Campi Elettromagnetici

Corso di Laurea in Ingegneria Informatica, Biomedica e delle Telecomunicazioni

a.a. 2019-2020 - Laurea “Triennale” – Secondo semestre - Secondo anno

Università degli Studi di Napoli “Parthenope”

Stefano Perna

Color legend

New formulas, important considerations,
important formulas, important concepts

Very important for the discussion

Memo

Mathematical tools to be exploited

Mathematics

Plane Waves

Time domain (TD)

Spectral domains

- Phasor Domain (PD)
- Fourier Domain (FD)
- Dispersive media: attenuation, distortion, phase velocity and group velocity

General expression of plane waves (PD)

Incidence (PD)

Incidence: Limit and Brewster angles

$$\begin{cases} 1-\Gamma = \dfrac{Z_1}{Z_2}\mathrm{T} \\ 1+\Gamma = \mathrm{T} \end{cases}$$

$$\Gamma = \frac{Z_2 - Z_1}{Z_1 + Z_2} \qquad \mathrm{T} = \frac{2Z_2}{Z_1 + Z_2}$$

$$k_1 = \omega\sqrt{\mu_1\varepsilon_1} \qquad k_2 = \omega\sqrt{\mu_2\varepsilon_2}$$

$$k_x = k_1 \sin\vartheta_I \qquad k_{1z} = k_1 \cos\vartheta_I$$

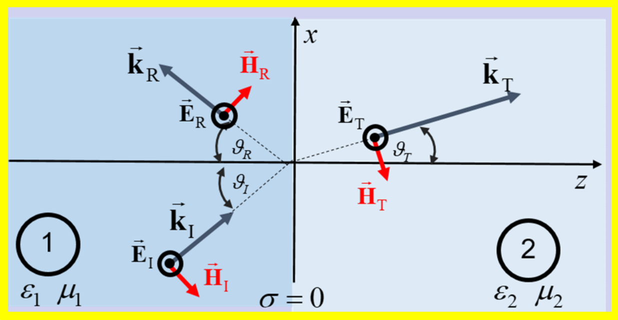
$$\vartheta_I = \vartheta_R$$

$$k_1 \sin\vartheta_I = k_2 \sin\vartheta_T$$

$$k_{2z} = \sqrt{k_2^2 - k_1^2 \sin^2\vartheta_I}$$

$\left[H_x, E_y, H_z\right]$

$$Z_1 = \frac{\omega\mu_1}{k_{1z}} \qquad Z_2 = \frac{\omega\mu_2}{k_{2z}}$$



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$\left[E_x, H_y, E_z\right]$

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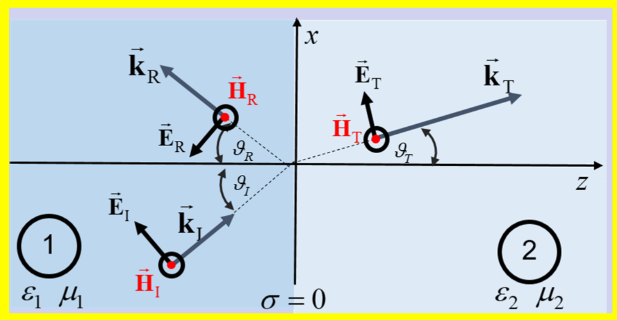

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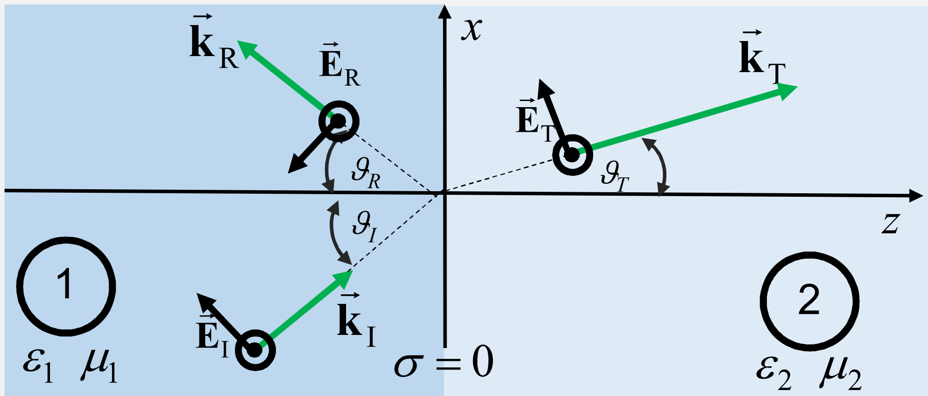

Incidence: Limit angle

$$\begin{cases} 1-\Gamma = \dfrac{Z_1}{Z_2}\mathrm{T} \\ 1+\Gamma = \mathrm{T} \end{cases}$$

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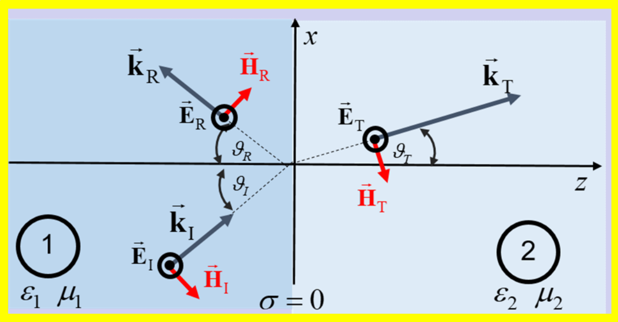

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$[E_x, H_y, E_z]$

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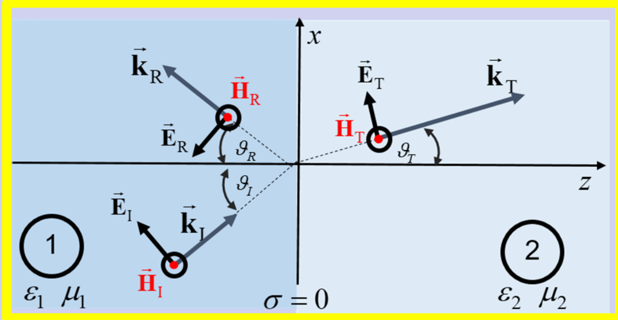

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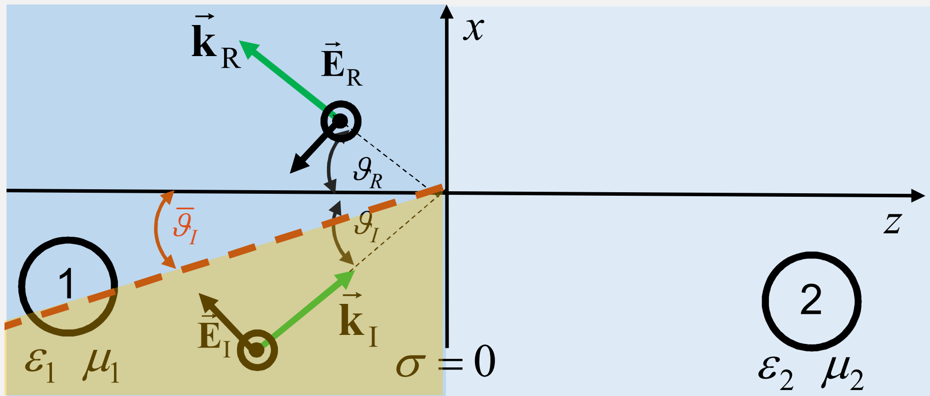
$$if \; \frac{k_2}{k_1} < 1$$

An angle $\bar{\vartheta}_I$ exists, referred to as **limit angle**, such that for $\vartheta_I \geq \bar{\vartheta}_I$ no propagation occurs in the second half-space

$$\sin\bar{\vartheta}_I = \frac{k_2}{k_1}$$



Incidence: Brewster angle

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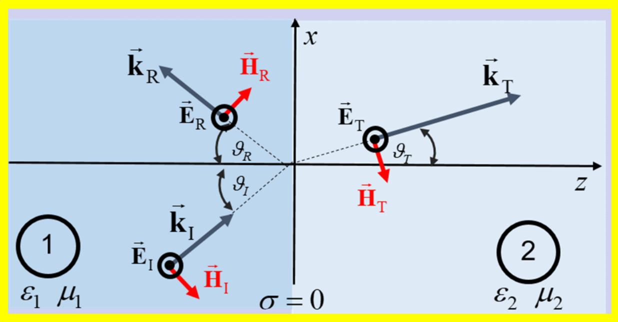

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$[E_x, H_y, E_z]$

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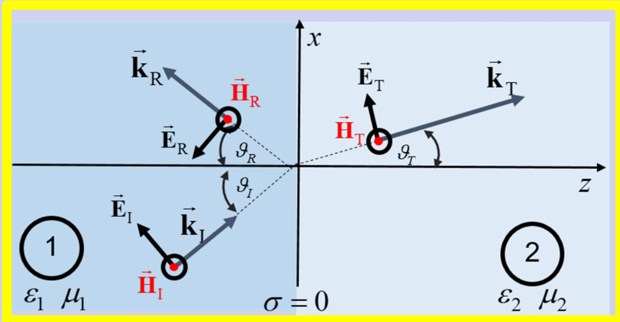
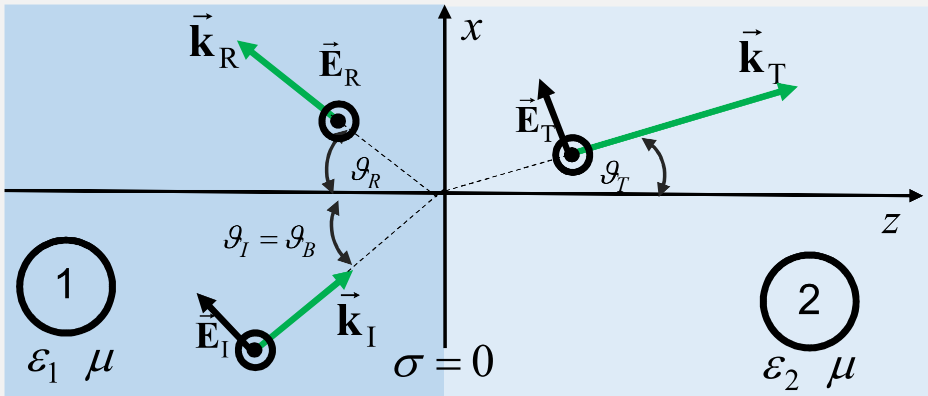


$\parallel$

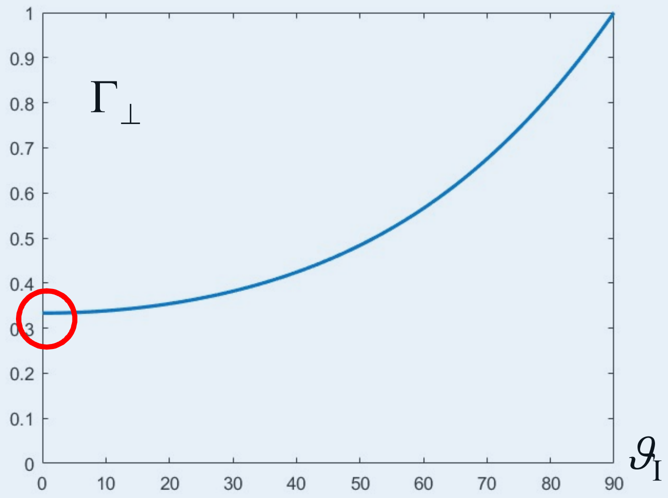
if $\mu_1 = \mu_2$ *and* $\varepsilon_1 \neq \varepsilon_2$

An angle ϑ_B exists, referred to as **Brewster angle**, such that an unpolarized plane wave incident at angle $\vartheta_I = \vartheta_B$ is reflected with perpendicular polarization

$$\sin^2\vartheta_B = \frac{\varepsilon_2}{\varepsilon_1 + \varepsilon_2}$$



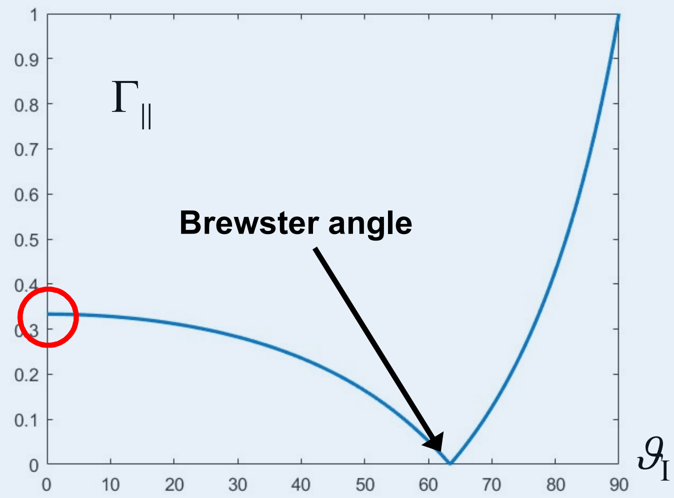
Fresnel coefficients



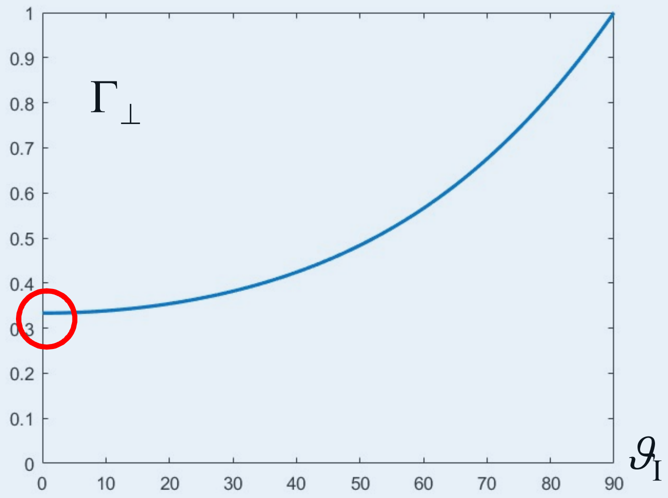
$$\mu_1 = \mu_2$$

$$\varepsilon_2 = 4\varepsilon_1$$

$$\frac{k_2}{k_1} > 1$$



Fresnel coefficients



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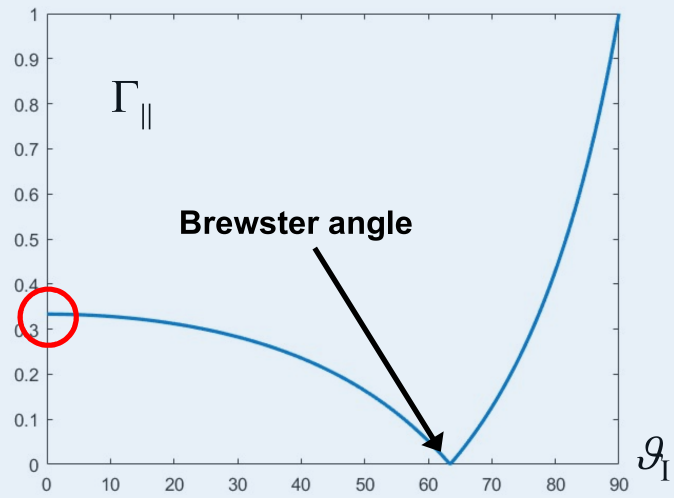
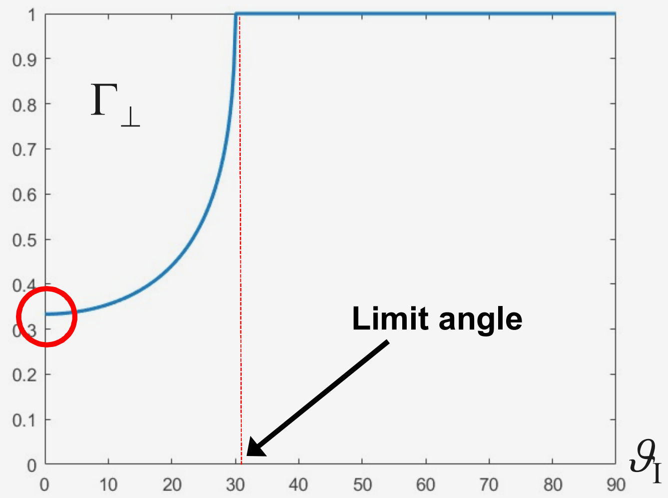
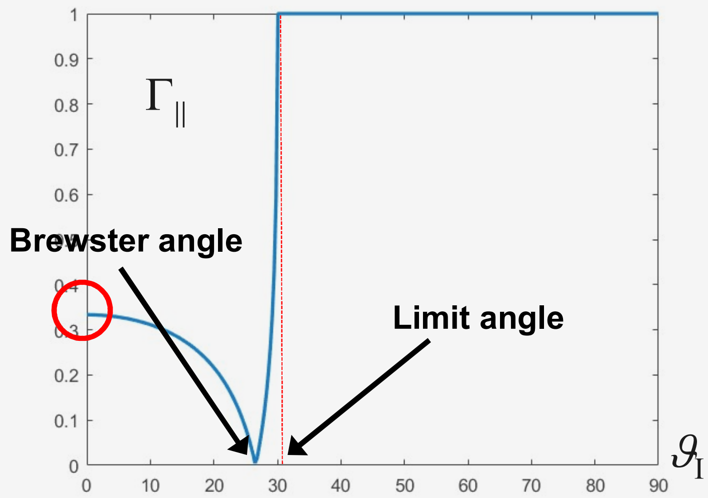




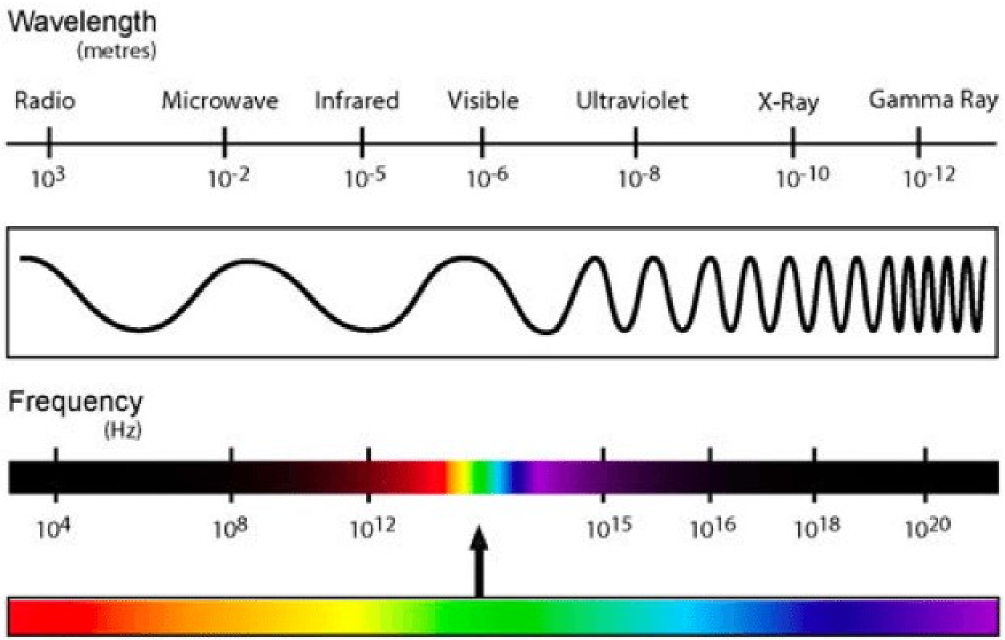
$$\mu_1 = \mu_2$$

$$4\varepsilon_2 = \varepsilon_1$$

$$\frac{k_2}{k_1} < 1$$



Electromagnetic spectrum



Free space (Linear, isotropic, local, homogeneous)

$$\lambda = \frac{c}{f}$$

f: frequency
λ: wavelength
c: light speed

Incidence: Limit angle