CALCULATIONS OF THE K^+-NUCLEUS MICROSCOPIC OPTICAL POTENTIAL AND OF THE CORRESPONDING DIFFERENTIAL ELASTIC CROSS SECTIONS

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Relativization approach for K^+ + A scattering

- k(0.8 GeV/c) > m_{K+}(0.494 GeV)
- The semi-relativistic wave equation

$$(\Delta + k^2)\psi(\mathbf{r}) = 2\mu\gamma_r U(r)\psi(\mathbf{r})$$

- k – relativistic momentum in c.m. system
- γ_r – relativistic correction factor

Microscopic optical potential (OP)

The microscopic OP corresponds to optical limit of the Glauber theory

$$U^H = V^H + iW^H = -\frac{\hbar v}{(2\pi)^2} \sum_{\nu=p,n} \bar{\sigma}_K^\nu (\bar{\alpha}_K^\nu + i) \int_0^\infty dq\, q^2 j_0(qr) \rho_\nu(q) f_K^\nu(q)$$

- β=k/E - relative velocity in the system
- σ_K – the KN total cross section
- α_K=Re $F_K(0)$/Im $F_K(0)$ – with F_K – the KN amplitude
- $\rho(q)$ – nuclear form factor

The K$^+$N scattering amplitude

The K$^+$N scattering amplitude is parameterized as follows

$$F_K^\nu(q) = \frac{k\sigma_{tot}^\nu}{4\pi}(i + \alpha_K^\nu) f_K^\nu(q)$$

$$f_K^\nu(q) = \exp(-\beta_\nu q^2/2)$$

In the case of k^{lab}=0.8 GeV/c one has

$$\beta_p = 0.01\ fm^2, \qquad \sigma_K^p = 1.32\ fm^2, \quad \alpha_K^p = -1.31$$
$$\beta_n = 0.00135\ fm^2, \qquad \sigma_K^n = 1.7\ fm^2, \quad \alpha_K^n = -0.323$$

Input values for K^+(0.8 GeV/c) + ^{12}C,^{40}Ca

Relativistic momentum in c.m. system

$$k = \frac{m_2 k^{lab}}{\sqrt{(m_1 + m_2)^2 + 2 m_2 T^{lab}}}$$

Correlation factors

$$\gamma_r^I = \frac{k^2}{(W - m_2)^2 - m_1^2} \frac{W - m_2}{\mu}$$

Ingemarsson, 1974

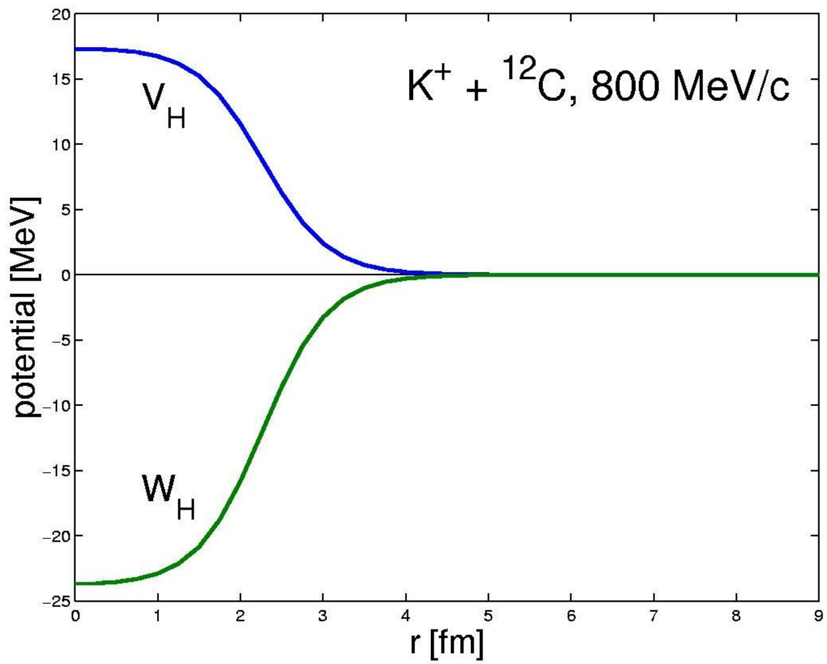
$$\gamma_r^{II} = \frac{k}{v} \frac{1}{\mu}$$

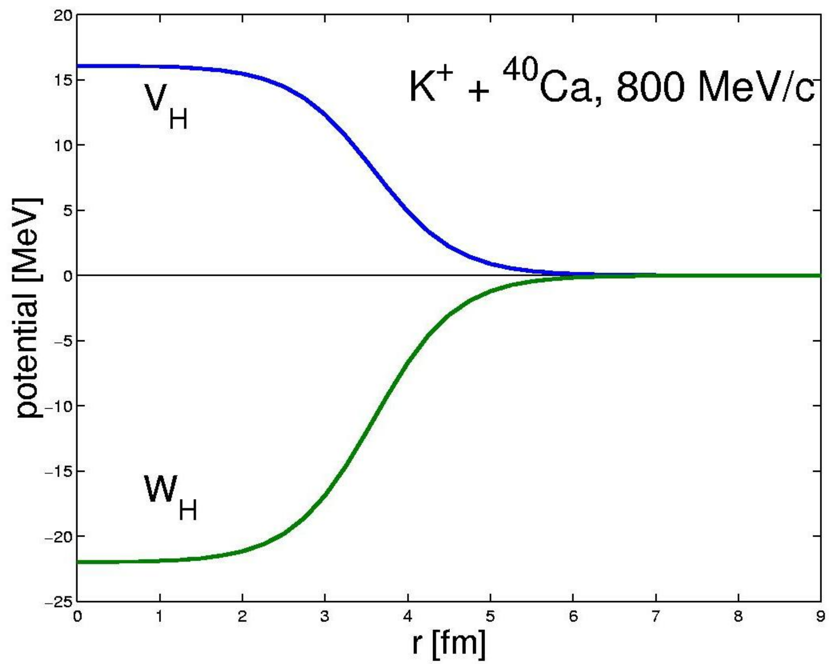
Faldt, Ingemarsson, Mahalanabis, 1992

$$\gamma_r^{III} = \frac{W - m_2}{W} \frac{m_2}{\mu}$$

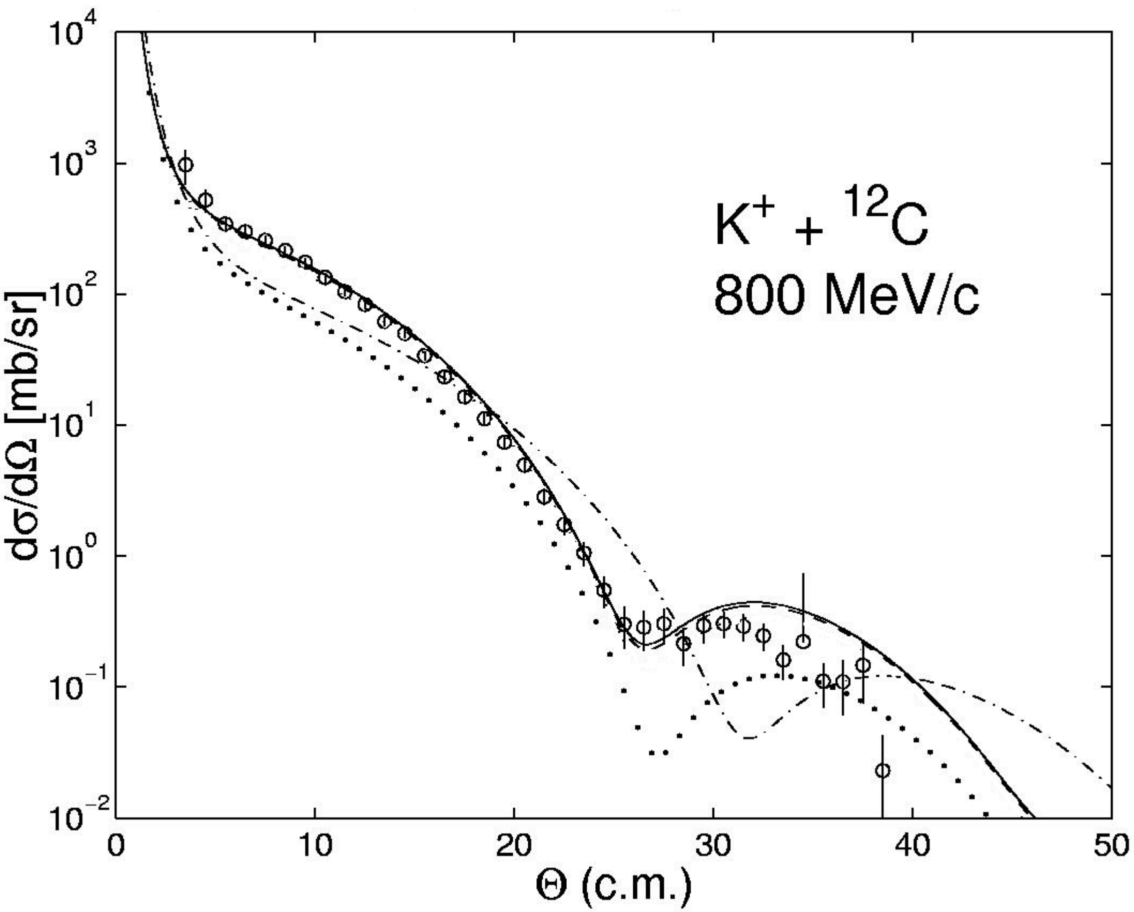
Goldberger, Watson, 1964

Calculated microscopic OP (at γ_r=1)





Differential elastic cross sections $K^+ + {}^{12}C$ (0.8 GeV/c)



$\gamma^{II}=1.838$

$\sigma^{tot}=131.8$ mb

$\gamma^{I}=\gamma^{III}=1.787$

$\sigma^{tot}=129.3$ mb

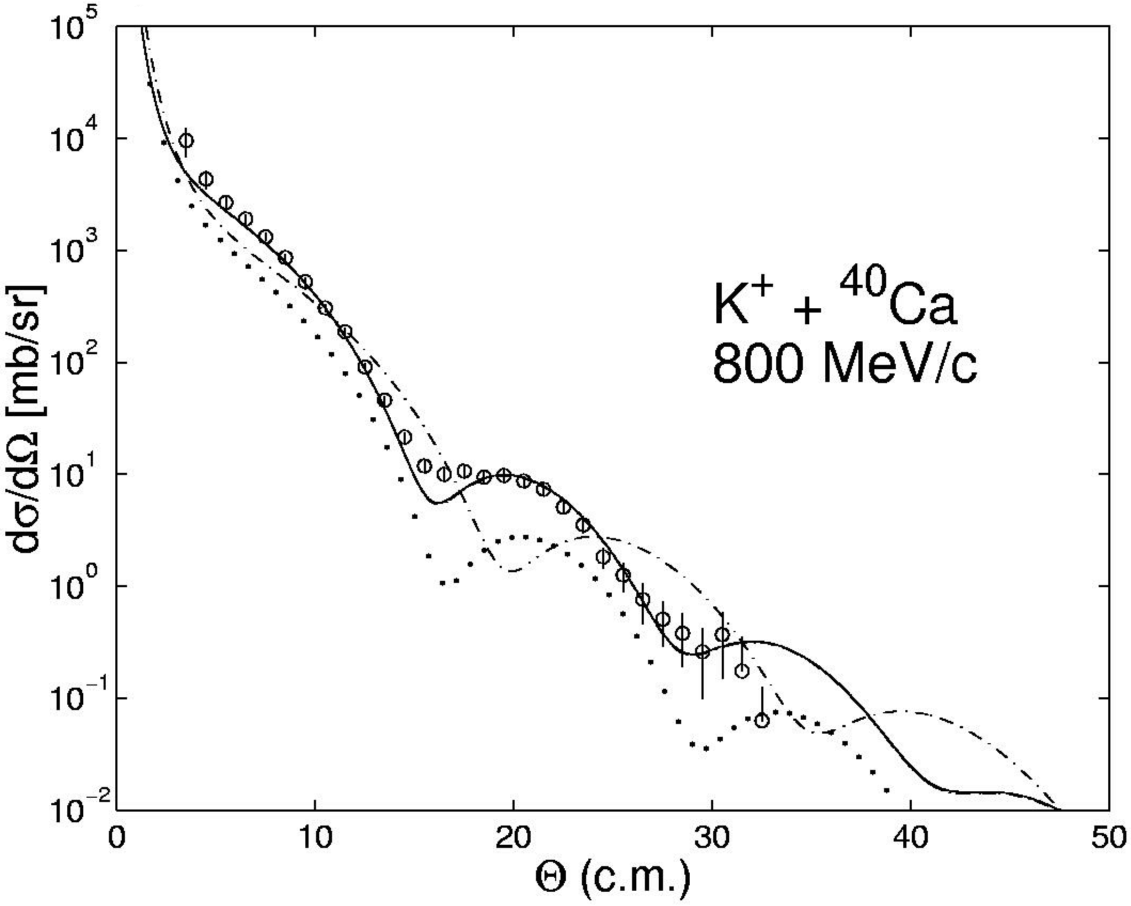
$\gamma=1$

$\sigma^{tot}=83.9$ mb

non-relativistic

$\sigma^{tot}=94.3$ mb

Differential elastic cross sections $K^+ + {}^{40}Ca$ (0.8 GeV/c)



— $\gamma^{II}=1.88$ $\sigma^{tot}=367.0$ mb

- - - $\gamma^{I}=\gamma^{III}=1.863$ $\sigma^{tot}=365.1$ mb

...... $\gamma=1$ $\sigma^{tot}=244.2$ mb

-·— non-relativistic $\sigma^{tot}=274.6$ mb

Conclusions

- The relativistic effects begin to be important at 0.8GeV/c to get agreement with experimental data
- There are no free parameters whereas the used one are taken from independent experimental data
- It is not necessary to include the “in-medium” corrections of K^+N scattering amplitude at 0.8 GeV/c
- The method is proved to be a workable one for **K^++A** scattering calculations