

$$\nabla \cdot \mathbf{E} = \frac{\rho}{\epsilon_0}$$

$$\nabla \cdot \mathbf{B} = 0$$

$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$$

$$\nabla \times \mathbf{B} = \mu_0 \left( \mathbf{J} + \epsilon_0 \frac{\partial \mathbf{E}}{\partial t} \right)$$

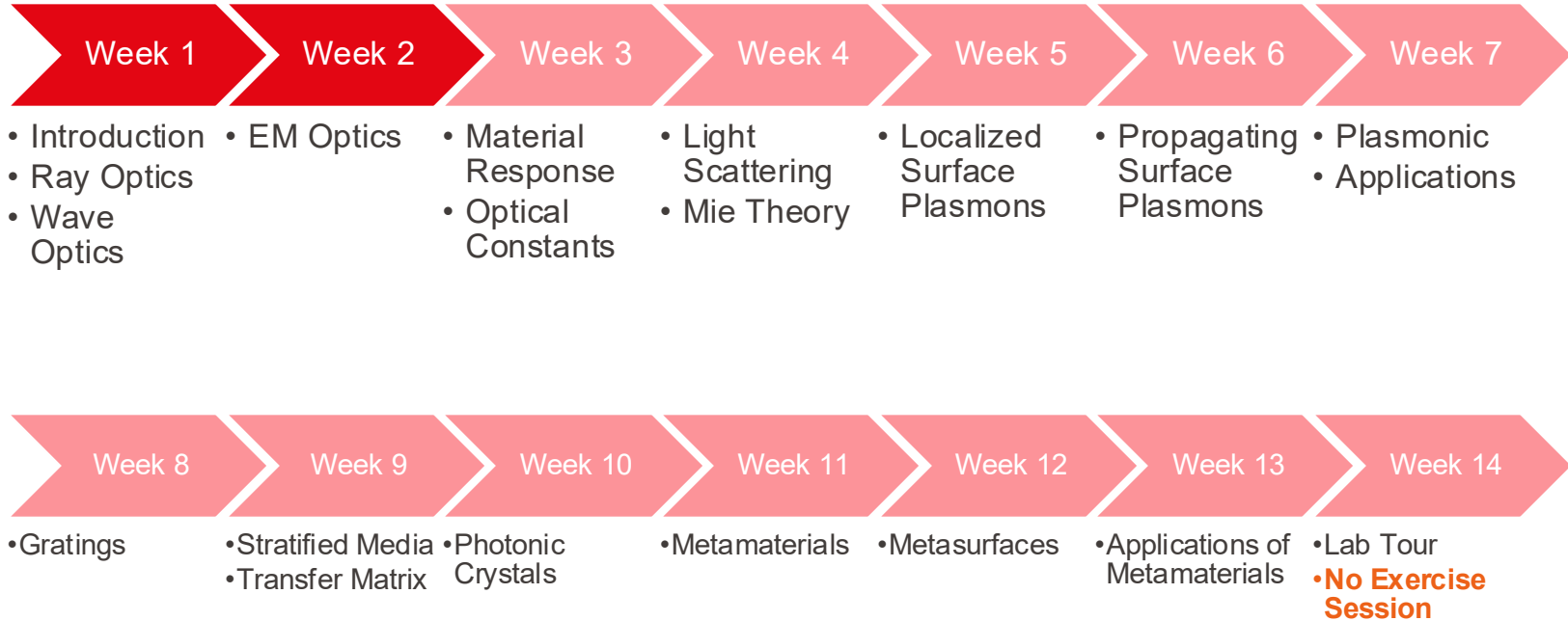
# Week 2

(Electromagnetic Optics)

Stavros Athanasiou

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# Course Timeline



- Demos with Jupyter notebook and Python



Use the course link : <https://go.epfl.ch/STIAO25>

A screenshot of a Jupyter Notebook interface. The left sidebar shows a file browser with a search bar and a list of files: 'additional\_mater...', 'exercises', 'demo.ipynb', 'LICENSE.md', and 'README.md'. The main area displays a notebook cell titled 'Demonstration' with the following content:

Interactive modes:

- Command mode
- Edit mode

How to switch between modes:

- From Edit to Command mode, use `ESC`.
- From Command to Edit mode, use `Enter`.

Cell type:

- Markdown
- Code
- Raw

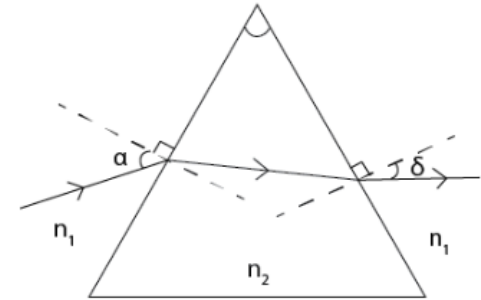
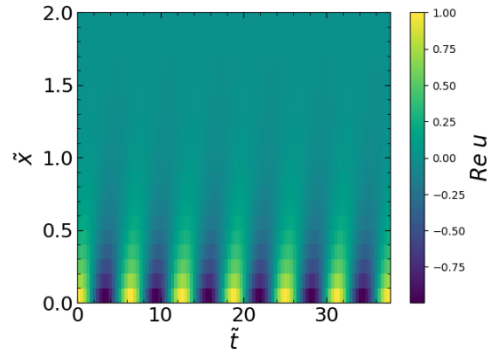
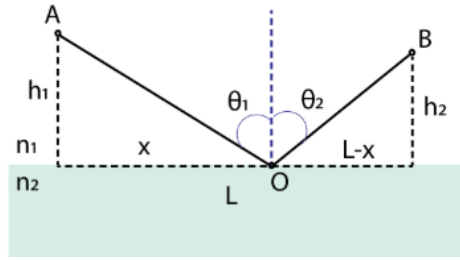
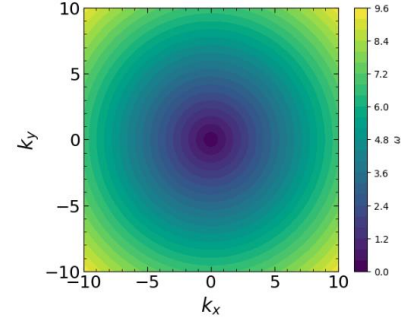
Some useful commands in Command mode:

- Use `b` to create a new cell below this one.
- Use `a` to create a new cell above this one.
- Use `x` to "cut" a cell (or remove a cell)
- Use `c` to copy a cell
- Use `x` to paste a cell below the current one.
- Use `m` to cast a cell into markdown type.
- Use `y` to cast a cell into code type.
- Use `r` to cast a cell into raw type.

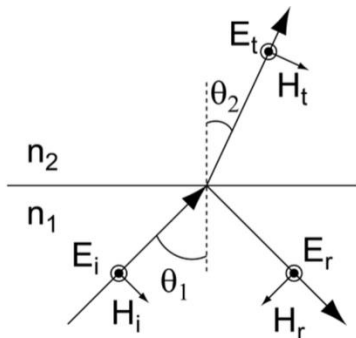
At the bottom of the cell, the code `import numpy as np` is visible.

Last week:

1. Fermat's principle
2. Propagating and evanescent waves
3. Dispersion relations
4. Reflection in a prism



- Derivation of the Fresnel Coefficients for TE-polarization



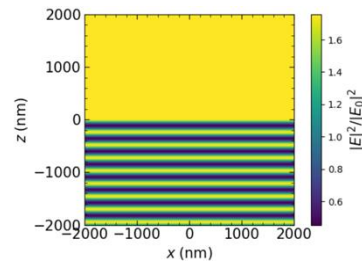
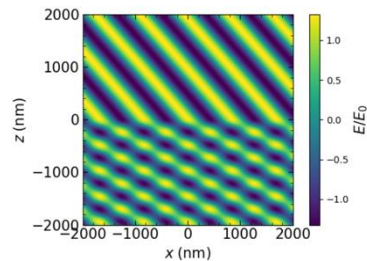
$$H_1^{\parallel} = H_2^{\parallel}, \quad D_1^{\perp} = D_2^{\perp}, \quad E_1^{\parallel} = E_2^{\parallel}, \quad B_1^{\perp} = B_2^{\perp}$$

$$r = \frac{n_1 \cos \theta_1 - n_2 \cos \theta_2}{n_1 \cos \theta_1 + n_2 \cos \theta_2}, \quad t = \frac{2n_1 \cos \theta_1}{n_1 \cos \theta_1 + n_2 \cos \theta_2}$$

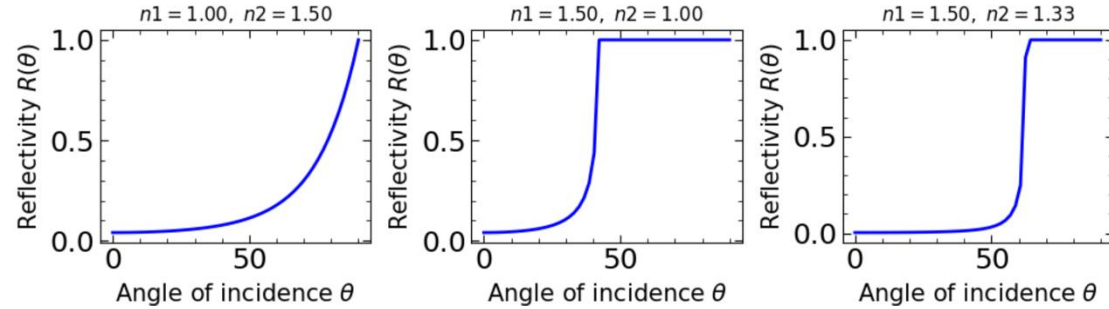
- Field Visualization

$$E_y(x, z < 0; \theta_{inc}) = e^{ik_x x + ik_z z} + r(\theta_{inc}) e^{ik_x x - ik_z z}$$

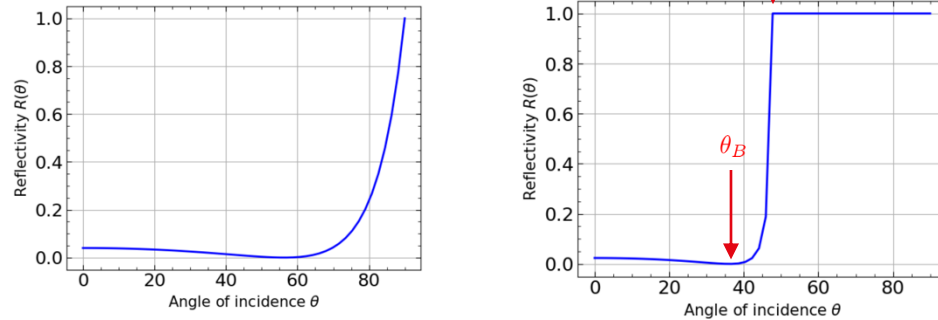
$$E_y(x, z > 0; \theta_{inc}) = t(\theta_{inc}) e^{ik'_x x + ik'_z z}$$



- Total Internal Reflection



- The Brewster Angle



# Understanding Reflection

- Classical Theory See Feynman Lectures, Vol I.
  - Macroscopic description : wave bouncing off surfaces
  - Microscopic description : electrons are treated as little oscillators which radiate
- Quantum Theory (microscopic)
  - Photons are absorbed by electrons, and are re-emitted
  - The probability amplitudes for all possible paths (reflection, transmission, scattering) interfere.

