Optical model potential (real part)

Optical model potential (OMP) is a complex function depending usually on the distance between colliding nuclei. In the "Nuclear transfer reaction" section of NRV project the real part of the OMP can be treated in the following forms:

1. **Woods-Saxon (volume)** form:

$$V(r) = \frac{V_0}{1 + \exp\left[\dfrac{r - R_V}{a_V}\right]},$$

where $V_0 < 0$ is the depth of the potential, $R_V = r_V A_T^{1/3}$ is its radius, A_T is the target mass number, and a_V is the diffuseness of the OMP.

2. **Woods-Saxon (surface)** form:

$$V(r) = -4a_D V_D \frac{d}{dr} \frac{1}{1 + \exp\left[\dfrac{r - R_D}{a_D}\right]},$$

where $V_D < 0$ is the depth of the potential, $R_D = r_D A_T^{1/3}$ is its radius, and a_D is the diffuseness of the OMP.

3. **Superposition form** is a sum of the volume and surface Woods-Saxon potentials.

4. **Proximity** potential [1]:

$$V(r) = 4\pi\gamma b \bar{R}_{12} \Phi(s)$$

where surface tension $\gamma = 0.95\left[1 - 1.7826\ I^2\right]$ MeV fm^{-2}, $I = (N - Z) / A$ is the isospin, $b \approx 1$ fm is the thickness parameter of nuclear surface, $\bar{R}_{12} = R_P R_T / (R_P + R_T)$ is the local nuclear surface curvature, $R_{P,T} = r_0 A_{P,T}^{1/3}$ is the target (T) or projectile (P) nucleus radius, parameter r_0 for each nucleus can be defined in the subsection "*Reaction*". The function $\Phi(s)$ is universal dimensionless form-factor tabulated in [1]. In the NRV project the function $\Phi(s)$ is defined in the following form

$$\Phi(s) = \begin{cases} -1.7817 + 0.927s + 0.143s^2 - 0.095s^3, & s \le 0, \\ -1.7817 + 0.927s + 0.01696s^2 - 0.05148s^3, & 0 \le s \le 1.9475, \\ -4.41\exp(-s / 0.7176), & s \ge 1.9475, \end{cases}$$

where the parameter $s = r - R_P - R_T$.

5. **Coulomb** potential is treated as the Coulomb interaction of the point-charge and uniformly charged sphere of radius $R_C = r_C A_T^{1/3}$:

$$V_C(r) = Z_1 Z_2 e^2 \begin{cases} \dfrac{1}{r}, & r > R_C, \\ \dfrac{1}{2R_C}\left(3 - \dfrac{r^2}{R_C^2}\right), & r \le R_C. \end{cases}$$

[1] Blocki, J. et al. Proximity forces. Ann. Phys. (N.Y.). 1977. Vol. 105. pp. 427 – 462.