Table of contents

Velocity - Movement of Matter in Space and Time

Matter and Vacuum - refraction, max. phase velocity, max. group velocity

Lightspeed, max. group velocity :

$$\begin{aligned}
&c = \frac{|\mathcal{E}|}{|\mathcal{B}|} = \frac{1}{\sqrt{\epsilon_0\mu_0}}\left[\frac{F_\mathcal{B}}{F_\mathcal{E}}\right] = \frac{1}{\sqrt{\epsilon_0\mu_0}} = \frac{\eta}{\sqrt{\varepsilon\mu}} = \frac{\eta}{\sqrt{\varepsilon_0\varepsilon_r\mu_0\mu_r}} = \\
&\eta \cdot c_{ph} = \sqrt{v_{phase}\cdot v_{matter}} = \\
&\frac{\omega}{k} = \frac{\lambda}{\mathcal{T}} = \nu\lambda = -\frac{d\lambda}{d\nu}\nu^2 = \lambda^2\frac{\mathcal{J}_\lambda}{\mathcal{J}_\nu} = \frac{\langle|\mathcal{S}|\rangle}{\langle \mathrm{w}_{EM}\rangle} = v_{gr}^{max} \\
&\leq v_{ph} - \lambda\frac{d}{d\lambda}v_{ph} = \frac{d}{dk}\omega = v_{gr}
\end{aligned} \tag{1}$$

where:

$F_\mathcal{E} = q\mathcal{E} \equiv$ Coulomb-Force (Electric, charge presence, localization in space)

$F_\mathcal{B} = q(v\times\mathcal{B}) \equiv$ Lorentz-Force (Magnetic, charge movement, localization in time)

$\left[\frac{F_\mathcal{B}}{F_\mathcal{E}}\right] = 1$

$\mathcal{J} \equiv$ Flux Density

$\mathcal{S} \equiv$ Poynting-Vector, Intensity

$\mathrm{w}_{EM} \equiv$ Energy Density ElectroMagnetic

$\eta \equiv$ Refraction Index

Refraction for identifying matter (property of matter):

$$\begin{aligned}
&\eta \overset{opt.}{=} \frac{sin(\alpha)}{\sin(\beta)} = \frac{\eta_\beta}{\eta_\alpha} \overset{prism}{=} \frac{\sin[\frac{1}{2}(\varpi + \varsigma_{min})]}{\sin[\frac{1}{2}\varpi]} \\
&\overset{phys.}{=} \sqrt{\epsilon_r\mu_r} = \frac{\lambda_\alpha}{\lambda_\beta} = \frac{v_{ph,\alpha}}{v_{ph,\beta}} = \frac{1}{2}\frac{\lambda}{d_r}\frac{n}{\cos(\beta)} = \sqrt{\left(\frac{n}{2}\frac{\lambda}{d_r}\right)^2 + \sin(\alpha)^2} \\
&\overset{dispersion}{=} \eta(\lambda) = \eta(\omega) \overset{anisotropy}{=} \eta(r)
\end{aligned} \tag{2}$$

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$$\text{Vacuum} \iff \eta = 1 f = FocalLength \qquad D = RefractivePower(dioptry)$$

$n \equiv$ order ("quantum cycle"):

$$n = \frac{\nu}{c}\Delta s = \frac{\Delta\varphi}{2\pi} = 2\eta\frac{d_r}{\lambda}\sqrt{\eta^2 - \sin(\alpha)^2} = 2\eta\frac{d_r}{\lambda}\cos(\beta) = \frac{q}{e_0} \quad \in \mathbb{N} \tag{3}$$

$$v^2 = \left(\frac{\nu\lambda}{\eta}\right)^2 = \left(\frac{\omega}{k\eta}\right)^2$$

$$\left(\frac{\eta}{c}\right)^2 = \epsilon\mu \qquad \epsilon = \epsilon_0\epsilon_r \qquad \mu = \mu_0\mu_r$$

where:
$\{\alpha, \beta\} :=$ radiation orientation angles
$d_r = r_{x+1} - r_x :=$ distance in space
$\alpha :=$ irradiaton angle, incoming radiation direction, from source/sender (Einstrahlungswinkel zur Normalen auf Grenzfläche des Mediums)
$\beta :=$ refraction angle for bented transmitted radiation A_t orientation in matter (Durchstrahlungsswinkel zur Normalen aus Grenzfläche ins Medium)
$\epsilon_0 :=$ Dieelectric Constant (conductiv electric charge)
$\mu_0 :=$ Magnetic Constant (permeability in vacuum)

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