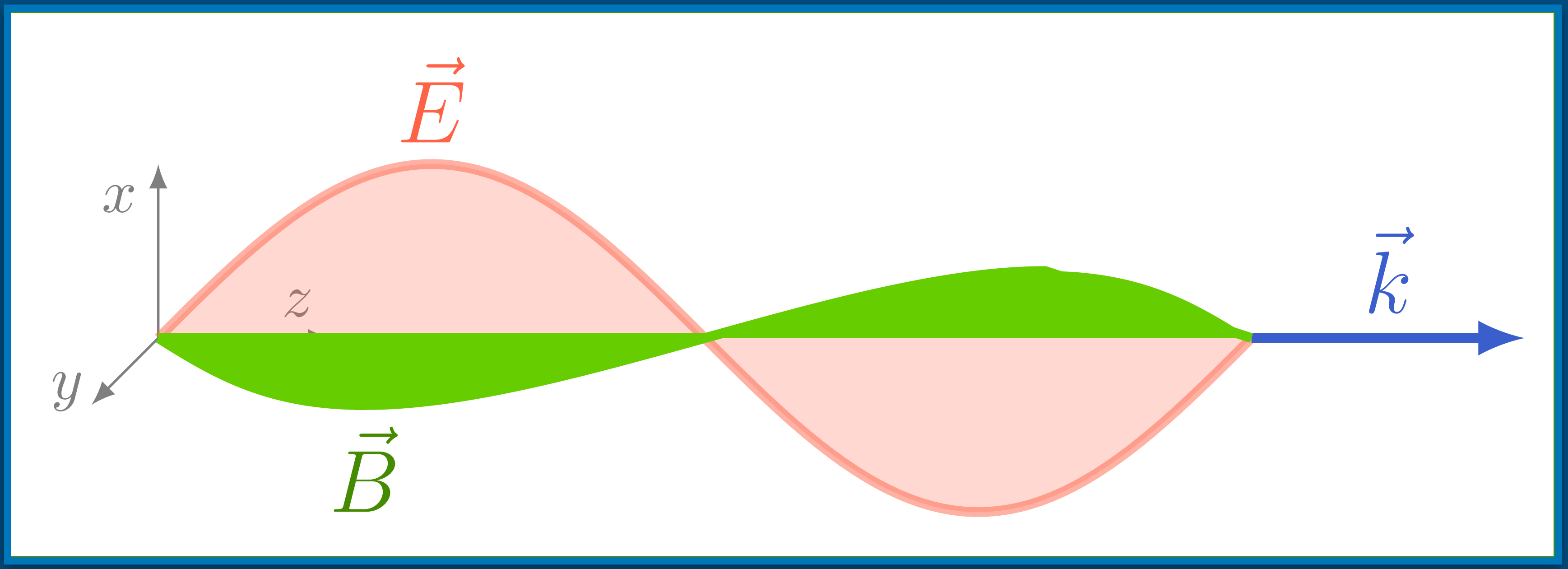
Potenciais eletrodinâmicos



EMA

27 outubro

Potenciais de Liénard e Wiechert

$$V(\vec{\mathbf{r}}, t) = \frac{1}{4\pi\epsilon_0} \frac{q}{\mathscr{r} - \vec{\mathscr{r}} \cdot \frac{\vec{\mathbf{v}}}{c}}$$

$$\vec{\mathbf{A}}(\vec{\mathbf{r}}, t) = \frac{\mu_0}{4\pi} \frac{q\vec{\mathbf{v}}}{\mathscr{r} - \vec{\mathscr{r}} \cdot \frac{\vec{\mathbf{v}}}{c}}$$

Potenciais de Liénard e Wiechert

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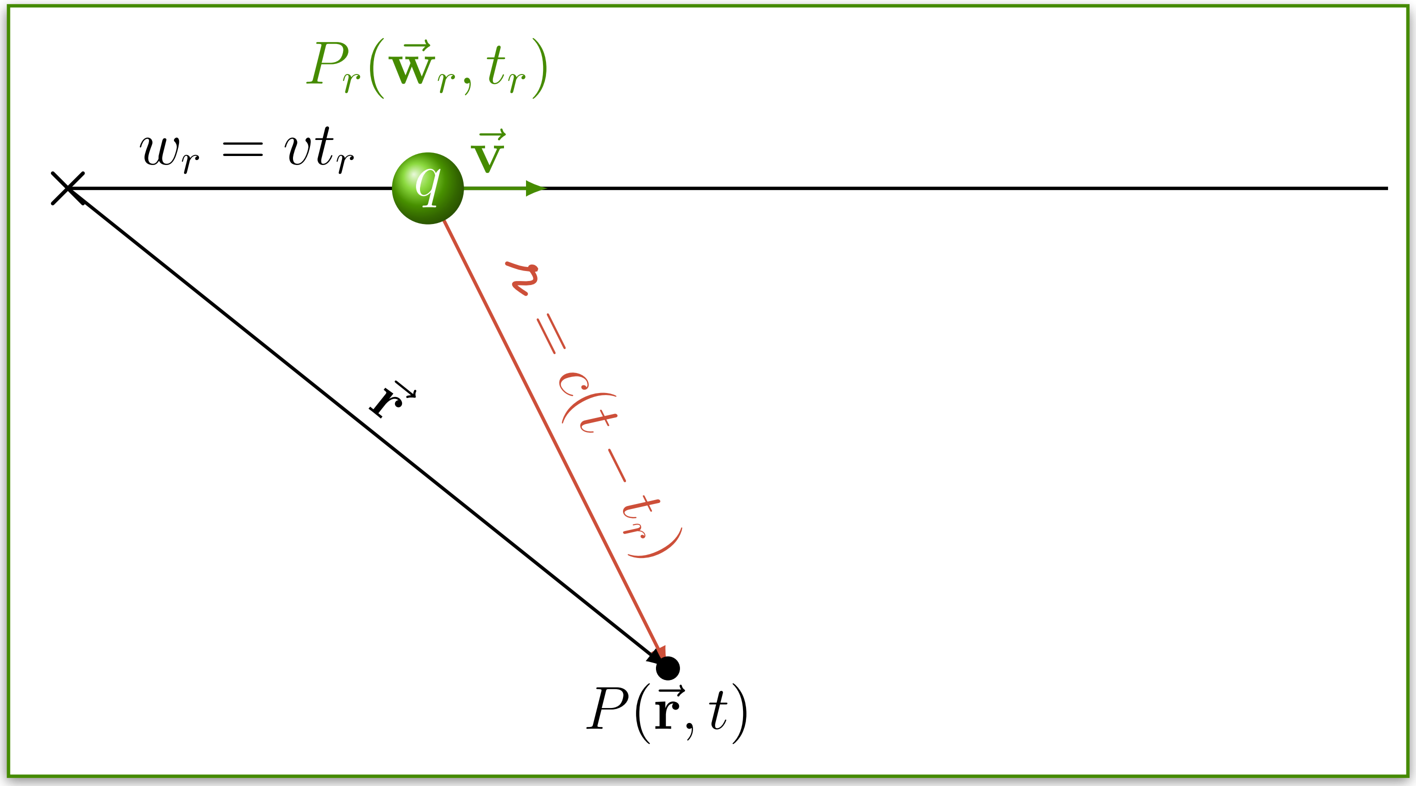
Movimento

uniforme



Potenciais de Liénard e Wiechert

$$V(\vec{\mathbf{r}}, t) = \frac{1}{4\pi\epsilon_0} \frac{q}{\mathscr{r} - \vec{\mathscr{r}} \cdot \frac{\vec{\mathbf{v}}}{c}}$$

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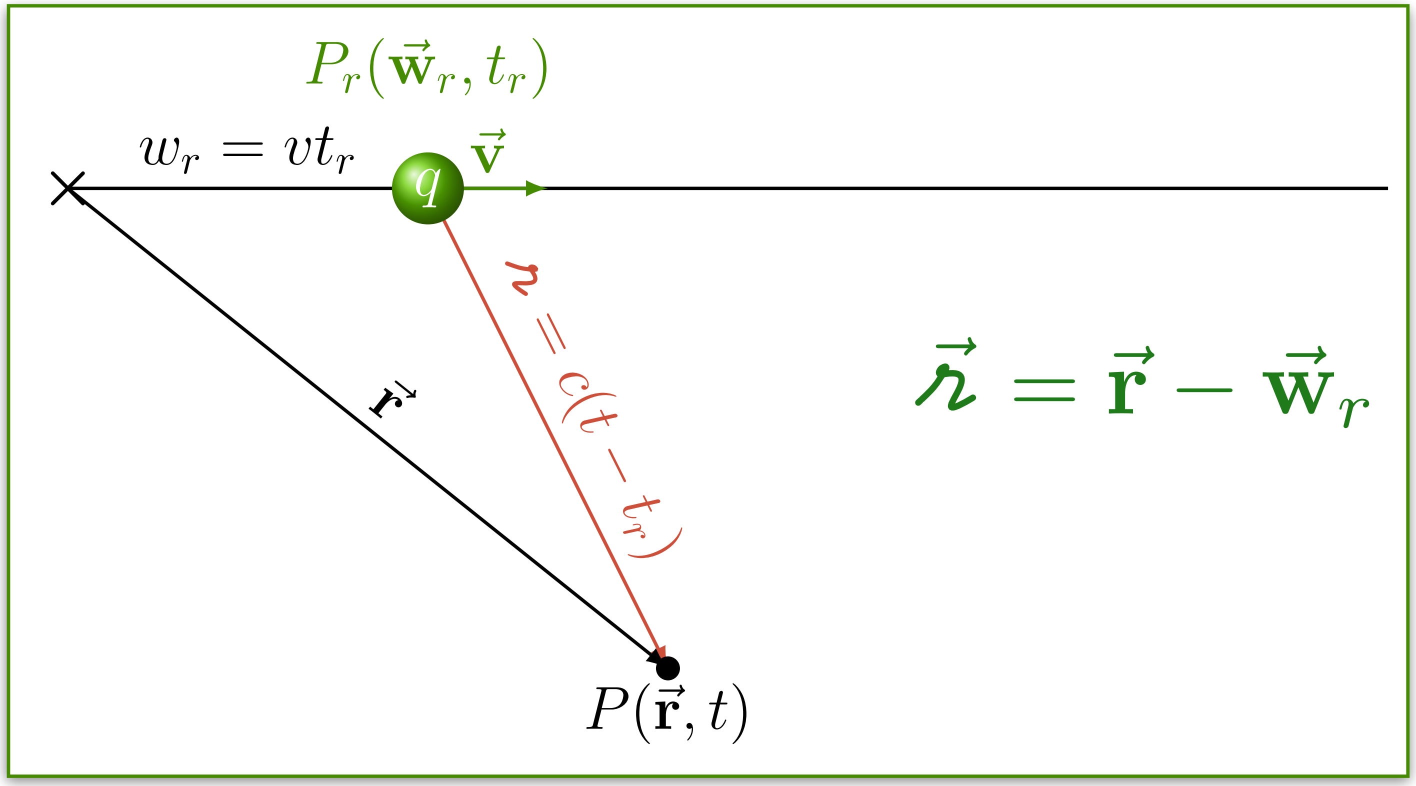
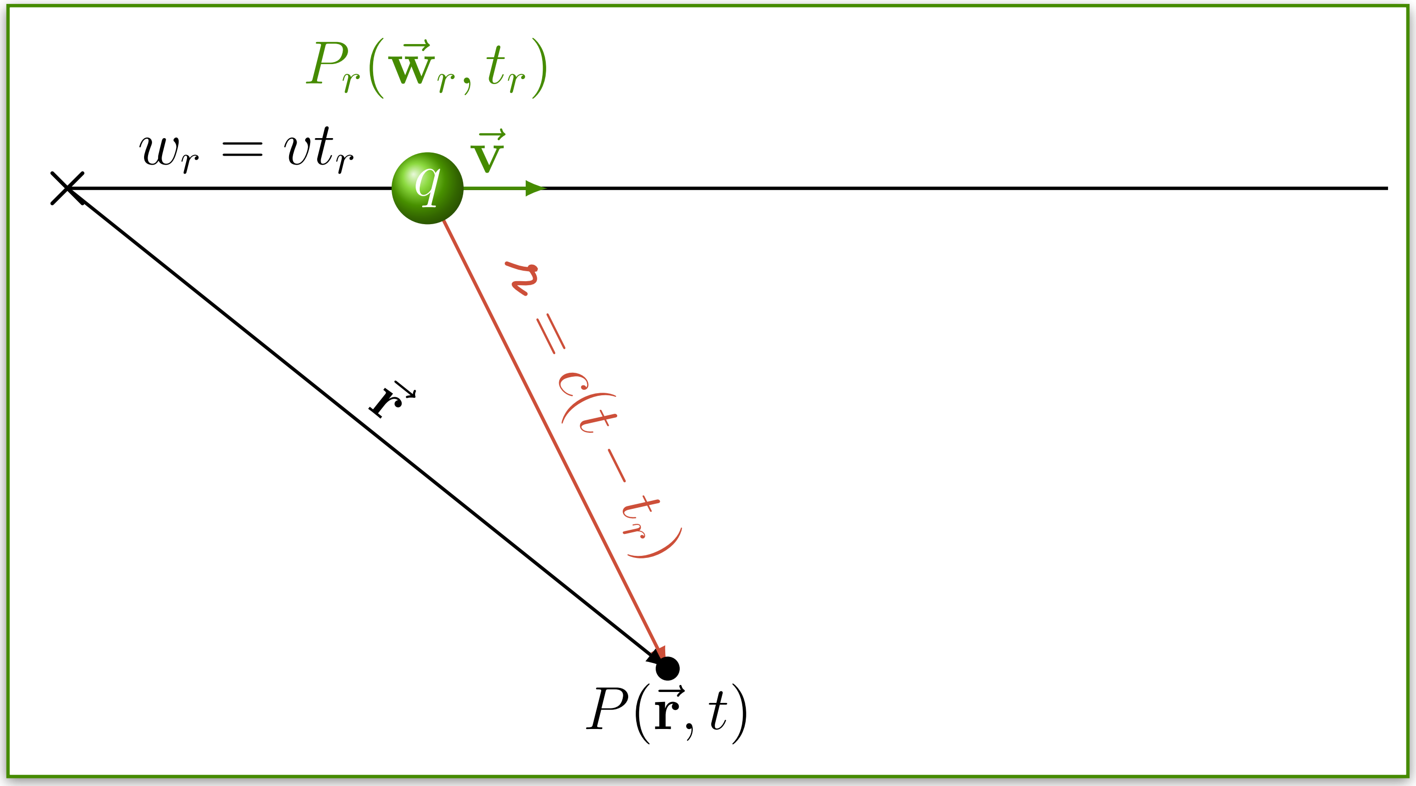
Movimento

uniforme

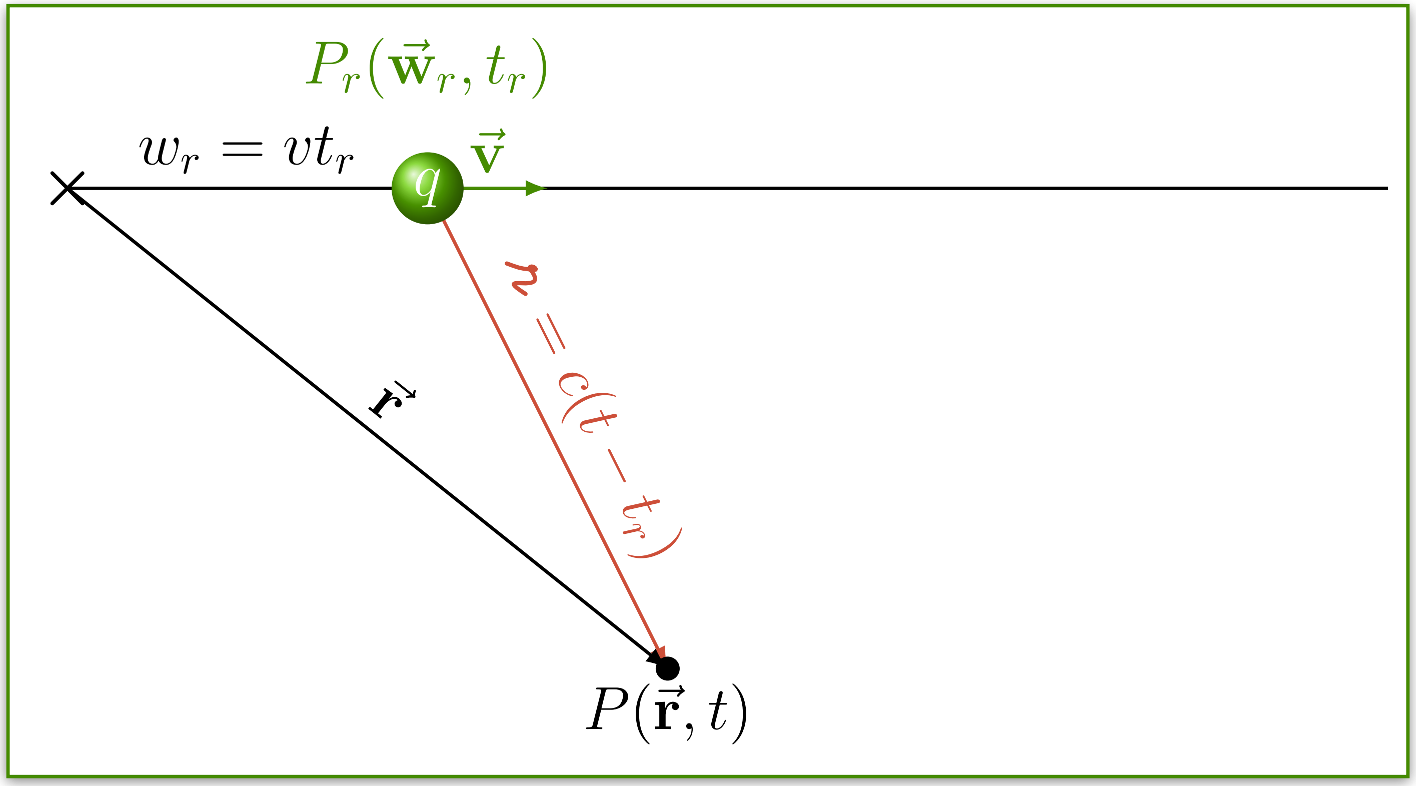


Potenciais de Liénard e Wiechert



$$t_r = \frac{c^2 t - \vec{\mathbf{r}} \cdot \vec{\mathbf{v}}}{c^2 - v^2} - \sqrt{\left(\frac{c^2 t - \vec{\mathbf{r}} \cdot \vec{\mathbf{v}}}{c^2 - v^2}\right)^2 - \frac{c^2 t^2 - r^2}{c^2 - v^2}}$$

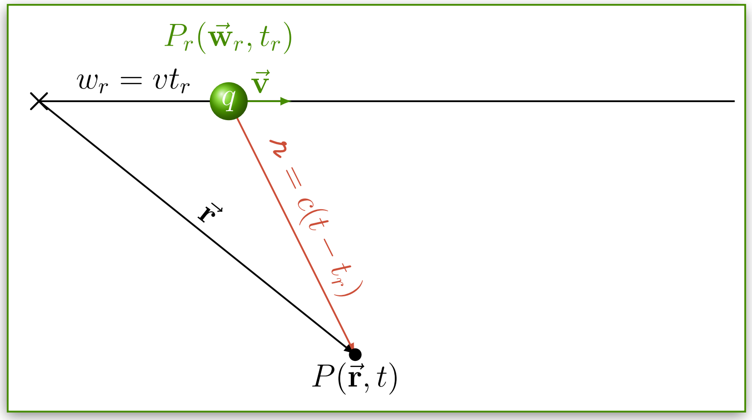
Potenciais de Liénard e Wiechert



$$t_r = \frac{c^2 t - \vec{\mathbf{r}} \cdot \vec{\mathbf{v}}}{c^2 - v^2} - \sqrt{\left(\frac{c^2 t - \vec{\mathbf{r}} \cdot \vec{\mathbf{v}}}{c^2 - v^2}\right)^2 - \frac{c^2 t^2 - r^2}{c^2 - v^2}}$$

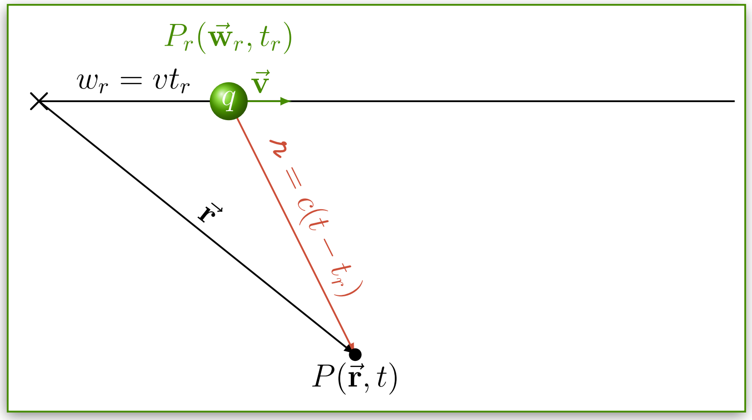
$$t_r = \frac{c^2 t - \vec{\mathbf{r}} \cdot \vec{\mathbf{v}} - \sqrt{\left(c^2 t - \vec{\mathbf{r}} \cdot \vec{\mathbf{v}}\right)^2 - (c^2 t^2 - r^2)(c^2 - v^2)}}{c^2 - v^2}$$

Potenciais de Liénard e Wiechert



$$t_r = \frac{c^2 t - \vec{\mathbf{r}} \cdot \vec{\mathbf{v}} - \sqrt{\left(c^2 t - \vec{\mathbf{r}} \cdot \vec{\mathbf{v}}\right)^2 - (c^2 t^2 - r^2)(c^2 - v^2)}}{c^2 - v^2}$$

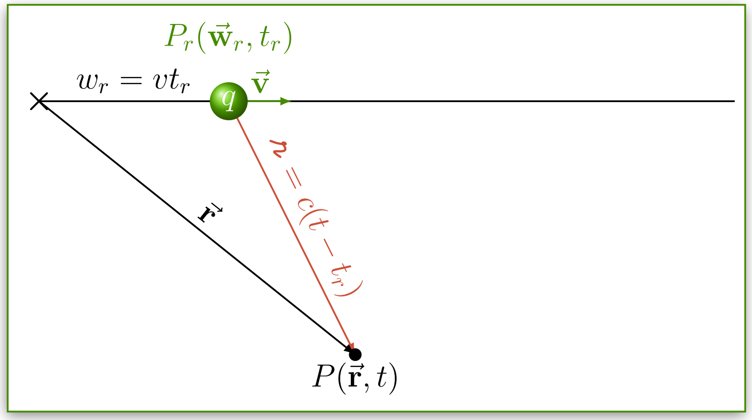
Potenciais de Liénard e Wiechert



$$t_r = \frac{c^2 t - \vec{\mathbf{r}} \cdot \vec{\mathbf{v}} - \sqrt{\left(c^2 t - \vec{\mathbf{r}} \cdot \vec{\mathbf{v}}\right)^2 - (c^2 t^2 - r^2)(c^2 - v^2)}}{c^2 - v^2}$$

$$(c^2 - v^2) t_r = c^2 t - \vec{\mathbf{r}} \cdot \vec{\mathbf{v}} - \sqrt{\left(c^2 t - \vec{\mathbf{r}} \cdot \vec{\mathbf{v}}\right)^2 - (c^2 t^2 - r^2)(c^2 - v^2)}$$

Potenciais de Liénard e Wiechert

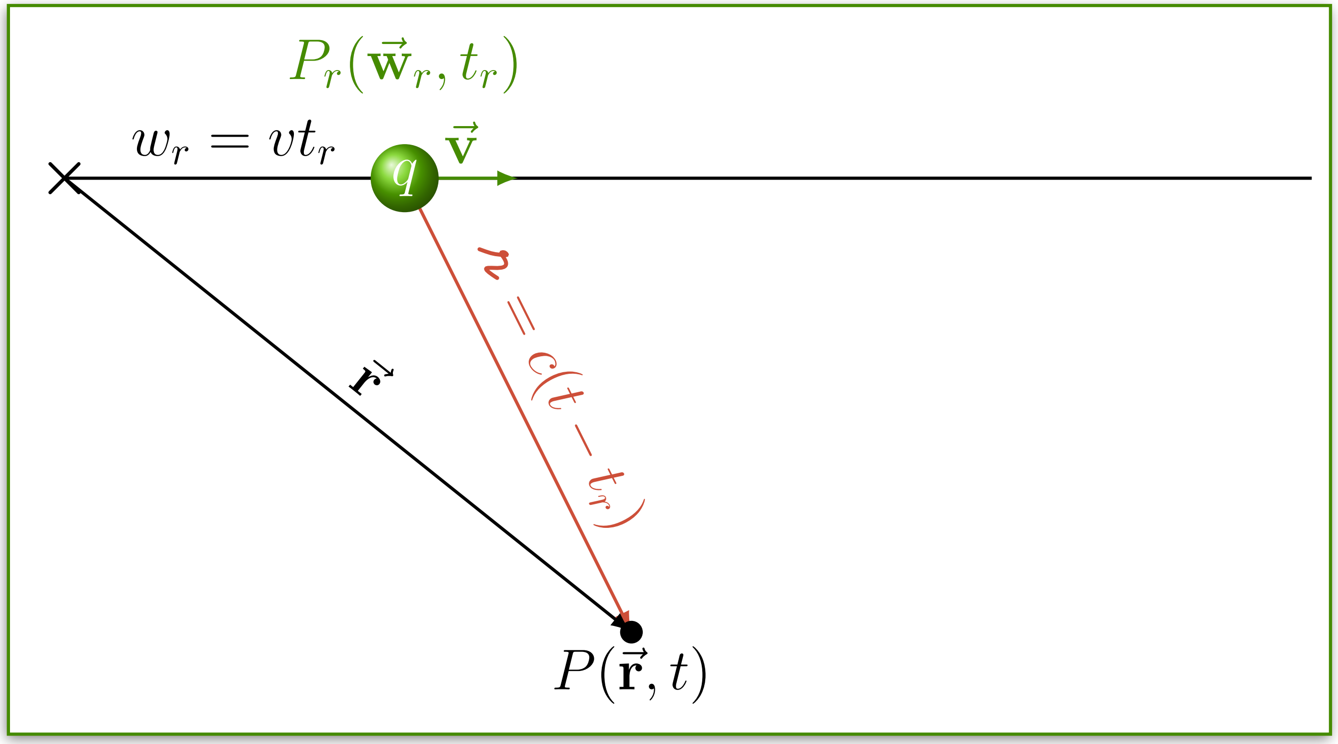


$$t_r = \frac{c^2 t - \vec{\mathbf{r}} \cdot \vec{\mathbf{v}} - \sqrt{\left(c^2 t - \vec{\mathbf{r}} \cdot \vec{\mathbf{v}}\right)^2 - (c^2 t^2 - r^2)(c^2 - v^2)}}{c^2 - v^2}$$

$$(c^2 - v^2) t_r = c^2 t - \vec{\mathbf{r}} \cdot \vec{\mathbf{v}} - \sqrt{\left(c^2 t - \vec{\mathbf{r}} \cdot \vec{\mathbf{v}}\right)^2 - (c^2 t^2 - r^2)(c^2 - v^2)}$$

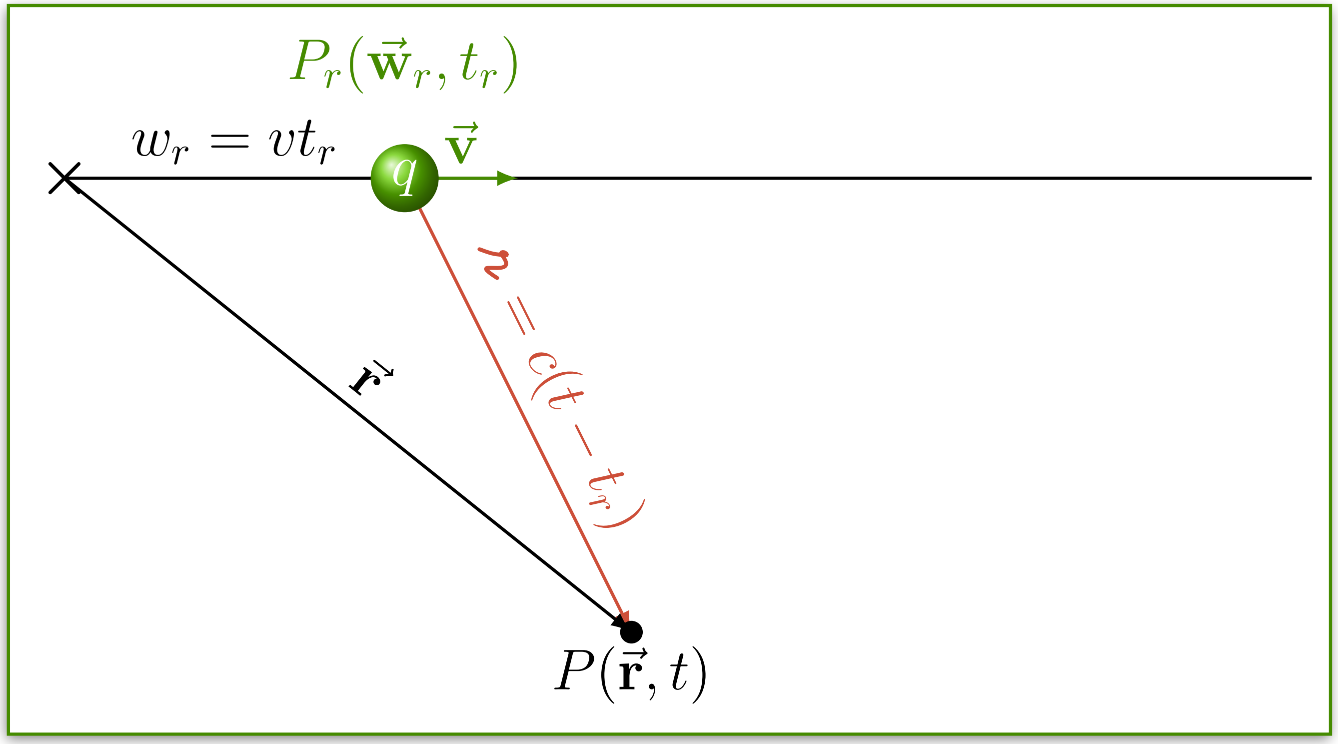
$$(c^2 - v^2)(t_r - t) = v^2 t - \vec{\mathbf{r}} \cdot \vec{\mathbf{v}} - \sqrt{\left(c^2 t - \vec{\mathbf{r}} \cdot \vec{\mathbf{v}}\right)^2 - (c^2 t^2 - r^2)(c^2 - v^2)}$$

Potenciais de Liénard e Wiechert



$$(c^2 - v^2)(t_r - t) = v^2 t - \vec{\mathbf{r}} \cdot \vec{\mathbf{v}} - \sqrt{\left(c^2 t - \vec{\mathbf{r}} \cdot \vec{\mathbf{v}}\right)^2 - (c^2 t^2 - r^2)(c^2 - v^2)}$$

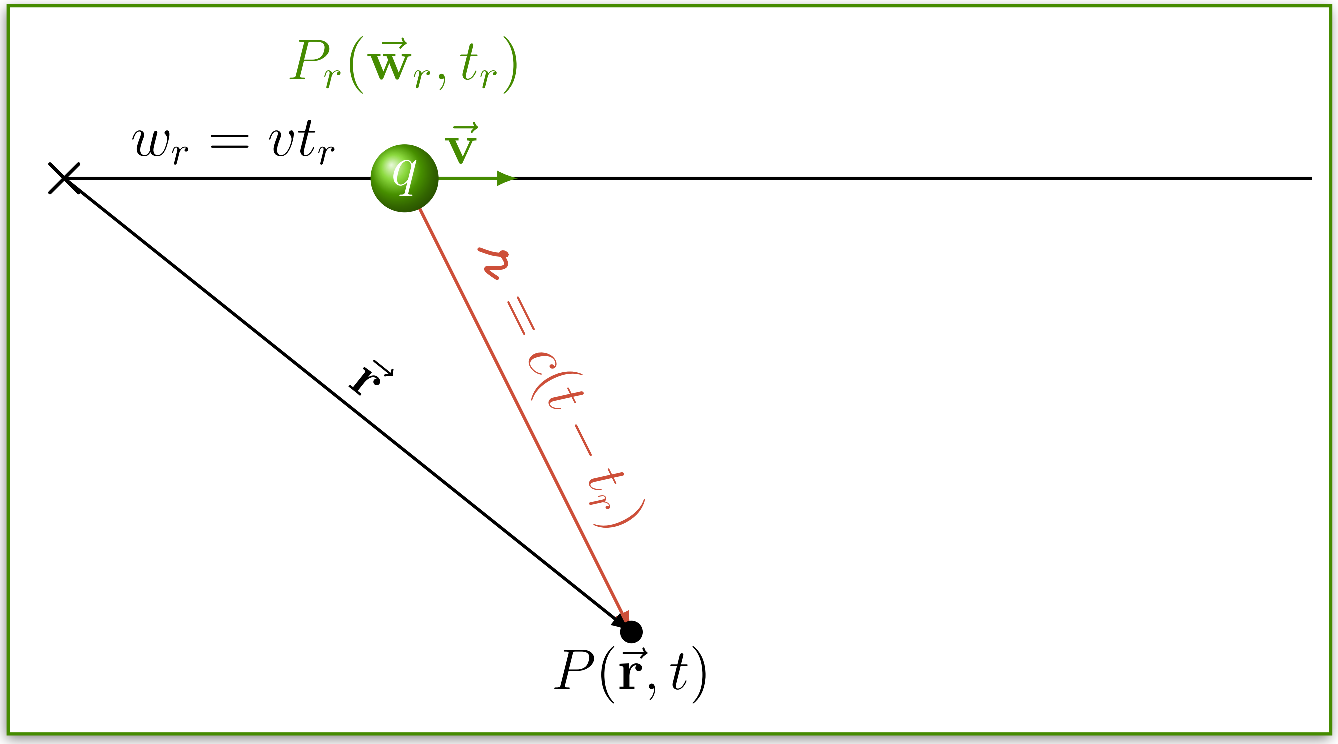
Potenciais de Liénard e Wiechert



$$(c^2 - v^2)(t_r - t) = v^2 t - \vec{\mathbf{r}} \cdot \vec{\mathbf{v}} - \sqrt{\left(c^2 t - \vec{\mathbf{r}} \cdot \vec{\mathbf{v}}\right)^2 - (c^2 t^2 - r^2)(c^2 - v^2)}$$

$$\boxed{V(\vec{\mathbf{r}}, t) = \frac{1}{4\pi\epsilon_0} \frac{qc}{c\mathscr{r} - \vec{\mathscr{r}} \cdot \vec{\mathbf{v}}}}$$

Potenciais de Liénard e Wiechert



$$(c^2 - v^2)(t_r - t) = v^2 t - \vec{\mathbf{r}} \cdot \vec{\mathbf{v}} - \sqrt{\left(c^2 t - \vec{\mathbf{r}} \cdot \vec{\mathbf{v}}\right)^2 - (c^2t^2 - r^2)(c^2 - v^2)}$$

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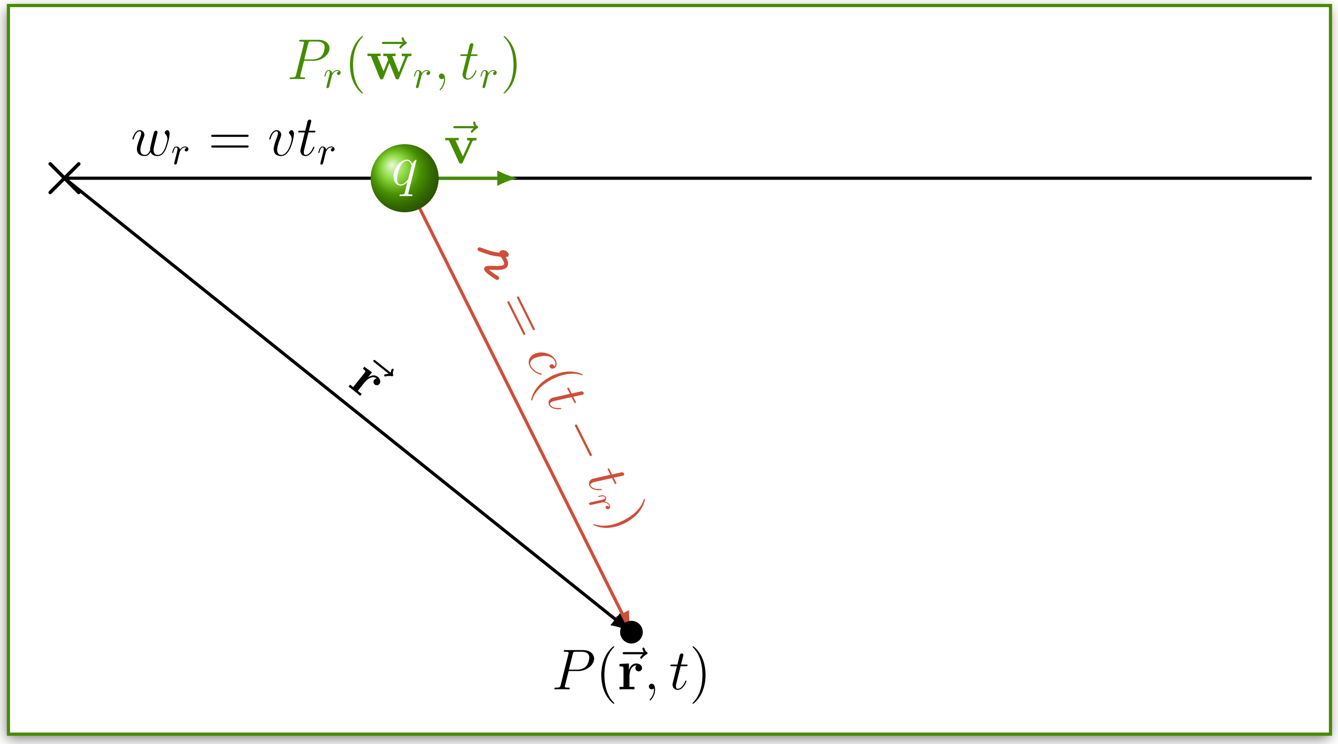
$$c\mathscr{r} - \vec{\mathscr{r}} \cdot \vec{\mathbf{v}} = c^2(t - t_r) - (\vec{\mathbf{r}} - \vec{\mathbf{v}} t_r) \cdot \vec{\mathbf{v}}$$

Potenciais de Liénard e Wiechert



$$(c^2 - v^2)(t_r - t) = v^2 t - \vec{\mathbf{r}} \cdot \vec{\mathbf{v}} - \sqrt{\left(c^2 t - \vec{\mathbf{r}} \cdot \vec{\mathbf{v}}\right)^2 - (c^2 t^2 - r^2)(c^2 - v^2)}$$

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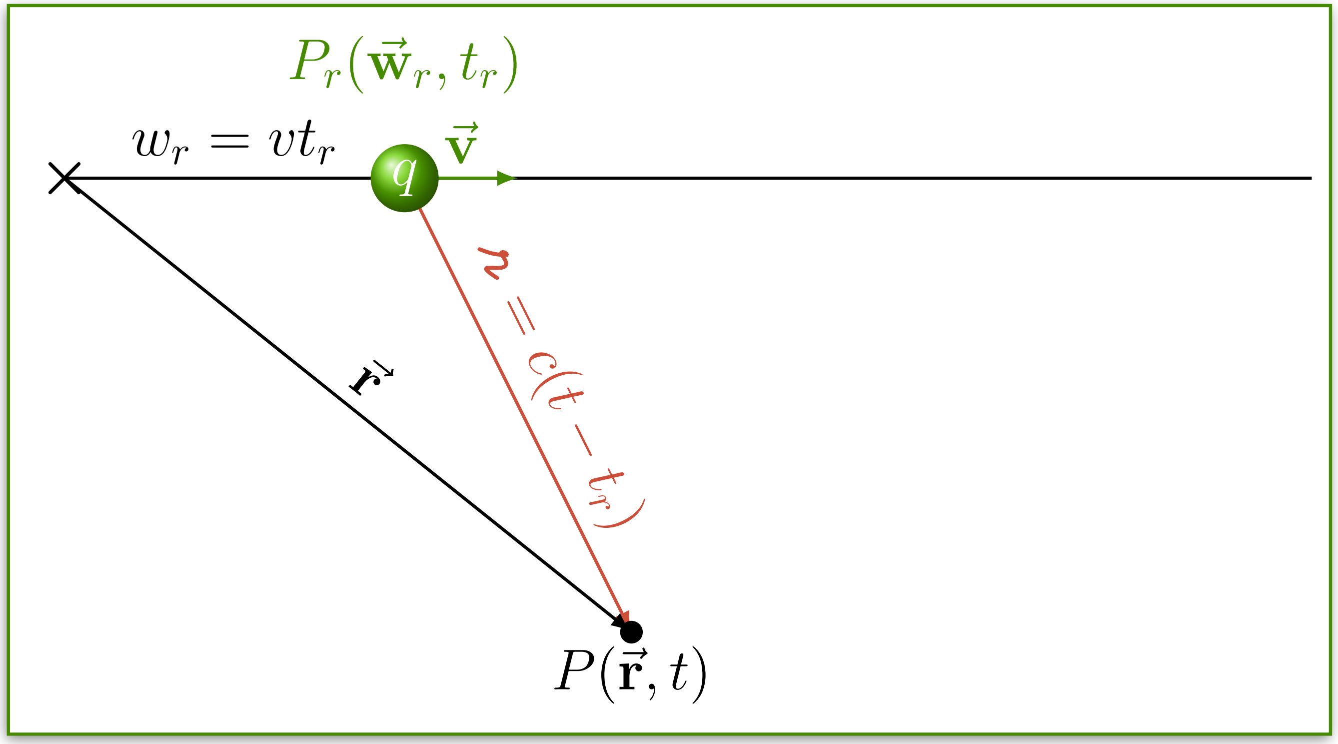
$$c\mathscr{r} - \vec{\mathscr{r}} \cdot \vec{\mathbf{v}} = c^2(t - t_r) - \vec{\mathbf{r}} \cdot \vec{\mathbf{v}} + v^2 t_r$$

Potenciais de Liénard e Wiechert



$$(c^2 - v^2)(t_r - t) = v^2 t - \vec{\mathbf{r}} \cdot \vec{\mathbf{v}} - \sqrt{\left(c^2 t - \vec{\mathbf{r}} \cdot \vec{\mathbf{v}}\right)^2 - (c^2 t^2 - r^2)(c^2 - v^2)}$$

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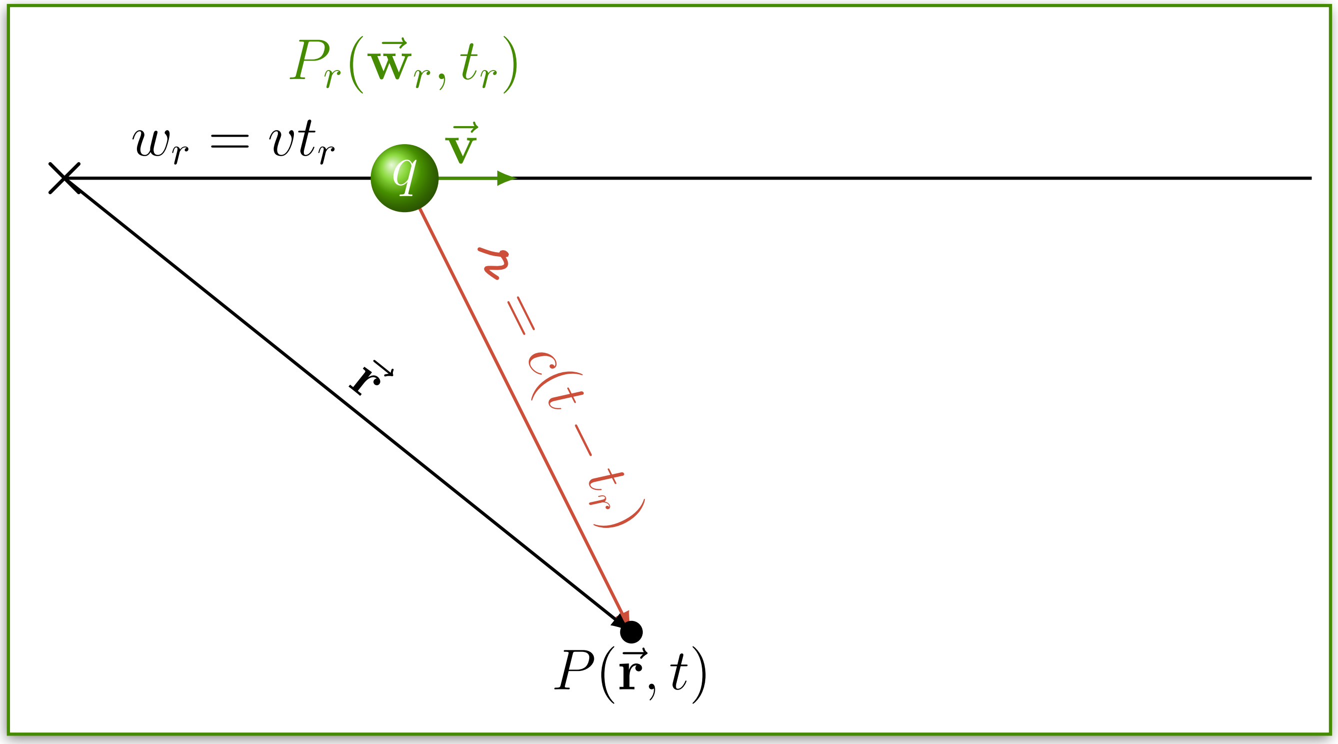
$$c\mathscr{r} - \vec{\mathscr{r}} \cdot \vec{\mathbf{v}} = c^2(t - t_r) - \vec{\mathbf{r}} \cdot \vec{\mathbf{v}} + v^2 t_r$$

$$c\mathscr{r} - \vec{\mathscr{r}} \cdot \vec{\mathbf{v}} = (c^2 - v^2)(t - t_r) - \vec{\mathbf{r}} \cdot \vec{\mathbf{v}} + v^2 t$$

Potenciais de Liénard e Wiechert

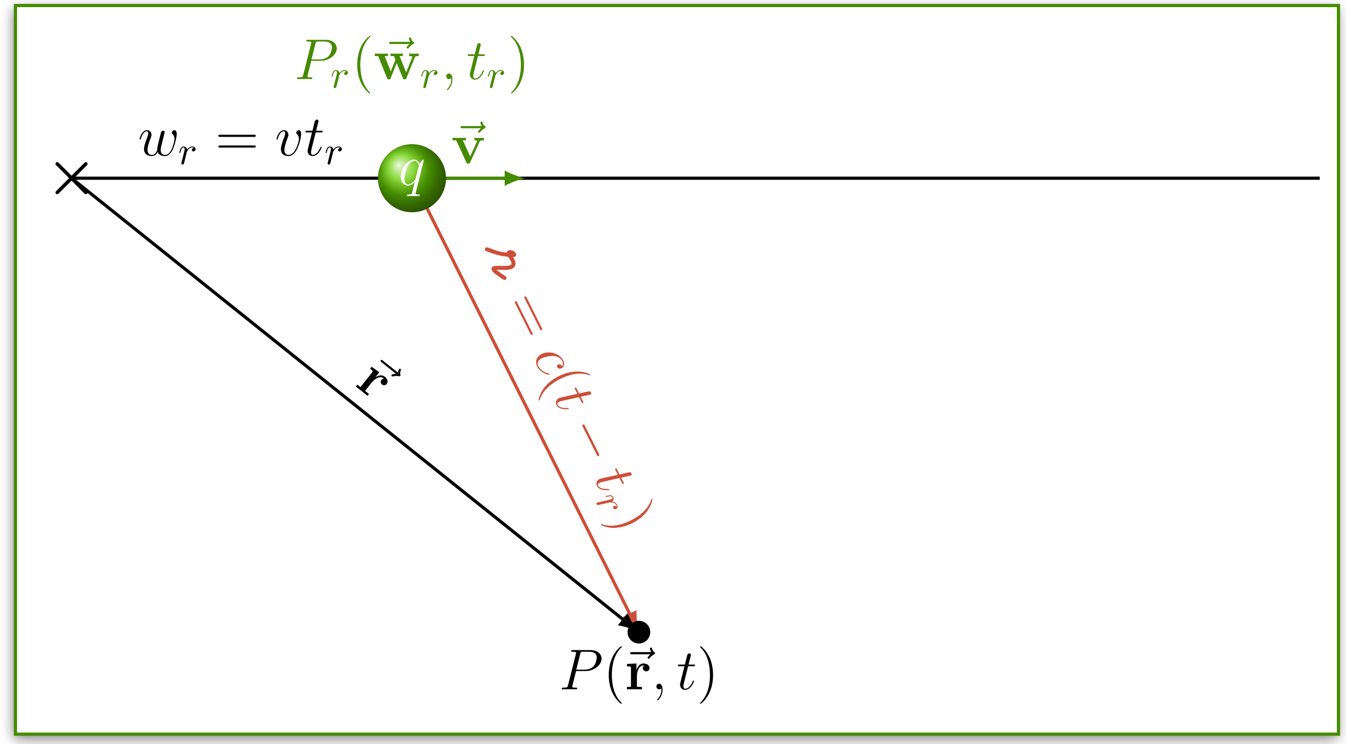


$$V(\vec{\mathbf{r}}, t) = \frac{1}{4\pi\epsilon_0} \frac{qc}{c\mathscr{r} - \vec{\mathscr{r}} \cdot \vec{\mathbf{v}}}$$

$$c\mathscr{r} - \vec{\mathscr{r}} \cdot \vec{\mathbf{v}} = \sqrt{\left(c^2 t - \vec{\mathbf{r}} \cdot \vec{\mathbf{v}}\right)^2 - (c^2 t^2 - r^2)(c^2 - v^2)}$$

Potenciais de Liénard e Wiechert

$$V(\vec{\mathbf{r}}, t) = \frac{1}{4\pi\epsilon_0} \frac{qc}{c\mathscr{r} - \vec{\mathscr{r}} \cdot \vec{\mathbf{v}}}$$



$$c\mathscr{r} - \vec{\mathscr{r}} \cdot \vec{\mathbf{v}} = \sqrt{\left(c^2 t - \vec{\mathbf{r}} \cdot \vec{\mathbf{v}}\right)^2 - (c^2 t^2 - r^2)(c^2 - v^2)}$$

$$V(\vec{\mathbf{r}}, t) = \frac{1}{4\pi\epsilon_0} \frac{qc}{\sqrt{\left(c^2 t - \vec{\mathbf{r}} \cdot \vec{\mathbf{v}}\right)^2 - (c^2 t^2 - r^2)(c^2 - v^2)}}$$

Potenciais de Liénard e Wiechert

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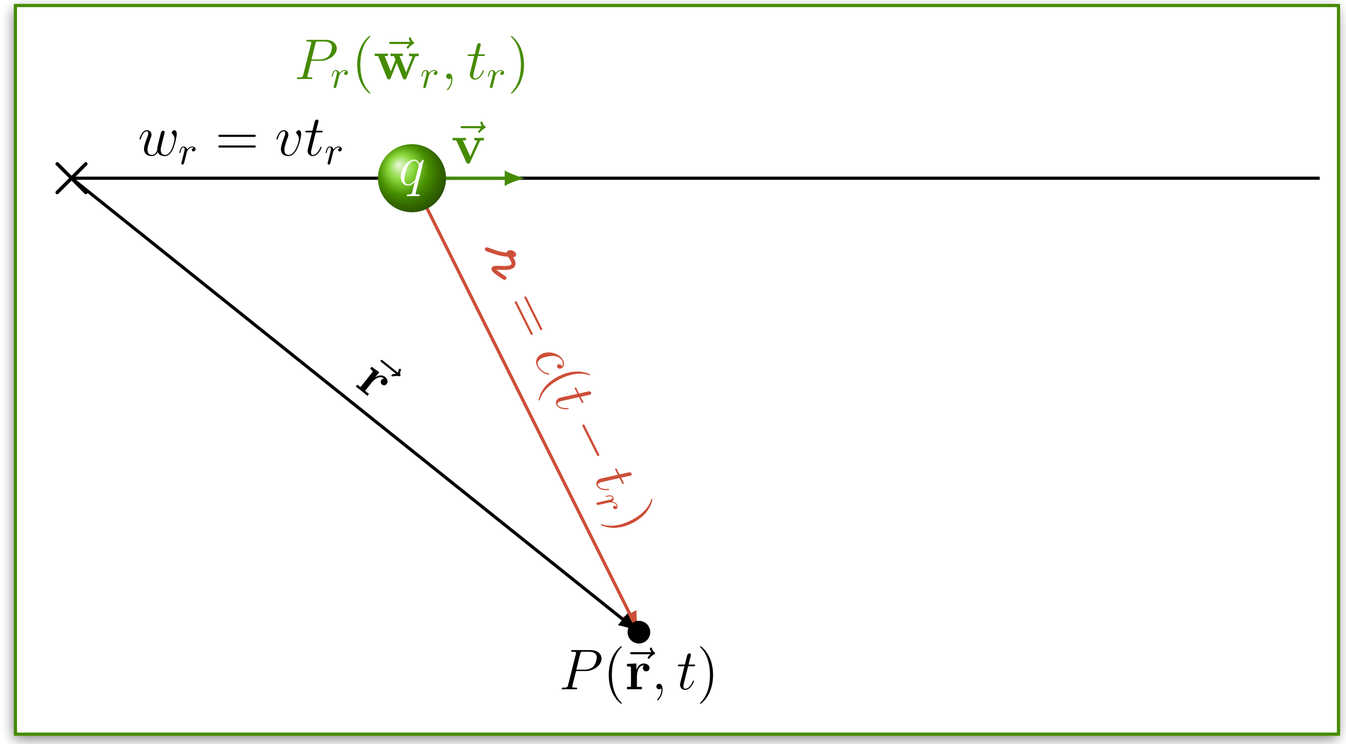
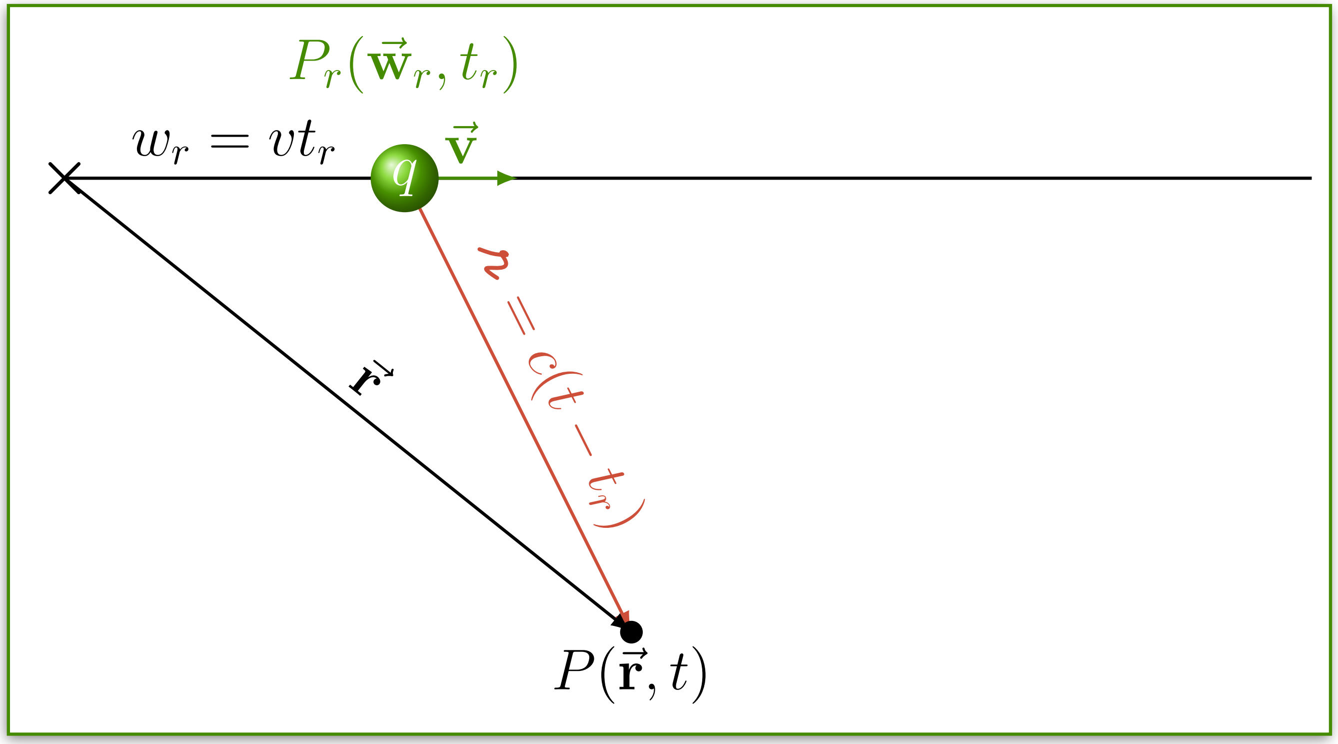


$$c\mathscr{r} - \vec{\mathscr{r}} \cdot \vec{\mathbf{v}} = \sqrt{\left(c^2 t - \vec{\mathbf{r}} \cdot \vec{\mathbf{v}}\right)^2 - (c^2 t^2 - r^2)(c^2 - v^2)}$$

$$\vec{\mathbf{r}} \equiv \vec{\mathbf{R}} + \vec{\mathbf{v}} t$$

Potenciais de Liénard e Wiechert

$$V(\vec{\mathbf{r}}, t) = \frac{1}{4\pi\epsilon_0} \frac{qc}{c\mathscr{r} - \vec{\mathscr{r}} \cdot \vec{\mathbf{v}}}$$



$$c\mathscr{r} - \vec{\mathscr{r}} \cdot \vec{\mathbf{v}} = \sqrt{\left(c^2 t - \vec{\mathbf{r}} \cdot \vec{\mathbf{v}}\right)^2 - (c^2 t^2 - r^2)(c^2 - v^2)}$$

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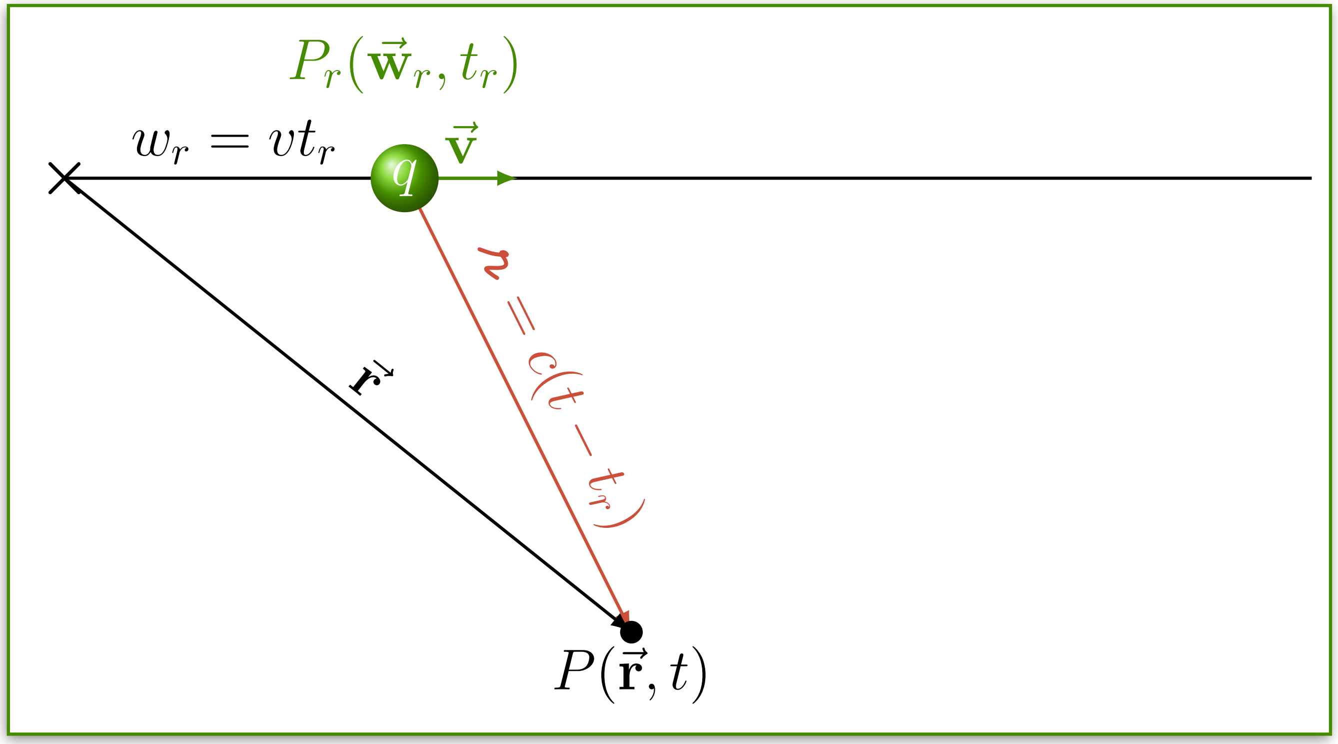
Potenciais de Liénard e Wiechert

$$V(\vec{\mathbf{r}},t) = \frac{1}{4\pi\epsilon_0}\frac{qc}{c\mathscr{r} - \vec{\mathscr{r}}\cdot\vec{\mathbf{v}}}$$



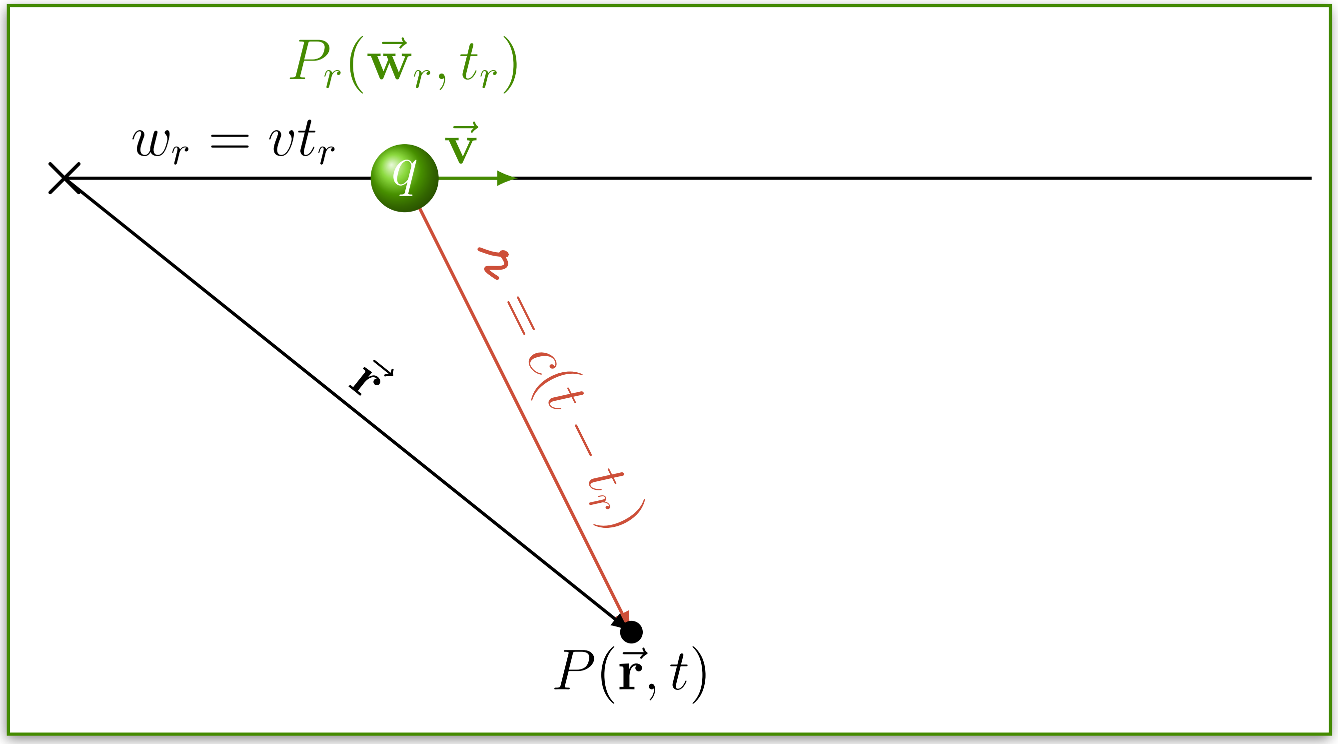
$$c\mathscr{r} - \vec{\mathscr{r}}\cdot\vec{\mathbf{v}} = \sqrt{\left(c^2 t - \vec{\mathbf{r}}\cdot\vec{\mathbf{v}}\right)^2 - (c^2t^2 - r^2)(c^2 - v^2)}$$

$$\vec{\mathbf{r}} \equiv \vec{\mathbf{R}} + \vec{\mathbf{v}}t$$

$$c\mathscr{r} - \vec{\mathscr{r}}\cdot\vec{\mathbf{v}} = \sqrt{\left((c^2 - v^2)t - \vec{\mathbf{R}}\cdot\vec{\mathbf{v}}\right)^2 - \left((c^2 - v^2)t^2 - R^2 - 2\vec{\mathbf{R}}\cdot\vec{\mathbf{v}}t\right)(c^2 - v^2)}$$

Potenciais de Liénard e Wiechert

$$V(\vec{\mathbf{r}}, t) = \frac{1}{4\pi\epsilon_0} \frac{qc}{c\mathscr{r} - \vec{\mathscr{r}} \cdot \vec{\mathbf{v}}}$$



$$c\mathscr{r} - \vec{\mathscr{r}} \cdot \vec{\mathbf{v}} = \sqrt{\left(c^2 t - \vec{\mathbf{r}} \cdot \vec{\mathbf{v}}\right)^2 - (c^2 t^2 - r^2)(c^2 - v^2)}$$

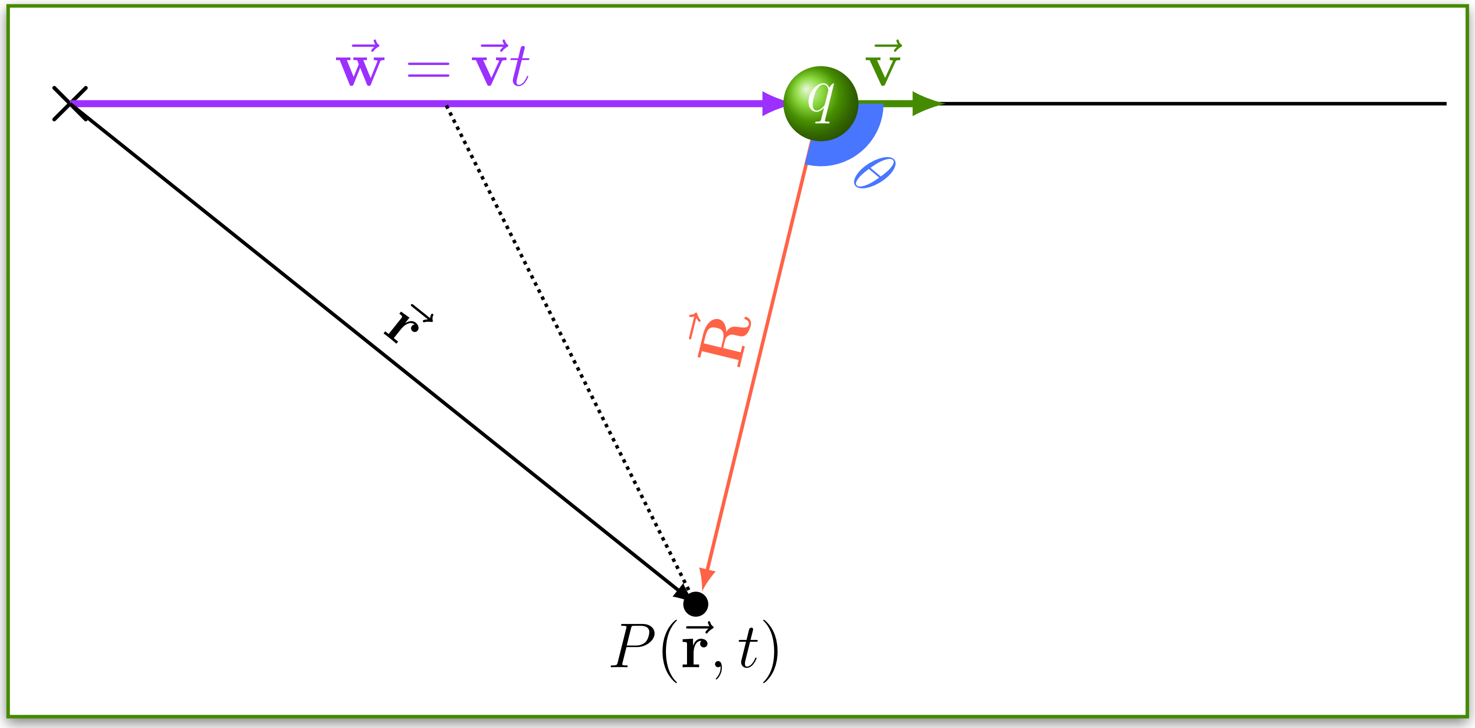
$$\vec{\mathbf{r}} \equiv \vec{\mathbf{R}} + \vec{\mathbf{v}}t$$

$$c\mathscr{r} - \vec{\mathscr{r}} \cdot \vec{\mathbf{v}} = \sqrt{\left((c^2 - v^2)t - \vec{\mathbf{R}} \cdot \vec{\mathbf{v}}\right)^2 - \left((c^2 - v^2)t^2 - R^2 - 2\vec{\mathbf{R}} \cdot \vec{\mathbf{v}}t\right)(c^2 - v^2)}$$

$$c\mathscr{r} - \vec{\mathscr{r}} \cdot \vec{\mathbf{v}} = \sqrt{(\vec{\mathbf{R}} \cdot \vec{\mathbf{v}})^2 + R^2(c^2 - v^2)}$$

Potenciais de Liénard e Wiechert

$$V(\vec{\mathbf{r}}, t) = \frac{1}{4\pi\epsilon_0} \frac{qc}{c\mathscr{r} - \vec{\mathscr{r}} \cdot \vec{\mathbf{v}}}$$



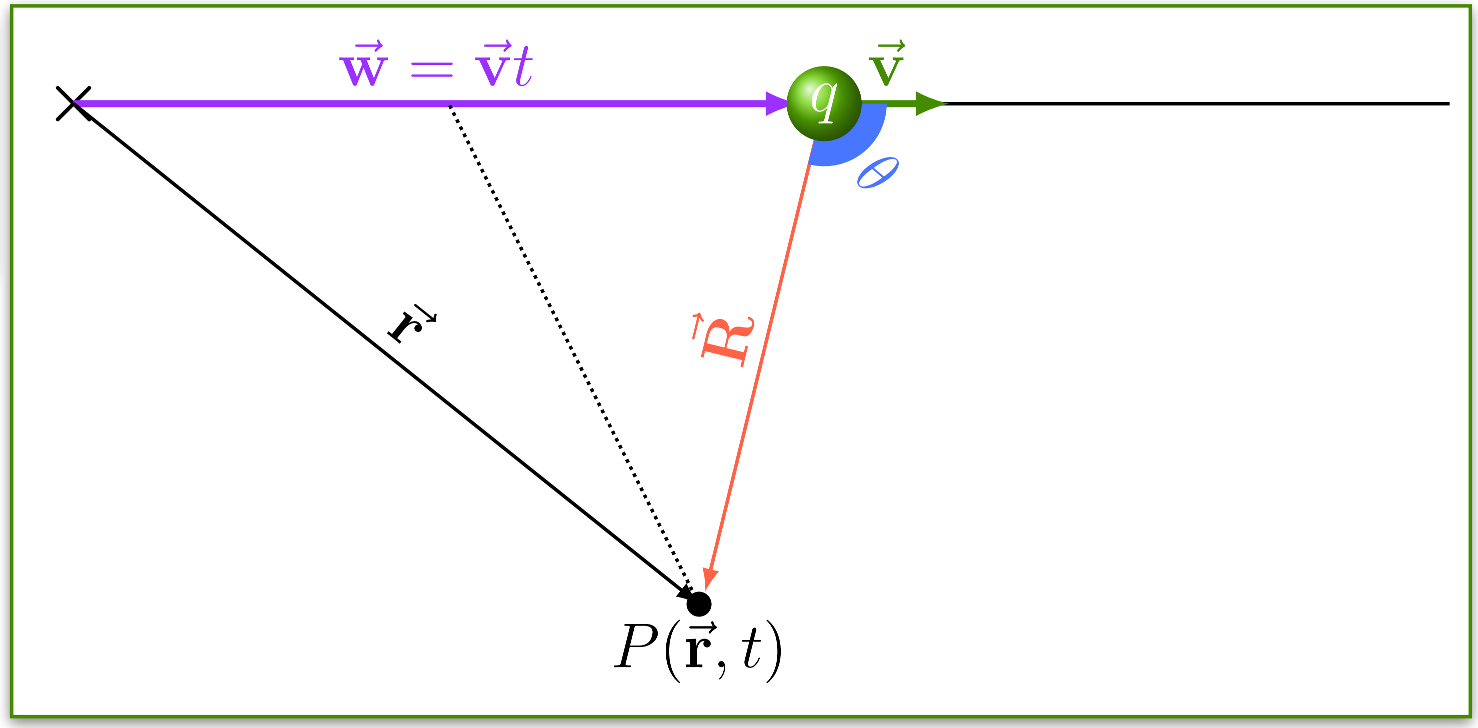
$$V(\vec{\mathbf{r}}, t) = \frac{1}{4\pi\epsilon_0} \frac{qc}{\sqrt{(\vec{\mathbf{R}} \cdot \vec{\mathbf{v}})^2 + R^2(c^2 - v^2)}}$$

$$\vec{\mathbf{r}} \equiv \vec{\mathbf{R}} + \vec{\mathbf{v}}t$$

$$V(\vec{\mathbf{r}}, t) = \frac{1}{4\pi\epsilon_0} \frac{qc}{\sqrt{R^2(c^2 - v^2 \sin^2 \theta)}}$$

Potenciais de Liénard e Wiechert

$$V(\vec{\mathbf{r}}, t) = \frac{1}{4\pi\epsilon_0} \frac{qc}{c\mathscr{r} - \vec{\mathscr{r}} \cdot \vec{\mathbf{v}}}$$



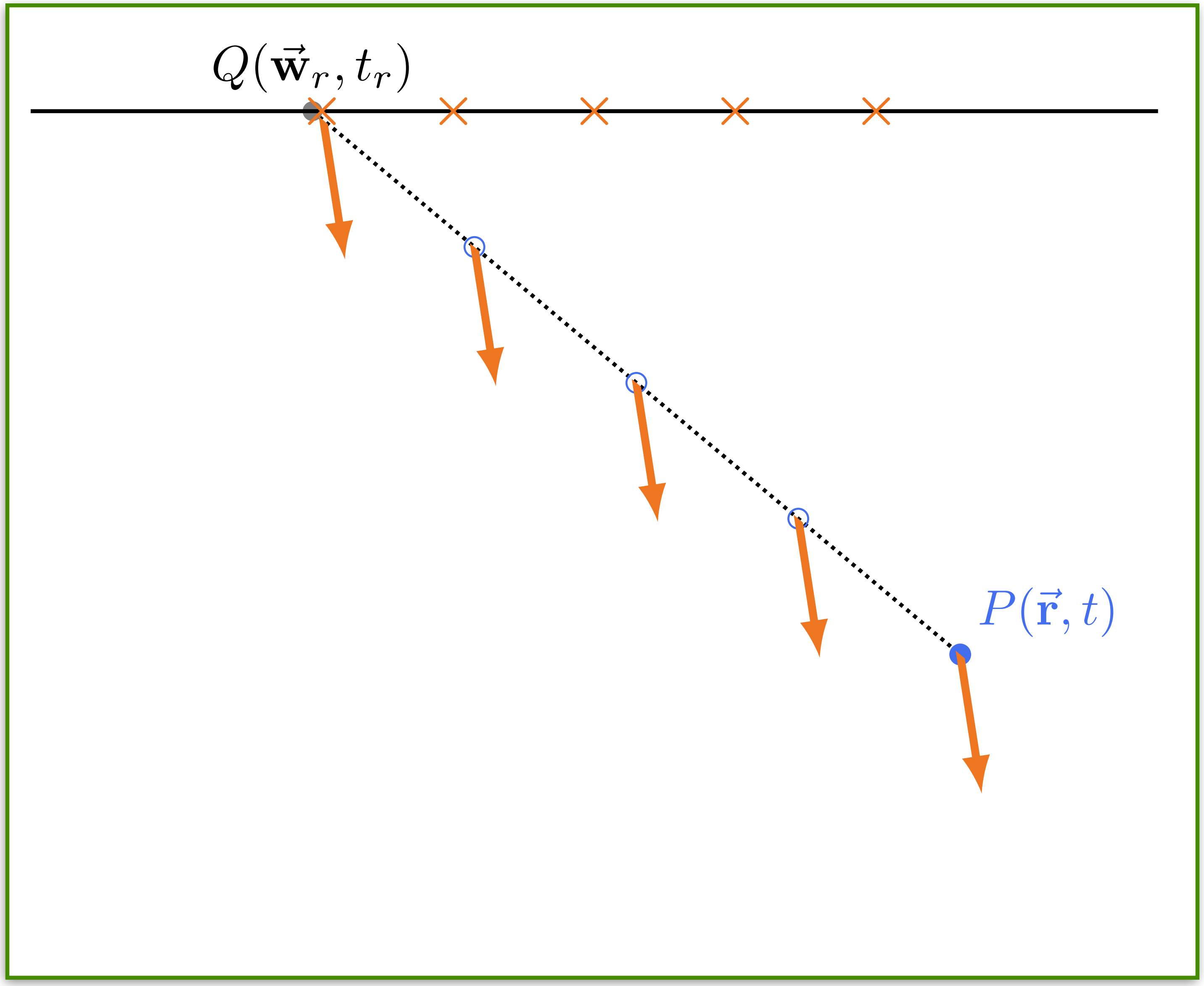
$$V(\vec{\mathbf{r}}, t) = \frac{1}{4\pi\epsilon_0} \frac{qc}{\sqrt{(\vec{\mathbf{R}} \cdot \vec{\mathbf{v}})^2 + R^2(c^2 - v^2)}}$$

$$\vec{\mathbf{r}} \equiv \vec{\mathbf{R}} + \vec{\mathbf{v}}t$$

$$V(\vec{\mathbf{r}}, t) = \frac{1}{4\pi\epsilon_0} \frac{q}{R\sqrt{1 - (\frac{v}{c})^2 \sin^2\theta}}$$

Potenciais de Liénard e Wiechert

$$V(\vec{\mathbf{r}}, t) = \frac{1}{4\pi\epsilon_0} \frac{qc}{c\mathscr{r} - \vec{\mathscr{r}} \cdot \vec{\mathbf{v}}}$$

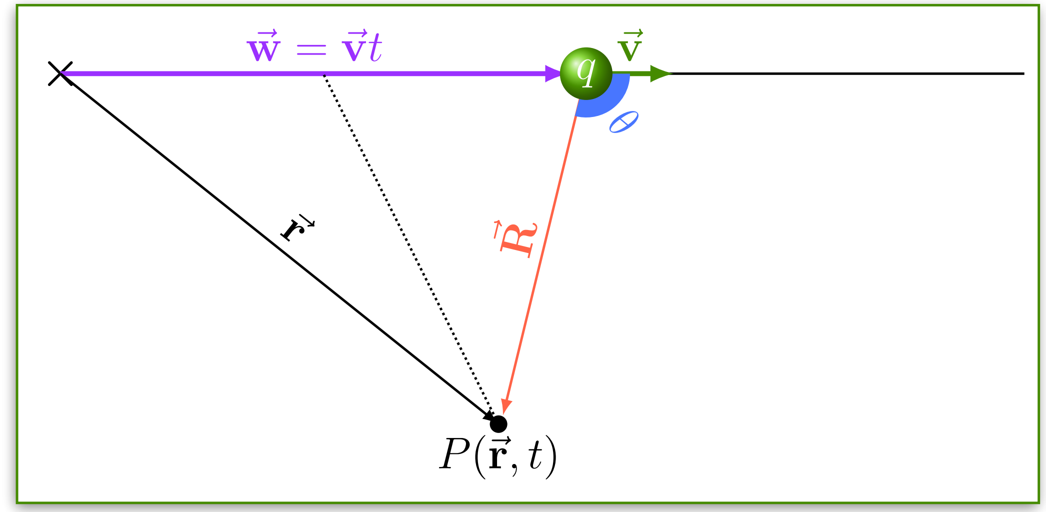


$$V(\vec{\mathbf{r}}, t) = \frac{1}{4\pi\epsilon_0} \frac{q}{R\sqrt{1 - (\frac{v}{c})^2 \sin^2\theta}}$$

Potenciais de Liénard e Wiechert

$$V(\vec{\mathbf{r}},t) = \frac{1}{4\pi\epsilon_0}\frac{q}{R\sqrt{1-(\frac{v}{c})^2\sin^2\theta}}$$

$$\vec{\mathbf{A}}(\vec{\mathbf{r}},t) = \frac{\mu_0}{4\pi}\frac{q\vec{\mathbf{v}}}{R\sqrt{1-(\frac{v}{c})^2\sin^2\theta}}$$



$$\vec{\mathbf{r}} \equiv \vec{\mathbf{R}} + \vec{\mathbf{v}}t$$

$$-\vec{\boldsymbol{\nabla}}V = \frac{q}{4\pi\epsilon_0}\left[\frac{\hat{\mathbf{R}}}{R^2\sqrt{1-(\frac{v}{c})^2\sin^2\theta}} - \frac{(\frac{v}{c})^2\sin\theta\cos\theta\,\hat{\theta}}{R\left(1-(\frac{v}{c})^2\sin^2\theta\right)^{3/2}}\right]$$