The Lippmann-Schwinger equation reads

$$\psi_k(x) = \phi_k(x) + \int dx' \ G_0(x,x')V(x')\psi_{k'}(x'), \tag{1}$$

where (cf. previous document)

- ψ is the *exact* wavefunction whereas ϕ is the eigensolution of H_0;
- a whole set of quantum numbers defining the states should be put: for the moment we have put only k, k' to label the relative motion, but later we will put back quantum numbers for the nuclei;
- accordingly, x, x' should be a set of coordinates for the nuclei and their relative motion.

This leads to the scattering amplitude

$$f(\theta) = -\frac{m}{2\pi\hbar^2}\int dx'\phi_{k'}(x')V(x')\psi_k(x'). \tag{2}$$

In the case of elastic scattering, the internal degrees of freedom can be integrated out, and

$$f(\theta) = -\frac{m}{2\pi\hbar^2}\int d_3r' e^{-i\vec{k}'\cdot\vec{r}'}V(\vec{r}')\psi_k(\vec{r}'). \tag{3}$$

The cross section is

$$\frac{d\sigma}{d\Omega} = |f(\theta)|^2. \tag{4}$$

(One should remember that this is only true for elastic scattering, while in the general case a factor k_f/k_i must be introduced).
Common approximations to the exact expression for the scattering amplitude are briefly enumerated.

- Born approximation means first-order approximation in the potential V. That is, ψ_k is replaced by ϕ_k;
- if the relative motion is treated by means of plane waves we have the plane-wave Born approximation (PWBA);
- an alternative choice is when H_0 includes part of the interaction (an optical potential U). Then the relative motion part of the wavefunction is a "distorted wave" χ. The potential V must become $V - U$. This is called distorted wave Born approximation (DWBA).