Light Microscopy & Verification of Malus' Law

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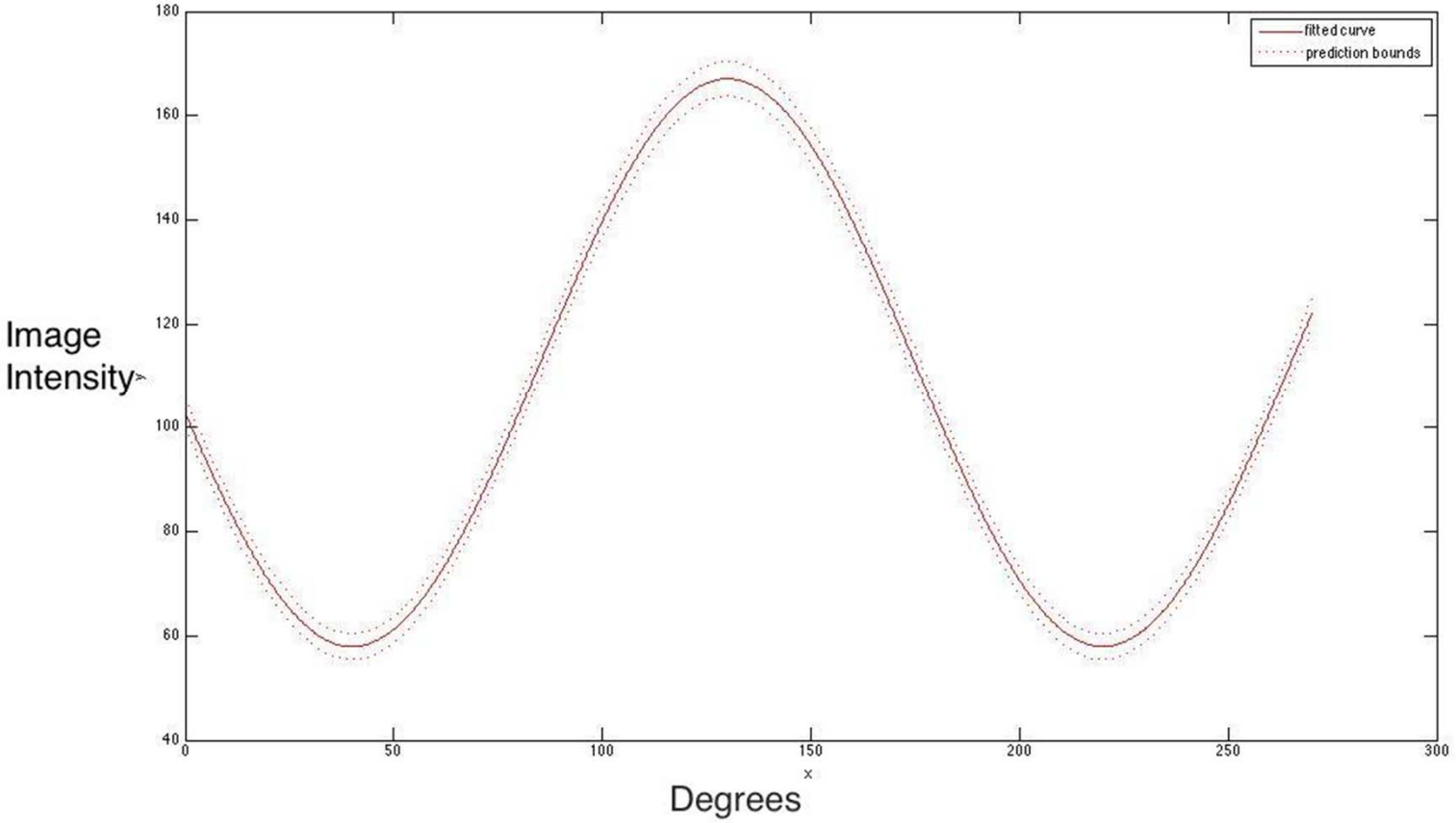


Outline

- Light Microscopy and Variations
- Purpose of Experiment
- Method of Experiment
- Results

Light Microscopy

- Utilises Light to View Object:
- *Dark Field*
- *Bright Field*
- Three Basic Categories:
- *Compound*
- *Stereo*
- *Digital*

Dark Field

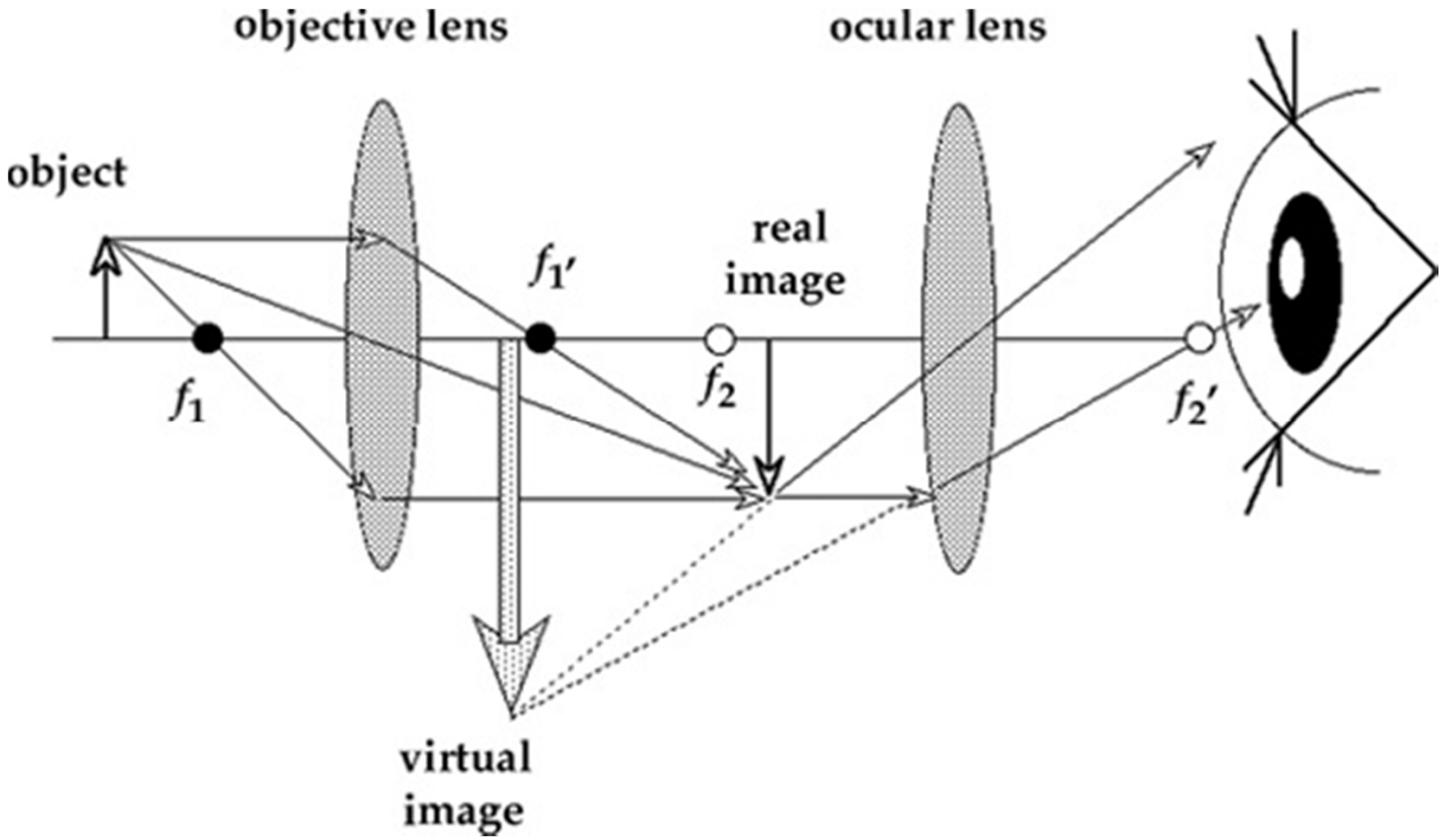
- Sample Fully Illuminated
- Dark Background
- Good Contrast
- Good for Biological Samples
- Directly Transmitted Light not Collected by Objective
- High Intensity Light- Possible Sample Damage

Bright Field

- Simple Technique
- Bright Background Dark Image
- Popular
- Very Low Contrast

Compound Microscopes

- Two Eyepiece Lenses of 10X – 15X Magnification
- Single Optical Path
- Combine with 3-4 Objective Lenses to give up to 1000X Magnification
- Useful for Identifying Drug Structures
- Relatively Inexpensive


objective lens
ocular lens
object
real
image
$f_{1'}$
f_1
f_2
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virtual
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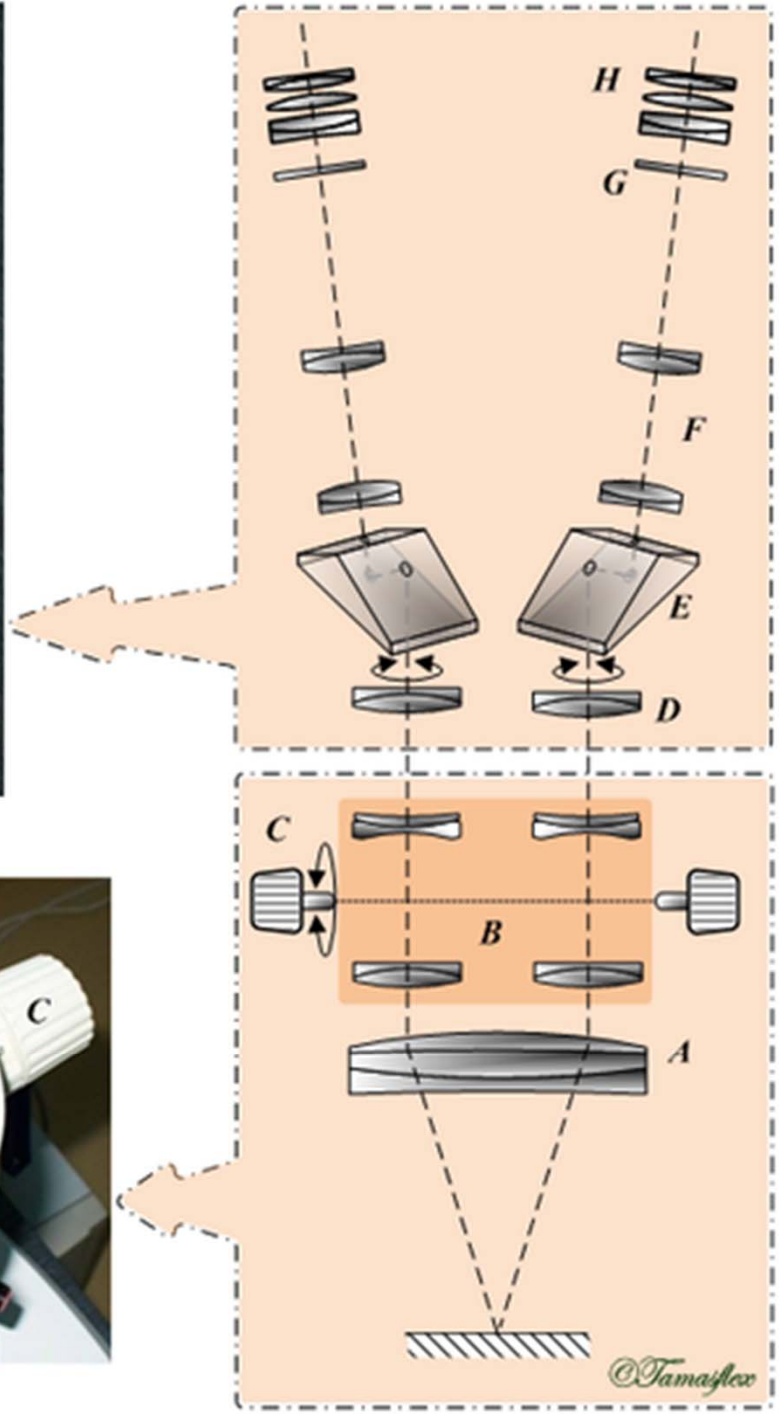
Stereo Microscope

- Two Optical Paths at Differing Angles
- Provides 3D viewing of Sample
- Low Magnification
- Used for Circuit Board Inspection, Microsurgery and Watchmaking
- Relatively Inexpensive


H
G
F
E
D
C
B
A
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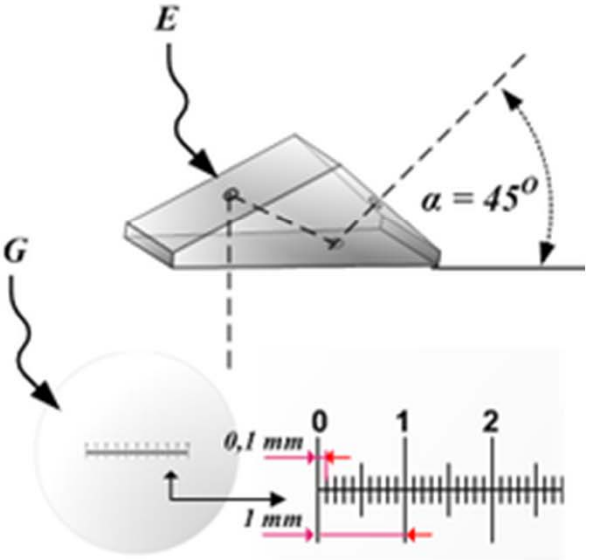
C


E
α = 45°
G
0,1 mm
1 mm
0
1
2

Digital Microscope

- Eyepieces Optional
- Uses Computers to View Detailed Images
- Real Time Imaging Possible
- Up to 1000X Magnification
- Ease of Image Analysis

Malus' Law

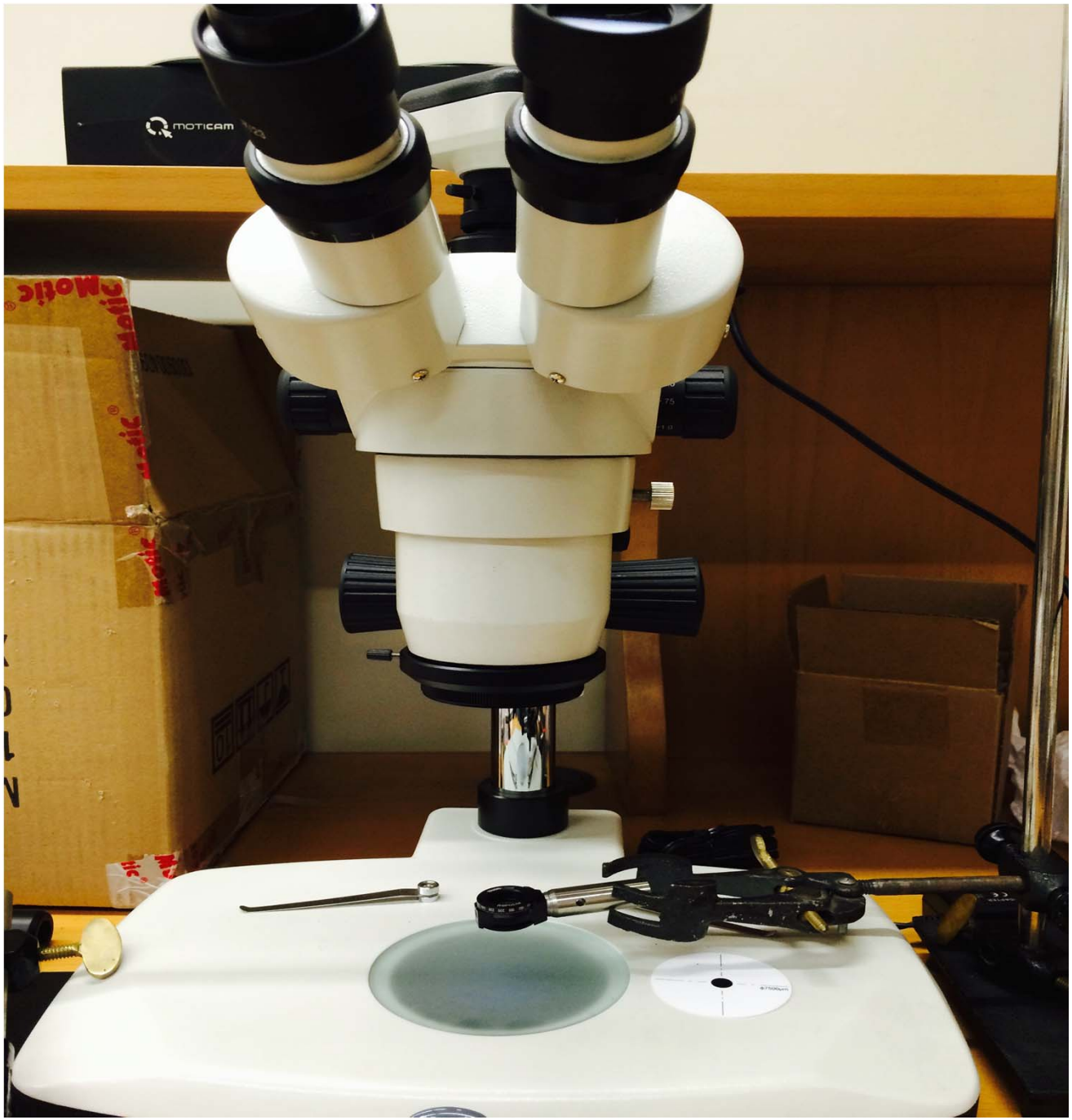
- When completely plane polarised light is incident on the analyser, the intensity I of the light transmitted by the analyser is directly proportional to the square of the cosine of angle between the transmission axes of the analyser and the polariser.
- Electric Field Vector Resolved into Two Components
- Perpendicular Component Absorbed
- I = I(Cos(x))^2

Purpose of Experiment

- To Verify Malus' Law
- Gain Basic Understanding of Polarisation
- Ability to Analyse and Interpret Data
- Use of Computational Software to Ease and Accelerate Work

Experimental Setup

- Apparatus:
- *Motic Stereo Zoom Microscope SMZ 168*
- *Motic Polarising Accessory*
- *Thor Labs Rotating Polariser RSP05/M*
- *Retort Stand*
- *Motic Imaging Camera 2.0 MP*
- Data Analysis:
- *Motic Imaging Software*
- *Matlab 2013*



Rotating Polariser being Viewed Underneath The Stereo Zoom Microscope.
Fixed Polariser Attached To Microscope.

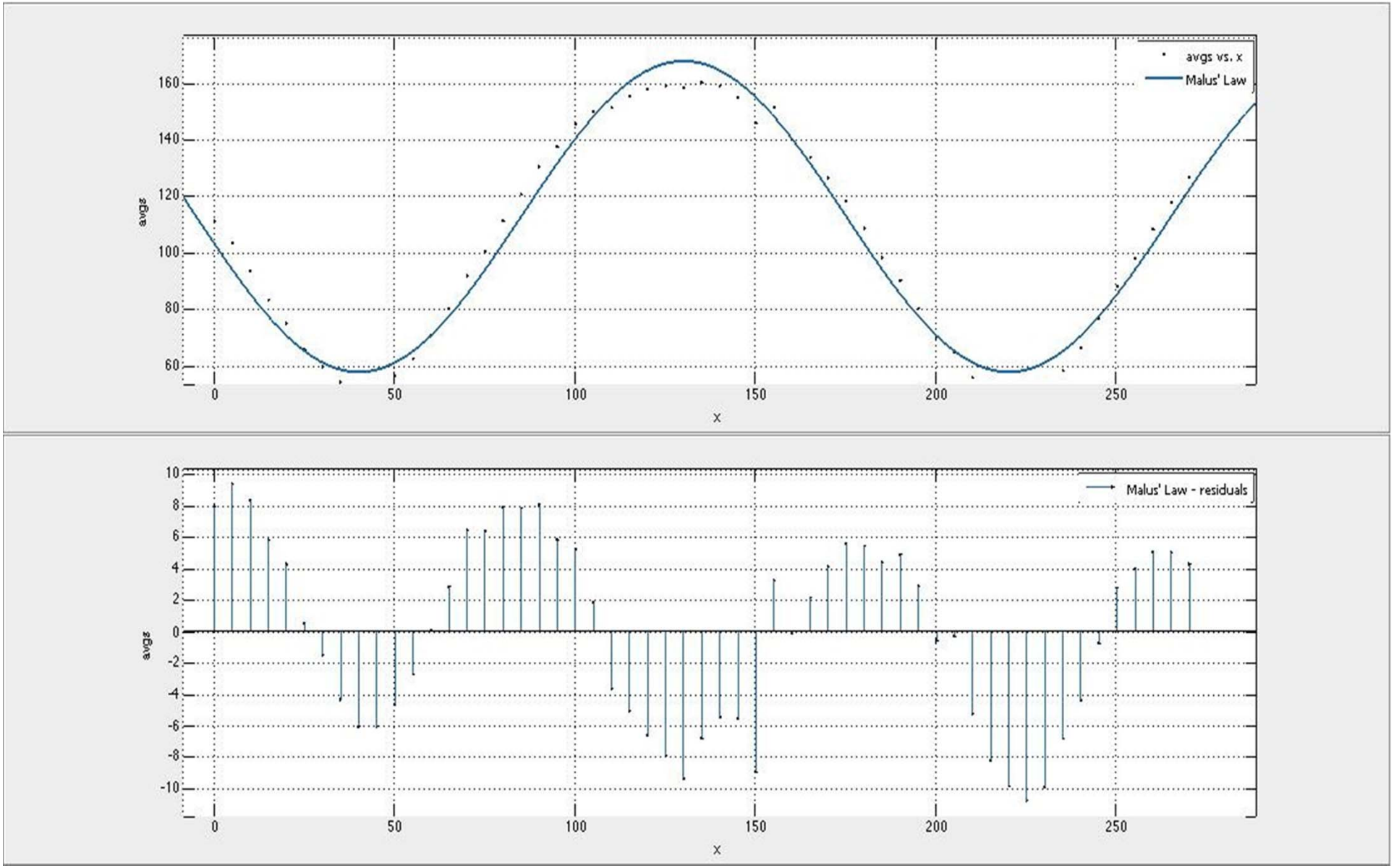
Method of Experiment

- Polarisers were Set up and Focused
- Bright Field Technique was Used
- Rotating Polariser was Rotated at 5 Degree intervals
- Resulting Images were Collected using Motic Imaging Software
- Images were Loaded into Matlab as Matrices

Data Analysis

- Images in Matlab were converted to Grey scale with Pixel Intensities Ranging from 0-255
- A Specific Region of the Images was Cropped
- Mean Value of Intensities from Cropped Matrices were Extracted
- Mean Values were Plotted Against Degrees
- Curve Fitting was Performed

Results


avgs vs. x
Malus' Law
avgs
x
0
50
100
150
200
250
60
80
100
120
140
160
Malus' Law - residuals
avgs
x
-10
-8
-6
-4
-2
0
2
4
6
8
10

Uncertainty in Results