Hands-on experimental and computer laboratory in optics

The Young Double Slit Experiment

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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

What teacher need?

Teacher/Learner needs a crucial tool to animate his class:

- Low-cost equipment and techniques that are suitable for physics education in many developing countries.
- Easy to build and to use.

Example: ALOP

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.

Computations

ALOP does not contain computations. Nowadays, science is not only the classic two divisions: Theory and Experiment.

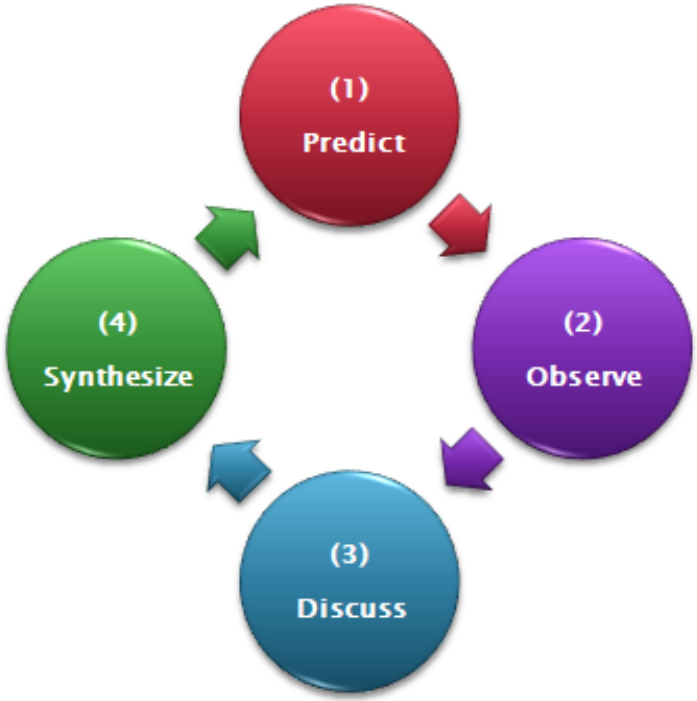

Figure: ALOP learning cycle.

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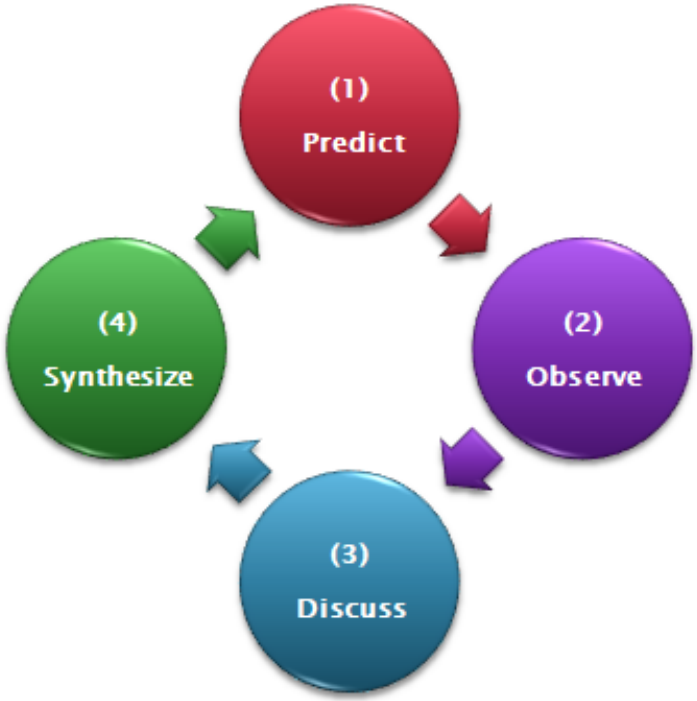

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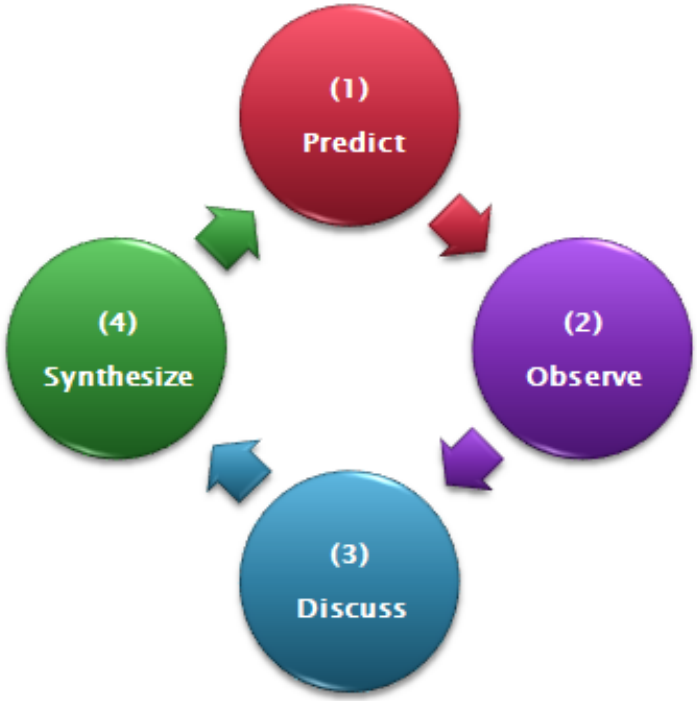

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Active Learning in Simulating Optics (ALSO)

The role of computing in science

Scientific computing is often closely related to theory, but it also has many characteristics in common with experimental work.
It is therefore often viewed as a new third branch of science.
Nowadays a vast majority of both experimental and theoretical papers involve some numerical calculations, simulations or computer modeling.
To start computing we need to learn a programming language.

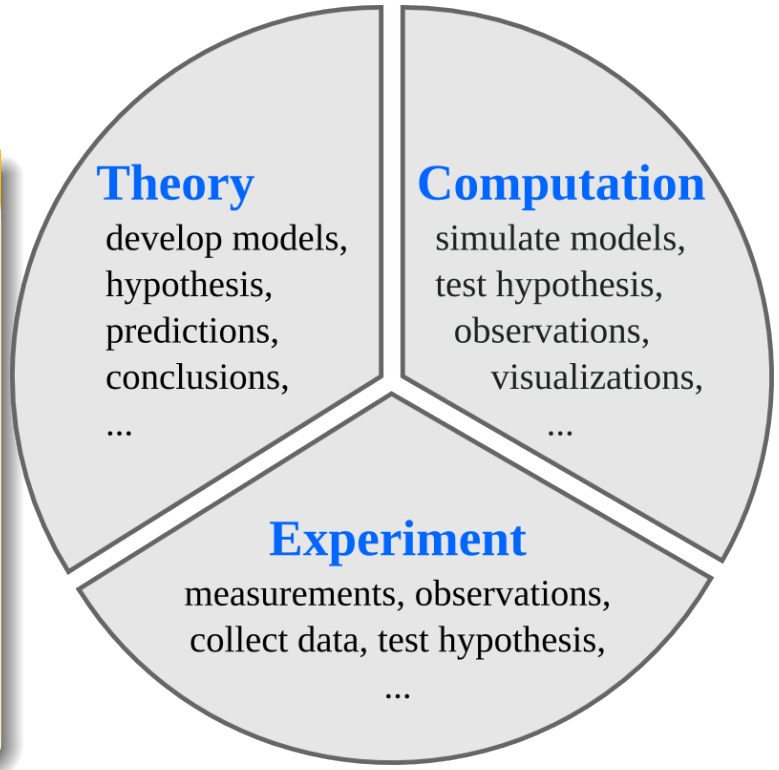


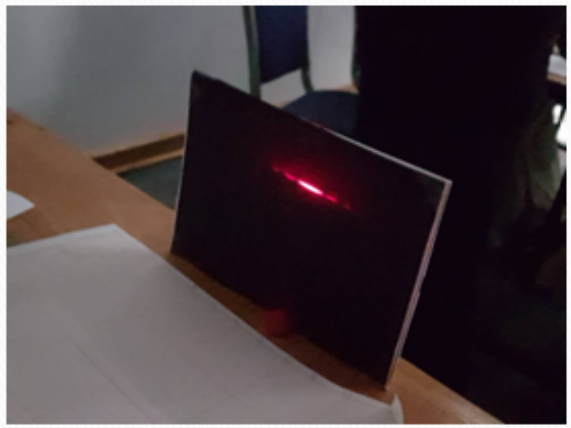
Figure: Three branch of science.

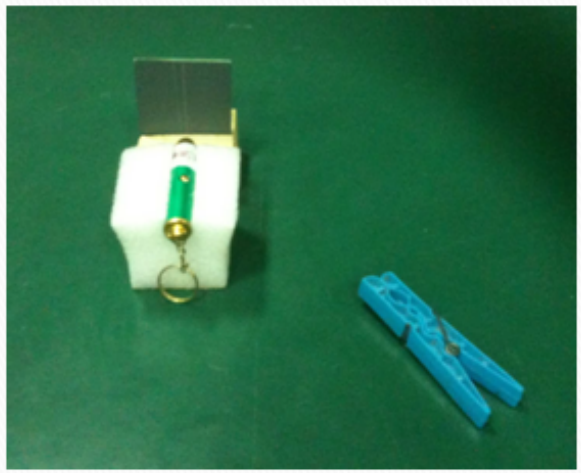
Python

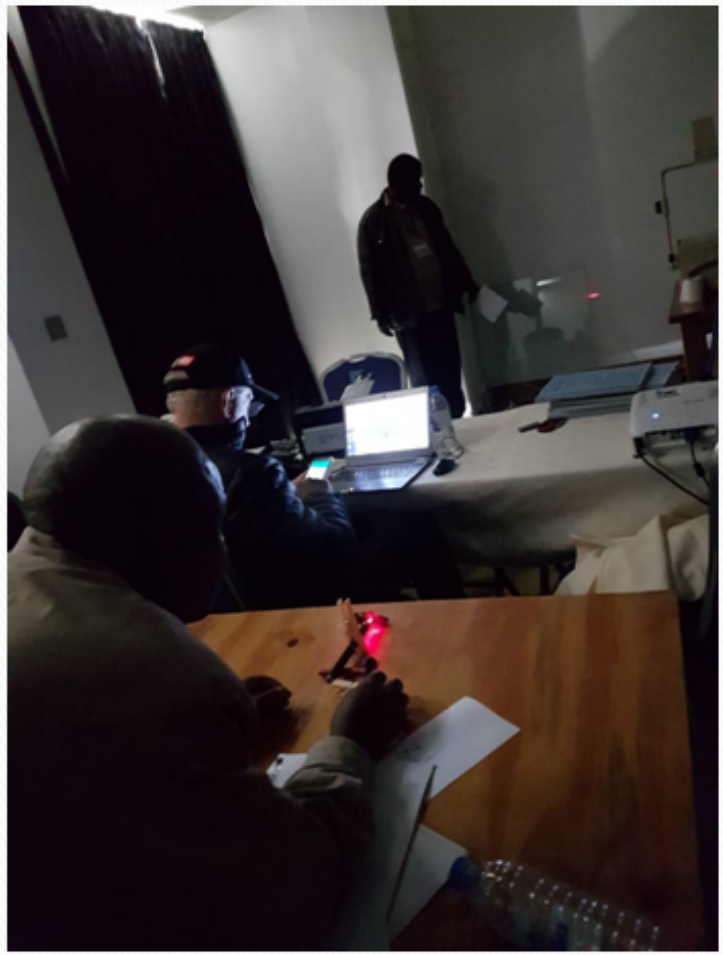
Python is a modern, general-purpose, object oriented, high-level programming language.
General characteristics of Python:
Clean and simple language: Easy-to-read and intuitive code, easy-to-learn minimalistic syntax, maintainability scales well with size of projects.
Expressive language: Fewer lines of code, fewer bugs, easier to maintain.

Example: The Young Double Slit Experiment

ALOP, Zimbabwe, July 2018







Observation

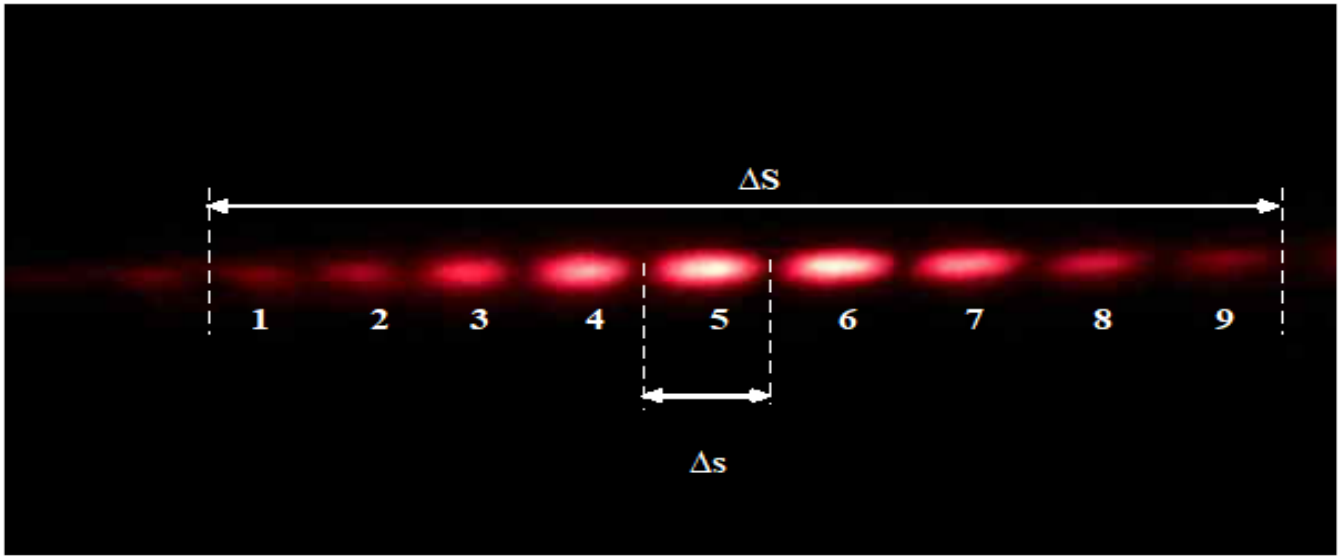
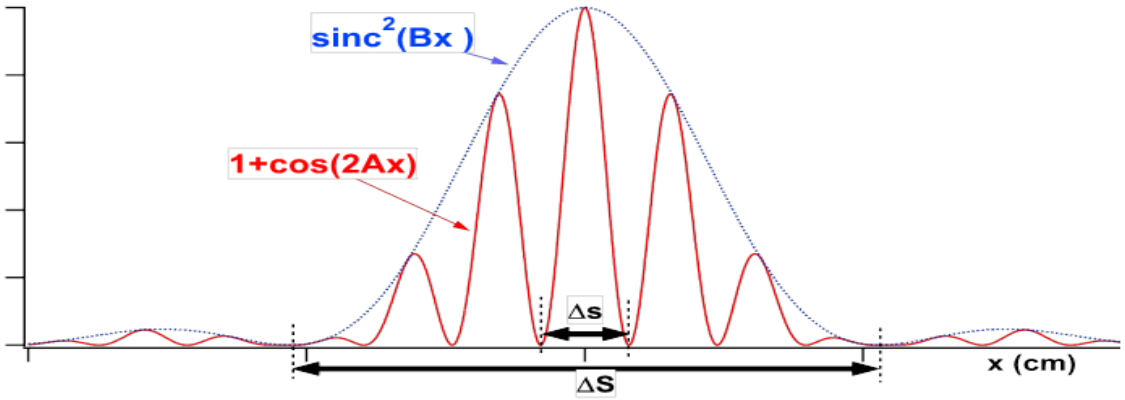
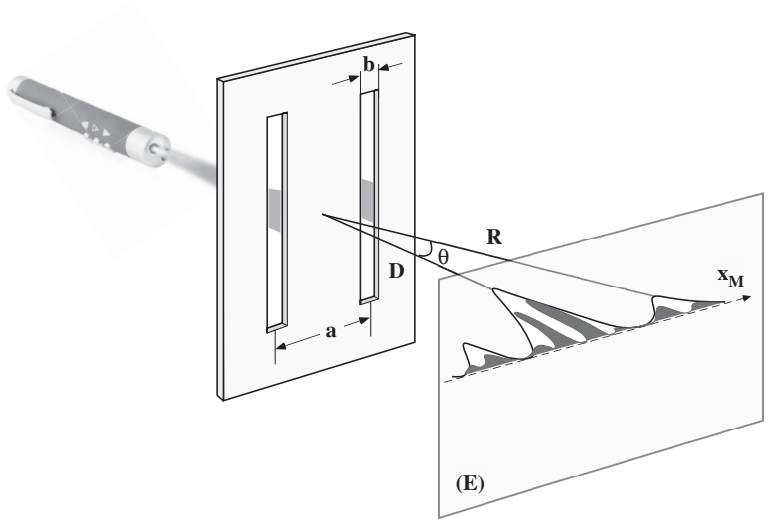


Figure: Measures of the size of the main central peak of diffraction ΔS, the size of the small spot du to the interferences Δs and enumeration of the number of interference peak inside the main peak of diffraction

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

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Clone or download the code source from GitHub:\ https://github.com/astrax/ETOP_2018

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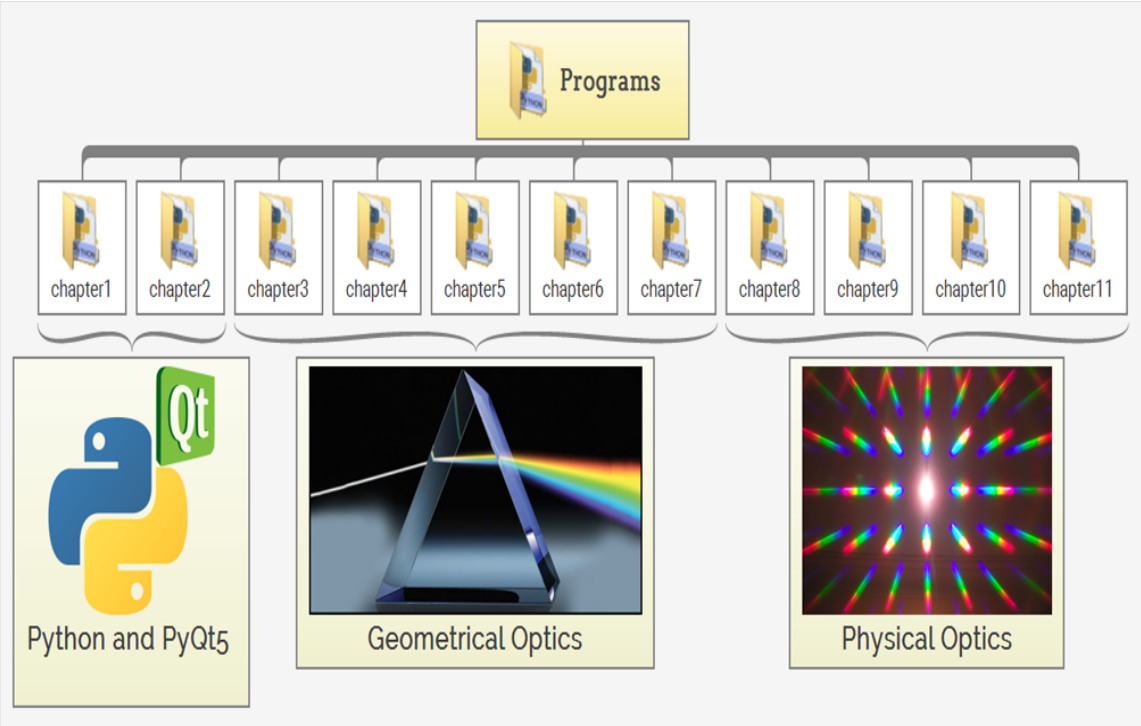

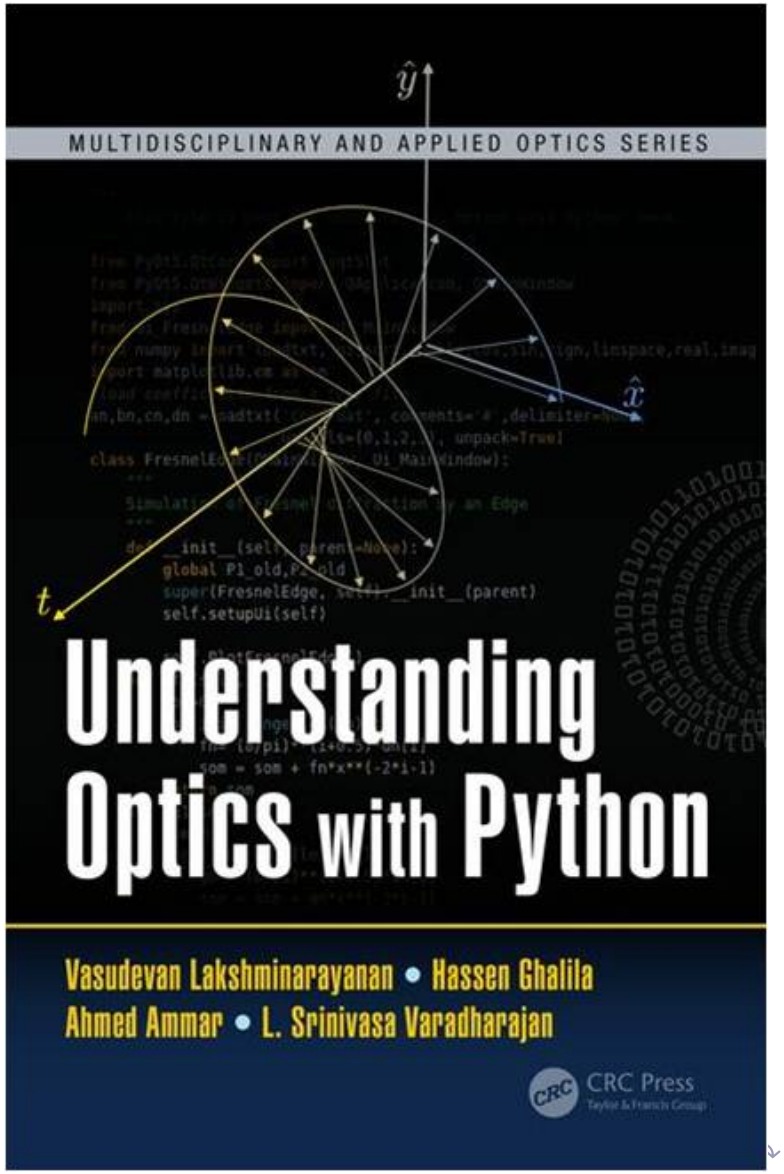

Thank you!