6. Electron Lenses

Problems

6.1. Consider an objective lens with spherical aberration coefficient $C_s = 1.52$ mm and a semi-angle of collection $\beta = 6.1$ mrad acting on electrons with energy 200. KeV.

a) What is the diffraction limit δ_d on the resolution?

b) What is the spherical-aberration limit δ_s on the resolution?

c) What is the *combined* resolution limit δ_{net}, including both diffraction and spherical aberration?

d) What is the *optimal* semi-angle of collection β_{opt} of the lens?

e) What is the *practical* resolution δ_{min} of the lens?

6.2. Find the net force on charge $q = -2.0$ nC with velocity $\mathbf{v}$ and magnetic field $\mathbf{B}$ given by:

a) $\mathbf{v} = (0.54c)\hat{\mathbf{z}}$, $\mathbf{B} = (0.90\ \text{T})\hat{\boldsymbol{\rho}} + (6.2\ \text{T})\hat{\mathbf{z}}$;

b) $\mathbf{v} = (0.0134c)\hat{\boldsymbol{\phi}} + (0.54c)\hat{\mathbf{z}}$, $\mathbf{B} = (6.2\ \text{T})\hat{\mathbf{z}}$

Recall that $c = 3.00 \times 10^8$ m/s. Also $1\ \text{T} = 1\ \text{N}/(\text{A}\cdot\text{m})$.

6.3. A cylindrical magnetic lens has uniform field along the lens axis ($-a \le z < a$), with no field extending outside the bore. The strength of the lens is given by $ka = 3\pi/13$. Assume $a = 1.00$ cm. Find:

a) the focal length f (in cm).

b) the rotation angle $2\phi(a)$ [in deg (°)] of the image with respect to the object ($0 \le 2\phi(a) < 360°$).