13. Prezentați subiectul: Ecuația undei plane

$$\begin{cases} x = \frac{d^2 f}{dx^2} - \frac{1}{c^2} \cdot \frac{d^2 f}{dt^2} = 0 \\ \Delta f - \frac{1}{c^2} \cdot \frac{d^2 f}{dt^2} = 0 \end{cases}$$

$$\frac{df}{dt} = \frac{df}{du} \cdot \frac{du}{dt} = \frac{df}{du} \qquad f\left(t - \frac{x}{c}\right) = f(u)$$

$$\frac{d^2 f}{dt^2} = \frac{d}{dt}\left(\frac{df}{dt}\right) = \frac{d}{du}\left(\frac{df}{du}\right)\frac{du}{dt} = \frac{d^2 f}{du^2}$$

$$\frac{df}{dx} = \frac{df}{du} \cdot \frac{du}{dx} = \frac{df}{du}\left(-\frac{1}{c}\right)$$

$$\frac{d^2 f}{dx^2} = \frac{d}{du}\left[\frac{df}{du}\left(-\frac{1}{c}\right)\right]\frac{du}{dx} = \frac{1}{c^2}\frac{d^2 f}{du^2}$$

$$\frac{d^2 f}{dx^2} = \frac{1}{c^2}\frac{d^2 f}{du^2} = 0 \qquad f\left(t - \frac{\vec{r} \cdot \vec{n}}{c}\right) = f(u)$$

$$\left.\begin{array}{l} \vec{r} = x\vec{i} + y\vec{j} + z\vec{k} \\ \vec{n} = n_x\vec{i} + n_y\vec{j} + n_z\vec{k} \end{array}\right\} \Rightarrow \vec{r} \cdot \vec{n} = x n_x + y n_y + z n_z$$

$$\frac{df}{dx} = \frac{df}{du} \cdot \frac{du}{dx} = \frac{df}{du}\left(-\frac{n_x}{c}\right)$$

$$\frac{d^2 f}{dx^2} = \frac{d}{du}\left[\frac{df}{du}\left(-\frac{n_x}{c}\right)\right]\frac{du}{dx} = \frac{n_x^2}{c^2}\frac{d^2 f}{du^2}$$

$$\begin{cases} \frac{d^2 f}{dx^2} = \frac{n_x^2}{c^2}\frac{d^2 f}{du^2} \\ \frac{d^2 f}{dy^2} = \frac{n_y^2}{c^2}\frac{d^2 f}{du^2} \\ \frac{d^2 f}{dz^2} = \frac{n_z^2}{c^2} \cdot \frac{d^2 f}{du^2} \end{cases}$$

$$\frac{d^2 f}{dx^2} + \frac{d^2 f}{dy^2} + \frac{d^2 f}{dz^2} = \frac{n_x^2 + n_y^2 + n_z^2}{c^2} \cdot \frac{d^2 f}{du^2} = \frac{1}{c^2} \cdot \frac{d^2 f}{du^2}$$

$$\Delta f = \frac{d^2 f}{dx^2} + \frac{d^2 f}{dy^2} + \frac{d^2 f}{dz^2} = \frac{1}{c^2} \cdot \frac{d^2 f}{du^2}$$

$$\frac{d^2 f}{du^2} = \frac{d^2 f}{dt^2} \Rightarrow \Delta f = \frac{d^2 f}{dt^2}$$

$$\Delta f - \frac{1}{c^2} \cdot \frac{d^2 f}{dt^2} = 0$$