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Velocity - Movement of Matter in Space and Time

Matter and Vacuum - Refraction, max. phase velocity, max. group velocity:

Lightspeed, group velocity max.:

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

where:

$\mathcal{J}\equiv$ Flux Density flow [1]

$\mathcal{S}\equiv$ Poyinting-Vector intensity

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

Refraction Index:

Refraction for identifying matter (property of matter):

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

Vacuum $\iff\eta=1$: [1]

$$
f=FocalLength\qquad D=RefractivePower(dioptry)
\tag{3}
$$

[1]Flux Density

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

$$n = \frac{\nu}{c}\Delta s = \frac{\Delta\varphi}{2\pi} = 2\eta\frac{d_l}{\lambda}\sqrt{\eta^2 - \sin(\alpha)^2} = 2\eta\frac{d_l}{\lambda}\cos(\beta) = \frac{q}{e_0} \qquad \in \mathbb{N} \tag{4}$$

$$v^2 = \left(\frac{\nu\lambda}{\eta}\right)^2 = \left(\frac{\omega}{k\eta}\right)^2 \tag{5}$$

$$\left(\frac{\eta}{c}\right)^2 = \epsilon\mu \qquad \epsilon = \epsilon_0\epsilon_r \qquad \mu = \mu_0\mu_r \tag{6}$$

where:

d_l := distance length

α := irradiation angle, incoming radiation direction, from source/sender (Einstrahlungswinkel zur Normalen auf Grenzfläche des Mediums)

β := refraction angle for bented transmitted radiation A_t orientation in matter (Durchstrahlungsswinkel zur Normalen aus Grenzfläche ins Medium)

[1] Brechkraft

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