Hands-on experimental and computer laboratory in optics

The Young Double Slit Experiment

H. Ghalila, A. Ammar*, Y. Majdi, S. Lahmar, Z Dhaoudi, M. Zghal, Zohra Ben Lakhdar, V. Lakshminarayanan*

Optical Society of Tunisia & LSAMA Lab, Faculty of Sciences of Tunis

August 21, 2018

Teaching has not changed over the centuries!

Figure: Henry of Germany lecturing at the University of Bologna. Painting by Laurentius de Voltolina (1350).

Active learning cycle

Teacher has to change the classical and usually passive way of teaching to one favoring Predictions, Observations, Discussions and Syntheses (PODS).

Learning through experimentation

Active Learning in Optics and Photonics (ALOP) UNESCO's programme is the best example for this concept that provide a set of experiments to understand optics and photonics.

Learning through simulation

ALOP does not contain computations or simulations. "Active learning" and "Optics simulations" together may be joined as "Active Learning in Simulating Optics" (ALSO).
Our goal is to encourage teachers and students to take an active part in developing their own codes as they design individual own experiments.

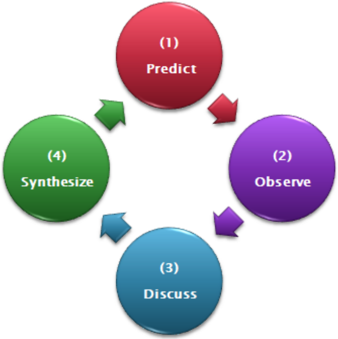


Figure: ALOP learning cycle.

Active Learning in Simulating Optics (ALSO)

Some of the criteria for a good computer simulation for classroom use

Some of the criteria that are relevant for learning via simulation include:

- The simulations should be true to life. That is, they should simulate the activity so well that there is little difference between the simulated environment and the real one, and the same kind of learning experience can take place.
- The simulations should be "hand-on," involving the students so that the students become participants in the simulation activity. This implies that students interact with the simulation, for example, by changing parameters, changing lines in the code, discussing the simulated results, etc.
- Simulations should motivate learning. Student involvement in the activity should be such they are motivated to learn more about the activity or the subject matter.
- Simulations should be customizable to the students' needs. Students' developmental requirements should be taken in consideration while designing simulations specifically for them.
- Simulations are meant to supplement, not replace other teaching modes. Integrating simulations into the curriculum also ensures that connections to domain knowledge and real-world applications are made explicit.
- As with any instructional technology, computer simulations should be chosen to meet the teaching objectives and teach the content.

Optics simulation with Python

What is Python?

Python is a modern, general-purpose, object oriented, high-level programming language.

- **Clean and simple language:** Easy-to-read and intuitive code, easy-to-learn minimalistic syntax, maintainability scales well with size of projects.
- **Expressive language:** Fewer lines of code, fewer bugs, easier to maintain.
- **Powerful Python packages:** open source pre-built and tested scientific and analytic Python packages that include NumPy, Pandas, SciPy, Matplotlib...
- **An easy way to install Python and its packages:** Anaconda is a cross platform Python distribution and easy-to-install free package and environment manager.

Example: The Young Double Slit Experiment

ALOP, Zimbabwe, July 2018

Observation

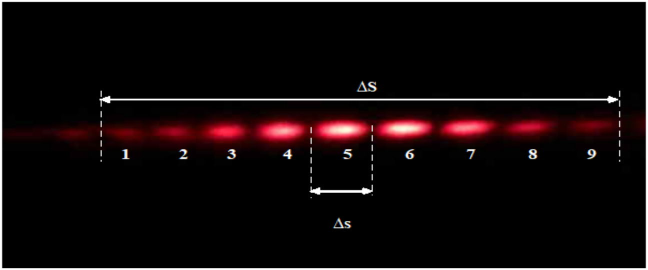
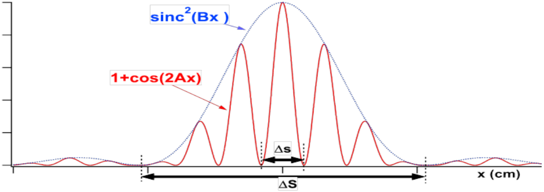
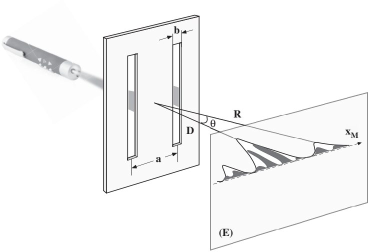


Figure: Measures of the size of the main central peak of diffraction ΔS, the size of the small spot du to the interferences Δs and enumeration of the number of interference peak inside the main peak of diffraction

The distance D acts as an input parameter and except for this parameter, which can be easily varied and measurable, the slit width and the distance between them are made imprecise or even unknown. All these parameters will be used when comparing experiments and numerical modeling and as goal of the experiment is to determine precisely these last two parameters (ΔS and Δs).

Numerical modeling



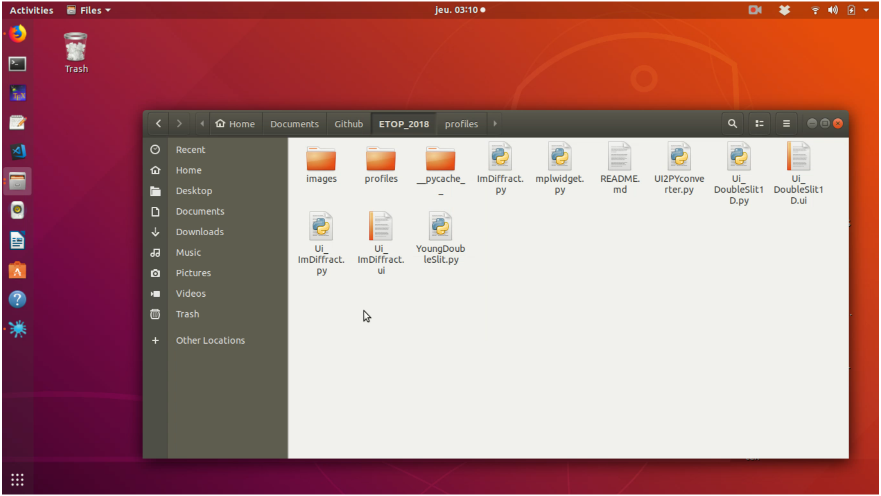


Analytical expression

$$I(x) = sinc^2(Bx)[1 + cos(2Ax)] \qquad where: \ A = \pi a/\lambda D \ and \ B = \pi b/\lambda D$$

b stands for the width of the slits, a represents the distance between slits, D is the distance of the screen to the plan of the slits and λ is the wavelength of the monochromatic incident light.

Python application

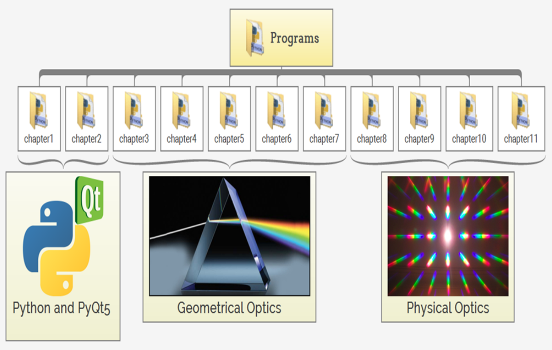


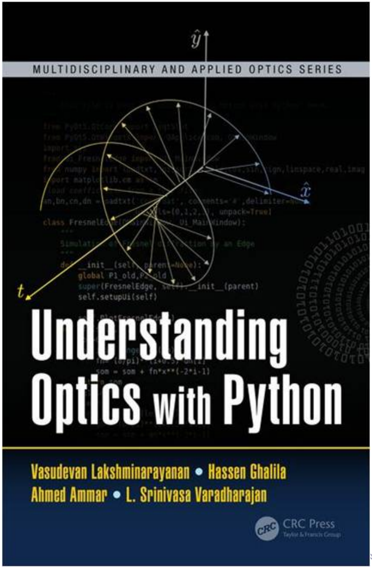
Clone or download the code source from GitHub:

https://astrax.github.io/ETOP_2018/

New published text book

More than 50 programs and applications are free to download on the book's web page: www.crcpress.com/9781498755047





Thank you!