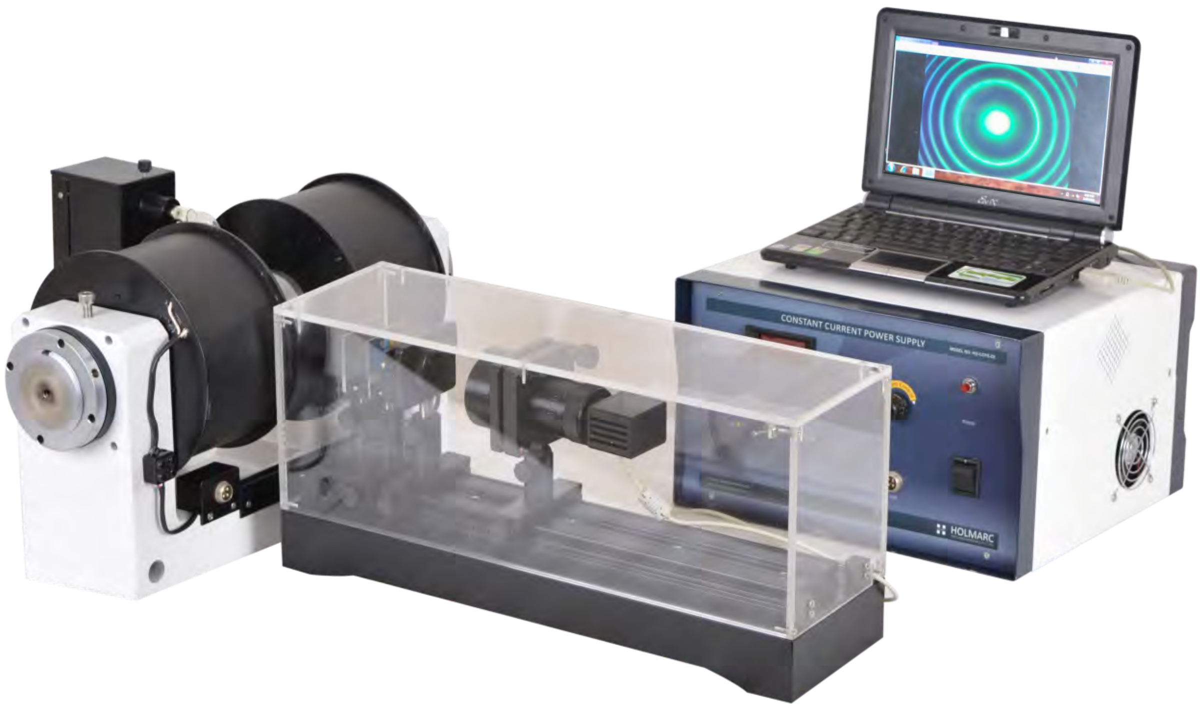
Instruction Manual



Zeeman Effect Apparatus

Model HO-ED-S-04A

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Product Features

Holmarc's Zeeman Effect Apparatus Model No: HO-ED-S-04A is designed for the verification of magnetic moment constant Bohr magneton (μ_0) and the fundamental constant *hc*. It demonstrates the effect of magnetic field on light emitted in a gas discharge, The Zeeman effect, and shows quantum nature of light and behavior of electrons. Traditional Zeeman Effect apparatus need more skills in operation and measurement. With its new and integrated design, this device is easier to setup and operate so that students can focus on understanding the principles and theories involved.

A low-pressure mercury lamp is placed between the pole pieces of a strong electromagnet. Light is passed through a narrow-band interference filter centered on the desired wavelength (546.1nm), and enters the Fabry-Perot etalon. This device consists of two reflective parallel plates which serve to transmit strong incoming radiation at different orders of wavelength. The apparatus has a built-in minimum separation of 3 mm. Small tilting knobs allow careful adjustment of the plate.

The significant difference in our setup is in the imaging system used for viewing and recording the interference pattern. We use a USB 2.0 camera; it can be directly connected to the PC to monitor the fringe pattern and can save the desired pictures. This makes the alignment of the optics much easier and eliminates the need for photographic processing.

Getting Started

Quick Start

Please check that the following items were unpacked and in good condition.

- Rail Based Platform .... 1 No.
- IR Filter Mount with Post, Post Holder & Carrier .... 1 No.
- Green Filter Mount with Post, Post Holder & Carrier .... 1 No.
- Polarizer with Variable Aperture, Post, Post Holder & Carrier .... 1 No.
- Fabry Perot Etalon with Post, Post Holder & Carrier .... 1 No.

Zoom Lens Assembly	1 No.
IR Filter	1 No.
Green Interference Filter	1 No.
CCD Camera	1 No.
Digital Gauss Meter	1 No.
Gauss Probe Holder	1 No.
Lamp House	1 No.
Mercury Discharge Tube	2 Nos.
Power Supply for Electromagnet	1 No.
Step up transformer with interface cable*	1 No.

*only for 110VAC power

Accessories

Dust protective cover	1 No.
Etalon tuning knobs	3 Nos.
Electromagnet connecting cable	1 No.
Shaft	2 Nos.
Lock Nut	2 Nos.
Washers	4 Nos.
Set Screws: m4 x 12	8 Nos.
m8 x 30	2 Nos.
Power cord	3 Nos.
Software CD	1 No.
Lever (For Adjusting Shafts)	1 No.
Allen Key Set	1 No.
Laptop (Optional)	1 No.

Items & Specifications

Rail Based platform

Model(ED-S-04A-RBP)

- Black Anodised Finish
- Aluminum Alloy made
- 0.25mm thick
- Core cell size of 5 sq.cm (approx.)
- M6 C'bored slot

IR Filter with Post, Post Holder & Carrier

Model(ED-S-04A-IRFM)

Filter Mount

- Dimensions (mm):50 x 50
- Thickness (mm):3.30
- Substrate:BOROFLOAT
- Transmission (%):> 92, 425 - 675nm
- Reflection (%):> 95, 750 - 1150nm

Post

- Length 50mm
- Diameter: 12mm
- M6 and M4 tapped holes

Post Holder

- Suitable for 12mm post
- M6 tapped hole at the base
- Black anodized finish

Rail Carrier

- Length 50mm
- Thickness: 12mm
- M6 and M4 tapped holes

Green Filter with Post, Post Holder & Carrier

Model(ED-S-04A-GFM)

Dichroic Green Filter Mount

- Type:Additive
- Color:Green
- Dimensions (mm):50 x 50
- Clear Aperture (%):≥85
- Thickness (mm):2 nominal
- Surface Quality:80 - 50
- Angle of Incidence (°):0
- Substrate:BOROFLOAT™

Post

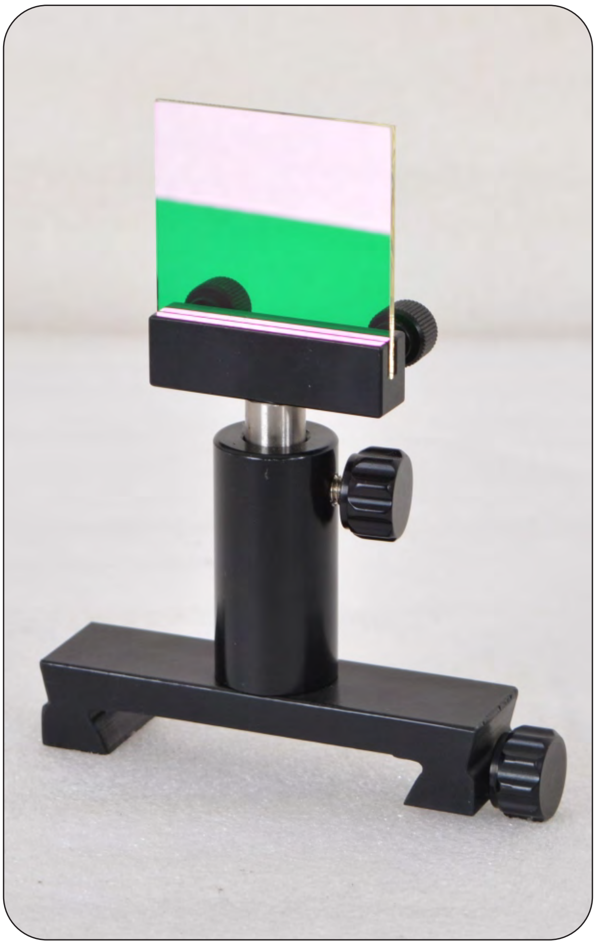
- Length 50mm
- Diameter: 12mm
- M6 and M4 tapped holes

Post Holder

- Suitable for 12mm post
- M6 tapped hole at the base
- Black anodized finish

Rail Carrier

- Length 50mm
- Thickness: 12mm
- M6 and M4 tapped holes



Polarizer with Aperture, Post, Post Holder & Carrier

Model(ED-S-04A-PVA)

Polarizer with Variable Aperture

- Sheet Polarizer
- Diameter: 25mm
- Manual Rotation 360°
- Adjustable opening position
- Black anodized finish

Post

- Length 50mm
- Diameter: 12mm
- M6 and M4 tapped holes

Post Holder

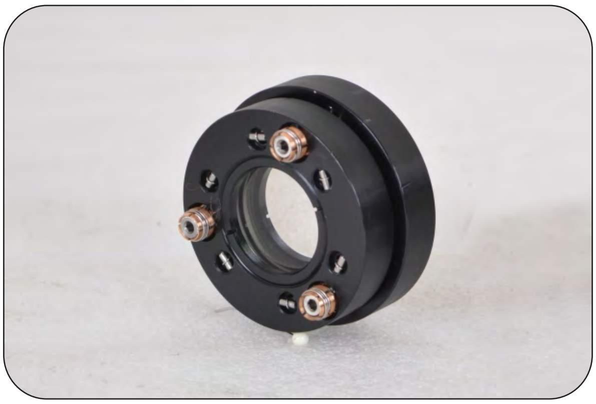
- Suitable for 12mm post
- M6 tapped hole at the base
- Black anodized finish

Rail Carrier

- Length 50mm
- Thickness: 12mm
- M6 and M4 tapped holes

Fabry- Perot Etalon

Model(ED-S-04A-FPE)



- Aperture:30mm
- Separation of plates:3 - 5mm variable
- R / T ratio:85/15

Zoom Lens Assembly with Post, Post Holder & Carrier

Model(ED-S-04A-CLA)

Zoom Lens Assembly

- Focal Length : 85 mm
- Optics held by threaded rings
- Post mountable
- Aluminium alloy construction
- Black anodized finish

Post

- Length 50mm
- Diameter: 12mm
- M6 and M4 tapped holes

Post Holder

Suitable for 12mm post
M6 tapped hole at the base
Black anodized finish

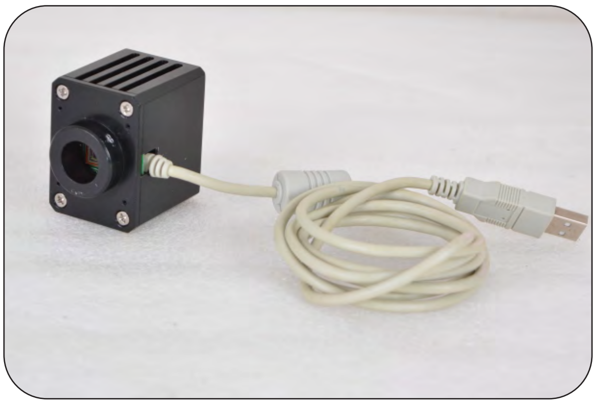
Rail Carrier

- Length 50mm
- Thickness: 12mm
- M6 and M4 tapped holes

CCD Camera

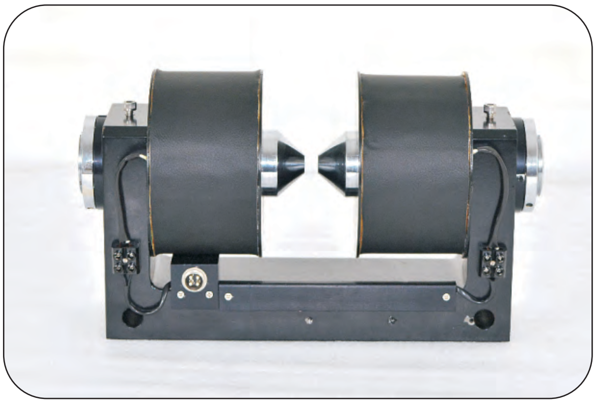
Model(ED-S-04A-CCDC)

- Resolution: 320-1280 pixels
- Interface:USB 2.0



Electromagnet
Model(ED-S-04A-EM)

- Field Density:1.8 Tesla at 10mm pole space
- Yoke material:Mild Steel



Electromagnet Power supply
Model(ED-S-04A-EMPS)

- 65 V DC, 0-3.5 A variable

Digital Gauss Meter
Model(ED-S-04A-DGM)

- Range:0-2KG & 0-20KG
- Resolution:1G at 0-2KG
- Accuracy:+/- 0.5%
- Display:7 segment LED
- Power:220V +/- 10%, 50Hz
- Transducer:Hall Probe - InAs

Gauss Probe Holder
Model(ED-S-04A-GPHM)

- Aluminium alloy construction
- Black anodized finish

Mercury Lamp House
Model(ED-S-04A-MVPS)

- Operating voltage: 4KV
- Current/ output: 30mA
- Tube length: 250 mm.
- Power input: 230 V/50Hz
- Power supply: Built-in
- Tube with long fine capillary in the middle.
- Casing dimension (mm): 120×60×320
- Material: Black anodized Aluminum alloy case

Step up Transformer *

- Voltage Converter Transformer 110v AC to 220V AC

**(ONLY for 110V AC power input equipment)*

Safety & Installation Instructions

Make sure you read and understand all instructions and safety precautions listed in this operating manual before installing or operating your unit. For further help and advice please contact Holmarc, e-mail:sales@holmarc.com or visit www.holmarc.com

- Always keep the equipment in moisture and dust free atmosphere.
- Care must be taken while handling optical components since this set up uses high precision and high quality optical components.
- Do not touch the reflecting surfaces of the etalon with bare hand.
- Spectral Discharge tube is very fragile. Do not drop, crush, bend or shake them. Vibration or impact will cause breakage and short lamp life.
- Handle probe of Digital Gauss meter with care. Do not bend the probe tip as damage may result. Use the protective cover when the probe is not in use.
- You must never open the casing of the power supply. Removal of casings and attempted adjustment or service by unqualified personnel will invalidate any warranty.

Caution: *Do NOT sustain high magnetic field for more than 2 minutes during image capturing. It will lead to the damage of both coil and power supply. It also causes residual magnetism in the core part.*

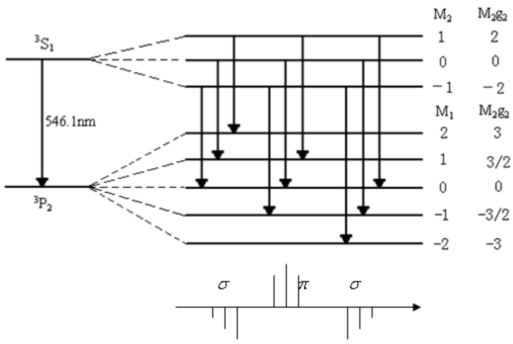
Fundamentals

Aim

- To observe splitting of spectral lines for Zeeman Effect
- To find spacing of the Etalon
- Calibration of the Magnetic field
- Verification of the Magnetic moment constant Bohr Magneton(μ_0)
- Analysis of Planck's constant (h) and speed of light (c)

Theory

The Zeeman Effect is observed by application of a strong or weak (For strong magnetic field it is called Normal zeeman and for weak magnetic field it is called anomolous zeeman) magnetic field to a mercury vapor lamp and exciting transitions across the sample. Energy splitting due to change of magnetic field can be measured by passing the light from the 546.07nm transition through a Fabry-Perot Etalon and measuring interference effects. The difference in energy splitting between the 6^3P_2 and 7^3S_1 states was found to be linear.



This model was later modified to fit a quantum mechanical model which utilized an m-state to describe the energy splitting found when placing an atom in a magnetic field.
Consider a magnetic dipole placed into an external magnetic field. The dipole inherently has some magnetic dipole constant, μ. Placing, the dipole into a magnetic field B, we find that the Hamiltonian of the system takes the form,

$$H\mu = -\mu \cdot B$$

Extending this idea to atoms, we find that the structure of the atom allows for two distinct electronic magnetic dipole moments. The first moment occurs from the inherent spin of the electron, μ_S while the second, μ_L, is a result of the orbital motion of the particle about the nucleus, derived from the angular momentum. These two moments can be given in terms of the quantum parameters L and S as,

$$\mu_S = -e/m\, S$$
$$\mu_L = -e/2m\, L$$

Thus, through first order-perturbation theory, we can express the energy splitting as,

$$\Delta E = e/\ 2m\ B\cdot < L + 2S > \quad (4)$$

In our experiment, an energy splitting for mercury was observed. However, as an order-of-magnitude estimate, we can calculate this difference of energy for the simplified case of hydrogen.
Knowing that $L_z = \bar{h} l$, we find that by the above equation $\Delta E \approx 10^{-28}$ J/gauss for a $\Delta m = 0$ transitions. In the analysis of the results, it will be seen that this estimate is in fact very accurate.
More specifically, in this experiment, we actually measure the difference of two unequal Zeeman splitting in the 6^3P_2 and 7^3S_1 states of mercury. This effect occurs from the difference in L between the states. Given the discussion above, the prediction can be made that the Zeeman splitting will follow the behavior,

$$\Delta E_{Zeeman},\ 6\ ^3P_2 = g_0|B| \quad (5)$$

$$\Delta E_{Zeeman},\ 7\ ^3S_1 = g_1|B| \quad (6)$$

for some constants g_0 and g_1. Using a linear polarizer, as discussed later, one can selectively choose to observe $\Delta m = 0$ transitions only and therefore extrapolate the experimental value of $g_1 - g_0$. The observation of a difference in the Zeeman splitting is often called the anomalous Zeeman Effect.

The etalon consists of two parallel flat glass plates coated on the inner surface with a partially reflecting layers separated by a distance t.

An incoming ray forming an angle θ with the normal to the plates will be split into the rays etc. the path difference between the wave fronts of two adjacent rays is

$$\delta = = 2\ t \cos\theta$$

and for a constructive interference to occur one must demand:

$$n\lambda = 2\ \mu t \cos\theta$$

This is the basic interferometer equation.

$$n\lambda = 2\ \mu t \cos\theta$$

Light entering the etalon at an angle θ is focused onto a ring of radius r = f θ where f is the focal length of the lens.

For small values θ_n, e.g. rays nearly parallel to the optical axis.

$$n = (2\ \mu t/\lambda) \cos\theta_n = n_0 \cos\theta_0$$

$$n_0 = 2\ \mu t/\lambda$$

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If θ_n is to correspond to a bright fringe, n must be an integer. However, n_0, which gives the interference at the center, is in general not an integer. If n_1 is the interference order of the first ring, clearly $n_1 < n_0$ since $n1 = n_0 \cos\theta_{n1}$.

We then let $n_1 = n_0 - E$; $0 < E < 1$ where n_1 is the closest integer to n_0.

If there are two components of a spectral line (splitting of one central line into two components) with wavelengths λ_a and λ_b, which are very close to one another, they will have fractional orders at the center E_a and E_b:

$$E_a = \frac{2\mu t}{\lambda_a} - n_{1,a} = 2\mu t\, \nu_a - n_{1,a}$$

$$E_b = \frac{2\mu t}{\lambda_b} - n_{1,b} = 2\mu t\, \nu_b - n_{1,b}$$

where $n_{1,a}$, $n_{1,b}$ is the interference order of the first ring. Hence, if the rings do not overlap by a whole order $n_{1,a} = n_{1,b}$ and the difference in wave numbers between the two components is

$$\Delta\nu_{ab} = \nu_a - \nu_b = (E_a - E_b)/\, 2\mu t$$

By substituting these fractional orders into the components a and b of E; with δ and Δ as average values we get for the difference of the wave numbers of the components a and b, anticipating μ = 1,

By putting δ_{bc} in the above equation, we can also find $\Delta\nu_{bc}$.

The change in energy, $\Delta E = hc(\Delta\nu_{ab} + \Delta\nu_{bc})$

The change in energy ΔE is proportional to the magnetic flux density B.

$$\Delta E = \mu_0 B$$

$$hc(\Delta\nu_{ab} + \Delta\nu_{bc}) = \mu_0 B$$

$$\mu_0/hc = (\Delta\nu_{ab} + \Delta\nu_{bc})/B$$

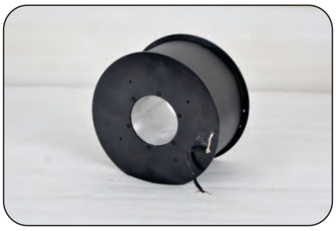
$$\mu_0/hc = (\Delta\nu_{ab} + \Delta\nu_{bc}) \,/\, |B|$$

Assembling the Electromagnet

1. Place the C core on the table. Insert one of the shafts.

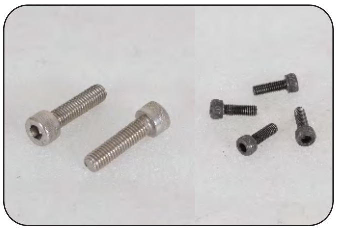
2. Take one of the coils. Insert the coil into the placed shaft.





3. Take two washers and one lock nut. Set the two washers on the locknut so that the four holes are parallel.

4. Screw the locknut on the shaft. Tight the washers by using Allen (m4x12) screws.

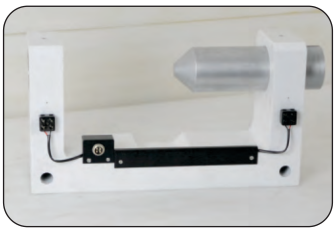



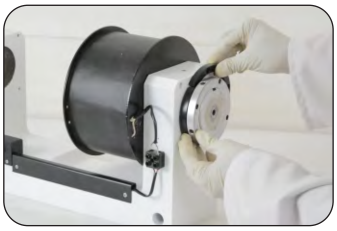
5. Take the other coil and keep it in the same position as the other coil. Insert the shaft though the coil and tight with lock nut and washers as done before.

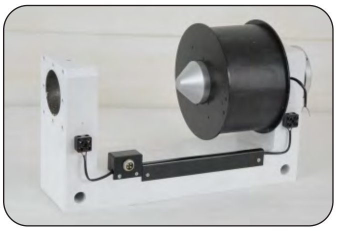
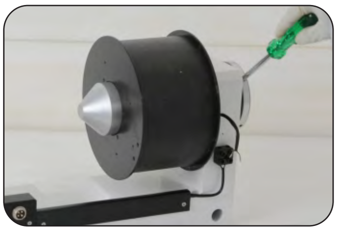
6. Adjust the spacing of the poles using the lever provided. Make the spacing nearly 10mm.

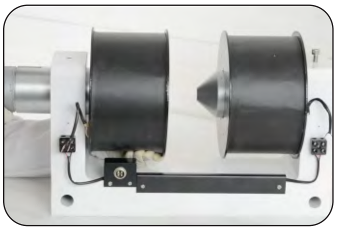
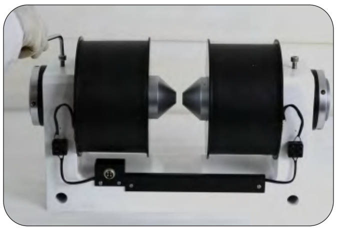
7. Insert Allen (m8x 50) screws into the slots provided on the top of the C core such that it firmly fit into the spacing on the shafts.

8. Connect the wires to the coil.



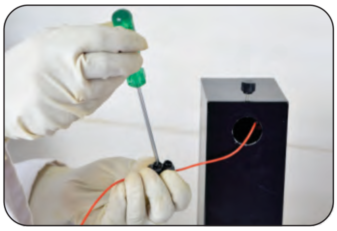




Assembling the Lamp house

1. Place the lamp house on the table.
2. Connect the wires to both ends of Mercury discharge tube.

Wires should be prevented from entering into the lamp house.





3. Insert the Lamp holders into the lamp house and tight the knob.

4. Connect the power cable provided to the power socket at the back panel of the lamp.

5. Lamp assembly completed.

Extreme care should be taken while handling the Mercury discharge tube as tube is highly fragile.

Follow the below given procedures ONLY for 110V AC power input.


Step up transformer

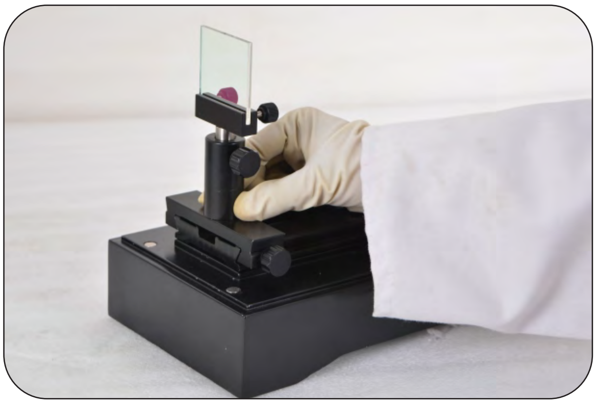

Mercury Lamp House with power cord

Insert the power cord of step up transformer. Connect one end of the power cable of lamp house to the power socket at the back panel of the step up transformer.

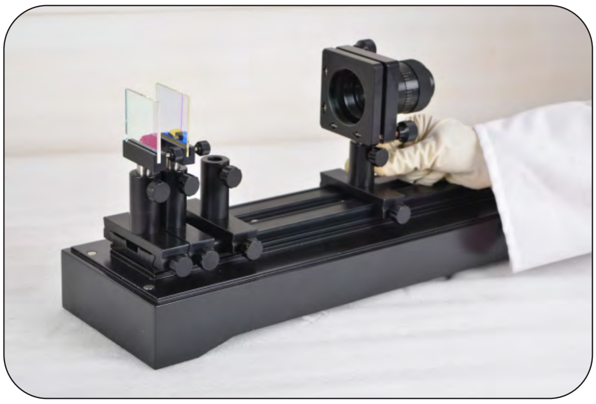
Connect the other end to the power socket of lamp house. Switch On the step up transformer and lamp house.

Assembling Zeeman effect setup

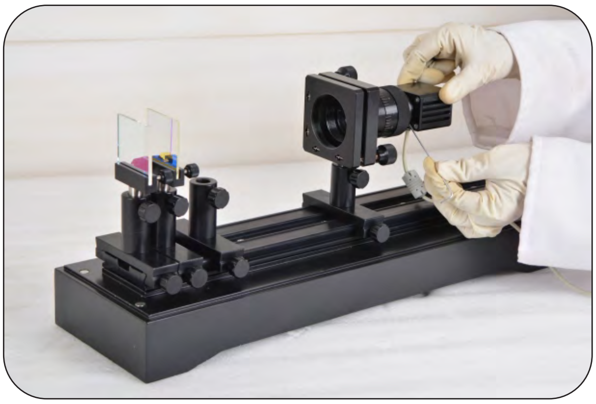
1. Place the IR filter and green filter with mount on the rail carefully. (Slide the rail carriers from one end of the rail.)

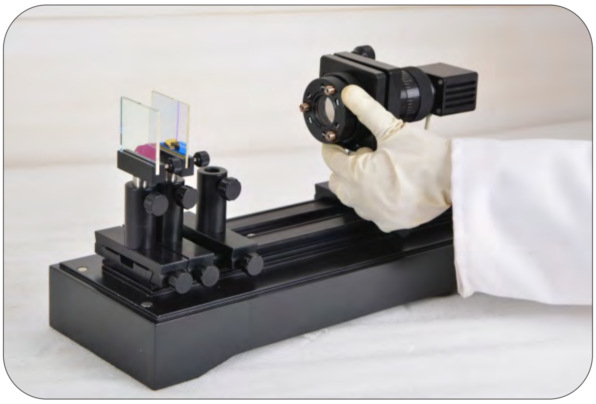


2. Place the holder of Polarizer. Mount the zoom lens assembly and tight it firmly.



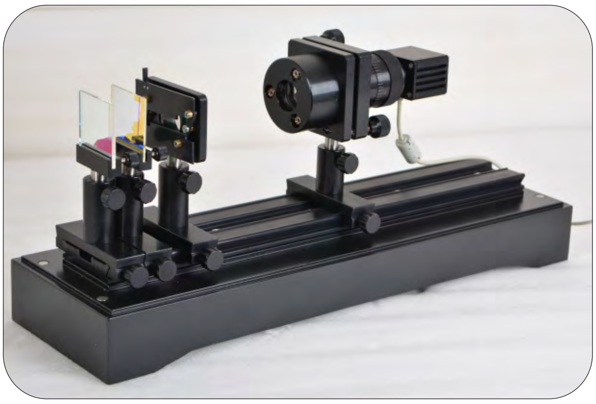
3. Fix the CCD camera to the zoom lens assembly using an allen key. Fix the Fabry-Perot Etalon as shown below.





4. Insert the polarizer with variable aperture in to its holder.

5. Fabry Perot interferometer assembly completed. A protective cover has been added to the Zeeman effect setup



Ensure that all the components are aligned at the same height.

Experimental Set up and Procedure

A. Calibration of Magnetic flux density B :

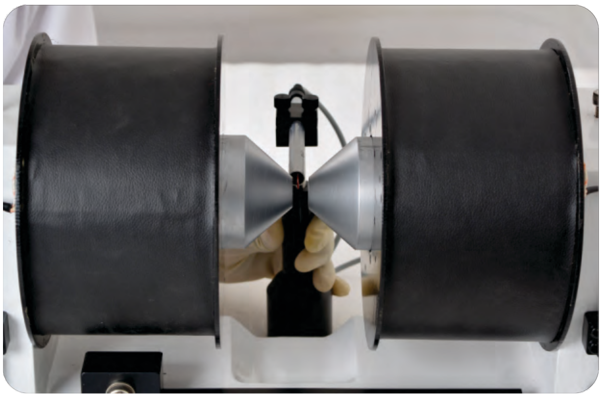
1. Connect the power code of Digital Gauss meter to the socket.

2. Mount the Hall probe of the Digital Gauss meter in the probe holder. Pull back the cover for exposing the sensor tip.

3. Switch ON the Digital gauss meter and turn the zero adjust knob to zero.

4. Connect the Constant Current Power Supply to Electromagnet.

5. Introduce the gauss meter probe at the centre of the air gap between the pole pieces of the electromagnet such that the surface of the probe is parallel to the pole pieces. The transducer (Indium Arsenide) is at the tip of the probe, so that this part should be at the centre of the air gap. Switch on the Power Supply of electromagnet.



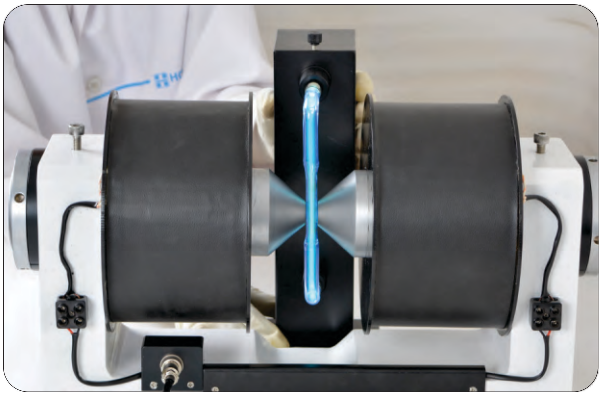
6. Slowly increase the current from zero up to its maximum value and note the corresponding magnetic field reading in the Gauss meter at regular intervals.

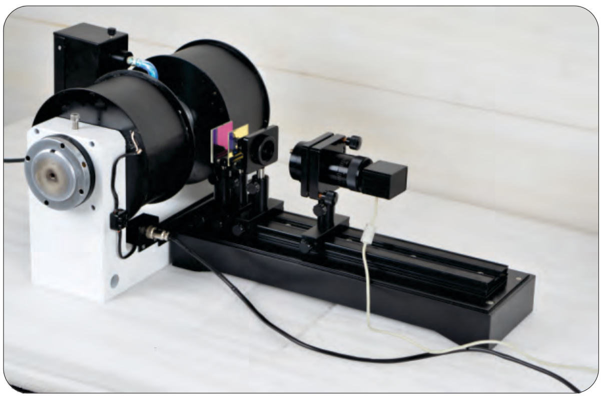
7. Plot the graph between the current (I) and the magnetic flux density (B).

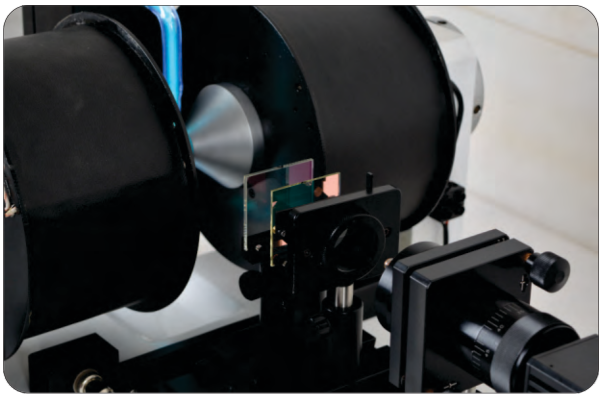
B. Zeeman Splitting

1. Introduce the Mercury discharge tube at the center of the air gap between the pole pieces of the electromagnet such that the tube is perpendicular to the pole pieces.

2. Place the Zeeman effect setup so that it collects the light from the center part of electromagnet.



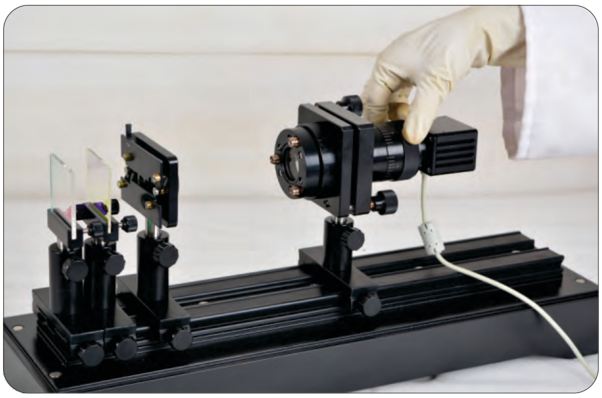




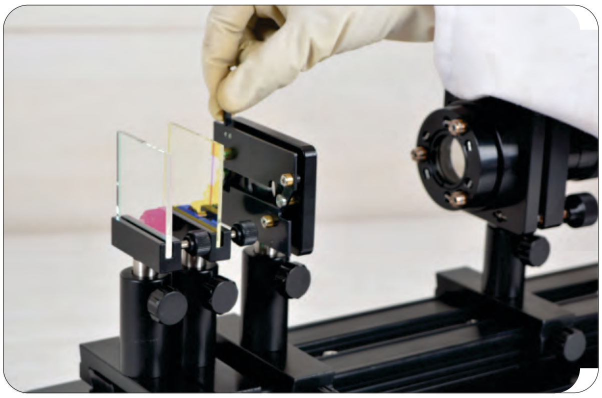
3. Connect the camera cable to the USB port of a PC. Open Holmarc Camera application Software (Refer Software section).

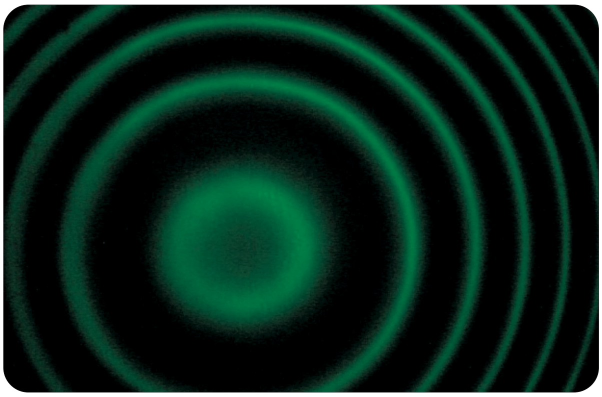
4. Remove the Polarizer from with variable aperture from its holder. Fine tune the etalon to get clear sharp circular fringes until we get the perfectly distinct and well defined interference fringes.

5. Insert the polarizer with variable aperture in to its holder. Adjust the zoom lens to get sharp fringes by viewing the output of the camera through Holmarc Camera application Software provided (Refer Software section).

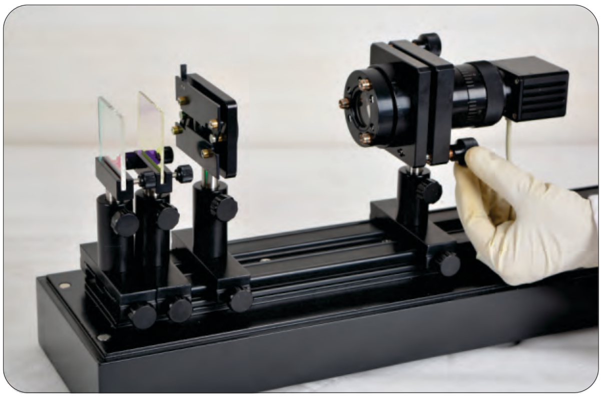


6. Adjust the slit width to get the best compromise between brightness and sharpness of the fringe pattern.

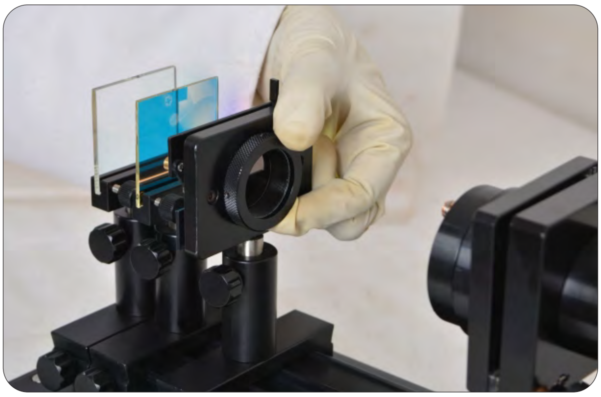


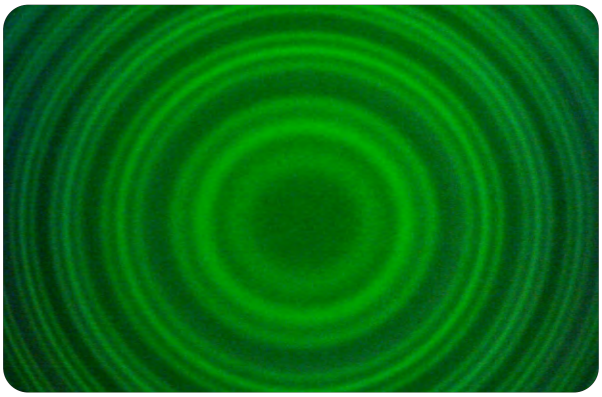


7. Adjust XY translation knob to achieve a sharp view of the fringe at the center of the window.



8. After getting sharp circular fringe apply the magnetic field. Increase the magnetic field by changing the current through the electromagnet and Observe the Fringe Splitting. Rotate the polarizer till we get the splitting of fringes into three.





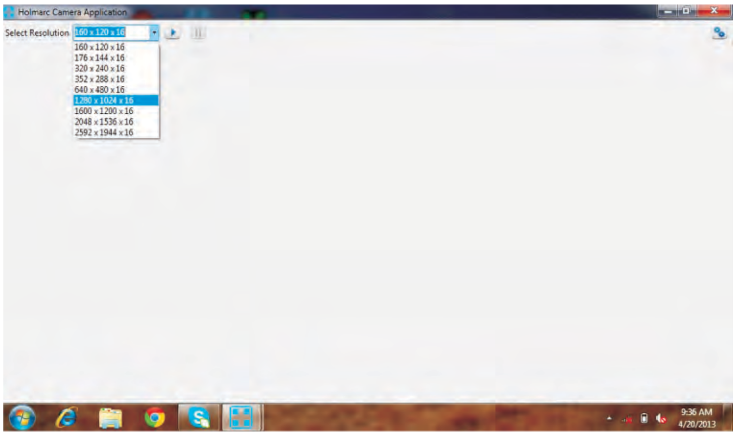
Do NOT sustain a high Magnetic field for more than 2min

Software Introduction

Holmarc camera application software helps to capture the images with different magnetic fields of Zeeman Effect experiment.

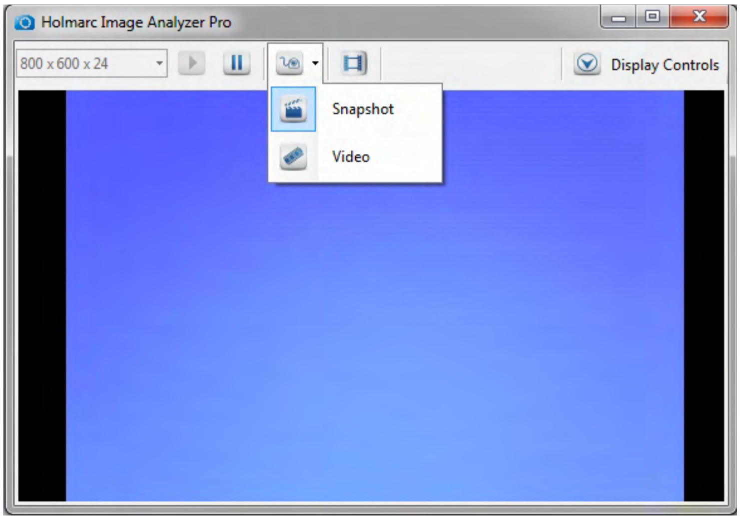
Start the software with a click to the icon on your desktop.

Select the required resolution of the image required and click on the start camera button to initialize the camera.



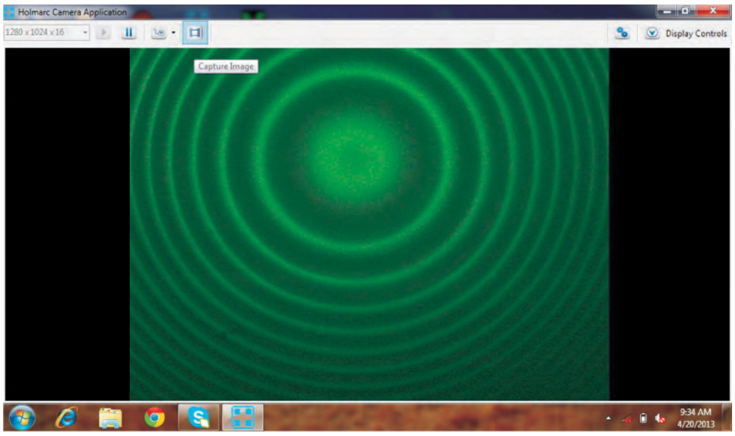
While tuning the etalon select 800 x 600 resolution. After getting sharp circular fringes change the resolution to 1280 x 1024.

After initializing the camera, click button and select the required camera mode if snapshot or video mode is required.



Capture the image of the fringe by clicking the capture button at the left top corner of the application window and save the image in the user defined location.

The application window enables the user to see the live Video image of the circular fringes. Then capture the image without applying the magnetic field. Also capture the images at different magnetic fields.



Additional Features

Camera and Video Control:

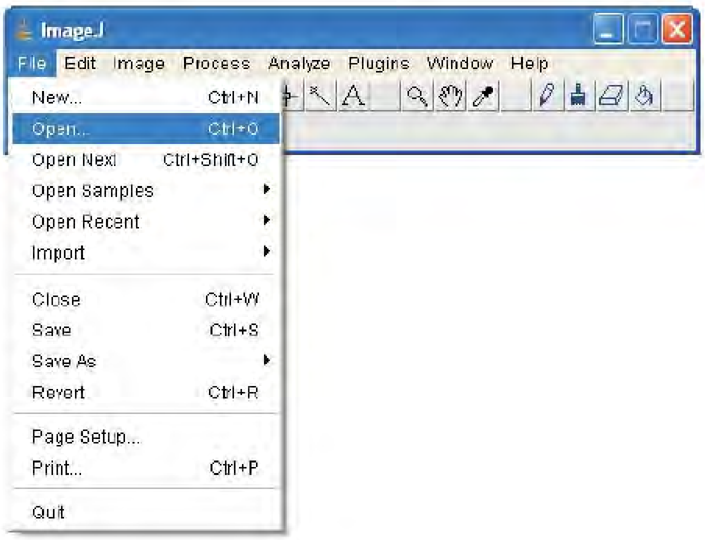
Camera properties like brightness, contrast etc. can be set so that camera properties remain the same every time.

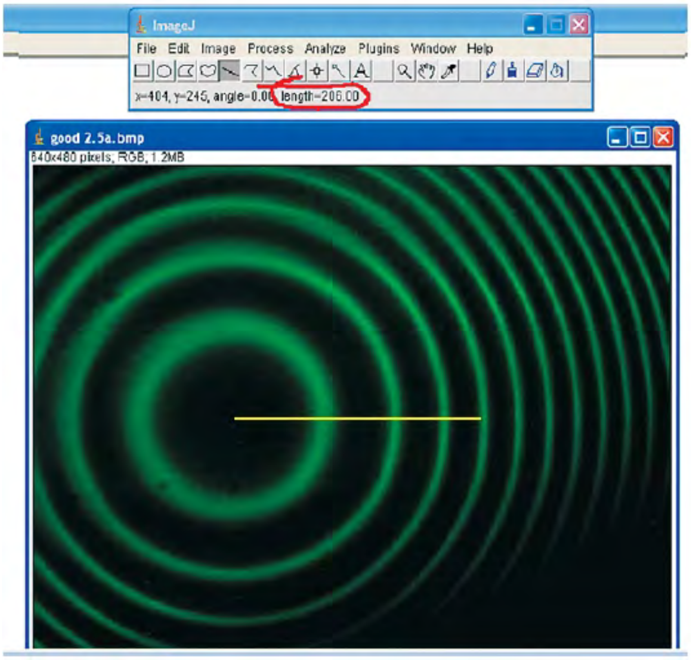
HOW TO MEASURE THE THICKNESS OF ETALON

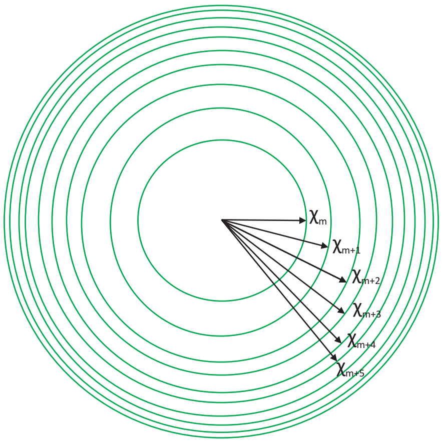
Start **ImageJ** software with a click to the icon on your desktop.

For finding the thickness of the etalon we measure the radius of the circular fringes. Open the image of zero magnetic field with the image analysis software 'Image J'.

Select Line Selection Tool button. Measure the length of the fringe by dragging the mouse. Note that the line should be exactly straight. We can take the readings from the top menu of the software window. The status bar displays the length in terms of pixels.







Line Drawing of Fabry Perot Fringe Pattern

The radius of the first circular fringe is taken as χ_m and the following as χ_m, χ_{m+1}, χ_{m+2}, χ_{m+3}, etc. These values are in pixels. Convert these values in to standard units.

1 Pixel = 7.8 microns (@ 640 x 480 resolution)

Note: This value may vary according to the CCD used as the detector.

Observations & Tabulations

Magnetic Field Calibration:

A gauss meter is used for the calibration of magnetic field. Introduce the gauss meter probe between the poles of electromagnet. Always make changes in the voltage fairly slowly. Run the current from zero up to its maximum value and from maximum to zero. Note the corresponding field strength from gauss meter at different intervals.

Sl. No	Current I (Amp)	Magnetic field Increment (Gauss)	Magnetic Field Decrement (Gauss)	Average B |B| (Gauss)
1.	0.00			
2.	0.25			
3.	0.50			
4.	0.75			
5.	1.00			
6.	1.25			
7.	1.50			
8.	1.75			
9.	2.00			
10.	2.25			
11.	2.50			
12.	2.75			
13.	3.00			
14.	3.25			
15.	3.50			
16.	3.60			

Thickness of Etalon:

Distance between Etalon and the camera, D = ... m

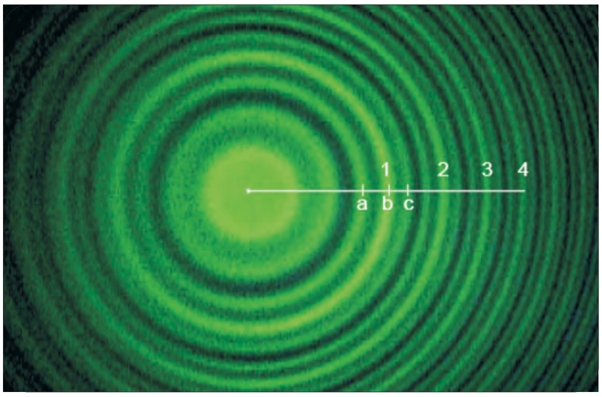
Order	Radius (Pixel)	Radius (m) x 10^{-6}	Radius^2 (m^2) x 10^{-6}	$\chi_n^2 = \chi_{m+n}^2 - \chi_m^2$ (m^2) x 10^{-6}	$t = nD^2\lambda/\chi_n^2$ x10^{-3} (m)
χ_m					
χ_{m+1}					
χ_{m+2}					
χ_{m+3}					
χ_{m+4}					

Average thickness, t = ... m

Zeeman Splitting:

Switch on the electromagnet power supply and increase the current. Rotate the polarizer in order to get only two transitions on a single line.

Apply magnetic field with different currents. Take the photographs for different currents. Open the photographs with Image Analysis software and take the measurements.



Current = ... A Magnetic Field = ... Gauss

Ring No		Radius (Pixel)	$Radius^2$ (Pixel)
1	a		
	b		
	c		
2	a		
	b		
	c		
3	a		
	b		
	c		
4	a		
	b		
	c		

Caution : Do NOT sustain high Magnetic field for more than 2 min. for taking the Photographs. It will lead to the damage of both coil and Power supply. Also that causes residual magnetism in the core part.

Ring No	Radius^2 (m^2) x 10^{-6}					Average
	a	δ_{ab}	b	δ_{bc}	c	
1.						
δ_{12}						
2.						
δ_{23}						
3.						
δ_{34}						
4.						
Average		δ_{ab} =		δ_{bc} =		

$< \Delta > =$

$\Delta \boldsymbol{Vab} = < \boldsymbol{\delta ab} > / 2t < \Delta > =$

= ....

$\Delta \boldsymbol{Vbc} = < \boldsymbol{\delta bc} > / 2t < \Delta > =$

= ....

$\mu 0 / hc = (\Delta \boldsymbol{Vab} + \Delta \boldsymbol{Vbc}) / |B|$

= ....

$\mu 0 / hc$ = **.................. cm^{-1} /Gauss**

Maintenance Notes

1. Always keep the equipment in a moisture and dust free atmosphere.
2. Do not touch the optical components with bare hands
3. Care must be taken while tuning the Etalon.

Troubleshooting

1. Alignment using Diode Laser

While viewing through camera if there is no fringe, we can make the plates of the etalon parallel with the help of a diode laser.

For that, insert the laser module in the laser mount. Place the etalon in front of the diode laser. Project the beam on to the screen. Now we can see multiple spots on the screen. Make the spots coincide by tuning the three knobs situated in front of the etalon.

If all the spots coincide, we can see a small part of the fringe on the screen.

Now we can place the etalon at the former position in the Zeeman Effect Experimental set up.

2. Replacing the Mercury Tube

While applying the magnetic field, if the image is not clear, then check the working of the mercury tube. If the ends of mercury tube is very dark, we can conclude that the tube is damaged. Replace the mercury tube with a fresh one and confirm that it is not damaged by repeating the checking process.

3. Non appearance of camera output in PC

a. Kindly check the USB cable is properly inserted in the camera as well as PC.

b. Before checking the focus, make sure that the camera sensor senses the light by closing and opening the sensor window.

c. If the sensor detects light, then try focusing by keeping some small objects in front of the camera.

d. If the camera is not sensing light in spite of all these measures, kindly contact our customer support and against confirmation, please make arrangements to send it back for repair.

Software

1. Computer has more than one Camera connected to it.

a. Disconnect the first camera from the system and try again.
If you are unable to disconnect the camera, do the following

i. Disconnect Holmarc's Camera from the computer.

ii. Go to ‘Device manager’ in Control panel.

iii. On the new 'Device Manager' window that opened up, expand the 'Imaging Devices' tree. If there is a camera Device present there, Right click the listing and select 'Disable'. This will disable the camera on the system. Repeat this for all the camera's currently connected to the system.

iv. Now connect Holmarc's camera to the system.

2. Problem when capturing image using the accompanied software.

This occurs when the USB device is running in a Low Speed mode. Try connecting the USB to another USB port; preferably one that is in the back of the computer. Then try again.

3. When opening the video window for capturing images, it shows an error.

Try restarting the computer. If the problem persists, reinstall the application, then restart the computer and try again.

4. Error while trying to use 'Export to PDF' function in the Table Window

Install Report Viewer 2010.exe Runtime from the CD provided . Restart the computer before starting the application.

Appendix

Specifications

Lamp	Mercury discharge lamp, slim design, AC, 5 W
Electromagnet	Built-in current-controlled power supply, 65V DC, 0-3.5A
Maximum Magnetic Field at 10mm pole space	1.8 Tesla
Fabry-Pérot Etalon	Aperture: 30 mm
Separation of Etalon Plates	3-5 mm
Distance between Etalon & the camera	85 mm
Interference Filter	Central Wavelength: 546.1 nm
Collimating Lens	Aperture: 37.0 mm
Focal Length	65mm
Power Input	230VAC, 50 Hz. (110VAC optional)

Fundamental Constants

Bohr Magneton (μ_0)	9.27400915×10^{-28} Joule/Gauss
Plancks constant (h)	6.62606896×10^{-34} Joule- Sec
Velocity of light (c)	3×10^{10} cm / sec
μ_0/hc	$4.6654\text{x}10^{-5}$ cm^{-1} /gauss

Technical Support

Contacting Technical Support

Before you call the HOLMARC Technical Support staff, kindly gather the following information:

- *If your problem is computer/software related, Please note:*

  1. Type of computer (make, model, speed)
  2. What kind of problem you are facing(Technical details).

- *If your problem is with the HOLMARC apparatus, Please note:*

  1. Title and model number (usually listed on the label)
  2. Approximate age of apparatus
  3. A detailed description of the problem/sequence of events
  4. Have the manual at hand to discuss your questions

Feedback

If you have any comments regarding our product or manual, please let us know. If you have any suggestions on alternate experiments or find a problem in the manual, kindly inform us. HOLMARC appreciates any customer feedback. Your inputs help us evaluate and improve our product.

For technical support, call us at
e-mail: sales@holmarc.com
web: www.holmarc.com

Holmarc Limited Warranty

Every Holmarc Instruments and its accessories are warranted by HOLMARC OPTO-MECHATRONICS LTD for a period of ONE YEAR from the date of original purchase.

Holmarc will repair or replace a product, or part thereof, found by Holmarc to be defective, provided the defective part is returned to Holmarc, with proof of purchase.

This warranty applies to the original purchaser and our distributors and is non-transferable.

Each returned part or product must include a written statement detailing the nature of the claimed defect, as well as the end user's name, address, and phone number.

This warranty is not valid in cases where the product has been abused or mishandled, where unauthorized repairs have been attempted or performed, or where depreciation of the product is due to normal wear-and-tear.

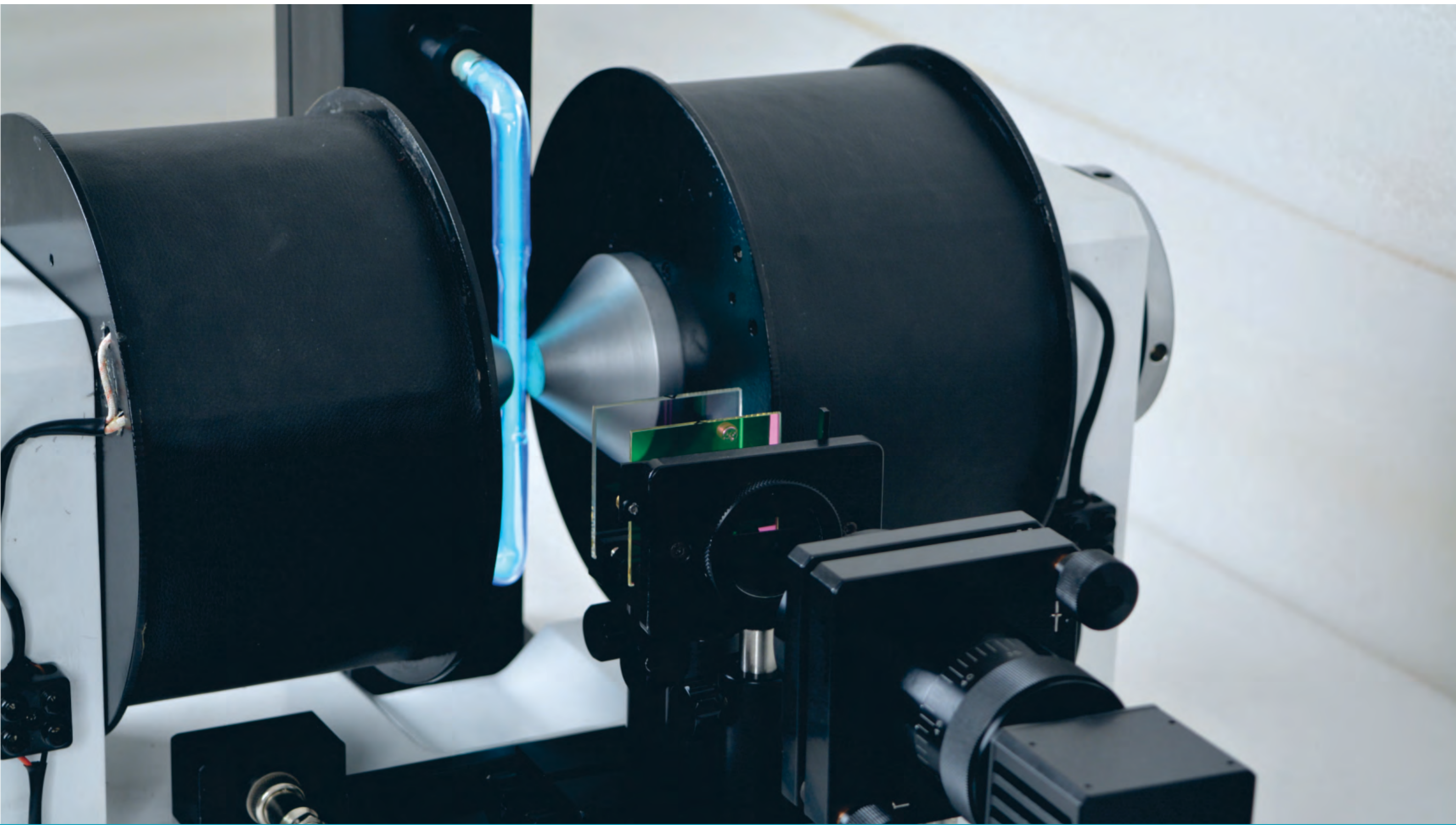
Holmarc specifically disclaims special, indirect, or consequential damages or lost profit which may result from a breach of this warranty. Any implied warranties which cannot be disclaimed are hereby limited to a term of one year from the date of original retail purchase.

Holmarc reserves the right to change product specifications or to discontinue products without notice.

Please refer our commercial invoice for warranty claim.

(Authorized Signatory)

HOLMARC
OPTO-MECHATRONICS LTD



INSTRUCTION MANUAL

ZEEMAN EFFECT APPARATUS

Model : HO-ED-S-04A

Educational Apparatus For General & Engineering PHYSICS

All products are manufactured and marketed by Holmarc Opto-Mechatronics Ltd

We have made a deliberate attempt in the design of educational apparatus to keep all components and modules open as far as possible. This approach helps students to gain deep understanding and in most cases provide them hands on experience in setting up the experiments. All components and modules used in our educational products are of highest quality comparable to the best in the world. The design of experiments are in tune with the state of the art trends in the field. Our expertise in the integration of optics, mechanics and electronics are fully made use of in all these apparatus and equipments.