Lecture 1

Review of a class that doesn’t exist and bits of EE 330

What is Spectroscopy?

Spectroscopy is the study of matter via its interaction with light

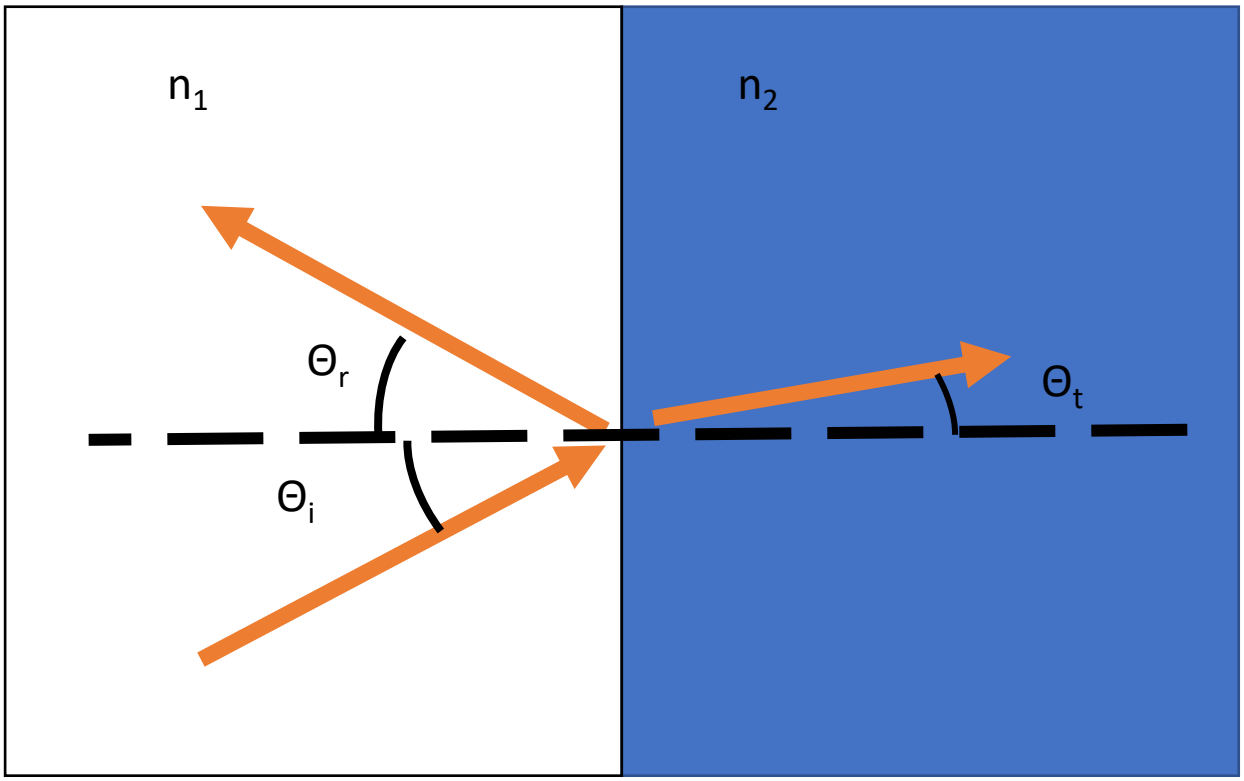
Transmission and reflection

- Electromagnetic wave incident on a surface will be reflected, transmitted, and/or absorbed
- Depends on the angle of incidence, wavelength of light, and the material

Snell's Law

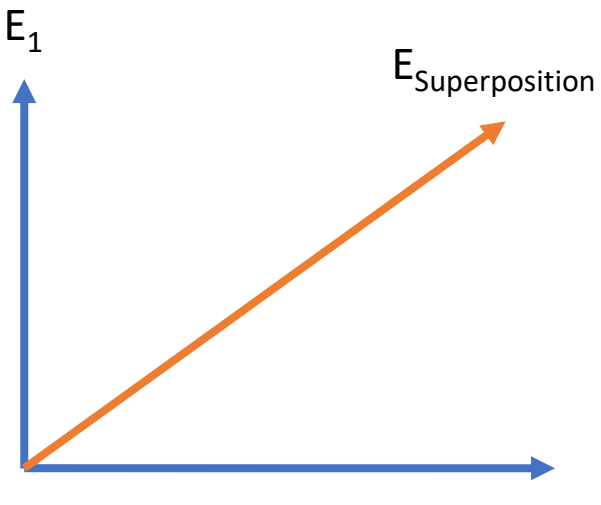
- Reflection: $\theta_i = \theta_r$
- Transmission: $\frac{\sin(\theta_t)}{\sin(\theta_i)} = \frac{n_1}{n_2}$

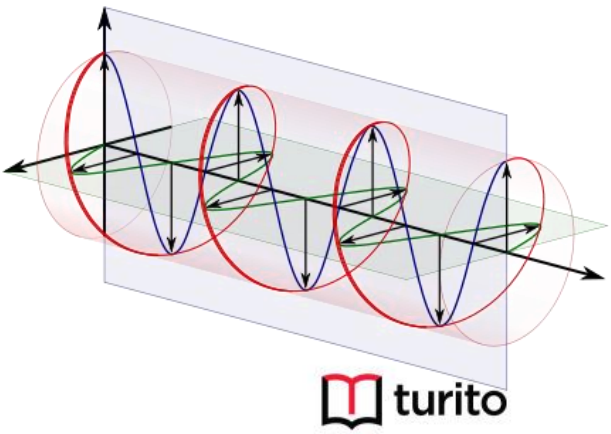
Question: Does the path of the wave move towards the normal or away from it when $n_2 > n_1$?

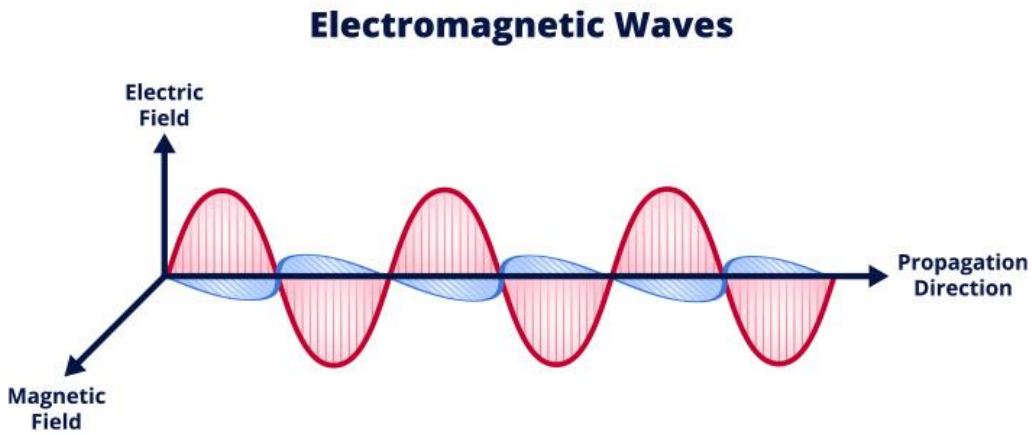


Polarization

- Defined in terms of the orientation of the E-field component.
  - Often we think of it as “horizontal” or “vertical” polarization based on which plane its oscillating
- Linear polarization: E-field oscillates linearly in one plane
- Other polarizations can be defined as superpositions of the multiple linear polarizations
  - Adding in phase variations leads to circular and elliptical polarizations

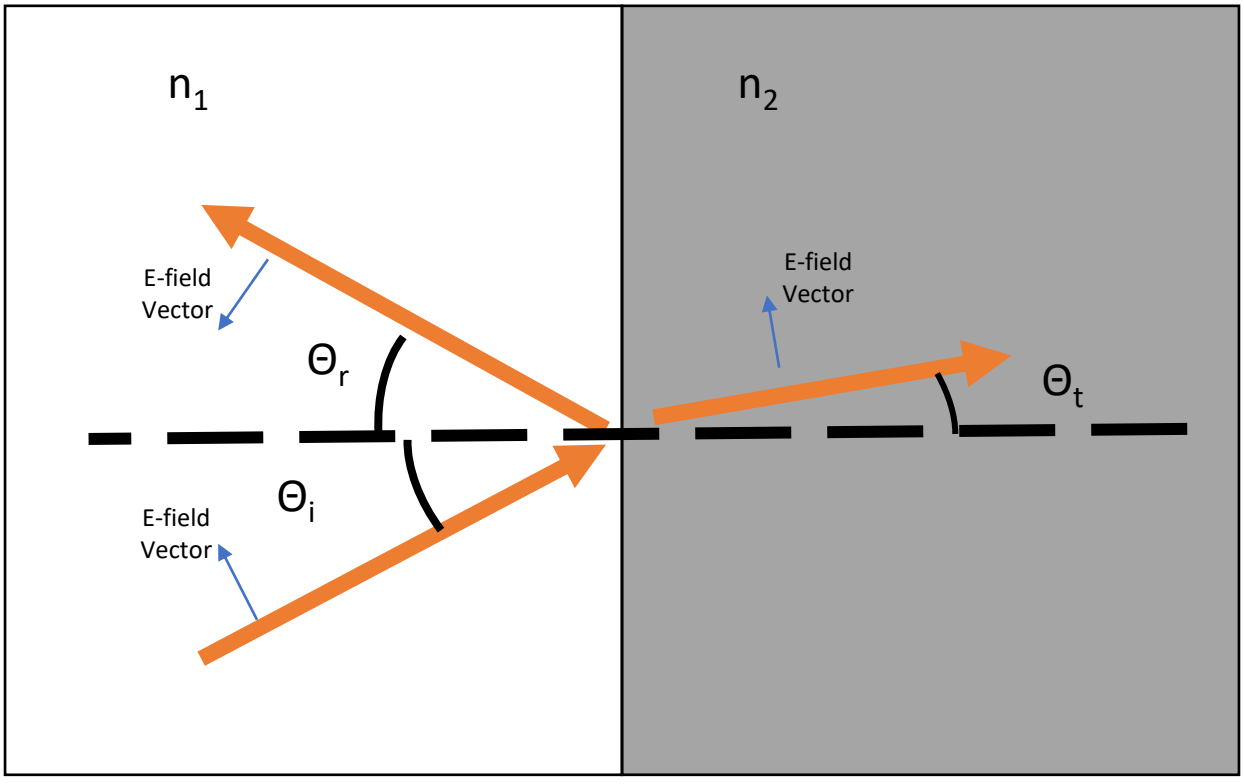






Oblique incidence: transmission and reflection

- Polarization plays a role in this case
- Defined as perpendicular and parallel based on the orientation of E-field with respect to angle of incidence
- Brewster's angle: angle where 100% transmission occurs for parallel polarization
  - $\theta_B = \arctan\left(\frac{n_2}{n_1}\right)$
- Critical angle: where total internal reflection happens.
  - $\sin(\theta_c) = \frac{n_2}{n_1}$
- Question can total internal reflection occur at transitions where $n_1 > n_2$?



Getting a laser beam where you want it

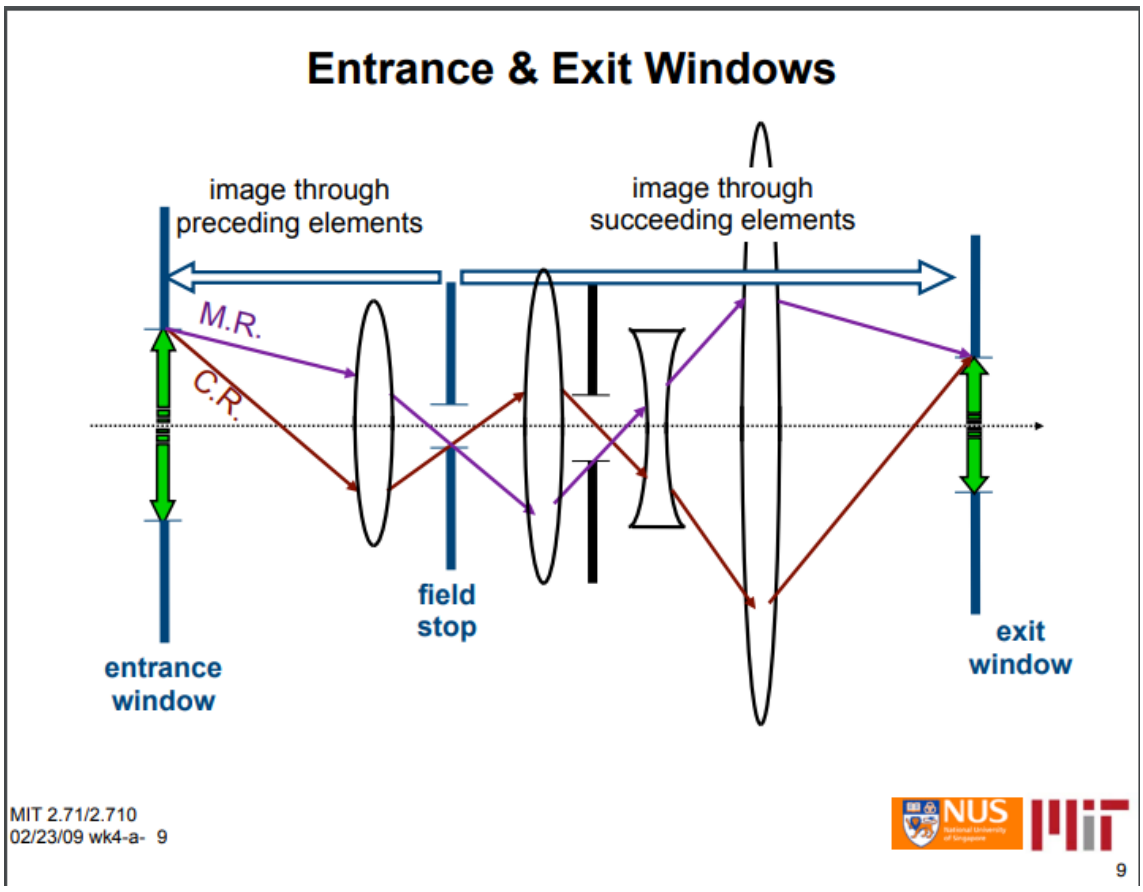
Getting a laser beam where we want it requires adjusting it for tip and tilt and being sure that it is vertically and laterally where we want it

Video explains z-fold and figure-4 techniques

Image Formation

Terms to know:

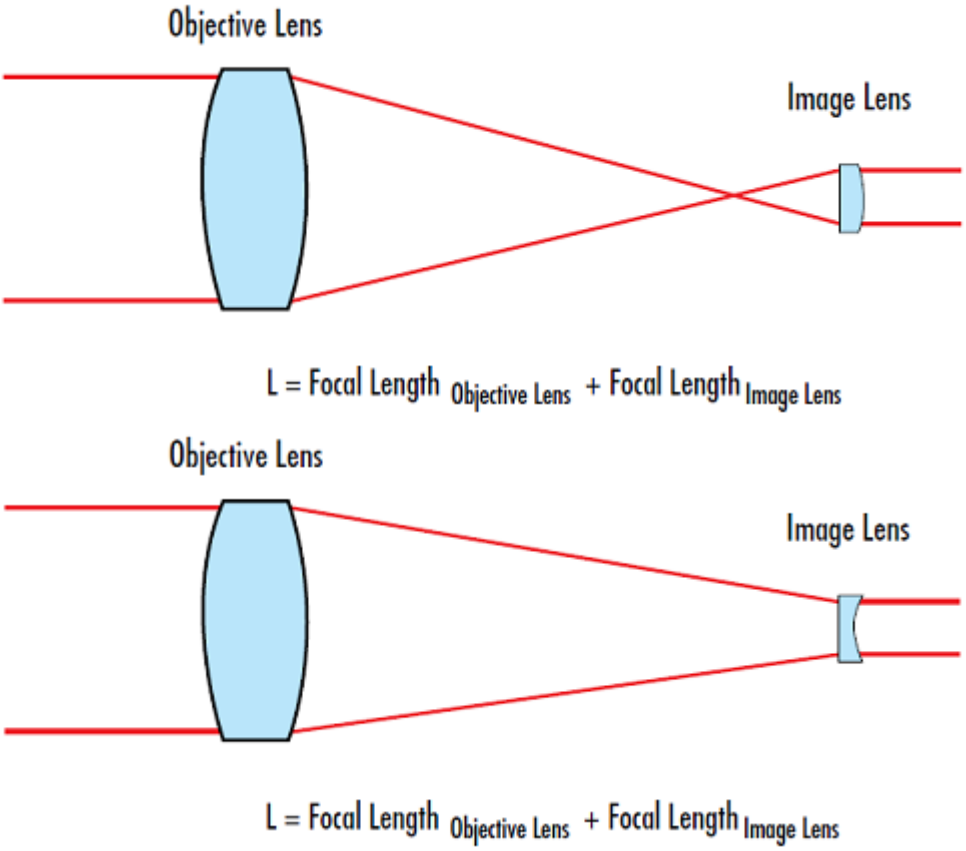
- **Converging lens:** Bends light towards a positive focus, forms a real image
- **Diverging lens**: light appears to diverge or emanate from a virtual image at the focal plane
- **Aperture Stop:** Limits the amount of energy that can enter the optical system, limits area that can enter
- **Field Stop:** limits the angle through which light can enter



Shamelessly stolen from MIT OCW

A focal systems and beam expanders

- Sometimes your laser beam is too small (or too big) to illuminate your target appropriately
- You need to embiggen it or shrink it



- No image is formed at the output
- Expanding the beam lowers the divergence, and paradoxically keeps the beam together better at longer distances