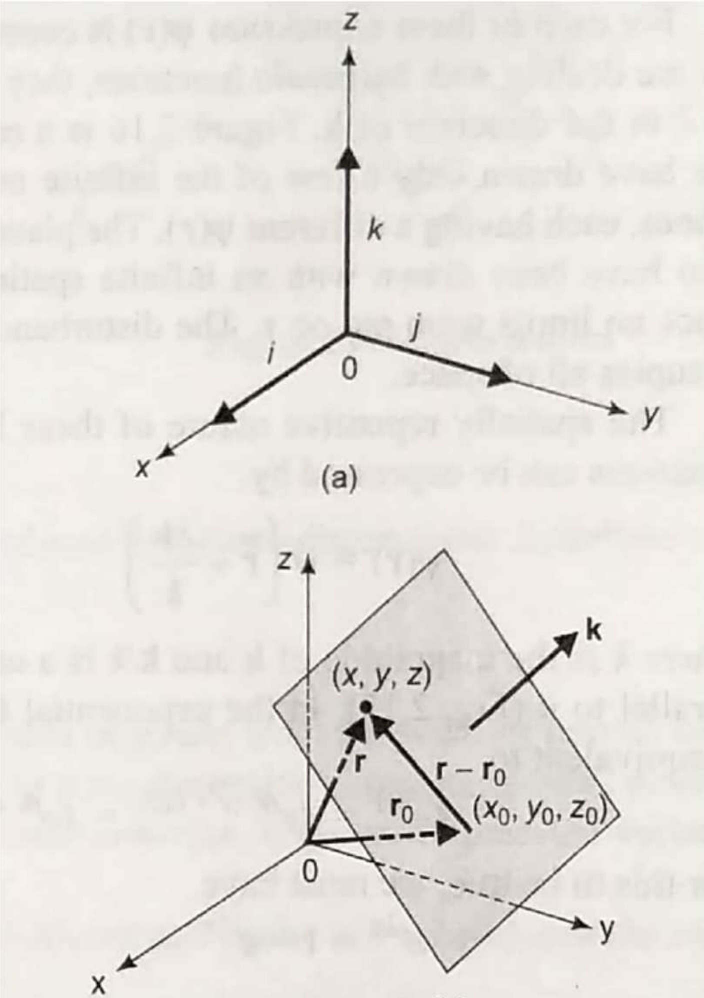
ONDA PLANA



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

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

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

O vetor $r\text{-}r_0$ fica em um plano perpendicular a k e r assume qualquer valor no plano

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

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

$$a = k_x x_0 + k_y y_0 + k_z z_0 = \text{constant} \qquad \mathbf{k} \cdot \mathbf{r} = \text{constant} = a$$

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

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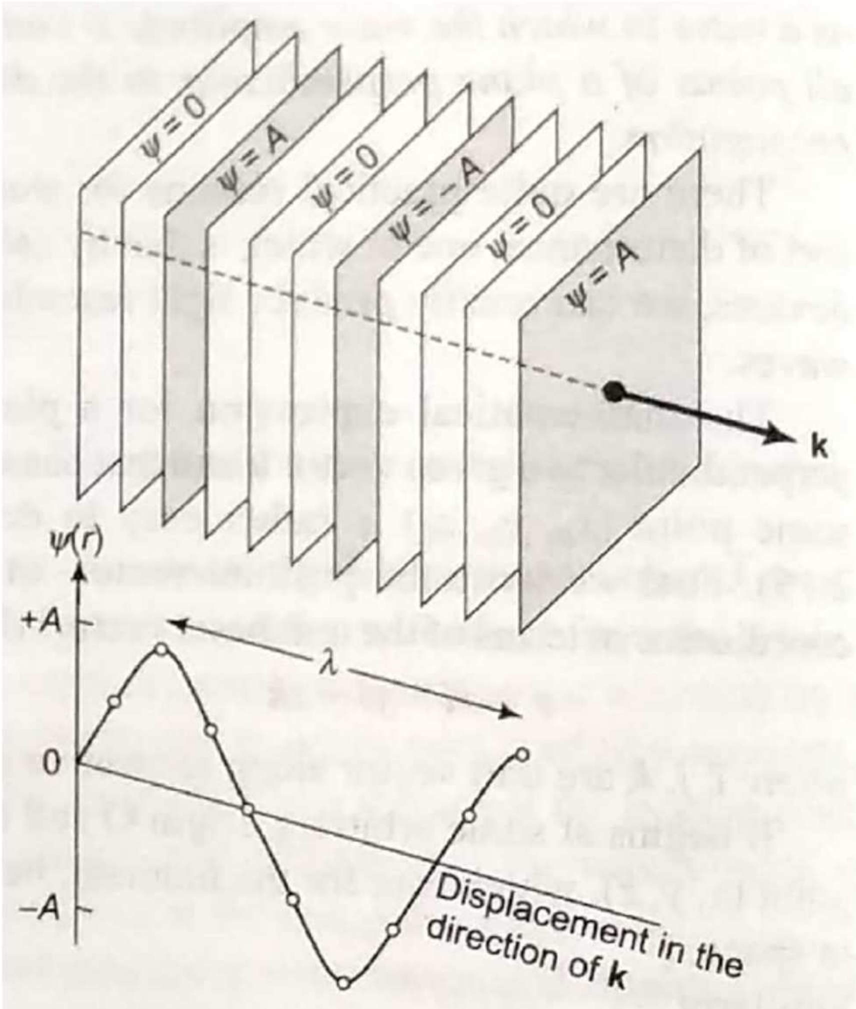

ONDA ESFÉRICA

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

Para ondas esfericamente simétricas: $\psi(\mathbf{r}) = \psi(r, \theta, \phi) = \psi(r)$

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

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

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

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

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