

ONDA PLANA

$$\mathbf{r} = x\mathbf{i} + y\mathbf{j} + z\mathbf{k}$$

$$(\mathbf{r} - \mathbf{r}_0) = (x - x_0)\mathbf{i} + (y - y_0)\mathbf{j} + (z - z_0)\mathbf{k}$$

Se $(\mathbf{r} - \mathbf{r}_0) \cdot \mathbf{k} = 0$

O vetor $\mathbf{r} - \mathbf{r}_0$ fica em um plano perpendicular a $\mathbf{k}$ e $\mathbf{r}$ assume qualquer valor no plano

$$\mathbf{k} = k_x\mathbf{i} + k_y\mathbf{j} + k_z\mathbf{k}$$

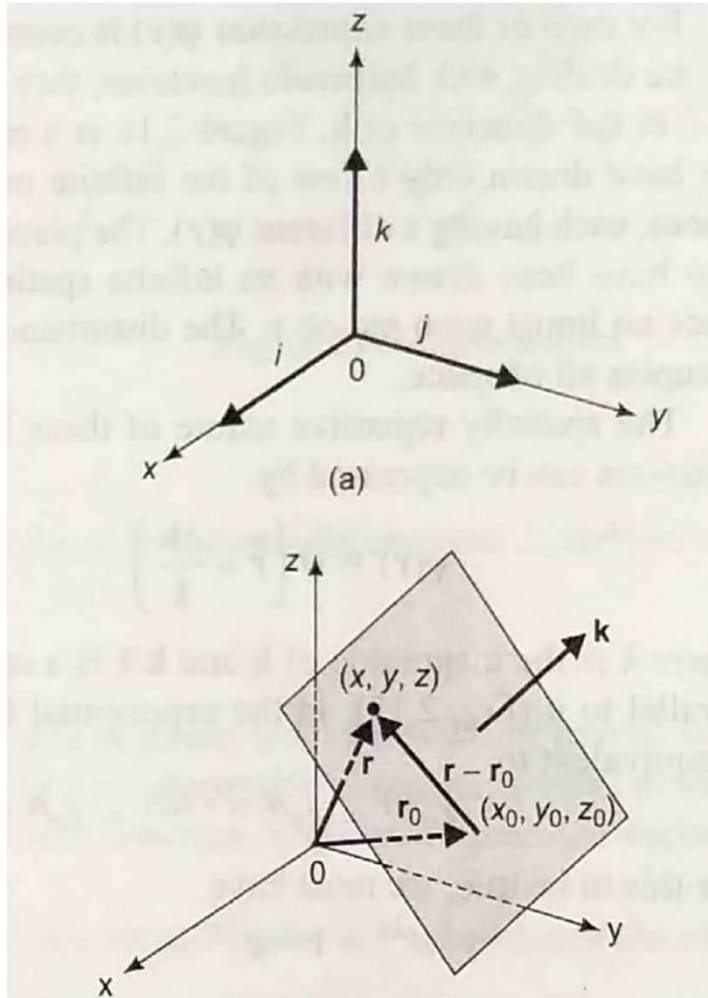
$$k_x(x - x_0) + k_y(y - y_0) + k_z(z - z_0) = 0$$

$$k_x x + k_y y + k_z z = a$$

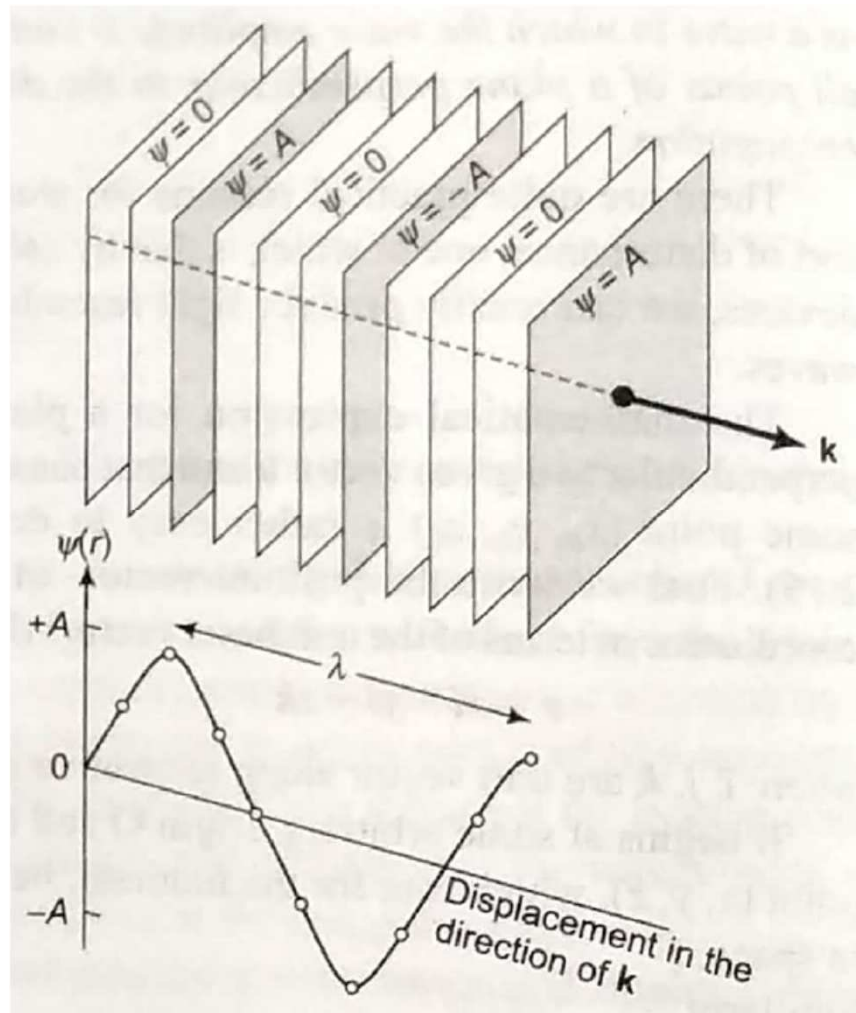
$$a = k_x x_0 + k_y y_0 + k_z z_0 = \text{constant}$$

$$\mathbf{k} \cdot \mathbf{r} = \text{constant} = a$$

$$\psi(\mathbf{r}) = A e^{i\mathbf{k} \cdot \mathbf{r}}$$



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ONDA ESFÉRICA

$$\nabla^2 \equiv \frac{1}{r^2} \frac{\partial}{\partial r} \left(r^2 \frac{\partial}{\partial r} \right) + \frac{1}{r^2 \sin \theta} \frac{\partial}{\partial \theta} \left(\sin \theta \frac{\partial}{\partial \theta} \right) + \frac{1}{r^2 \sin^2 \theta} \frac{\partial^2}{\partial \phi^2}$$

Para ondas esféricamente simétricas:

$$\psi(\mathbf{r}) = \psi(r, \theta, \phi) = \psi(r)$$

$$\nabla^2 \psi(r) = \frac{\partial^2 \psi}{\partial r^2} + \frac{2}{r} \frac{\partial \psi}{\partial r}$$

$$\nabla^2 \psi = \frac{1}{r} \frac{\partial^2}{\partial r^2} (r\psi)$$

$$\frac{1}{r} \frac{\partial^2}{\partial r^2} (r\psi) = \frac{1}{v^2} \frac{\partial^2 \psi}{\partial t^2}$$

$$\frac{\partial^2}{\partial r^2} (r\psi) = \frac{1}{v^2} \frac{\partial^2}{\partial t^2} (r\psi)$$

$$\psi(r, t) = \left(\frac{A}{r} \right) e^{ik(r \mp vt)}$$

