NATS 1870
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Lecture Note #2
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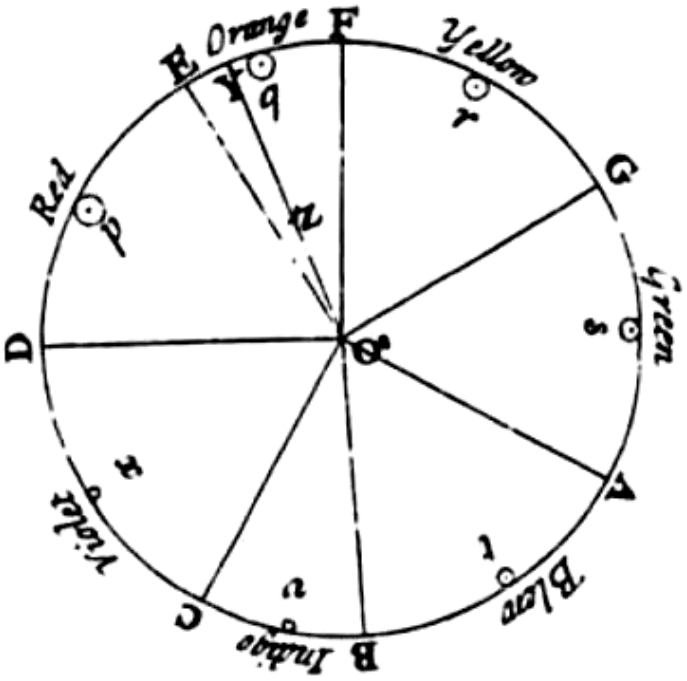
Colour + Light

Newton's Experiments

Experiment #1 (The composition of White Light) conclusion: white light is a combination of colours of the spectrum.
Experiment #2 (Experimuntum Crucis) conclusion: Colour is a fundamental part of light and not an object, once light is broken down or dispersed into its component, it cannot be further altered.

Prior to Newton: pre-scientific thought that colour was a property of an object

Newton wrapped the spectrum to create the colour wheel



Prior to Newton, Ancient Greeks and Aristotle arranged colour Linear
Black——White
Dark—— Light

Colour/Hues were along the line
Blue closer to Black/ Yellow closer to White / Red and Green in the middle

Other painters had created other colour wheels, precise colours used and the order of colours could vary
Often Black and White were part of the colour wheel.

Newton essentially established the order of colours and discussed how colours can mix
White lies at the centre of his wheel, and tints where in between the centre and the edge of the wheel

These would be Additive colours mixes

Moses Harris- made the colour wheel for painters
R Y B - Primaries
Mixed Secondaries (e.g. Red+Yellow = Orange)
Centre was black- Mixed shades in interior of circle
Opposites of colour wheel = Compliments

Better colour wheels today contain colours like Magenta and Purple (Magenta not present in past because its synthetic)

The Extra-spectral and Non Spectral Hues
* These include all hues between blue violet and orange red
* They are not part of the spectrum but are generated in the eye and brain
* They are not produced when white light is dispersed by a prism
* We perceive all colour using our eye colour receptors called cones in our brain

When we see colours like Magenta or Purple, 2 of our colour receptors are activated- Red Receptors and our Blue Receptors

We have 3 colour receptors in our eye:
Red Light Sensitivity
Green Light Sensitivity
Blue Light Sensitivity

Magenta and Purple are a mix of red and blue and they emphasize that colour is perceptual.

General Properties of Light

Light is a phenomenon in nature, it can behave like a wave, it can behave like a particle. The true nature of light has both wave and particle characteristics.

A Light beam consists of multiple waves and light waves travel through space
Light Travels though empty space at the speed of light = 300,000 km a second

A wavelength is the peaks within a wave
Amplitude relates to the brightness or intensity of the light

In a spectrum, the range of hues
V I B G Y O R
Is a range of a wavelength?

Wavelengths
Measured in fractions of a meter
Visible light (violet-red) uses nanometer= 1 billionth of 1 meter

Shortest Wavelength
Blue 400m
Green 500m
Red 600m
Longest Wavelength

Each part of the spectrum has a unique wavelength

Visible Light (what can be perceived by the human eye is one small portion of the electromagnetic spectrum

There are wavelengths that the human eye cannot perceive, we are sensitive to 400m—700m

Ultra violet, X Ray and Gamma Ray all have short wavelength
Radio, TV, Infrared all have long wavelength

All parts of the Spectrum can be characterized by
1. Wavelength
2. Frequency
3. Energy

Frequency measures how many peaks pass a point in 1 second
Energy piece of light is a photon. Photon has various energies.
* Short Wavelength= High Frequency= High Energy
* Long Wavelength= Low Frequency= Low Energy

All parts of the EM spectrum travel at the speed of light in a vacuum
Light can also be considered a particle: Photon

Interaction of Light + Matter

Atoms are of protons (p) positive charge
Neutrons (N) Neutral Charge

Central nucleus which is orbited by electrons (e) negative charge

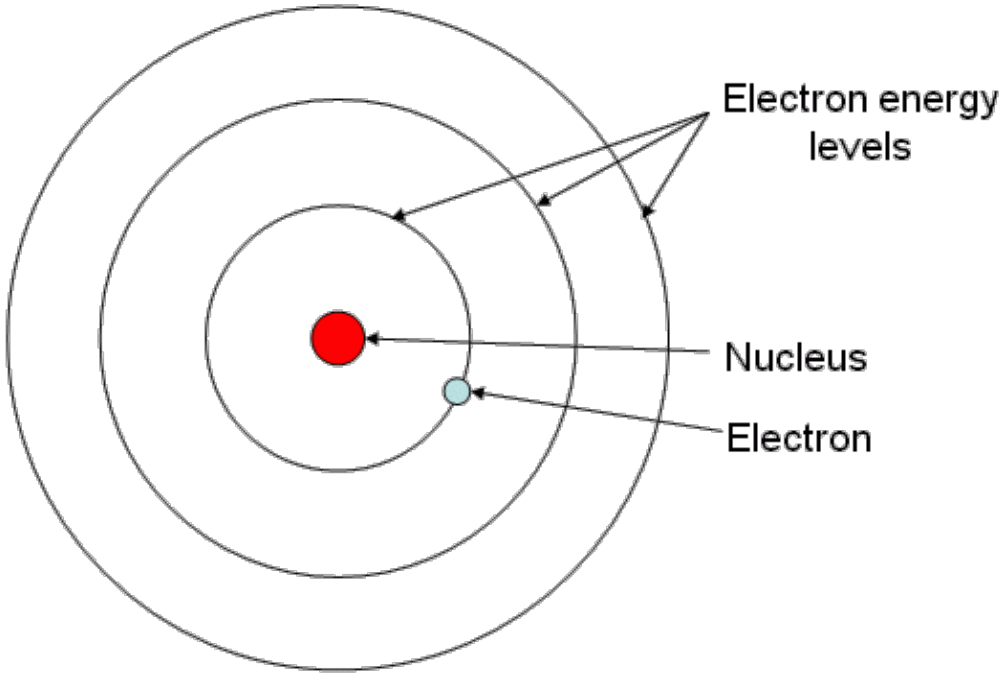
Each type of atom has different number of protons, neutrons and electrons

What characterizes a specific atom is the number of protons?

-A Neutral Atom has the same number of protons are = to number of electrons
-Ion occurs when an atom gains or loses electrons
-isotopes occur when an atom gains or loses neutrons

-What is key in colour is the way electrons are distributed and behave in the atom
-Electrons mediate the Interaction of Light+Matter

Bohr model of the Atom



Electrons orbit the nucleus
-each orbit has a specific energy
-each orbit is stable

Lowest energy is the closest to the nucleus and the subsequent orbit has higher energies

Each orbit has a very specific energy

The electron has to be in an orbit, it can NEVER be between orbits (its possible for it to move from one orbit to another, it does this by gaining energy through light from the sun or a transfer of kinetic energy)

The interactions are governed by the Conservation of Energy
-Energy cannot be created/ destroyed but can change from one kind to another.

Atoms have “internal energy
-when the electron is in the lowest orbit, it has the lowest internal energy
-higher orbits/further away orbits have higher internal energies