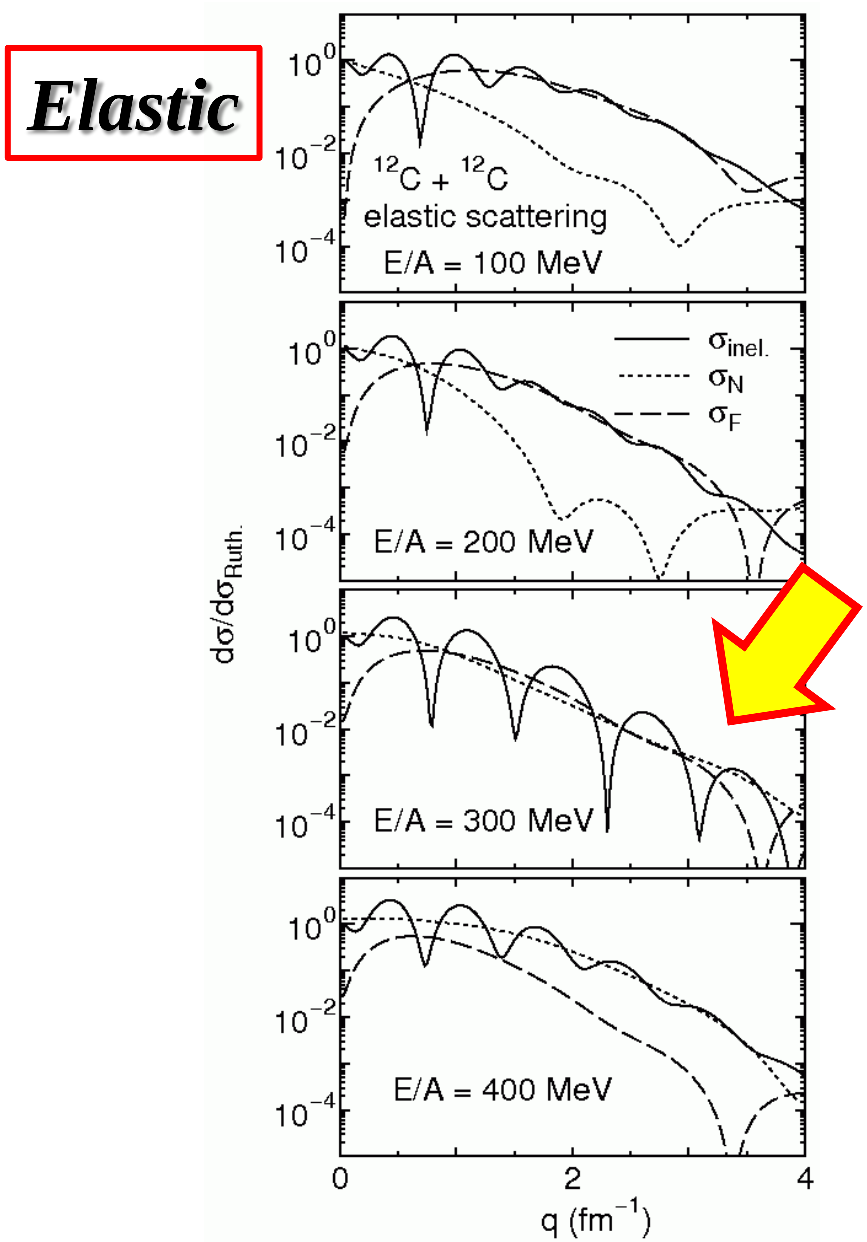
transition density CEG07

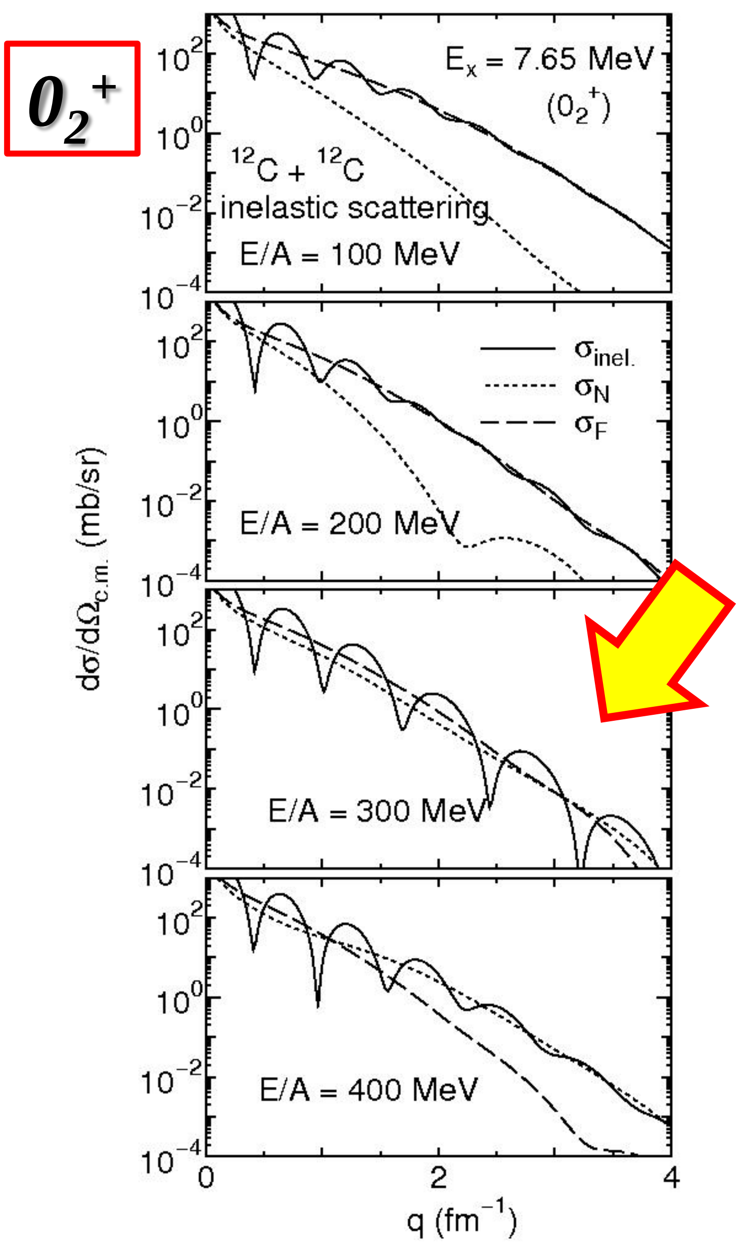
Transition density

$$\underline{\rho_{ik}(\vec{r})} = \left\langle \varphi_i(\xi) \middle| \sum_i \delta(\vec{r}_i - \vec{r}) \middle| \varphi_k(\xi) \right\rangle$$

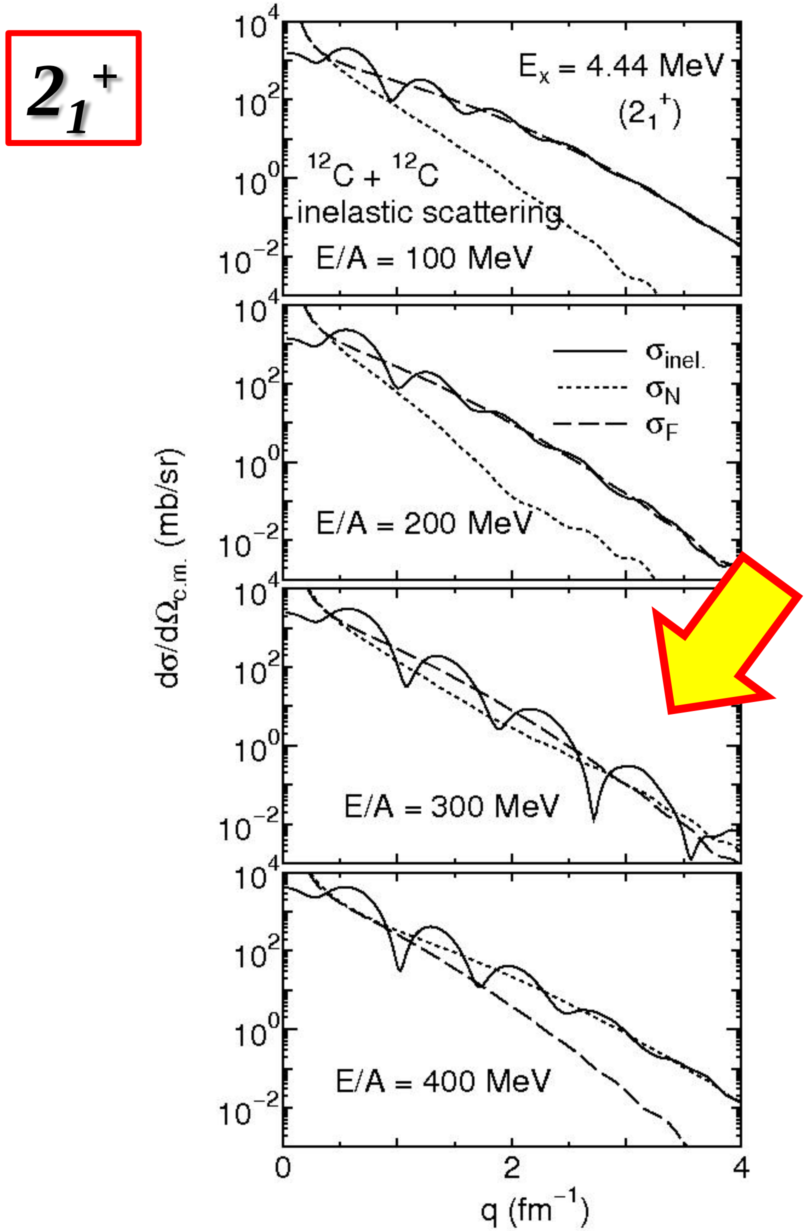


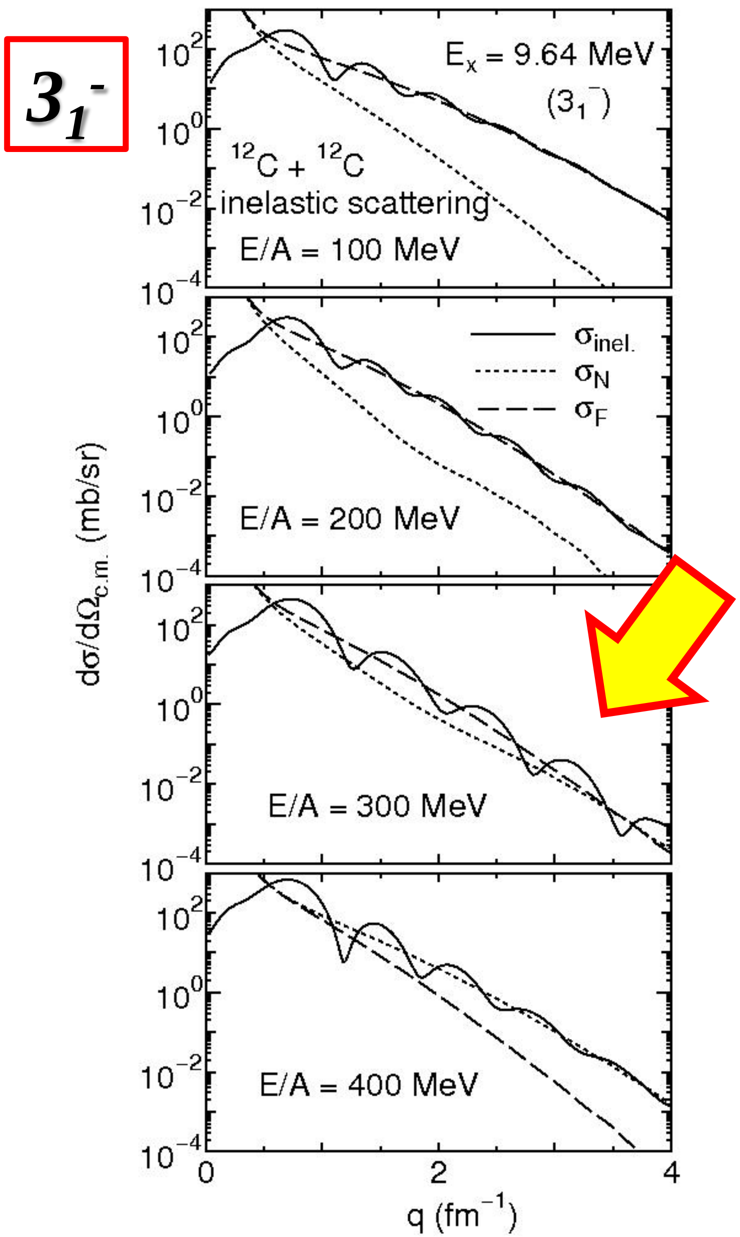
$^{12}C + ^{12}C$ elastic and inelastic scatterings at various energies





^{12}C + ^{12}C inelastic scatterings at various energies





Summary

CEG07 folding model predicts the repulsive nuclear potential at high energy region (E/A = 300 - 400 MeV).

It is first survey that the repulsive potential for heavy-ion system is derived from the microscopic view point.

Property of nuclear repulsive potential

- The nearside becomes large and the farside becomes small around backward angles **by not Coulomb potential but nuclear potential**.
- **The strong interference** appears at a certain energy by repulsive shift of nuclear potential in energy evolution.