Intrumentation for Characterization of Nanomaterials

3. Elastic Scattering

Problems

3.1. Find expressions for the intensities $I(\mathbf{r}) = |\psi(\mathbf{r})|^2$ of the wave functions below.

($\mathbf{k}$, $\mathbf{K}$, and $\mathbf{r}$ are real):

a) $\psi(\mathbf{r}) = A e^{2\pi i \mathbf{k} \cdot \mathbf{r} + i\phi}$, ($A$, ϕ real)

b) $\psi(\mathbf{r}) = i \cdot \cos(\theta) \cdot \dfrac{e^{2\pi i k r}}{r}$, [$\theta$ is real]

c) $\psi(\mathbf{r}) = e^{2\pi i \mathbf{k} \cdot \mathbf{r}} e^{-\mathbf{K} \cdot \mathbf{r}/2}$

d) $\psi(\mathbf{r}) = \dfrac{2}{5} \cdot e^{2\pi i \mathbf{k} \cdot \mathbf{r}} + i \cdot \dfrac{\sqrt{21}}{5} \cdot e^{-2\pi i \mathbf{k} \cdot \mathbf{r}}$

3.2. The following problems involve cross sections for some object at scattering angle θ ($0 \le \theta \le \pi$):

a) Given $d\sigma/d\Omega = A \cdot \cos^4 \theta$, find an expression for $\sigma_<(\theta)$.

b) Given $\sigma_<(\theta) = \sigma_{tot} \cdot \left[1 - \cos(\theta/2)\right]$, find an expression for $d\sigma/d\Omega$.