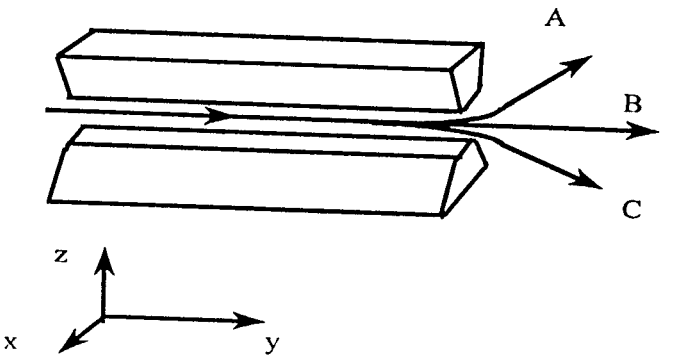
QM7a11988

A beam of particles, each with total angular momentum $J = 1$, travels along the y-axis and enters an inhomogeneous magnetic field (as in a Stern-Gerlach device) that has its field and field gradient along the z-axis as shown. Three beams of particles emerge.



A) The particles in the incident beam have been prepared in a single quantum state such that the intensities of the emerging beams are in the ratio A:B:C=1:2:1. Based on this information, what can be said about the incoming beam, stated in terms of eigenkets $|J,m_j\rangle$ of J^2 and J_z?

B) Beam B [undeviated in part (A)] is passed through a second Stern-Gerlach device whose field is along the x-axis and whose field strength increases along the positive x-axis. Determine the relative intensity of all emerging beams and specify the quantum state of each. (Assume that the gyromagnetic ratio of the particles is positive.)

Possibly useful information:

$$J_{\pm}|J,m_j\rangle = \sqrt{(J \mp m_j)(J \pm m_j + 1)}\ \hbar\ |J,m_j\rangle$$

For J=1:

$$(J_x) = \frac{\hbar}{\sqrt{2}}\begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix} \quad (J_y) = \frac{\hbar}{\sqrt{2}}\begin{pmatrix} 0 & -i & 0 \\ i & 0 & -i \\ 0 & i & 0 \end{pmatrix} \quad (J_z) = \hbar\begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & -1 \end{pmatrix}$$