Designing a Teaching Grade Phase-Contrast Microscope on an Optical Bench

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Introduction to Phase Contrast Microscopy

Phase contrast microscopy (PCM), is an optical technique that uses phase differences to produce high-contrast images of specimens.

The phase contrast microscope was invented by **Prof Frits Zernike** in 1933 for which he received the Nobel Prize in Physics in 1953.

Prof. Frits Zernike

Bright Field Microscopy

1. Absorption of light builds the image
2. Contrast is low
3. Can not be used to study transparent samples
4. Very simple setup

Phase Contrast Microscopy (PCM)

1. Differential optical density builds the image
2. Contrast is high
3. Can visualize transparent samples as well
4. Setup is a little complex

Design principle of PCM

When light rays pass through a specimen of varying optical densities/thicknesses, small phase changes are induced which are not detectable by human eye.

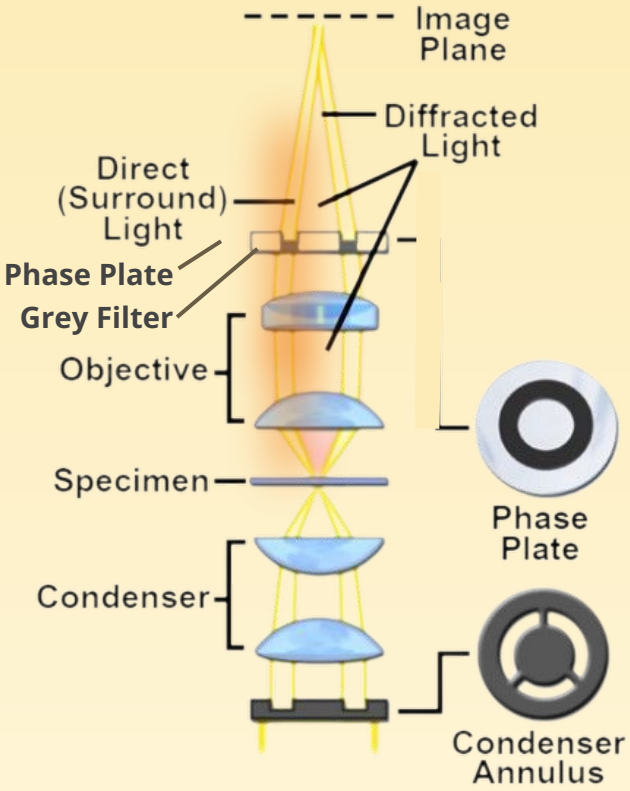
Adding few more optical components in the light path translates the phase information into intensity differences, creating an image.

A condenser annulus creates a narrow, hollow cone of light to illuminate the specimen.

A 90° phase plate is used to shift the phase of the this light to yield a higher contrast.

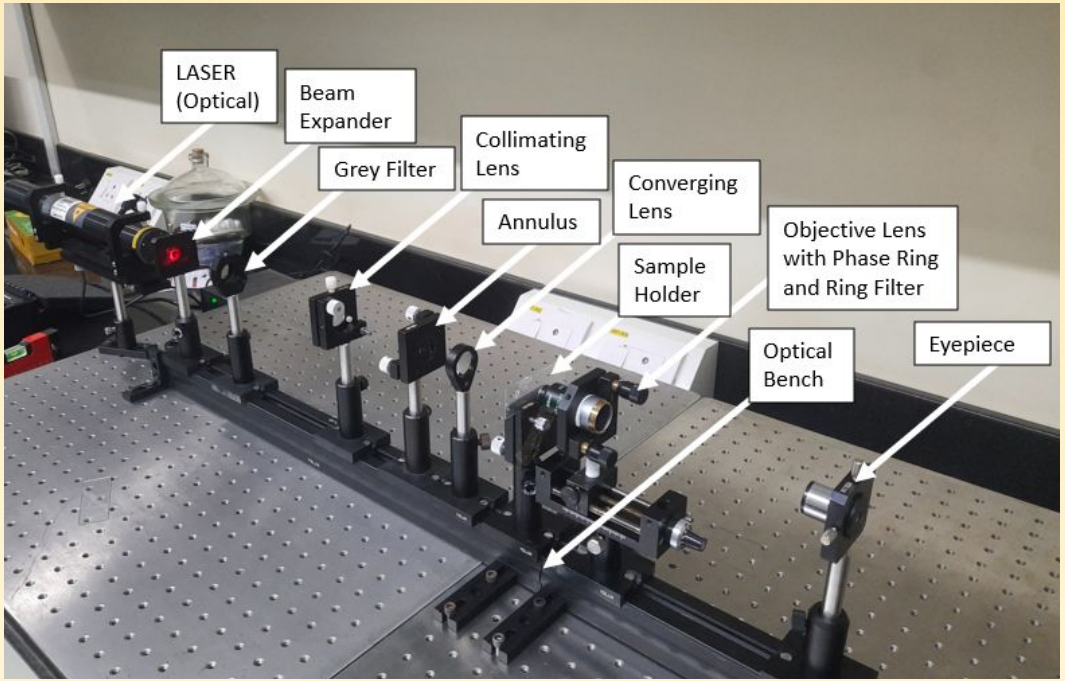
A gray filter is used to reduce the intensity of undeviated light

Diffracted and the undeviated light rays are made to interfere on a screen to form an image.

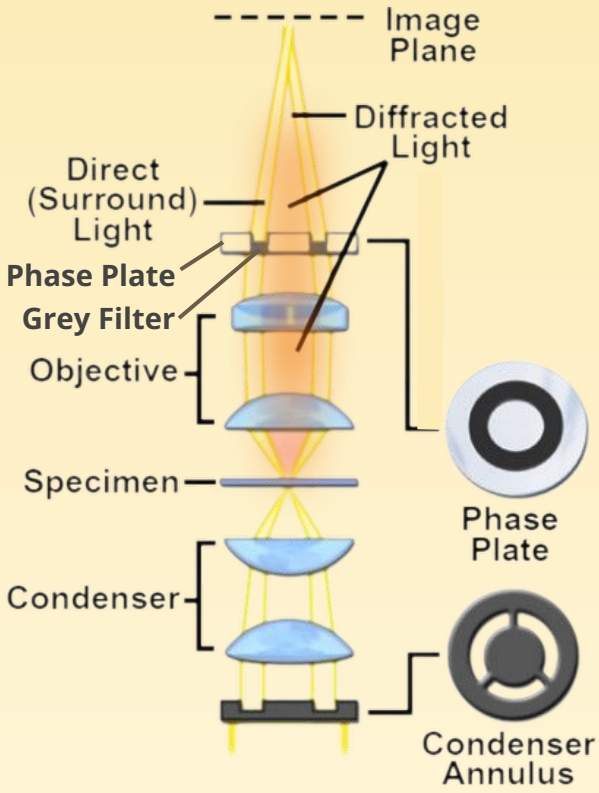


Schematic Representation of the Phase-Contrast Setup

Our Experimental Setup



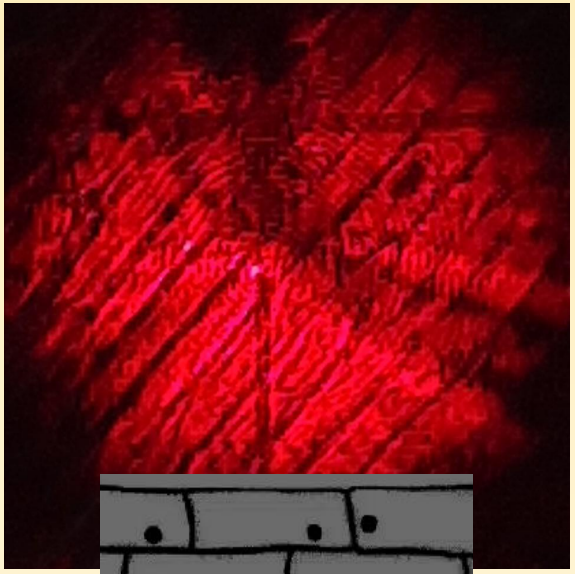
Phase-Contrast Setup



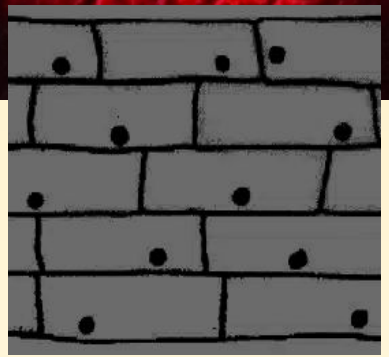
Schematic Representation of the Phase-Contrast Setup

Results: Imaging different specimens

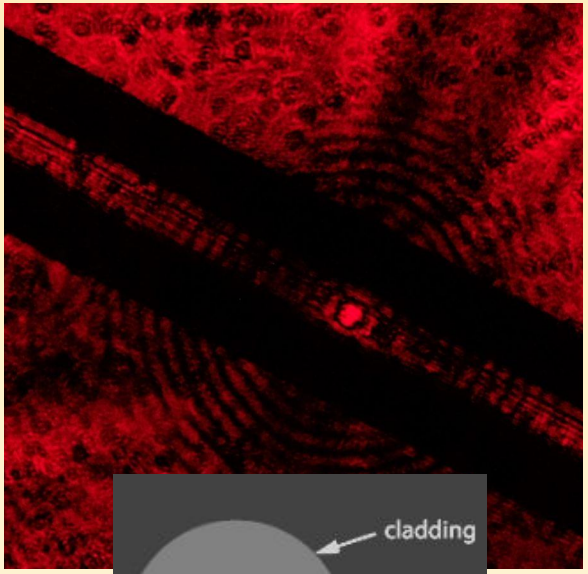
Onion Cells



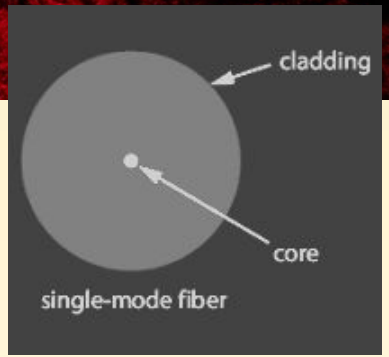
Schematic



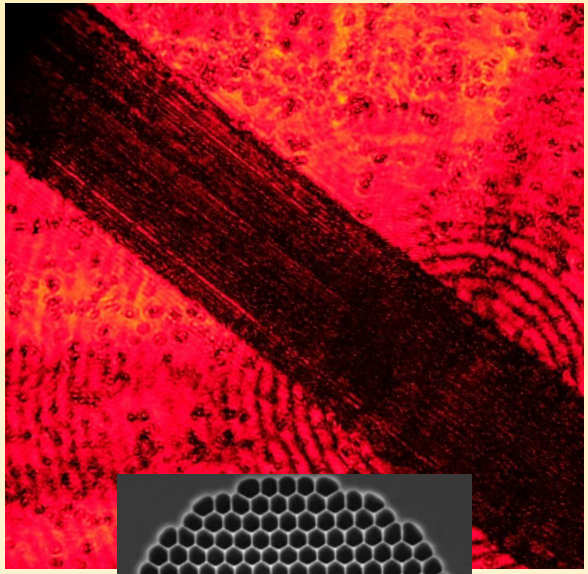
Optical Fibre



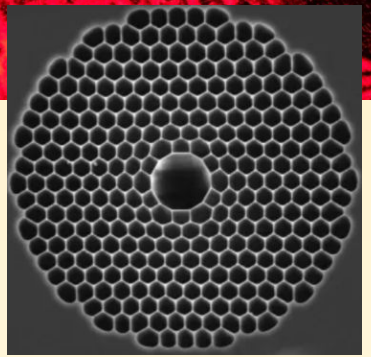
Schematic



Holey Fibre



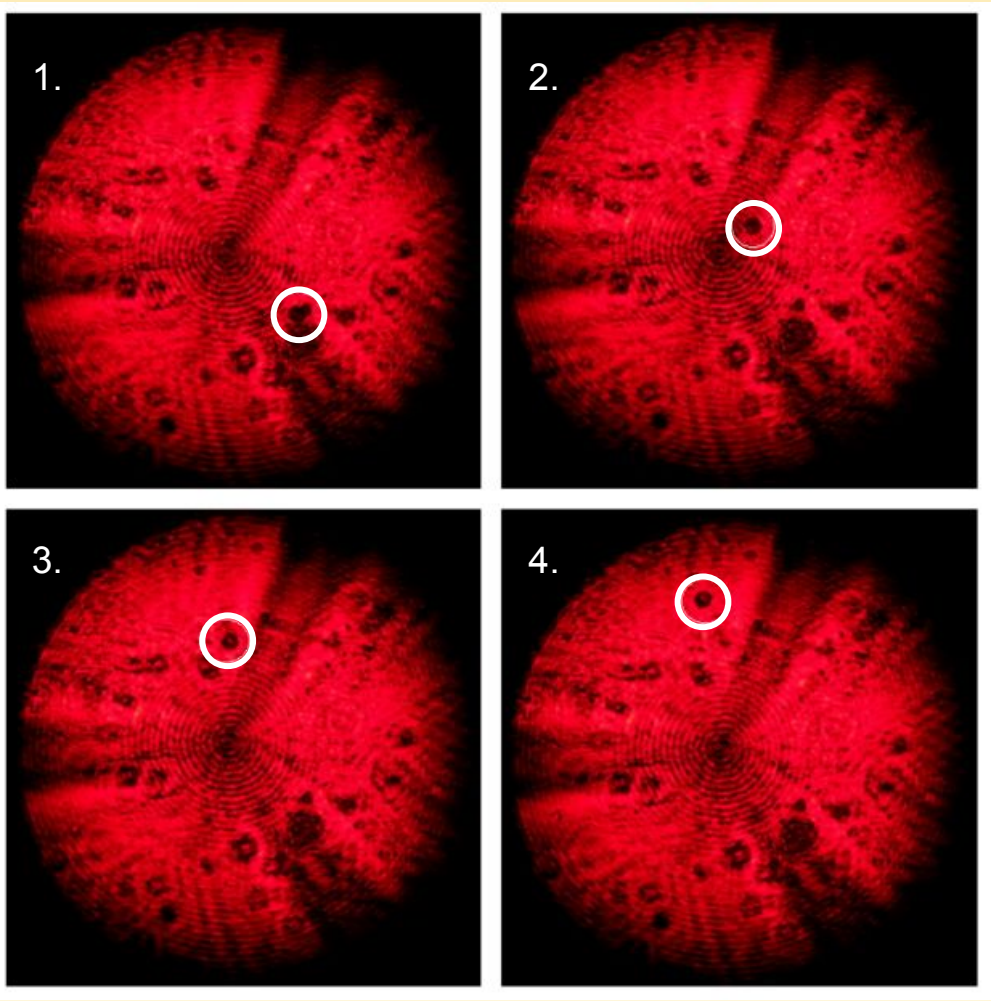
Schematic



Results: Imaging emulsion

We also studied droplets in the emulsion of two transparent liquids with similar refractive indices using the set up.

Preliminary images are shown in the adjacent figure.



Improving the Setup

Light Source - Plane white light source to remove diffraction effects

Magnification to see smaller objects

Improved Imaging - CCD cameras

Liquid Container - Microcuvette

Future Work

Size of emulsion bubbles, their stability and dynamics

Visualization of micro structures grown on glass substrate

Fluid interface phenomena

Summary

We demonstrated how to set up a Phase Contrast Microscopy on a table top for undergraduate students.

Successfully imaged various transparent objects.

An improved setup can provide valuable insights on many physics phenomena that are otherwise difficult to see in a laboratory.

References

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Thank You