



RANDOLPH-MACON  
COLLEGE



# Physics of Light: Travel Course to England



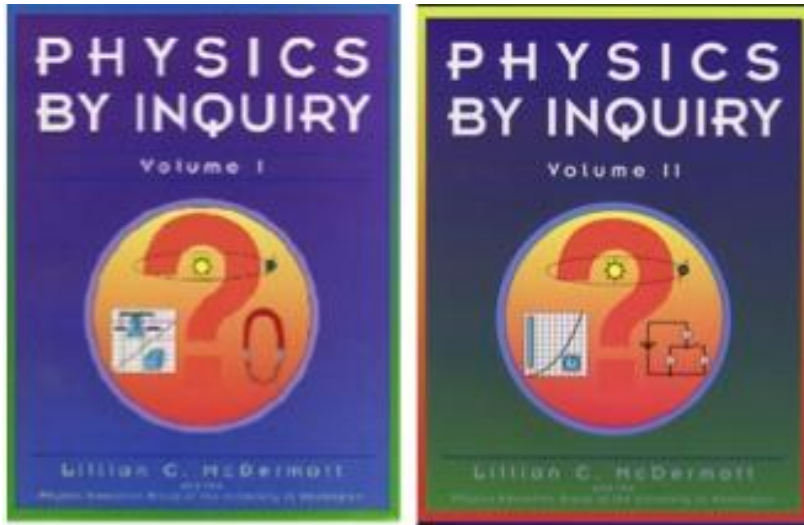
Rachele Dominguez  
Cedar Reiner  
Randolph-Macon College  
April 28, 2018  
CSAAPT Spring Meeting



# Overview

- January travel dual course
  - Physics of Light: Prof. R. Dominguez
  - Psychology of Vision: Prof. C. Reiner
- Timeline
  - One very intense week at Randolph-Macon
    - Main lab portion of course
    - Lectures on Psychology of Vision
    - Mini-labs at night
  - 2.5 weeks in England
    - Classes at Wroxton College
    - Day Trips
    - Stay in London

# One week intensive lab



## ***LIGHT AND OPTICS***

### **Part A: Plane mirrors and images**

- §1 Introduction to reflection.....
- §2 Image formation in a plane mirror .....
- §3 Multiple images .....

### **Part B: Lenses, curved mirrors, and images**

- §4 Introduction to refraction .....
- §5 Law of refraction: Snell's law .....
- §6 Examples of refraction in everyday life .....
- §7 Image formation by convex lenses .....
- §8 Image formation and ray diagrams.....
- §9 Image formation and the thin lens equation ...
- §10 Image formation by concave lenses .....
- §11 Image formation by curved mirrors .....
- §12 Optical instruments .....

## ***LIGHT AND COLOR***

### **Part A: Light and shadows**

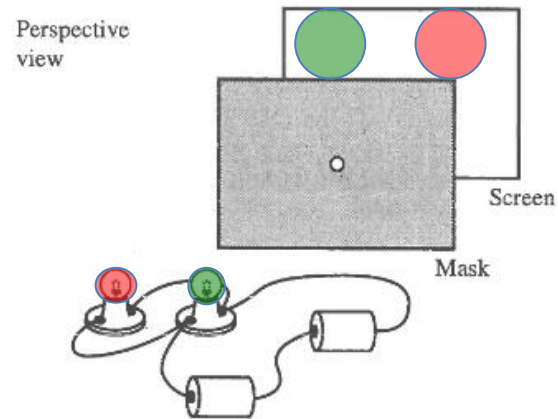
- §1 Introduction to light.....
- §2 Light sources, masks, and screens....
- §3 Pinhole cameras.....
- §4 Shadows .....

# Example of lab

## Experiment 2.7

This experiment should be performed in a darkened room.

A mask is placed between two small bulbs and a screen as shown.



A. Predict what you would see on the screen. Explain your reasoning.

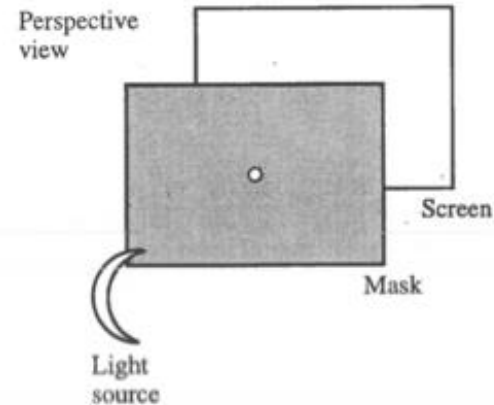
Set up the apparatus, and check your prediction.

B. Predict what you would see on the screen if you were to add a third bulb in line with the other two bulbs.

Check your prediction.

# Sample take-home exam questions

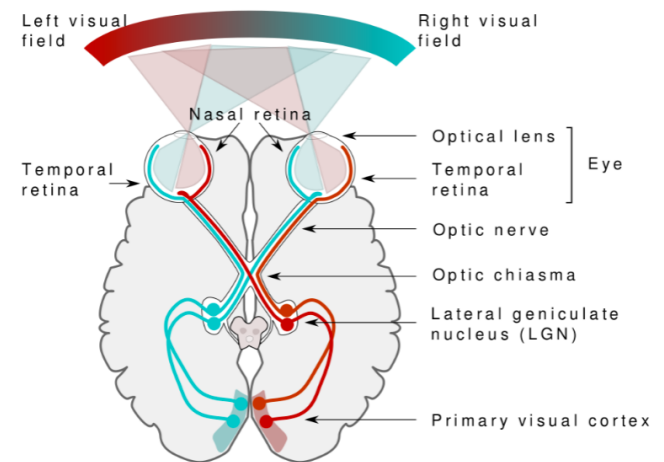
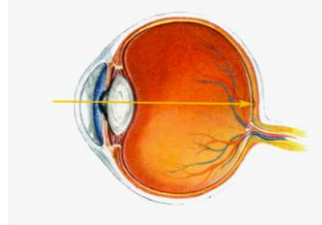
- B. The student then blocks part of the light to form a crescent (one of the shapes of the sun during an eclipse). Sketch what she would see on the screen in this case. Explain.



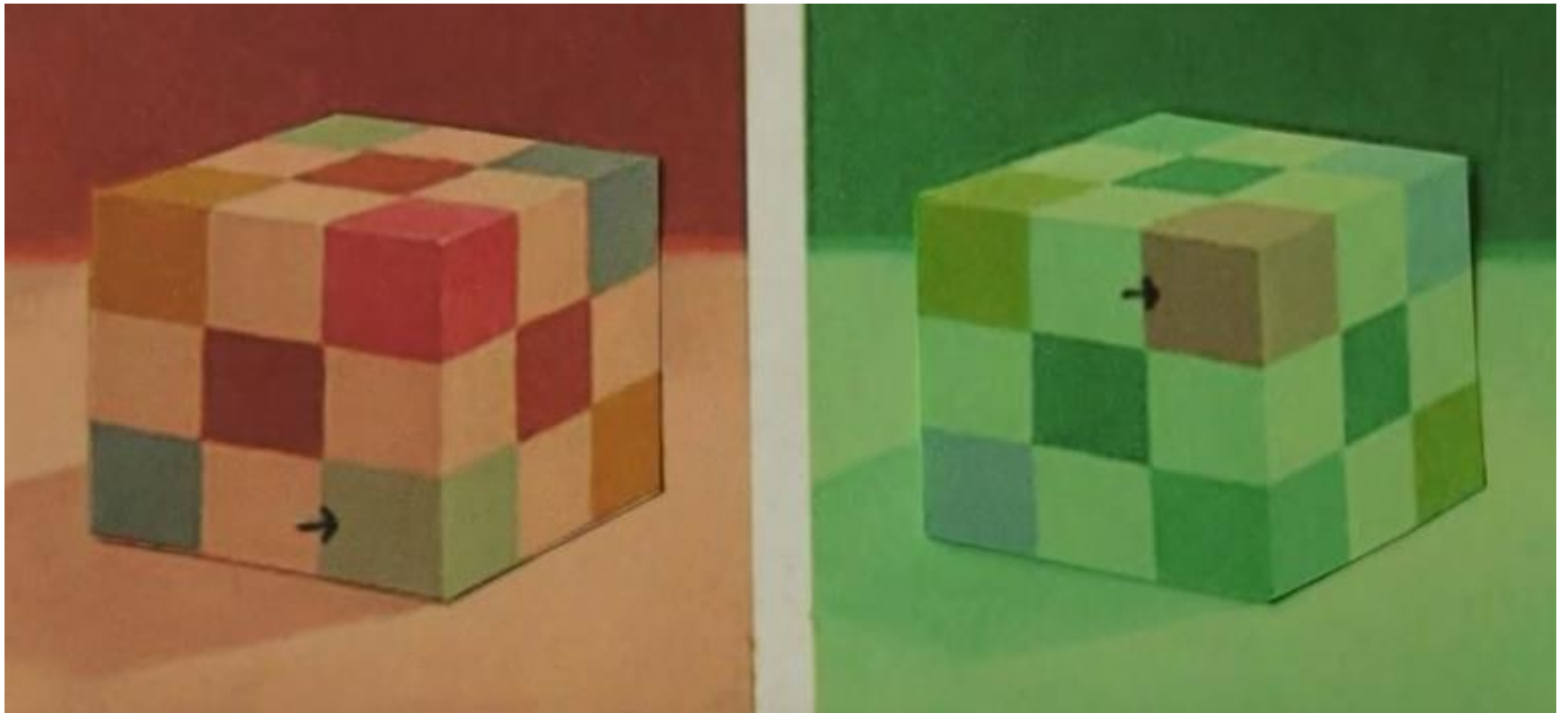
# Psychology of Vision

Dr. Cedar Reiner

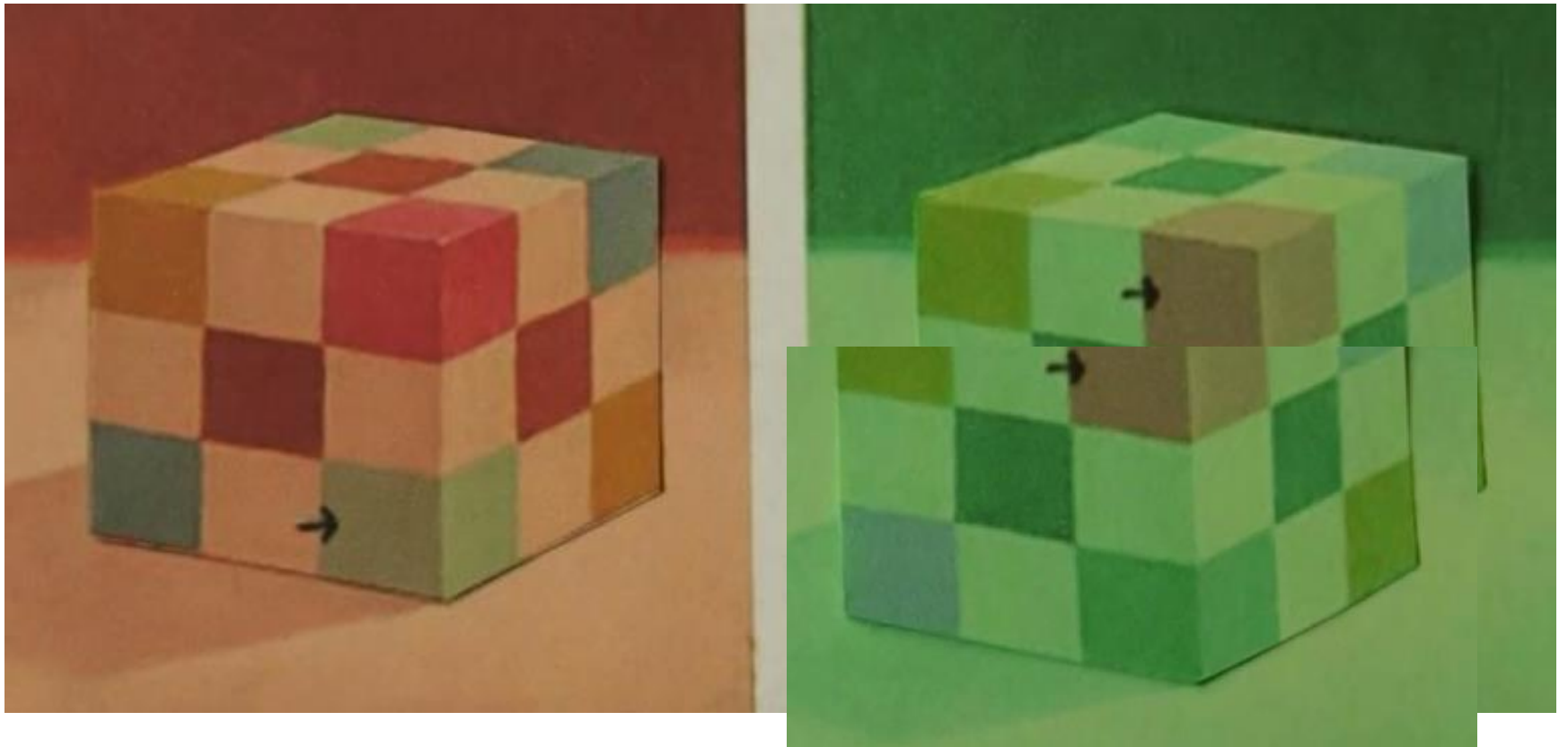
- The eye
- Eye and Brain
- Optics for Perception
- Color Perception
- Vision
- Depth Perception
- Adaptation and Animal Eyes



# Vision is a brain process

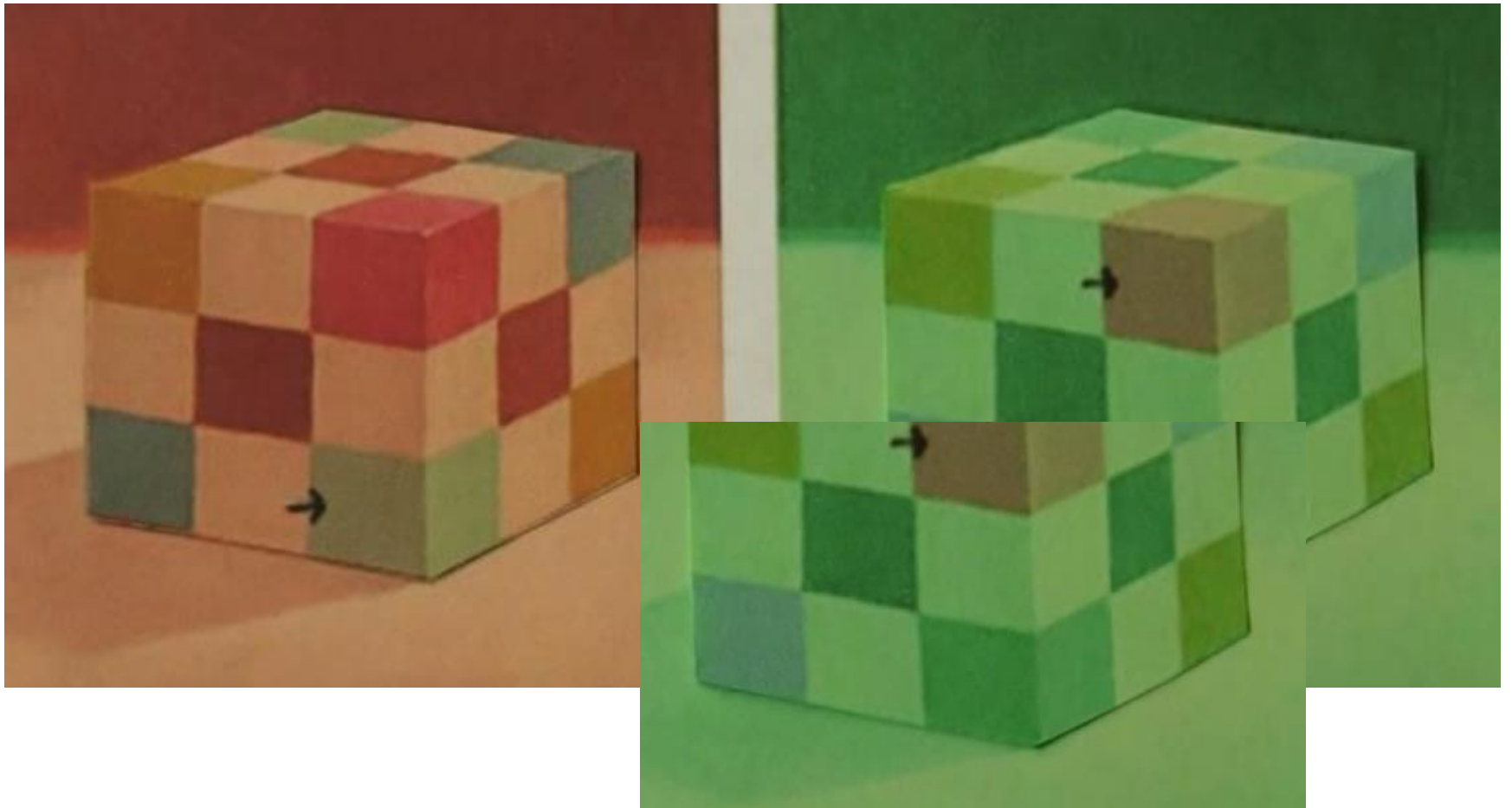


# Vision is a brain process

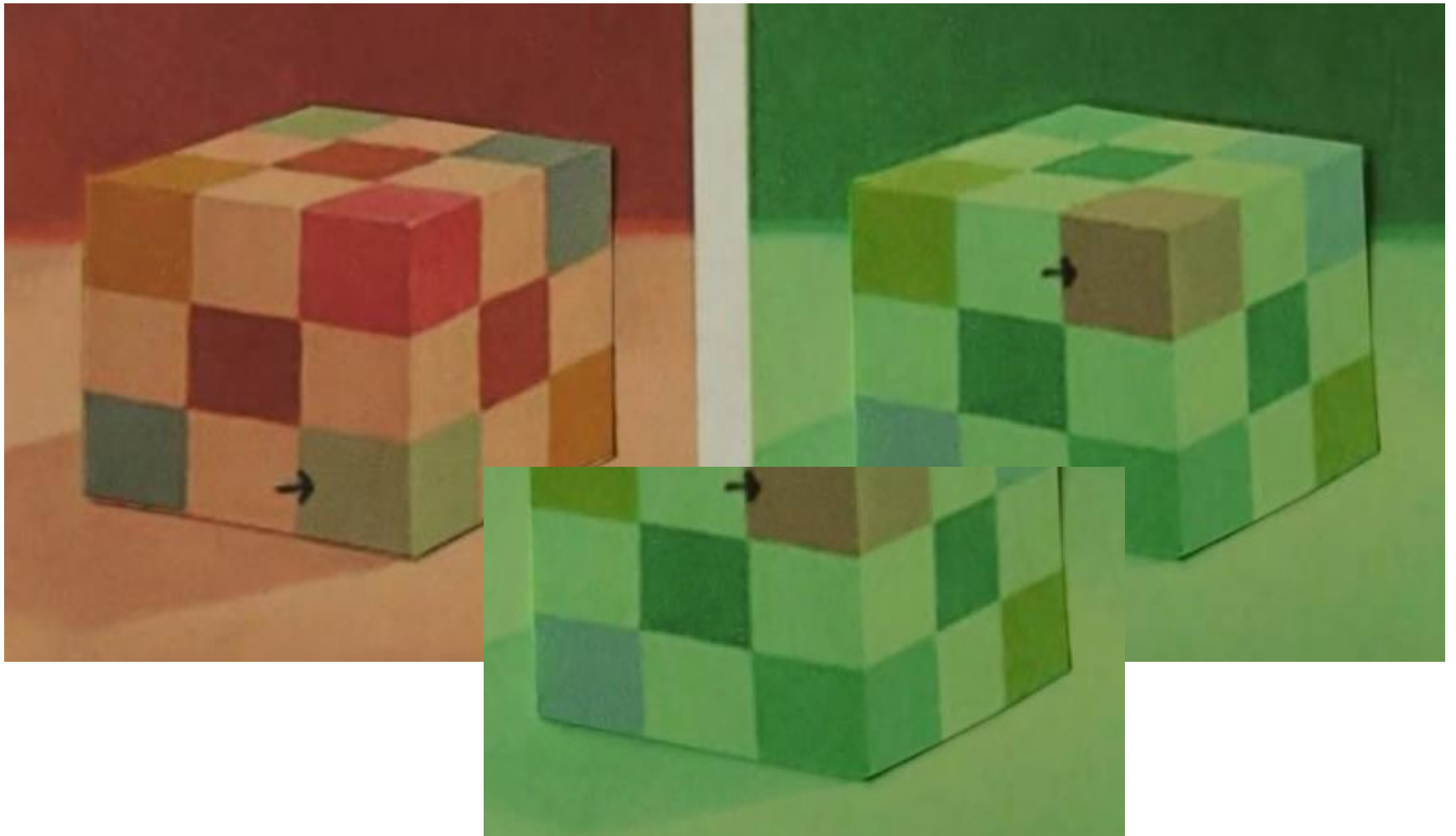




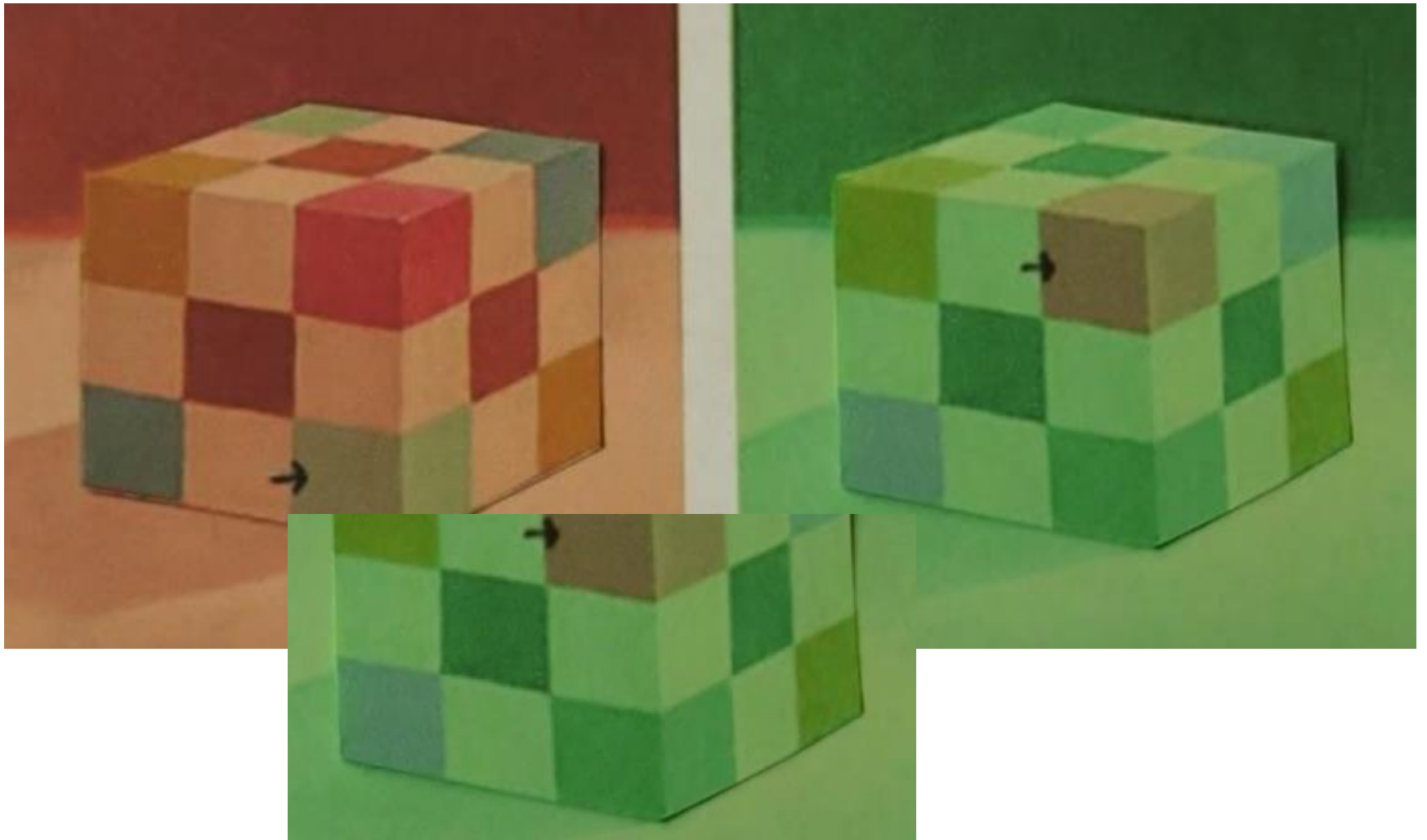
# Vision is a brain process



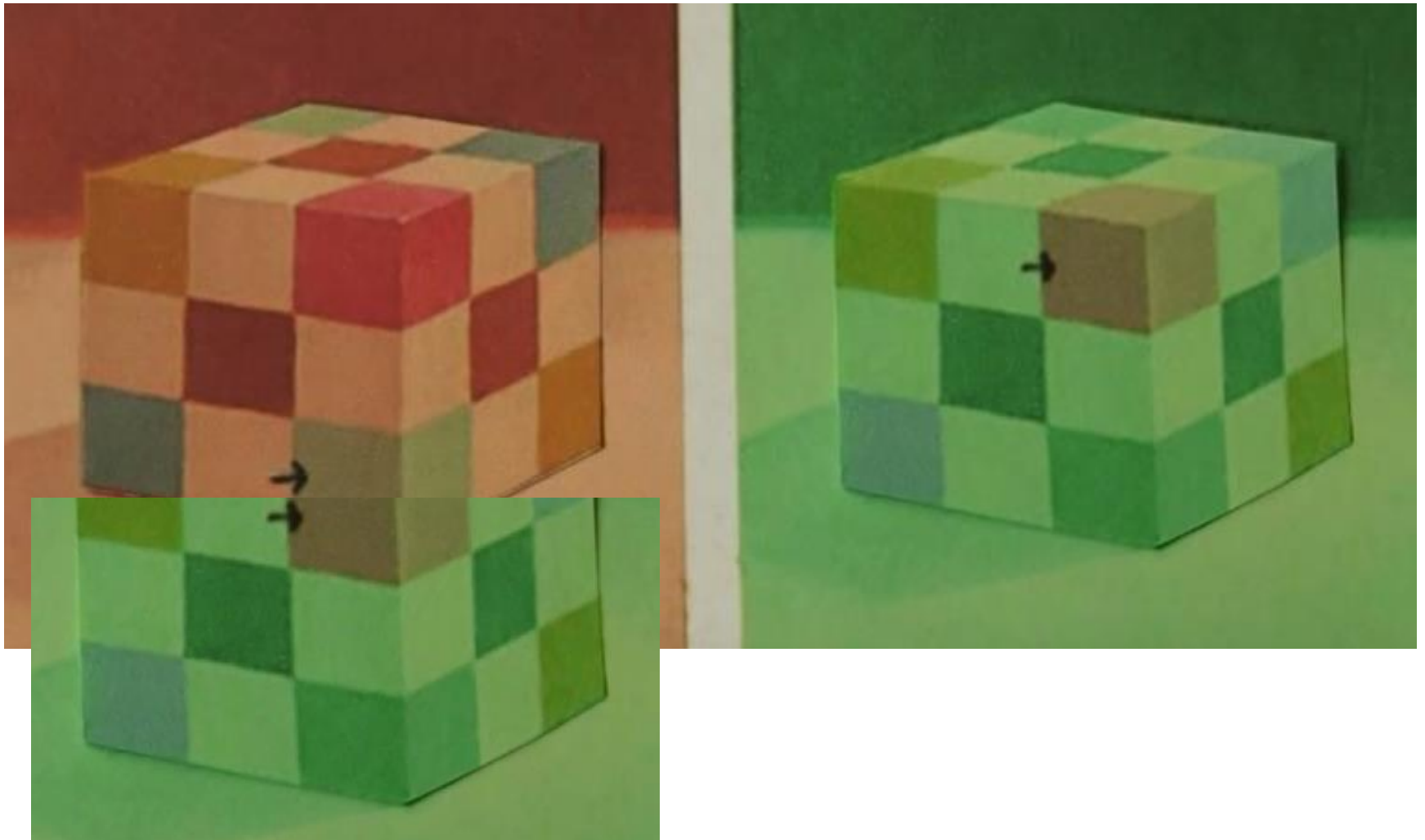
# Vision is a brain process



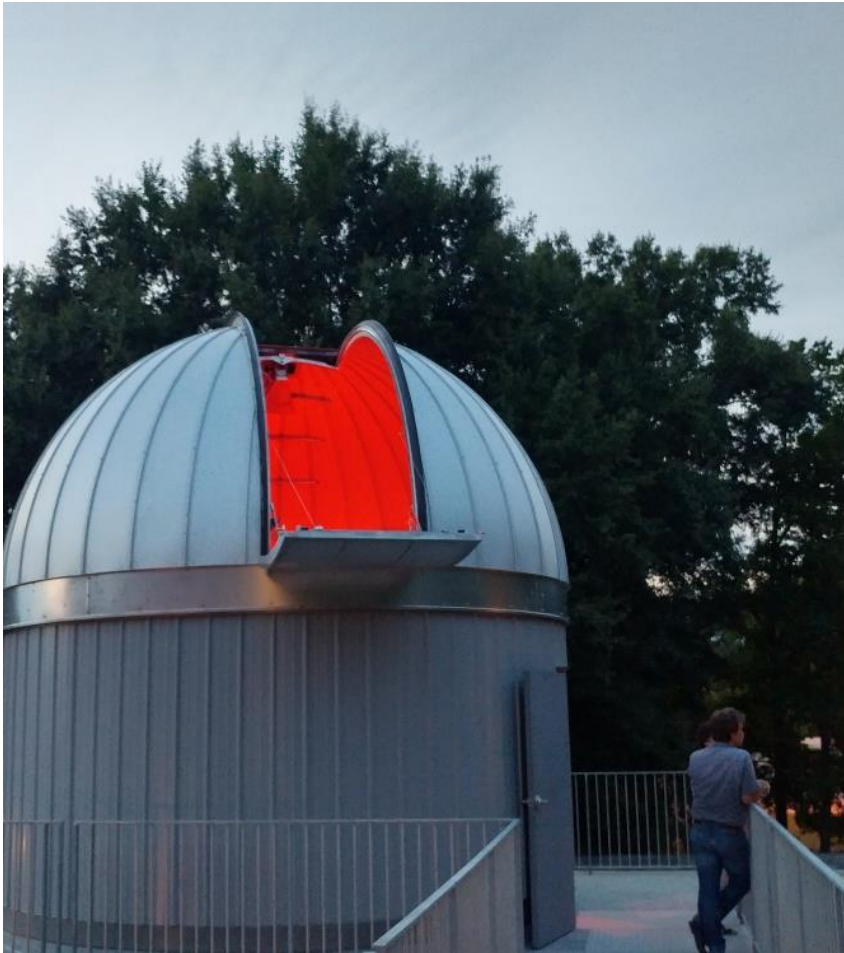
# Vision is a brain process



# Vision is a brain process



# Other Mini-labs



- Keeble Observatory
- Interference and diffraction patterns
- Emission spectra





# WROXTON COLLEGE

FAIRLEIGH DICKINSON UNIVERSITY



## **RANDOLPH MACON COLLEGE**

ECON Group  
PHYS/PSYC Group

*Sunday 14 – Thursday 25 January 2018  
(Thursday 25 – Wednesday 31 January – Group are in London)*



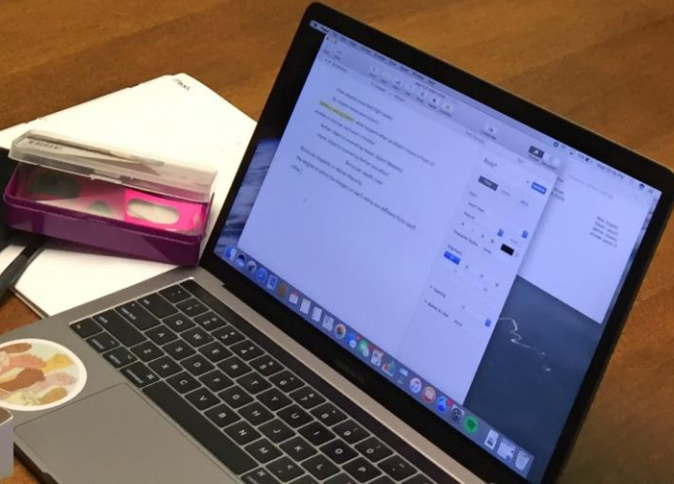
# Daily Schedule

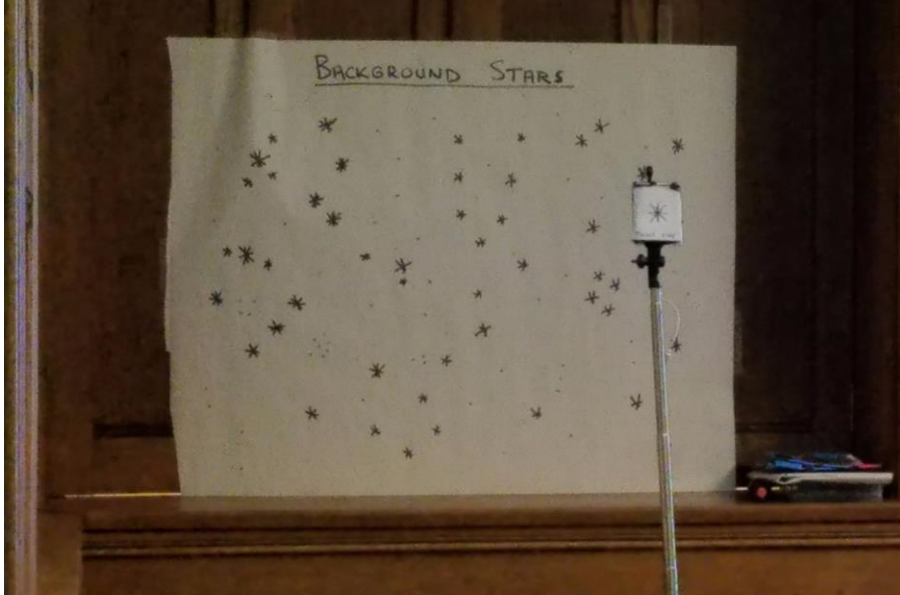
8.00-8.50am	Breakfast served in the Dining Room, Carriage House
9.00-10.45am	<b><i>PHYS/PSYC CLASS</i></b>
10.45-11.15am	Morning Coffee served in the Buttery, Carriage House
11.15am-1.00pm	<b><i>PHYS/PSYC CLASS</i></b>
1.00pm	Lunch served in the Dining Room, Carriage House
2.00-4.00pm	<b><i>PHYS/PSYC CLASS</i></b>
4.00-4.30pm	Afternoon Tea served in the Buttery, Carriage House
4.30-6.00pm	<b><i>PHYS/PSYC CLASS</i></b>
7.00pm	Dinner served in the Dining Room, Carriage House



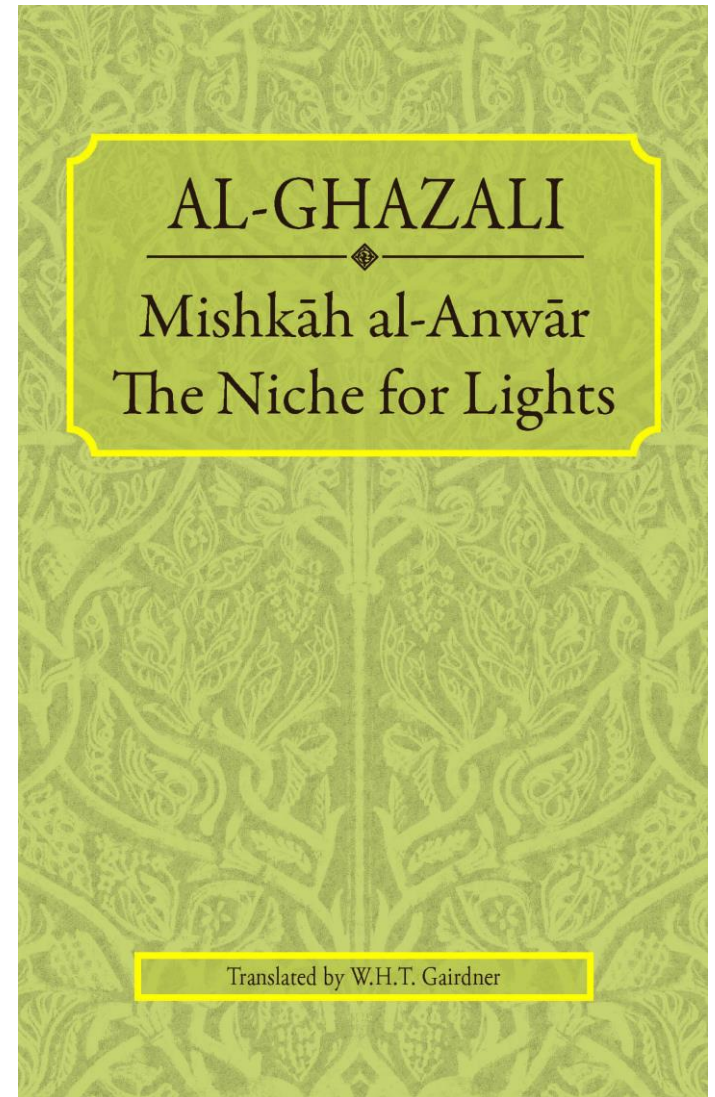
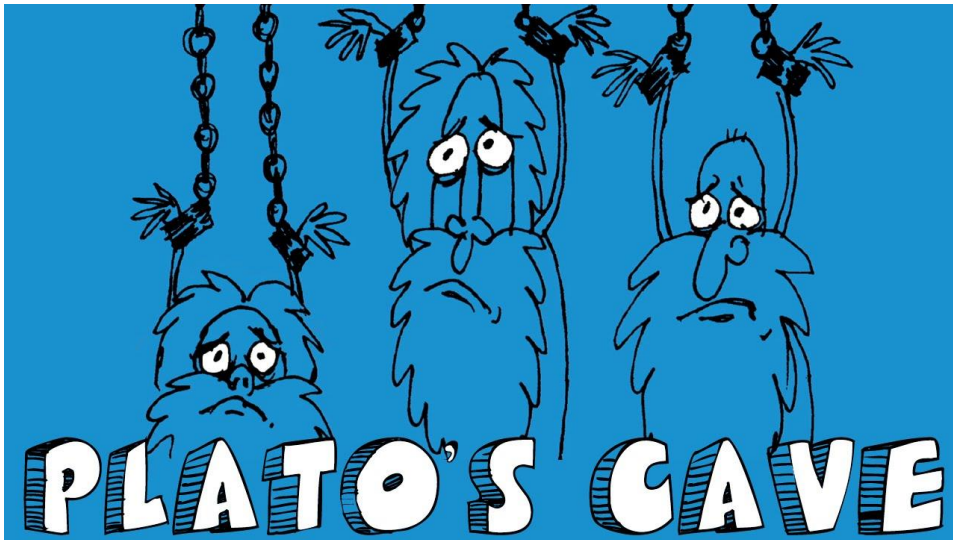


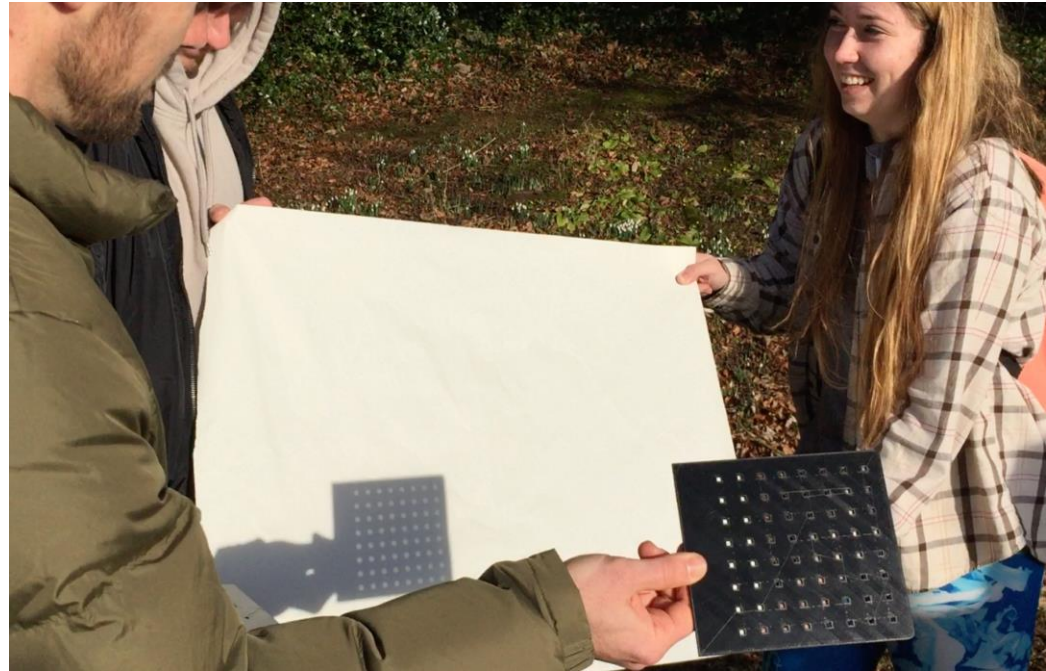
MEETING  
IN  
PROGRESS





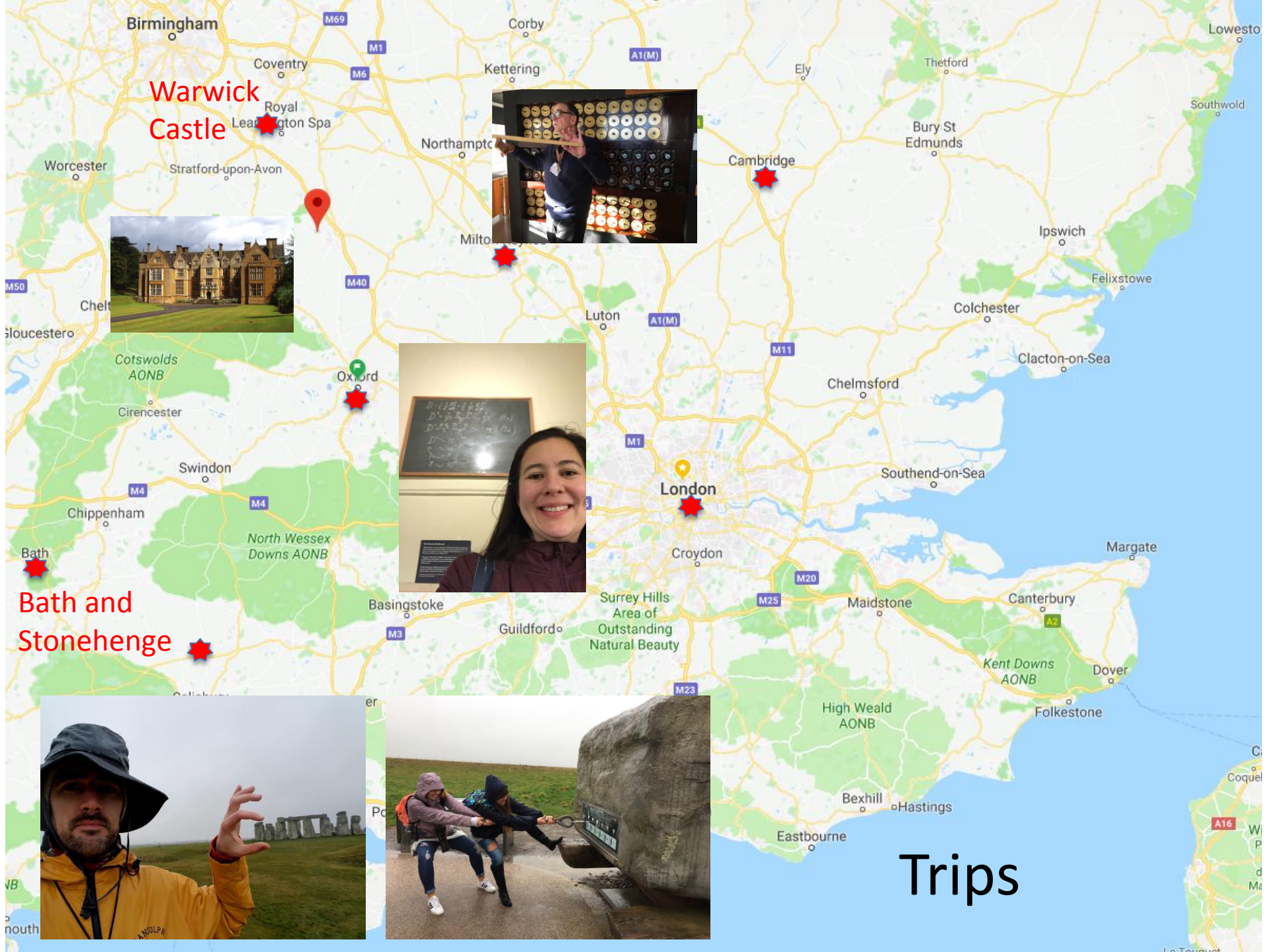
# Liberal Arts!!!!







Trips



**Warwick  
Castle**



**Bath and  
Stonehenge**



**Trips**

# Cambridge, UK

## Tour of Cavendish Museum with Malcolm Longair



# Cavendish Laboratory

## (29 Nobel prizes)

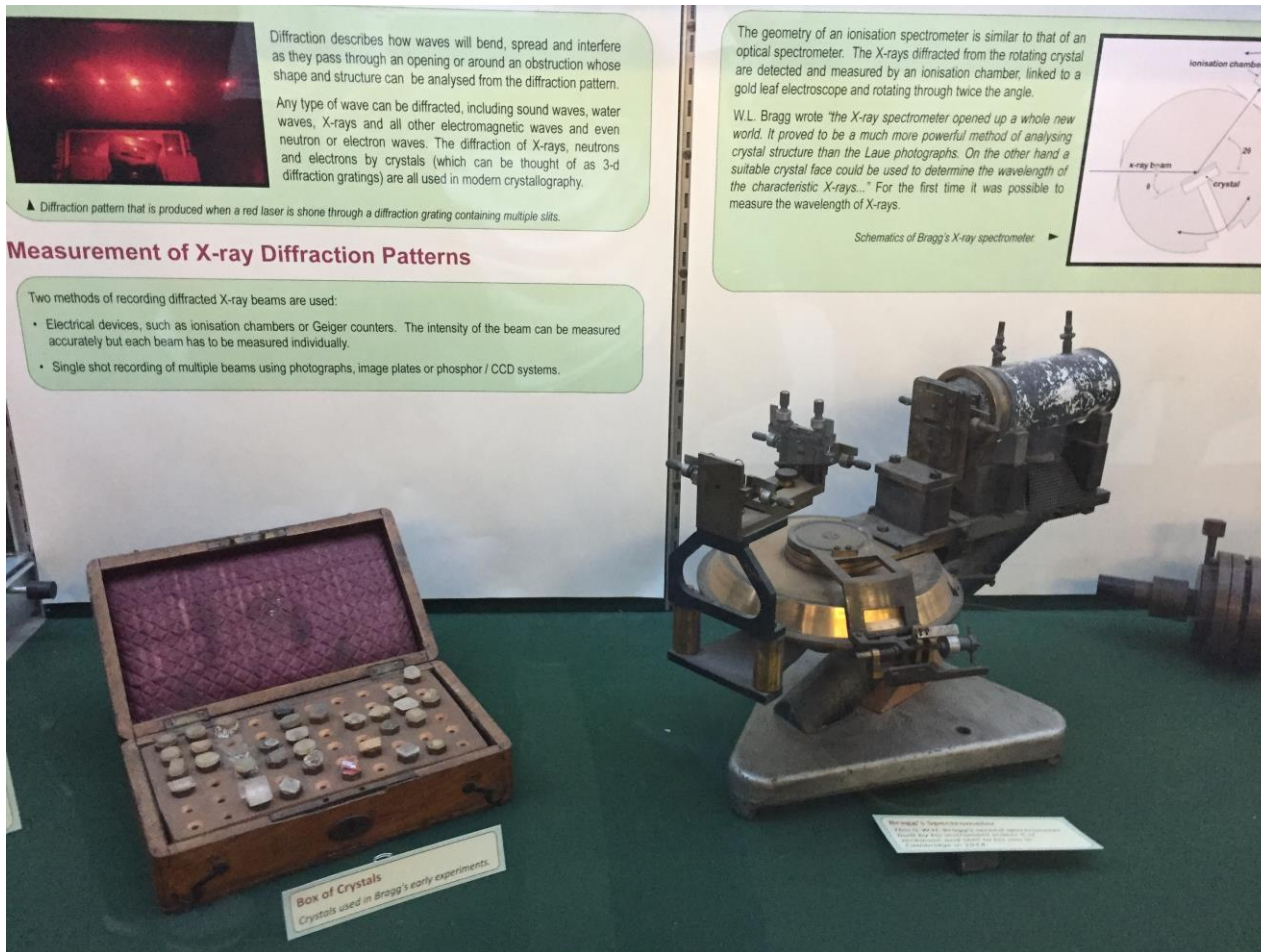
- James Clerk Maxwell (Electricity and magnetism)
- John William Strutt: Lord Rayleigh (black bodies at low frequencies)
- JJ Thomson (discovers electron)
- CTR Wilson (invents cloud chamber)
- Ernest Rutherford (father of atomic physics)
- Francis Aston (mass spectograph)
- James Chadwick (discovers neutron)
- Walton and Cockroft (proton accelerator)
- Watson and Crick (DNA)
- And many more....



# Wilson's Cloud chamber



# Bragg's spectrometer and some of his crystals



Diffraction describes how waves will bend, spread and interfere as they pass through an opening or around an obstruction whose shape and structure can be analysed from the diffraction pattern.

Any type of wave can be diffracted, including sound waves, water waves, X-rays and all other electromagnetic waves and even neutron or electron waves. The diffraction of X-rays, neutrons and electrons by crystals (which can be thought of as 3-d diffraction gratings) are all used in modern crystallography.

▲ Diffraction pattern that is produced when a red laser is shone through a diffraction grating containing multiple slits.

### Measurement of X-ray Diffraction Patterns

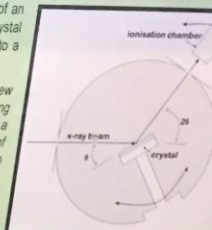
Two methods of recording diffracted X-ray beams are used:

- Electrical devices, such as ionisation chambers or Geiger counters. The intensity of the beam can be measured accurately but each beam has to be measured individually.
- Single shot recording of multiple beams using photographs, image plates or phosphor / CCD systems.

The geometry of an ionisation spectrometer is similar to that of an optical spectrometer. The X-rays diffracted from the rotating crystal are detected and measured by an ionisation chamber, linked to a gold leaf electroscope and rotating through twice the angle.

W.L. Bragg wrote "the X-ray spectrometer opened up a whole new world. It proved to be a much more powerful method of analysing crystal structure than the Laue photographs. On the other hand a suitable crystal face could be used to determine the wavelength of the characteristic X-rays..." For the first time it was possible to measure the wavelength of X-rays.

Schematics of Bragg's X-ray spectrometer

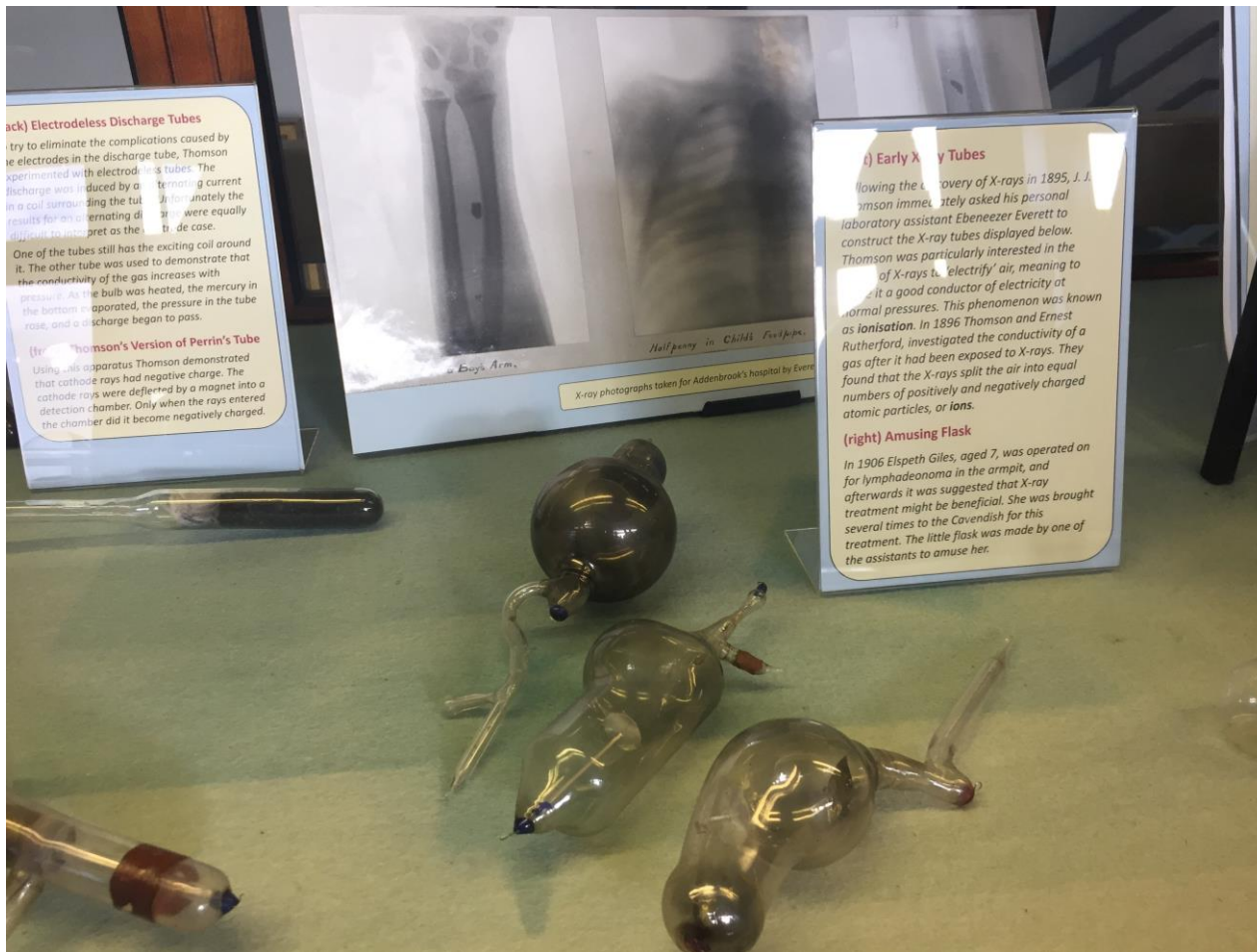


Box of Crystals  
Crystals used in Bragg's early experiments.

# Early decorative Crooke's tube



# Other early x-ray tubes

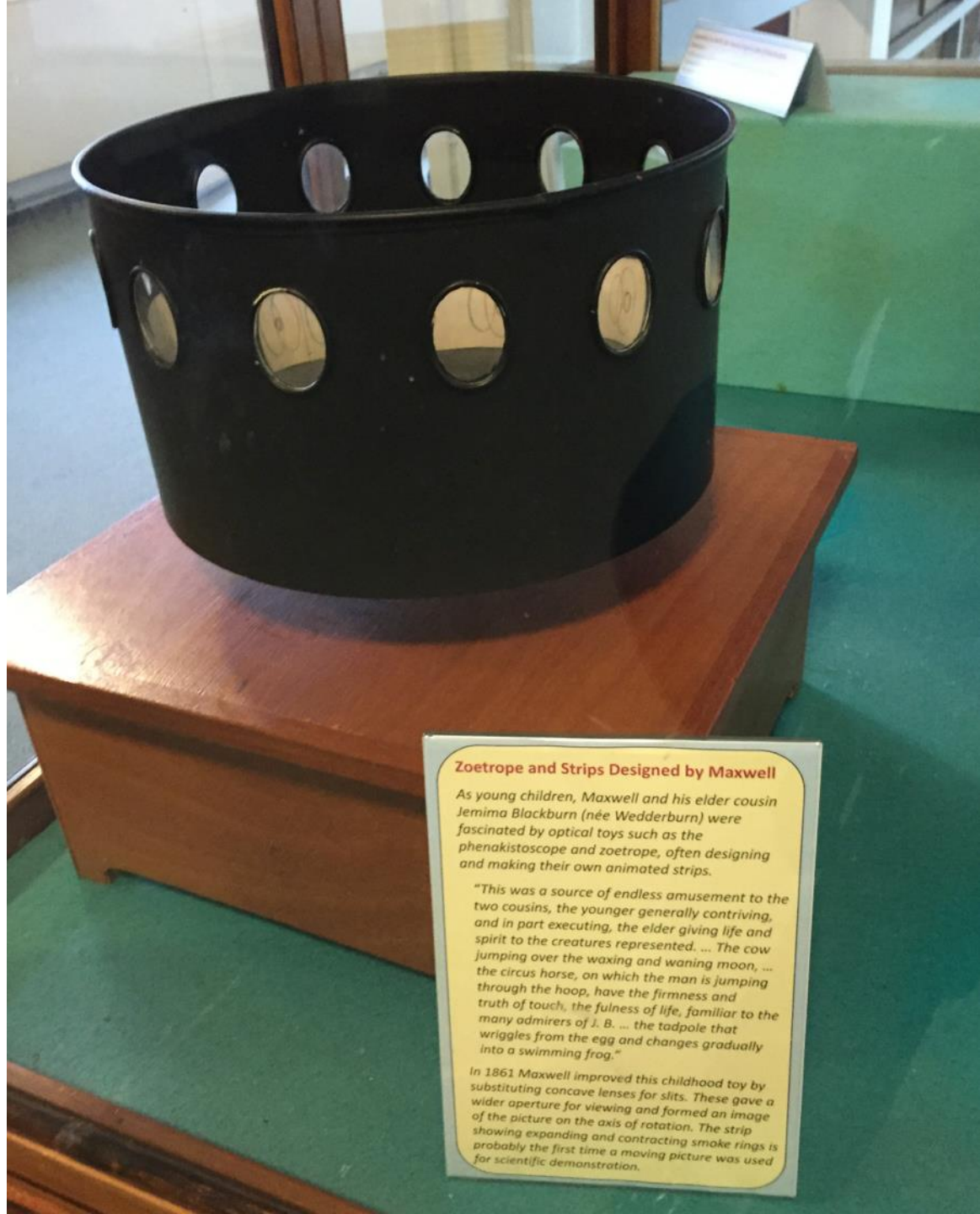






*Maxwell's colour wheel, 1855*

Maxwell had his colour wheel constructed whilst holding his fellowship at Trinity College in 1855. By changing the fraction of different colours, he derived the first equations to show how much of the primary lights, red, green and blue were required to reproduce any given colour. The results were the precursor of the modern CIE diagram which is used in all forms of modern colour display.



#### Zoetrope and Strips Designed by Maxwell

*As young children, Maxwell and his elder cousin Jemima Blackburn (née Wedderburn) were fascinated by optical toys such as the phenakistoscope and zoetrope, often designing and making their own animated strips.*

*"This was a source of endless amusement to the two cousins, the younger generally contriving, and in part executing, the elder giving life and spirit to the creatures represented. ... The cow jumping over the waxing and waning moon, ... the circus horse, on which the man is jumping through the hoop, have the firmness and truth of touch, the fulness of life, familiar to the many admirers of J. B. ... the tadpole that wriggles from the egg and changes gradually into a swimming frog."*

*In 1861 Maxwell improved this childhood toy by substituting concave lenses for slits. These gave a wider aperture for viewing and formed an image of the picture on the axis of rotation. The strip showing expanding and contracting smoke rings is probably the first time a moving picture was used for scientific demonstration.*



**Rutherford's crocodile** on the Mond building of the old Cavendish Laboratory in Cambridge. The Russian physicist Peter Kapitza called him the crocodile, because "in Russia the crocodile is the symbol for the father of the family and is also regarded with awe and admiration because it has a stiff neck and cannot turn back. **It just goes straight forward with gaping jaws— like science, like Rutherford.**"





162 16.266

PHILOSOPHIÆ  
NATURALIS  
PRINCIPIA  
MATHEMATICA.

Autore <sup>1642</sup> J. S. NEWTON <sup>Equit. Cantab.</sup> Trin. Coll. Cantab. Soc. Matheseos  
Professore <sup>Lucasiano</sup>, & Societatis Regiæ Sodali  
~~et Societatis Regiæ Societatis præside~~

IMPRIMATUR.  
S. PEPYS, Reg. Soc. PRÆSES.  
Julii 5. 1686.

LONDINI,

Jussu Societatis Regiæ ac Typis Josephi Streater. Prostat apud  
plures Bibliopolas. Anno MDCLXXXVII.



JOSEPH JOHN THOMSON  
per xxxiv annos physicae professor Cavendishianus  
vvida animi vi naturae portarum effregit claustra  
et discipulis ex orbe terrarum confluentibus novas  
scientiae vias munivit. Natus juxta Mancuniam  
AD XV kal Ian A S MDCCCIV in collegio quod singulari  
amore per LXIV annos discipulus socius magister  
foverat vir comis modestus simplex supremum  
diem obiit AD III kal Sept A S MDCCCXL.

ERNESTVS RUTHERFORD BARO DE NELSON  
PER XVIII ANNOS PHYSICAE PROFESSOR  
ET LABORATORII CAVENDISHIANI RECTOR  
QVI PRAETER AEQVALES OMNES  
CVM IPSE SVO VSVS INGENIO  
TVM ALIOS EXCITANDO  
SECRETA NATVRAE ILLVSTRAVIT  
IDEM SOCIVS HVIVS COLLEGII  
VARII SERMONIS VI COPIA FACILITATE  
AMICOS DELECTABAT ET REFCIEBAT  
DECESSIT A S MDCCCXXXVII AETATIS SVAE LXVII

FRANCISCVS CVLIELMVS ASTON  
QVEM VT SOLLERTI ARTIFICIORVM INVENTIONE  
VSQVE ACCVRATISSIMO PRAESTANTEM  
SIBI ADCIVIT IOSEPHVS THOMSON PHYSICAE PROFESSOR  
POSTHAC ET IPSE EXIMIAM DIGNITATEM FAMAM CONSECVTVS EST  
ATOMORVM VT DICVNT ISOTOPARVM REPETOR  
MUSICAE LYDORVM PERGRINATIONVM AMANTEM  
SODALIBVS COMEVSIVIT APERTA SIMPLICITAS  
HVIVS COLLEGII PER VIVSTRA SOCIVS  
OBIIT AD KAL XII DEC MDCCCXIV NATVS ANNOS LXVIII

PIOTR LEONIDOVICH KAPITZA  
E RVSSIA LEONIA PER VIVSTRA SOCIVS  
NOVIS RATIONIBVS NOVIS LACUNIS VSVS  
NATVRAE SVAVILITATE INSPECTO REFRACTABAT  
MOX DVRA SVAE LEGE INTRARE RETENTVS  
PHYSICORVM INVENTORVM COLLEGIIVS HABEBATVR  
VIR FACETVS GRACIOSVS COLLEGIIVS SEMPER MEMOR  
SOCIIS HONORIBVS SVIS SVAVILITER RECEPTVS EST  
OBIIT AD VI ID OCT MDCCCXXXVI AETATIS SVAE XC



# London

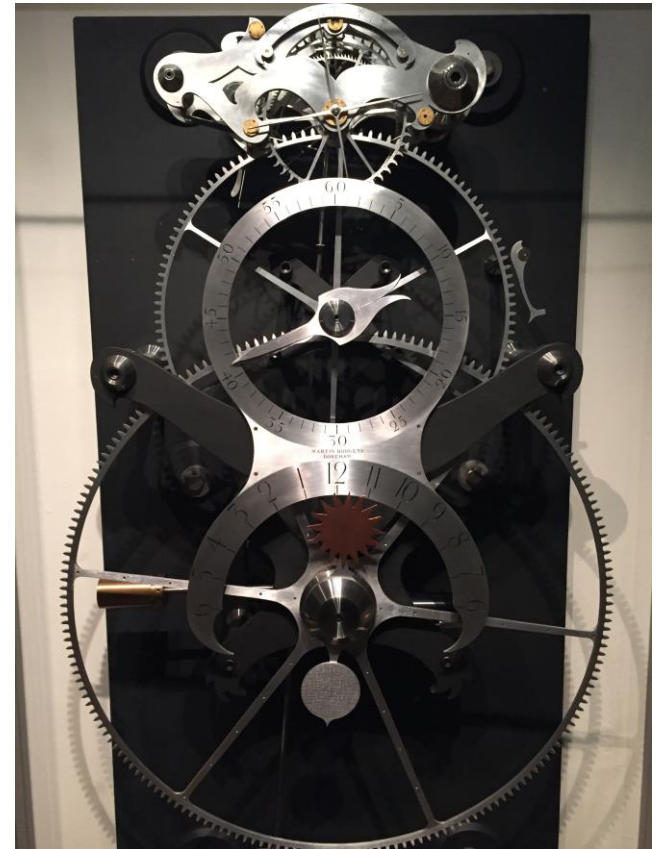
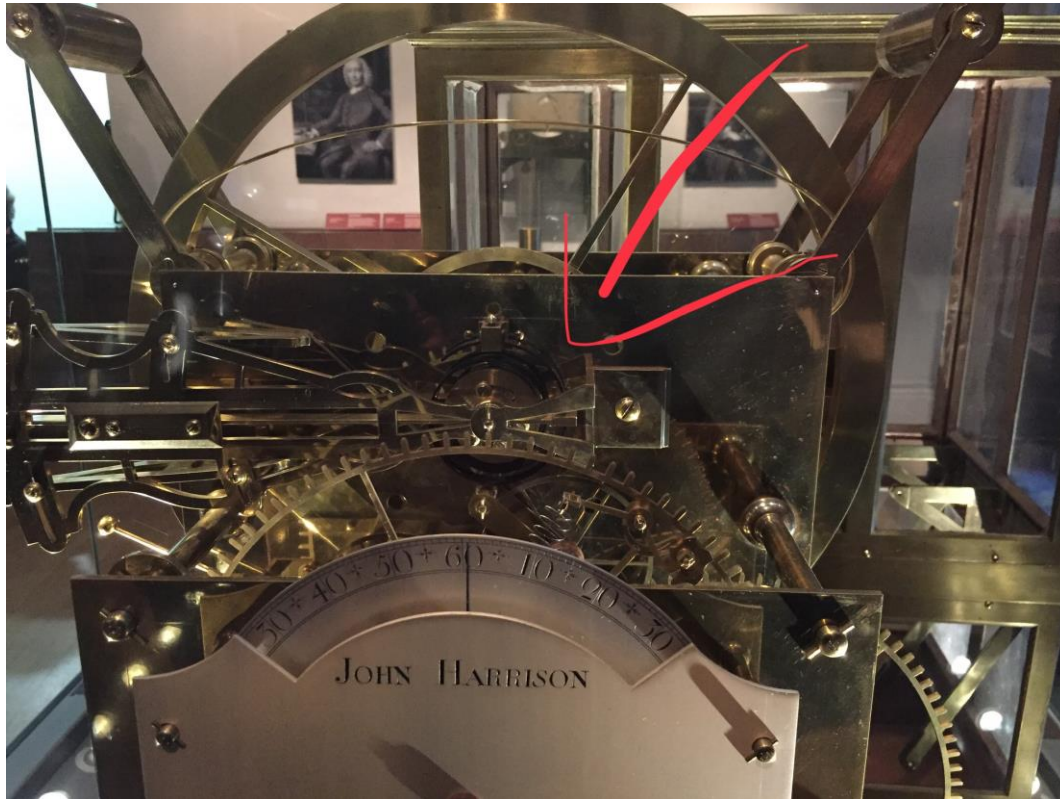


# Greenwich Royal Observatory



Alexia Hopson

# Clocks at Greenwich Royal Observatory







LOVING MEMORY OF  
OUR PARENTS  
ADELINE SARAH  
APPLETON  
DIED 27th AUG 1969  
AND HER HUSBAND  
WILLIAM ALBERT  
APPLETON  
DIED 19th SEPT 1985  
BY NEXUS

ELLEN WILEY  
DIED 19th AUG 1911  
AGE 81  
AND  
ALFRED JAMES  
WOODOPER  
DIED 19th AUG 1911  
AGE 81  
BY NEXUS

LISE  
MEITNER  
1878-1968  
A physicist  
who never lost  
her humanity

Bramley, Hampshire

# Light and Illusion inspired tattos



Thanks!

