



## Factors Responsible for Shifting in Wavelength in Electromagnetic Spectrum

Hemant K Suryawanshi<sup>a</sup>, AnuradhaChhillar<sup>b</sup>

<sup>a</sup>Assistant professor Department Of Physics VPMK'S Arts Commerce and Science College Kinhavali,India

<sup>b</sup>Lecturer, Department of Physics, KHM Model Happy Child Senior Secondary School Bahadurgarh

### ABSTRACT

Different Concentration of black ink is added to 100ml of water in a transparent glass shaped in frustum of cone varying from 0.02826ml to 0.16956ml. White light is perpendicularly allowed to pass through the closed side of glass and observation is done from the open side of glass. The white light is passed from the phone torch means emitter is phone torch. The angle between emitter and observer should be 180 degree. With the increase in amount of ink in water the white light changes to blue, Blue to Violet and finally red color is observed. If the source of light or emitter is sun then white light changes to red and reddish orange color is observed. If the observation is done from inside the glass then at lesser circumference red color is observed and at greater circumference blue color is observed. If observation is done from outside the glass the blue color is observed at less circumference and red color at greater circumference. With the help of color observed the wavelength is determined just by matching it with visible spectrum. Curve is plotted between concentration and wavelength. Curve is also plotted between wavelength and circumference when observation is done from inside the glass and outside the glass.

Keywords: Electromagnetic Spectrum, Red Shift, Reference Frame, Curvature of Space

### 1. Introduction

Various phenomenon of universe weather they occur at atomic level such as spectrum of hydrogen or they occur at large level such cosmological red shift all require the study of electromagnetic spectrum. Electromagnetic spectrum plays an important role in studying the history and origin of universe. If the universe is to be studied then it should be studied in terms of vibration, energy and frequency. Electromagnetic spectrum is defined as a scale which has measurement of an increasing order of wavelength and decreasing order of frequencies. Spectrum of electromagnetic wave is very useful to us. Spectrum can be of continuous type absorption type. In this experiment three region of electromagnetic spectrum are discussed. Near Ultraviolet, Visible region, Near Infrared region. The word near is used because human eyes can observe visible spectrum. Though human eye cannot detect these regions. But one can observe shifting of wavelength to these region. If red wavelength is observed then means near infrared region is observed and if violet colour observed then it means the spectrum is near ultraviolet region. How shifting in wavelength take place between these region are well represented on a curve.

Various known and unknown factors are responsible for shifting in wavelength towards different regions. The most which is responsible is observation from different frame of reference and how shifting of wavelength can be seen in different region from different frame of reference. In this experiment it is well proved. We already know that when a light move from one medium to other normally there is no change in speed of light. In this experiment wave is allowed to pass normally.

There are various phenomenon that show shifting of wavelength in an electromagnetic spectrum. Red shift in galaxies is also an instance of it. This red shift is of different type Doppler's red shift, cosmological red shift, gravitational red shift. All three red shift have different cause. Can there is a sudden

change in wavelength in a way that first it decrease continuously and then it suddenly move to higher wavelength. Means sudden transition. Sudden transition is only possible of when there is a discrete spectrum. From the experiment above first there is observation of continuous spectrum then properties of discrete spectrum is shown. When the concentration of black ink in water is increased then red colour is observed when seen from appropriate position. Here also there is a shift in wavelength from violet to red. Similar red shift is observed in galaxies. When galaxies are moving away from observer then red shift is observed. From the above fact and experiment observed is it possible that the red shift in universe depend on concentration of black matter in universe. Calculation, observation and measurement of things in universe depend upon the frame of reference. From different frame of reference different observation and different measurements are done. If galaxies are observed by observer who is near to galaxy will observe blue colour and the observer who is away from galaxy will observe red colour.

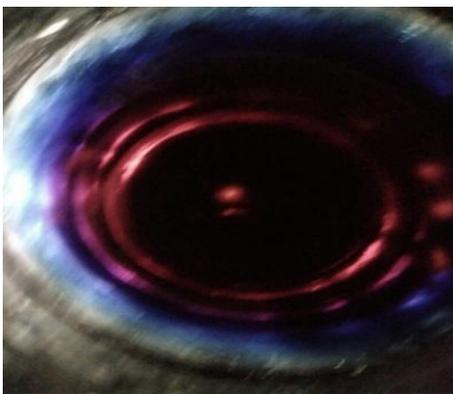
Observation also depend on curvature of space. From the theory of relativity speed of light remain same in every frame of reference. Speed of light do not change when a light passes through one medium to other medium perpendicularly. This prove that in above experiment speed of light do not change, but still there is a shift in wavelength? what causes shift in wavelength. Even in universe shift in wavelength phenomenon is observed. What is similarity between those shift and the shift in wavelength observed here. Speed of light remain same in every frame of reference. This means that speed of light is responsible for maintaining the symmetry of universe or control this universe.

## 2. Experimental Description

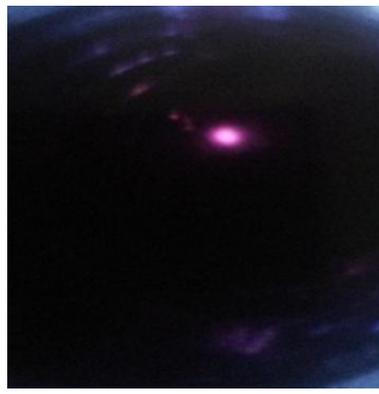
A transparent frustum shaped glass is taken. It is filled with 100ml water. Very small amount of ink is diffused in water after sometime the water is diffused with ink. Allow the white light to pass through diffused liquid. Observe the colour of light through diffused liquid. The angle formed between emitter and observer to be 180 degree. The straight line should be along the length of diffused liquid. When only small amount of ink is allowed to diffuse in a solution no colour is observed but when the amount of ink is increased colour changes slowly from blue than violet than pink and at last red. Graph is plotted between amount of concentration and wavelength of different colour. The wavelength of colour is written on the basis of colour observed. Since the white light is pass through water normally, then it is sure that velocity of light does not change. Here causes of refraction is not possible



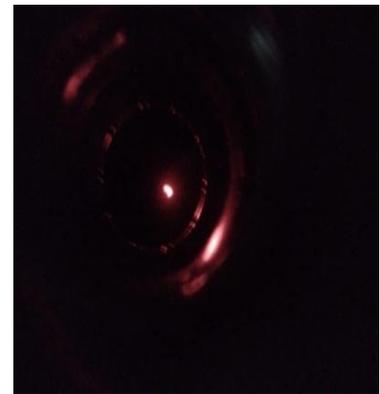
Fig 1. Experimental description with the help of picture. These photographs are taken while doing experiments



Few drop of ink are diffused in water .then white light is passed through it. White light remains same. No change is passed through it. White light remains same.



When amount of concentration increase white light changes to blue.



Further increase in concentration white light change to violet than pink. Further increase in concentration white light changes to red

3. Result and Discussion

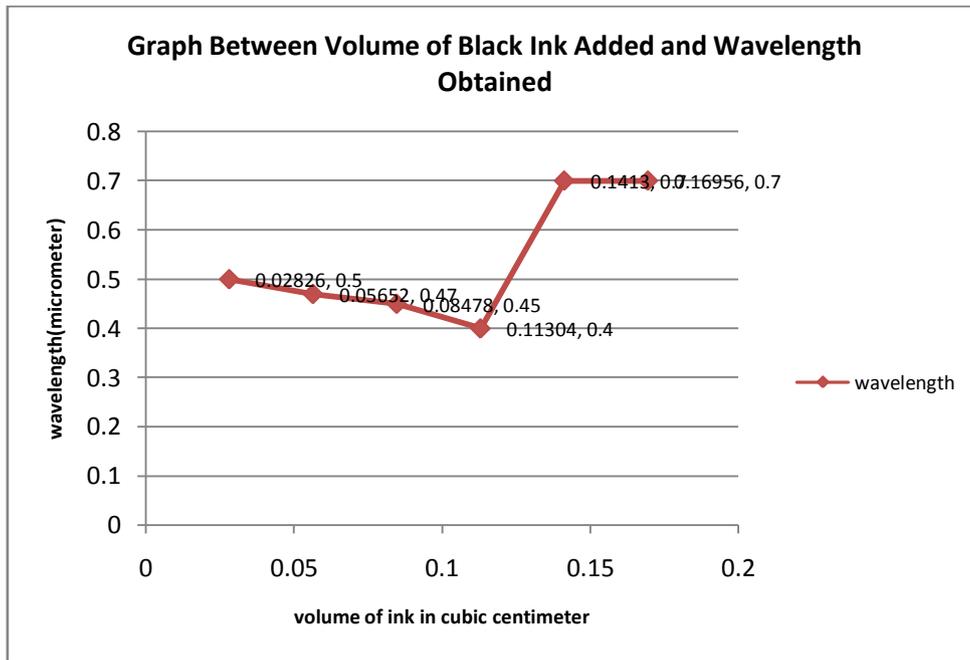


Figure 1.

1. In this graph we observe that when there is an increase in concentration of ink in water, the wavelength of the emitter first decreases, moving towards the ultraviolet region, then after that a sudden transition is shown. It moves to the infrared region. Violet color comes in the end of the ultraviolet region. Red color comes in the starting of the infrared region. 0.4 (micrometer) is the wavelength of violet color. And 0.7 is the wavelength of red color.
2. As we continue to increase the concentration of ink, the number of ink particles increases, then visible light is moving towards the ultraviolet region. This is because white light first changes to blue then violet then pink then red. It means that the frequency of the light wave increases when the ink particle absorbs light. After that red color light is re-emitted by the particles.
3. The new thing we discover through this experiment is that what can be the reason of sudden transition. Why pink color is seen when it does not lie in the electromagnetic spectrum. This pink color is becoming the center point between the ultraviolet region and the infrared region.
4. If we consider a continuous spectrum, that means that pink color is a combination of all 7 colors of the rainbow.
5. With an increase in black ink, only red shift is shown. In the universe, galaxies are present which show the red shift. According to cosmology, from a point of view with an increase in dark matter in the universe, red shift is shown. Similarity is seen in both situations. Then black ink can be considered as dark matter.

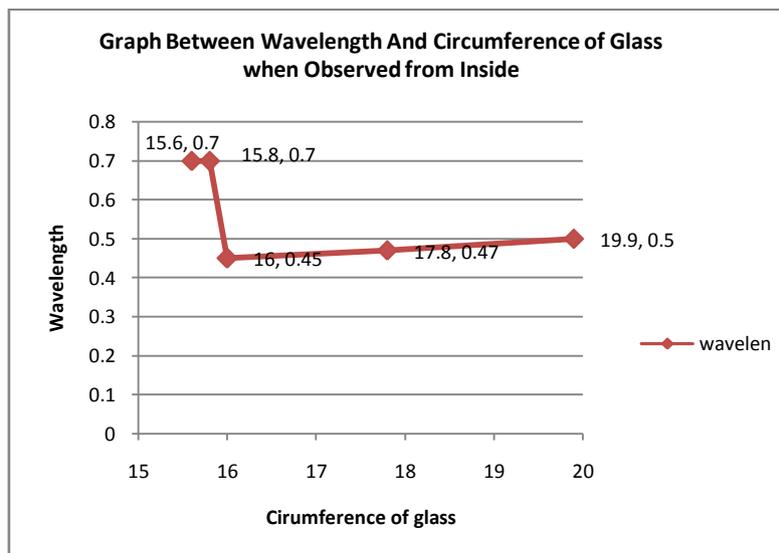
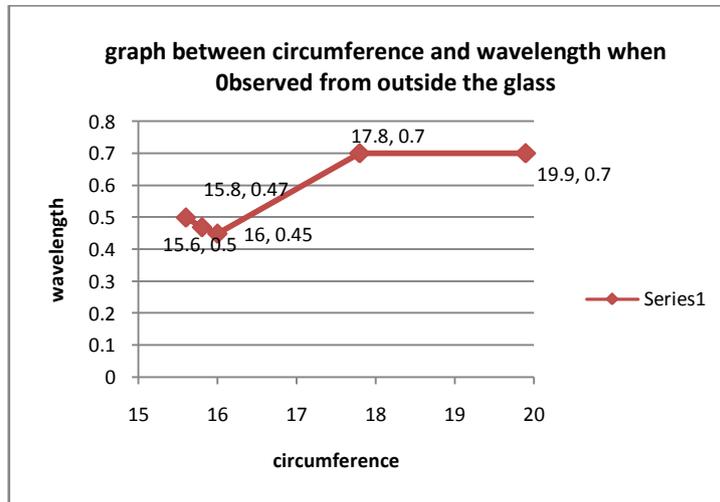


Figure 2. Circumference in Cm , Wavelength in Micrometer



**Figure3 circumference in centimeter and wavelength in micrometre**

1. In above figure first wavelength decreases with increase in circumference than after 16 cm it increases.
2. In figure 2 when light is observed from inside the glass then at large circumference there is violet colour and at small circumference red colour.  
Larger circumference = violet colour (lowest wavelength)  
Smaller circumference = red colour (highest wavelength)
3. In figure 3 when light is observed from outside the glass at lower circumference violet colour is observed and at larger circumference red colour is observed.  
Larger circumference = red colour (highest wavelength)  
Smaller circumference = violet colour (lowest wavelength)

#### 4. Conclusion

1. Speed of light is independent of shifting of wavelength. Speed of light do not change while there is shifting in wavelength.
2. Shifting of wavelength does not depend on refractive index of glass. Because we know that there is no change in velocity of light when it passes normally from one medium to another medium.
3. There is no dependence on refractive index. So shifting in wavelength is not due to rayleighs scattering
4. Shifting of wavelength depends upon the concentration of black ink.
5. Shifting of wavelength depends upon the circumference or curvature.
6. Shifting of wavelength depends upon reference frame. Means from where we are making observation, from inside the glass or outside the glass.
7. Similarity of cosmological red shift and red shift in this experiment is seen because here glass is somewhat possess hyperbolic shape and when black colour liquid is filled in it it is analogous to universe. This is because expansion of universe is described hyperbolic curve. This can be confirmed from reference 5.
8. If graph obtain in figure 2 and 3 combine then the combination of curve match with the rotation curve of a typical spiral galaxy. this can be confirmed from reference 6.

#### REFERENCES

- [1] <http://hubblesite.org/contents/article/the-electromagnetic-spectrum>
- [2] Optics 5th edition page 7.15 by ajoyghatak
- [3] Ink diffusion in water in European journal of physics
- [4] the cosmological red shift manifest the curvature and interpreted as a degree of hyperbolicity of the spacetime in journal for foundation and applications of physics ,vol 3,no. 1(2016) ISSN 2394-3688
- [5] Journal for foundation and application of physics vol3 no.1(2016) page 44 line 2
- [6] Journal for foundation and application inphysics vol3 no.1(2016) page 45.
- [7] Spectroscopy in Astronomy| Astronomy : the sky and the solar system
- [8] The red shift and geometrical aspect of photons hongjun pan Department of chemistry University of north Texas ,Denton, Texas 76203, USA