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EP20B012

Assignment I — July-Nov 2022

Due date: August 10th, in class

Contents

1 Problem 1

Fermi's golden rule:- The rate at which the scattering occurs will be proportional to the matrix element squared $\left|V'_{if}\right|^2$

$$V'_{if} = \int \psi_f^* V(r) \psi_i d\tau$$

Given,

$$\psi_f = e^{(i\bar{k_f}.\bar{r})}$$

$$\psi_i = e^{(i\bar{k_i}.\bar{r})}$$

Potential V(r) is,

$$V(r) = -\frac{Ze^2}{4\pi\epsilon_o} \int \frac{\rho_e(r')}{\left|\bar{r} - \bar{r'}\right|} d\tau'$$

$$V'_{if} = \int (e^{(-i\bar{k_f}.\bar{r})})(e^{(i\bar{k_i}.\bar{r})}) \left(-\frac{Ze^2}{4\pi\epsilon_o} \int \frac{\rho_e(r')}{\left|\bar{r} - \bar{r'}\right|} d\tau' \right) d\tau$$

$$V'_{if} = -\frac{Ze^2}{4\pi\epsilon_o} \int e^{i\bar{q}.\bar{r}} \left(\int \frac{\rho_e(r')}{\left|\bar{r} - \bar{r'}\right|} d\tau' \right) d\tau \quad (\because \bar{q} = \bar{k_i} - \bar{k_f})$$

multiplying with $e^{+i\bar{q}.\bar{r'}}$ and $e^{-i\bar{q}.\bar{r'}}$ and writing $\bar{r} - \bar{r'} = \bar{R}$ also, $\bar{R} = \bar{r} - \bar{r'} \rightarrow dR = dr$

$$V'_{if} = -\frac{Ze^2}{4\pi\epsilon_o} \int e^{i\bar{q}.\bar{R}} \left(\int \frac{\rho_e(r') e^{i\bar{q}.\bar{r'}}}{\left|\bar{R}\right|} d\tau' \right) d\tau$$

Form Factor, $F(\bar{q}) = \int \rho_e(r') e^{i\bar{q}.\bar{r'}} d\tau'$

$$V'_{if} = -\frac{Ze^2}{4\pi\epsilon_o} \int \frac{e^{i\bar{q}.\bar{R}}}{\left|\bar{R}\right|} F(\bar{q}) d\tau$$

2 Homework 1.2

3 Homework 1.3