Study the Atmospheric Extinction for Different Colours

***Jameer Manur*[1], *Ranjan Gupta*[1]**

[1] *Inter-University Centre for Astronomy and Astrophysics (IUCAA), Post Bag 4, Ganeshkhind, Pune 411007, India*

[*jameer@iucaa.in*](mailto:jameer@iucaa.in)

ranjaniucaa@gmail.com

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Title of the experiment: Study the atmospheric extinction for different colours

Learning objective/Outcome of the experiment: To determine the atmospheric extinction in different colours by observing a standard star for different Zenith angles.

MATERIALS: C-8 telescope/any other telescope, Photometer with B, V & R filters and other accessories.

INTRODUCTION: Atmospheric extinction is a phenomenon that affects the brightness of light from celestial objects as it passes through Earth's atmosphere. The extinction process is caused by various factors, including atmospheric particles and molecules' absorption and scattering. Using a photometer, the atmosphere extinction for different colours is based on the Beer-Lambert law. The Beer-Lambert law states that the intensity of light passing through a medium such as Earth's atmosphere decreases the density of the medium and the length travelled by the light. When observing the celestial bodies, the light they emit must pass through the Earth's atmosphere, which contains particles and gases that scatter and absorb light. This leads to a reduction in the intensity of the light received by the observer/instrument. The degree of attenuation depends on the wavelength of the light, with shorter wavelengths, such as blue light being more affected than the longer wavelength, such as red light. colour dependence is due to the Rayleigh scattering. Rayleigh scattering occurs when light interacts with gas molecules.

One of the essential characteristics of atmospheric extinction is its dependence on the wavelength or colour of light. Different colours of light experience varying degrees of extinction as they travel through the atmosphere. This colour dependence is primarily due to the different scattering properties of the atmosphere for different wavelengths of light.

A photometer is a device used to measure light intensity in specific spectral bands or colours. It typically consists of a sensor that detects light and converts it into an electrical signal, which is then recorded and then analysed. In the context of studying atmospheric extinction, the photometer allows us to quantify the amount of light reaching the detector after passing through the atmosphere.

To study colour-dependent atmospheric extinction, the photometer is equipped with filters or monochromatic sources that isolate specific wavelengths of light (e.g., blue(B), green(G), red(R) and visible(V)). By using these filters, the photometer can measure the intensity of light at distinct colours individually. The photometer's sensitivity and accuracy are crucial to obtaining reliable data during the experiment.

PROCEDURE:

1) Select a standard bright star which may be at Zenith or near the eastern horizon. To determine the atmospheric extinction, one has to monitor the magnitude of the star as it sets from Zenith to the west or as it rises from the eastern horizon to the Zenith.

2) Acquire the star in the photometer reticle and take the reading (dark subtracted).

3) Move the telescope to a nearby star-free sky region (at least two circular reticle diameters away) and take the sky background reading (dark subtracted).

4) Note the actual star reading (after subtracting the sky background).

5) Repeat steps 2-4 several times within 1 minute and take the average star reading (R_λ) for that IST.

6) Repeat the above steps every half hour (or at least every hour till the star sets or reaches the zenith.

7) The above readings must also be taken with all the available filters (B, V & R).
8) The magnitude of the star, as observed, is given by

$$m_\lambda = -2.5\ log_{10}(R_\lambda)$$

9) Airmass (X) to be calculated for each IST of observations

$$x = \sec(z) * (\text{for } Z < 60^\circ)$$

$$= (\sin\phi \sin\delta + \cos\phi \cos\delta \cos H)^{-1}$$

10) Plot m_{lambda} ^ i versus X for each colour B, V and R.

11) From the plot, estimate extinction in magnitudes per unit airmass for each colour.

Note: ϕ = Observer's Latitude (degrees)

δ = DEC of the star (degrees)

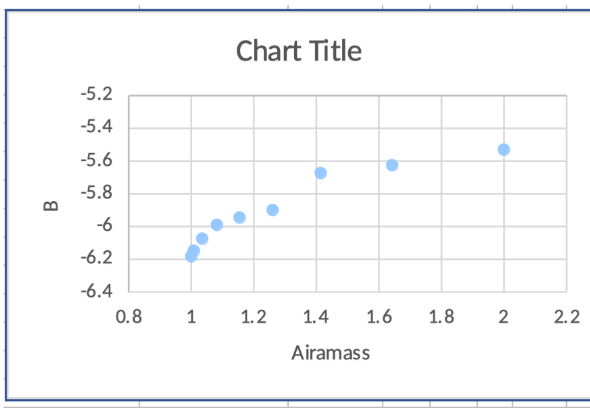
H = Hour angle of star in degrees

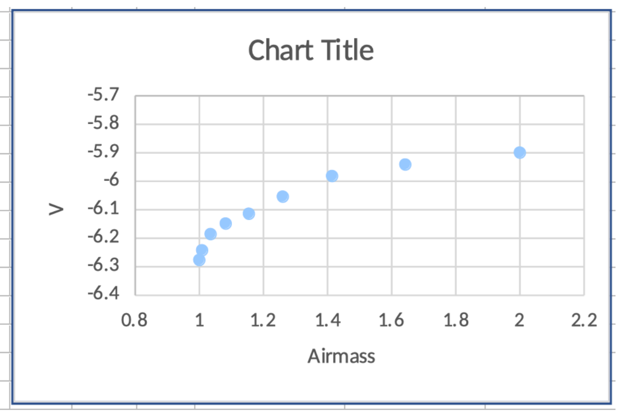
z = apparent zenith distance

Observation table: (Sample observations)

Date of Obs.	24/03/2023		Star Name				Reguls								
	4 min = 1°														
IST	Angle from Zenith	Airmass	Filter		Error		Background		Corrected		m= -2.5*log(counts/s)				
	ϴ°	X	B	V	B	V	B	V	B	V	B	V			
11:03:00 PM	0	1	299	325	10	5	2	1	297	324	-6.181891123	-6.276362526			
11:33:00 PM	7.5	1.00863	290	315	5	10	2	1	288	314	-6.148481219	-6.24232412	Slope (B)=	0.651020551	mag/airmass
12:03:00 AM	15	1.03527	270	300	4	10	1	2	269	298	-6.0743807	-6.18554066	Slope (V)=	0.360251844	mag/airmass
12:33:00 AM	22.5	1.08239	250	290	5	5	1	2	249	288	-5.990498368	-6.148481219			
01:03:00 AM	30	1.15469	240	280	10	4	1	1	239	279	-5.945994752	-6.114010508			
01:33:00 AM	37.5	1.26045	230	265	10	10	1	1	229	264	-5.899588706	-6.054009817			
02:03:00 AM	45	1.41418	190	250	10	10	4	3	186	247	-5.673782361	-5.981742383			
02:33:00 AM	52.5	1.64262	180	240	10	10	2	2	178	238	-5.626050006	-5.941442393			
03:03:00 AM	60	1.99989	165	230	10	10	2	1	163	229	-5.530469011	-5.899588706			
03:33:00 AM	67.5	2.61291	120	170	10	10	2	3	118	167	-5.179705018	-5.556791178			

Result: (Sample)





B atmospheric extension plot

V atmospheric extension plot

References:

1. Bohren, C. F., & Huffman, D. R. (1983). Optics of the Atmosphere: Scattering by Molecules and Particles. Wiley-VCH.
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