# NPHY322 PRACTICAL REPORT

## EXPERIMENT 9:ATMOSPHERIC EXTINCTION,AIRMASS(ATM-EXT)

## GROUP 2 2024

## DATE:05 October 5, 2024

| INITIALS AND SURNAME | STUDENT NUMBER |
|---|---|
| OR MALETSWA | 36824798 |
| N MOKOENA | 37320629 |
| RK MAKETSWA | 37174134 |
| T MUKWENA | 37299565 |
| PN RALUTHAKA | 37949128 |
| T MNISI | 37171755 |

## AIM OF THE EXPERIMENT:

The aim of this experiment is to measure the atmospheric extinction by determining how much starlight is absorbed or scattered as it passes through Earth's atmosphere. This involves calculating the air mass for different celestial objects and quantifying the extinction coefficient.

## BACKGROUND THEORY:

Atmospheric extinction and airmass are important concepts in the study of astronomy and atmospheric physics. They describe how the Earth's atmosphere affects the passage of light from celestial objects to an observer on the ground

Atmospheric extinction refers to the reduction in the intensity of light from astronomical objects as it passes through the Earth's atmosphere, influenced by factors such as airmass and atmospheric composition. Understanding this phenomenon is crucial for accurate astronomical observations. Atmospheric extinction is quantified by the airmass, which is the path length of light through the atmosphere relative to its path at zenith. Higher airmass values correspond to greater atmospheric thickness, leading to increased extinction (Manduca & Bell, 1979).

Rayleigh Scattering occurs when light interacts with particles smaller than the wavelength of the light, such as molecules of nitrogen and oxygen in the atmosphere. Rayleigh scattering is responsible for the blue color of the sky and is more effective at shorter wavelengths, causing blue light to scatter more than red light. Mie Scattering occurs with larger atmospheric particles, such as dust and water droplets. Mie scattering is less wavelength-dependent than Rayleigh scattering and can affect all wavelengths more uniformly, contributing to a general dimming of light.

Atmospheric extinction depends on the wavelength of light, the shorter the wavelength the more strongly scattered and absorbed which lead to higher extinction.  The longer the wavelength the less affected by Rayleigh scattering but susceptible to absorption by water vapor and $CO_2$.

Airmass is a measure of the path length of light from a celestial object as it passes through the Earth's atmosphere, relative to the path length at the zenith. It represents the amount of atmosphere the light must pass through and is an important factor in calculating atmospheric extinction.

The figure shows two stars at different altitude above the horizon, they are observed with a single telescope. The photons from both stars should move through the atmosphere, but  the difference is that the path length of light traveling through the atmosphere is quite different for the two stars. Since we are  studying  stars in any part of the sky,  then path length for the traveling of light through the atmosphere will not be same in each case. Not all observatories are on the same altitude above sea level and for this reason we are able to correct the effect. In other words, even if we observe the same star from two observatories, and the star is at the zenith at both, then the path length of its light through the atmosphere will not be the same if the observatories are at different altitudes above sea level. To compare measurements made by different telescopes, in different locations, we must correct as far as possible for any atmospheric effects. From the figure we see that, if we make the simple assumption of a slab for the atmosphere, and if the thickness of the atmosphere is h, then the path length through the atmosphere for any arbitrary zenith angle θ, will be equal to

$$l = h \sec \theta$$

Suppose now that the energy flux for a specific star (measured in W $m^{-2}$ ) at a specific wavelength λ, measured above the atmosphere is $I_0$. It is well known that light intensity decreases exponentially when it passes through a medium according to the following relation

$$I(i)=I_0 e^{-kl}$$

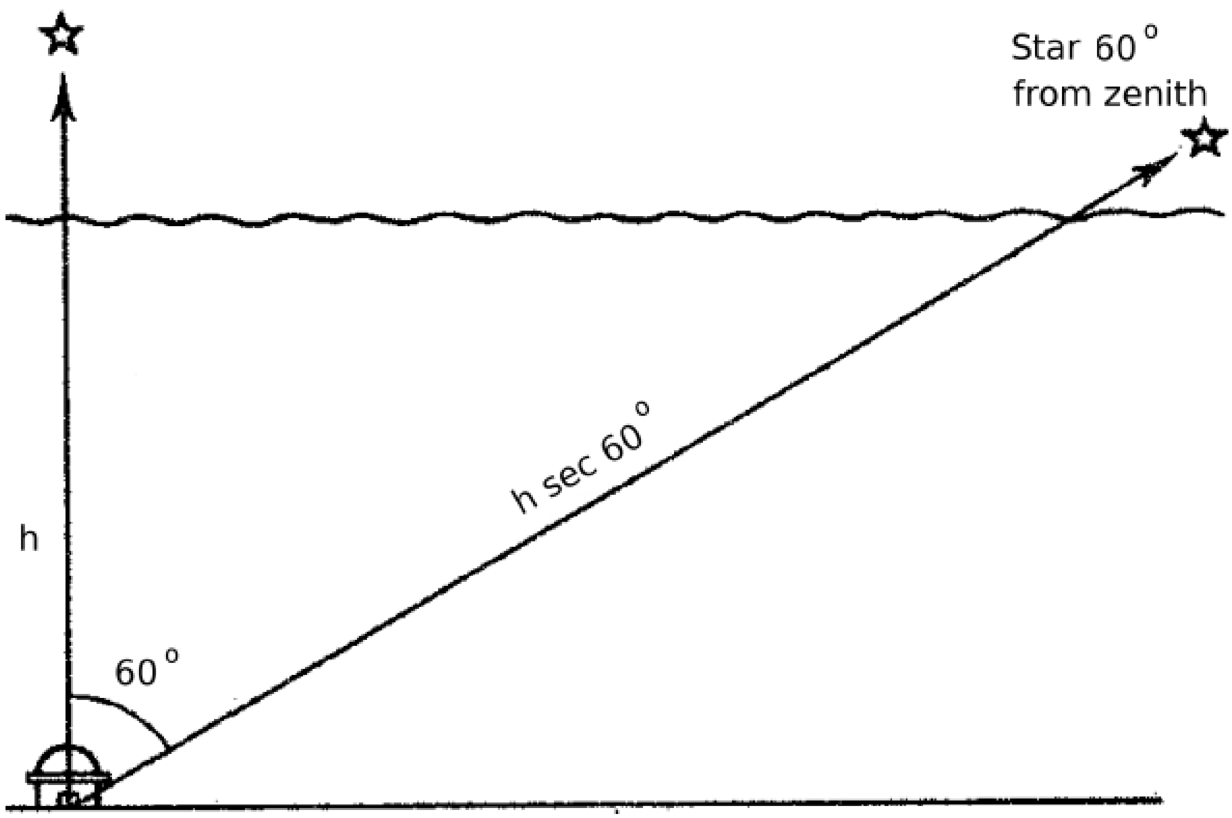


Figure 1: For a flat slab of atmosphere, the absorption would vary as the secant of the angle from the vertical, being a minimum (not zero) at the zenith.

$\kappa$ is the absorption coefficient and the path length is given by l. Note that the unit of $\kappa$ is $m^{-1}$ . In practice we can measure L(l) and we want $I_o$, which is the intensity/flux above the atmosphere. In terms of logarithms, we have

$$\log L(l) = \text{“} \log I_0 - \kappa l \log e$$

If we work with magnitudes we must multiply with -2.5. That gives

$$m\lambda = m_0\lambda + (2.5 \log e)k\lambda L$$

$$\propto m_0\lambda + 1.086k\lambda \sec\theta$$

$$= m_0\lambda + a\,\lambda\,X$$

where we indicate the wavelength dependence with the subscript. $a\lambda$ is the extinction coefficient and X = sec θ is the air mass.

The measurement at the telescope is not an intensity or flux but rather a count rate (count rate per second). We define the instrumental magnitude as

$M' = -2.5 \log (\text{count rate})$

$M_0$ is the apparent magnitude of a star above the atmosphere

## PROCEDURE:

• The operator meticulously assembled the telescope in accordance with the manufacturer's instructions, ensuring that every part was firmly attached.

• Once the telescope was fully assembled, the operator fastened the photometer to the optical system, utilizing a specific adaptor to guarantee accurate alignment and efficient light gathering.

• For system calibration, the operator used a standard light source a recognized photometric standard, to calibrate the photometer. To ensure precise readings, the operator modified the parameters and recorded the calibration data for later use, which was essential for reducing systematic errors in the measurements.

• The operator selected a suitable star for observation, preferably one with variable brightness, noting its coordinates and any relevant catalog information.

• With care, the operator located the chosen star, ensuring it was centered in the eyepiece and within the field of view of the photometer,

• The operator turned on the photometer and began taking measurements while pointing the telescope toward the star. One by one, different wavelength filters (U, B, V, and R) were utilized. Before taking a reading of the light intensity for each filter, the operator allowed the photometer to stabilize. The filter used, along with other pertinent observational details such as observation time and weather conditions, was recorded.

• For each measurement, the operator documented the intensity reading, the associated wavelength filter, and the observation duration in a comprehensive log. The information was organized in a clear tabular format for future reference and comparison, and any noticeable changes or anomalies during the measurements were remarked upon when possible.

• To account for air absorption, the operator applied Bouguer's formula to the recorded intensities.

• The operator conducted the measurement process on multiple stars of varying brightness and color to ensure the robustness of the results. A thorough comparison study required observations of three to five stars, all recorded using the previously mentioned format.

## RESULTS AND DISCUSSION:

Blue Filter

| Airmass | Exposure Time | Total Flux (I) | Background Flux (B) | N (I-B) | Instrumental Magnitude (mλ) |
|---|---|---|---|---|---|
| 1.08045806006827 | 40.00 | 263969 | 70560 | 193409 | -13.2161917 |
| 1.08533513459838 | 40.00 | 273392 | 75379 | 198013 | -13.24173426 |
| 1.09049711104683 | 40.00 | 264993 | 68190 | 196803 | -13.23507929 |
| 1.09592413584782 | 40.00 | 259078 | 65485 | 193593 | -13.21722412 |
| 1.10162709729881 | 40.00 | 259539 | 67000 | 192539 | -13.21129678 |
| 1.10761499151936 | 40.00 | 275138 | 77513 | 197625 | -13.23960471 |
| 1.11387584471617 | 40.00 | 262747 | 67219 | 195528 | -13.2280224 |
| 1.12045738768548 | 40.00 | 269338 | 73472 | 195866 | -13.22989764 |
| 1.12731427680093 | 40.00 | 271696 | 73768 | 197928 | -13.24126809 |
| 1.13449226433717 | 40.00 | 262242 | 68188 | 194054 | -13.2198065 |
| 1.14418889711185 | 40.00 | 260755 | 65557 | 195198 | -13.22618841 |
| 1.15211592529787 | 40.00 | 266752 | 72073 | 194679 | -13.22329777 |
| 1.16037336680870 | 40.00 | 268947 | 73859 | 195088 | -13.22557639 |
| 1.16897088422994 | 40.00 | 267323 | 72445 | 194878 | -13.22440703 |
| 1.17794002367249 | 40.00 | 257402 | 65235 | 192167 | -13.20919703 |
| 1.18726841204991 | 40.00 | 265547 | 74261 | 191286 | -13.20420796 |
| 1.19698386546721 | 40.00 | 255246 | 67509 | 187737 | -13.18387468 |
| 1.20709676411916 | 40.00 | 256087 | 66444 | 189643 | -13.19484204 |
| 1.21759375847668 | 40.00 | 261860 | 73049 | 188811 | -13.190068223 |
| 1.22853194190668 | 40.00 | 253048 | 64292 | 188756 | -13.18975191 |
| 1.23988992311533 | 40.00 | 270724 | 82293 | 188431 | -13.18788088 |
| 1.25169035683426 | 40.00 | 252878 | 67327 | 185551 | -13.17115825 |
| 1.26396839204445 | 40.00 | 252850 | 71294 | 181556 | -13.14752651 |
| 1.27670290924993 | 40.00 | 259287 | 73479 | 185808 | -13.17266102 |
| 1.28995368898513 | 40.00 | 258693 | 78487 | 180206 | -13.13942312 |
| 1.30523850292010 | 40.00 | 261438 | 78443 | 182995 | -13.15609806 |
| 1.32001701091314 | 40.00 | 261494 | 79422 | 182072 | -13.15060791 |
| 1.33539675356252 | 40.00 | 255395 | 76451 | 178944 | -13.13179285 |
| 1.35136539089901 | 40.00 | 262821 | 81853 | 180968 | -13.14400447 |
| 1.36801131825103 | 40.00 | 251831 | 75751 | 176080 | -13.11427507 |
| 1.36801131825103 | 40.00 | 253047 | 74187 | 178860 | -13.13128307 |
| 1.38529386265038 | 40.00 | 252960 | 75278 | 177682 | -13.12410859 |
| 1.40329361205839 | 40.00 | 258899 | 65548 | 193351 | -13.21586606 |
| 1.42202217173138 | 40.00 | 273531 | 99016 | 174515 | -13.1045819 |
| 1.44149840643549 | 40.00 | 265490 | 93525 | 171965 | -13.08860016 |
| 1.46178339805837 | 40.00 | 250380 | 80106 | 170274 | -13.07787085 |
| 1.48288377531029 | 40.00 | 261945 | 92657 | 169288 | -13.07156544 |
| 1.50488284430339 | 40.00 | 270332 | 100592 | 169740 | -13.0746049 |
| 1.52777276573342 | 40.00 | 250842 | 83452 | 167390 | -13.05932377 |
| 1.55161557494615 | 40.00 | 256584 | 93710 | 162874 | -13.02962941 |
| 1.57647633091264 | 40.00 | 259974 | 99451 | 160523 | -13.01384317 |
| 1.60360672905345 | 40.00 | 263279 | 99416 | 163863 | -13.03620225 |
| 1.63069164806232 | 40.00 | 253448 | 100272 | 153176 | -12.96297681 |

| | | | | | |
|---|---|---|---|---|---|
| 1.65890341981858 | 40.00 | 258132 | 102101 | 156031 | -12.98302723 |
| 1.68836831404645 | 40.00 | 255609 | 101185 | 154424 | -12.97178699 |
| 1.71908087406560 | 40.00 | 252133 | 102954 | 149179 | -12.93426923 |
| 1.75113779270980 | 40.00 | 251471 | 101070 | 150401 | -12.94312681 |
| 1.78465026102964 | 40.00 | 267860 | 118101 | 149759 | -12.93848233 |
| 1.81961537320183 | 40.00 | 266010 | 116823 | 149187 | -12.93432745 |
| 1.85620491491497 | 40.00 | 262477 | 120424 | 142053 | -12.88112602 |
| 1.89439510987832 | 40.00 | 255612 | 114246 | 141366 | -12.87586242 |
| 1.93442149732560 | 40.00 | 274350 | 133447 | 140903 | -12.8723006 |
| 1.97625072922923 | 40.00 | 250641 | 114201 | 136440 | -12.83735428 |
| 2.02000898060766 | 40.00 | 265577 | 134098 | 131479 | -12.79714098 |
| 2.06583518743486 | 40.00 | 261700 | 132680 | 129020 | -12.77664259 |

I

## Indigo Filter

| Air Mass | Exposure Time | Total Flux (I) | Background Flux (B) | N (I-B) | Instrumental Magnitude (mλ) |
|---|---|---|---|---|---|
| 1.08259444139571 | 15.00 | 998073 | 35536 | 962537 | -14,95854358 |
| 1.0876076985935 | 15.00 | 975187 | 27611 | 947576 | -14,94153513 |
| 1.09288294419887 | 15.00 | 959064 | 34054 | 925010 | -14,91536607 |
| 1.09843661402648 | 15.00 | 919256 | 36015 | 883241 | -14,86519805 |
| 1.10425634572845 | 15.00 | 924291 | 35599 | 888692 | -14,87187818 |
| 1.1103791728183 | 15.00 | 942295 | 26287 | 916008 | -14,90474817 |
| 1.11677399624574 | 15.00 | 967777 | 34496 | 933281 | -14,92503106 |
| 1.12346830863231 | 15.00 | 900121 | 29505 | 870616 | -14,84956661 |
| 1.13047835761855 | 15.00 | 939492 | 37647 | 901845 | -14,88782975 |
| 1.1377971440541 | 15.00 | 989964 | 35334 | 954630 | -14,9495877 |
| 1.14768499306076 | 15.00 | 985198 | 33510 | 951688 | -14,94623648 |
| 1.15574706850877 | 15.00 | 971098 | 34688 | 936410 | -14,92866511 |
| 1.16416455723266 | 15.00 | 928784 | 34530 | 894254 | -14,87865223 |
| 1.17293149052036 | 15.00 | 842373 | 39293 | 803080 | -14,76189703 |
| 1.1820497159735 | 15.00 | 838432 | 35124 | 803308 | -14,76220523 |
| 1.191556084656329 | 15.00 | 976904 | 33471 | 943433 | -14,93677766 |
| 1.20143942507838 | 15.00 | 953822 | 34254 | 919568 | -14,90895962 |
| 1.21172636933997 | 15.00 | 908149 | 32452 | 875697 | -14,85588465 |
| 1.2224282591873 | 15.00 | 994487 | 30785 | 963702 | -14,9598569 |
| 1.23353588843052 | 15.00 | 946529 | 33420 | 913109 | -14,90130656 |
| 1.24510042707091 | 15.00 | 971109 | 32750 | 938359 | -14,93092256 |
| 1.25710668627875 | 15.00 | 948016 | 28475 | 919541 | -14,90892775 |
| 1.26957637129641 | 15.00 | 969981 | 30035 | 959946 | -14,95561701 |
| 1.28255834796151 | 15.00 | 985871 | 33718 | 952153 | -14,94676685 |
| 1.29601745971365 | 15.00 | 987245 | 34160 | 953085 | -14,94782909 |
| 1.3117837746018221 | 15.00 | 913408 | 30795 | 882613 | -14,8644258 |
| 1.32681543630403 | 15.00 | 988026 | 34771 | 953255 | -14,94802273 |
| 1.34246638750984 | 15.00 | 928894 | 34722 | 894172 | -14,87855267 |
| 1.35874012993507 | 15.00 | 954313 | 28630 | 925683 | -14,91615572 |
| 1.37565066973033 | 15.00 | 977415 | 23592 | 953823 | -14,94866948 |
| 1.39327699730696 | 15.00 | 879765 | 30275 | 855273 | -14,83026191 |
| 1.41156681036598 | 15.00 | 994951 | 24492 | 970459 | -14,96744298 |
| 1.43064863389156 | 15.00 | 899709 | 30499 | 869210 | -14,84781179 |
| 1.4504741695754 | 15.00 | 901840 | 34900 | 866940 | -14,8449726 |
| 1.47111319628856 | 15.00 | 974028 | 35464 | 938564 | -14,93115973 |
| 1.49262977600437 | 15.00 | 987777 | 35854 | 951923 | -14,94650455 |
| 1.51499783507163 | 15.00 | 964531 | 36006 | 928525 | -14,919484 |
| 1.5626000725012 | 15.00 | 952662 | 36815 | 915847 | -14,90455732 |
| 1.58791787711272 | 15.00 | 831109 | 29633 | 801476 | -14,75972631 |
| 1.6159581041323 | 15.00 | 952142 | 36661 | 954865 | -14,94985494 |
| 1.64314667376507 | 15.00 | 958526 | 37795 | 920731 | -14,91033191 |
| 1.67194060238657 | 15.00 | 996908 | 36401 | 960507 | -14,95625134 |
| 1.70193589063549 | 15.00 | 938322 | 36491 | 901831 | -14,8878129 |
| 1.73327392697526 | 15.00 | 983058 | 36049 | 947009 | -14,94088527 |
| 1.76595198931913 | 15.00 | 882835 | 31449 | 851386 | -14,82531626 |

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|---|---|---|---|---|---|
| 1.80010043970594 | 15.00 | 987140 | 31823 | 955317 | -14,95036877 |
| 1.83579424628436 | 15.00 | 976033 | 30956 | 945077 | -14,93866799 |
| 1.87306617322932 | 15.00 | 980744 | 36382 | 944362 | -14,93784626 |
| 1.9121017832875 | 15.00 | 985840 | 36899 | 948941 | -14,94309803 |
| 1.9528760067435 | 15.00 | 978878 | 36356 | 942522 | -14,93572874 |
| 1.99559343435514 | 15.00 | 961432 | 35267 | 926165 | -14,91672091 |
| 2.04024457355604 | 15.00 | 954420 | 28570 | 925850 | -14,91635158 |
| 2.08698739340335 | 15.00 | 926837 | 33234 | 893603 | -14,87786155 |
| 2.13594785976771 | 15.00 | 945277 | 31334 | 913943 | -14,90229778 |

## Violet Filter

| Air Mass | Exposure Time | Total Flux (I) | Background Flux (B) | N (I-B) | Instrumental Magnitude (mλ)2 |
|---|---|---|---|---|---|
| 1.08147799762517 | 23.00 | 977565 | 99206 | 878359 | -14,85918014 |
| 1.08643534761123 | 23.00 | 957655 | 95543 | 8622112 | -17,33903415 |
| 1.09164946058903 | 23.00 | 916421 | 92219 | 824202 | -14,79008416 |
| 1.09713485307239 | 23.00 | 889115 | 87859 | 801256 | -14,75942824 |
| 1.10290012035233 | 23.00 | 861199 | 86338 | 7774861 | -17,22673158 |
| 1.10893758230147 | 23.00 | 851930 | 84135 | 767795 | -14,7131132 |
| 1.11527632110995 | 23.00 | 846783 | 81266 | 765517 | -14,7098871 |
| 1.11527632110995 | 23.00 | 832066 | 79119 | 752947 | -14,69191102 |
| 1.12884129406770 | 23.00 | 813842 | 77374 | 736468 | -14,6678847 |
| 1.13609373881251 | 23.00 | 807846 | 76310 | 731536 | -14,66058926 |
| 1.14587759186982 | 23.00 | 792633 | 73862 | 718771 | -14,64147637 |
| 1.15387792937731 | 23.00 | 771042 | 70764 | 700278 | -14,61317621 |
| 1.16219931371837 | 23.00 | 762465 | 68280 | 694185 | -14,60368806 |
| 1.17088716820342 | 23.00 | 758899 | 67178 | 691721 | -14,5998274 |
| 1.17992844329886 | 23.00 | 735043 | 64150 | 670893 | -14,56663315 |
| 1.18933869501618 | 23.00 | 717700 | 63187 | 654513 | -14,53979569 |
| 1.19914212767288 | 23.00 | 710145 | 62979 | 647166 | -14,52753923 |
| 1.20932656520333 | 23.00 | 691439 | 62642 | 628797 | -14,49627615 |
| 1.21993189803412 | 23.00 | 690321 | 61026 | 629295 | -14,4971357 |
| 1.23095680779697 | 23.00 | 680745 | 60041 | 620704 | -14,48221136 |
| 1.24240059458719 | 23.00 | 678341 | 59900 | 618441 | -14,47824568 |
| 1.25431442568914 | 23.00 | 654433 | 59209 | 595224 | -14,43670109 |
| 1.26668027940106 | 23.00 | 650034 | 58776 | 591258 | -14,42944257 |
| 1.27953095694595 | 23.00 | 649281 | 57966 | 591315 | -14,42954724 |
| 1.29289467599591 | 23.00 | 630004 | 57008 | 572996 | -14,39537898 |
| 1.30829620819413 | 23.00 | 617449 | 56951 | 560498 | -14,37143517 |
| 1.32320935495782 | 23.00 | 609997 | 54967 | 555030 | -14,36079114 |
| 1.33869486504878 | 23.00 | 600005 | 54006 | 545999 | -14,34297962 |
| 1.35482430212811 | 23.00 | 587888 | 52920 | 534968 | -14,32081951 |
| 1.37158322939952 | 23.00 | 570065 | 52312 | 517753 | -14,28530656 |
| 1.38902144957513 | 23.00 | 557571 | 51440 | 506131 | -14,26065735 |
| 1.40718068904254 | 23.00 | 548567 | 50080 | 498487 | -14,24413459 |
| 1.42604436314883 | 23.00 | 521861 | 49087 | 472774 | -14,18663396 |
| 1.4457147151669 | 23.00 | 509812 | 47432 | 462380 | -14,1624976 |
| 1.46614360579419 | 23.00 | 498349 | 46840 | 451509 | -14,13666603 |
| 1.48744835013693 | 23.00 | 490006 | 45345 | 444661 | -14,1200726 |
| 1.509621143248765 | 23.00 | 472345 | 43510 | 428835 | -14,08072556 |
| 1.53270088146766 | 23.00 | 466522 | 41904 | 424618 | -14,069996 |
| 1.53270088146766 | 23.00 | 448765 | 40058 | 408707 | -14,02853019 |
| 1.55676699171256 | 23.00 | 421143 | 39674 | 381469 | -13,95364813 |
| 1.58181652946943 | 23.00 | 406754 | 37300 | 369454 | -13,91890093 |
| 1.60922982855266 | 23.00 | 392783 | 37001 | 355782 | -13,87795993 |
| 1.63651426306024 | 23.00 | 381789 | 35478 | 346311 | -13,84866572 |
| 1.66500203124296 | 23.00 | 369098 | 33232 | 335866 | -13,81541511 |
| 1.69471418377353 | 23.00 | 357775 | 31436 | 326339 | -13,78417245 |
| 1.30829620891413 | 23.00 | 314764 | 30901 | 283863 | -13,63277197 |
| 1.79185254442404 | 23.00 | 287501 | 29753 | 257748 | -13,52798826 |
| 1.82720183543835 | 23.00 | 245672 | 27567 | 218105 | -13,34666405 |
| 1.86408271144992 | 23.00 | 224955 | 25400 | 199555 | -13,25015653 |
| 1.90266393952757 | 23.00 | 206876 | 23198 | 183678 | -13,16014285 |
| 1.94307027080937 | 23.00 | 178904 | 21456 | 157448 | -12,99284287 |
| 1.98526952527239 | 23.00 | 153988 | 20001 | 133987 | -12,81765666 |
| 2.029506704506 | 23.00 | 136789 | 19888 | 116901 | -12,66954557 |
| 2.07568383739124 | 23.00 | 128009 | 19076 | 108933 | -12,59289866 |
| 2.12413099849754 | 23.00 | 128166 | 18678 | 109488 | -12,59841631 |

## Ultraviolet Filter

| Air mass | Exposure time | Total Flux (I) | Background Flux (B) | N (I-B) | Instrumental Magnitude (mλ) |
|---|---|---|---|---|---|
| 1.0782790716916 | 90.00 | 92525 | 8754 | 83771 | -12,30773425 |
| 1.08306126218641 | 90.00 | 100148 | 33167 | 66981 | -12,06487907 |
| 1.08809651056052 | 90.00 | 116664 | 35871 | 80793 | -12,26843434 |
| 1.09340231941374 | 90.00 | 136495 | 37575 | 98920 | -12,48821027 |
| 1.09897824591069 | 90.00 | 124768 | 35945 | 88823 | -12,37131359 |
| 1.10482593450343 | 90.00 | 126362 | 40538 | 85824 | -12,33402188 |
| 1.11096731119425 | 90.00 | 105710 | 37633 | 68077 | -12,08250102 |
| 1.11739731078418 | 90.00 | 97248 | 23006 | 74242 | -12,17662416 |
| 1.12412317584896 | 90.00 | 97164 | 36426 | 60738 | -11,95865122 |
| 1.13116586033089 | 90.00 | 131151 | 46966 | 84185 | -12,31308679 |
| 1.14067080640109 | 90.00 | 127154 | 51515 | 75639 | -12,19686445 |
| 1.14844165829311 | 90.00 | 103149 | 59273 | 43876 | -11,60556757 |
| 1.15653495255449 | 90.00 | 139798 | 24207 | 115591 | -12,65731005 |
| 1.16498809995773 | 90.00 | 128555 | 37665 | 90890 | -12,39629026 |
| 1.17377839880659 | 90.00 | 131156 | 50081 | 81075 | -12,27221739 |
| 1.18293992327172 | 90.00 | 104326 | 35318 | 69008 | -12,0972486 |
| 1.1924870801122 | 90.00 | 99262 | 21758 | 77504 | -12,22331029 |
| 1.20240030786464 | 90.00 | 165235 | 40944 | 124291 | -12,73609921 |
| 1.21273187477115 | 90.00 | 160640 | 60634 | 100006 | -12,50006514 |
| 1.22346767416529 | 90.00 | 102111 | 51825 | 50286 | -11,75361773 |
| 1.23462020915867 | 90.00 | 130763 | 37391 | 93372 | -12,42554165 |
| 1.24622783076558 | 90.00 | 134668 | 38112 | 96556 | -12,46194817 |
| 1.25827069545308 | 90.00 | 126873 | 58654 | 68219 | -12,08476337 |
| 1.27080024096861 | 90.00 | 127029 | 37199 | 89830 | -12,3835535 |
| 1.2838201114389 | 90.00 | 166022 | 46494 | 119528 | -12,69367413 |
| 1.29883339483007 | 90.00 | 132856 | 37769 | 95087 | -12,44530286 |
| 1.31336321921346 | 90.00 | 113054 | 44603 | 68451 | -12,08844949 |
| 1.32845348110065 | 90.00 | 126628 | 38125 | 88503 | -12,36739498 |
| 1.34418017268517 | 90.00 | 105022 | 62272 | 42750 | -11,5773403 |
| 1.36050381348341 | 90.00 | 146941 | 44894 | 102047 | -12,5220006 |
| 1.37750327742747 | 90.00 | 135705 | 38352 | 97353 | -12,47087335 |
| 1.3951890486988 | 90.00 | 131317 | 47078 | 84239 | -12,31378301 |
| 1.41357487014144 | 90.00 | 117379 | 43950 | 73429 | -12,16466903 |
| 1.43273180288686 | 90.00 | 114511 | 34750 | 79761 | -12,25447648 |
| 1.45262638490025 | 90.00 | 100983 | 39201 | 61782 | -11,97715491 |
| 1.47337343612427 | 90.00 | 114916 | 46908 | 68008 | -12,08140001 |
| 1.49496531078234 | 90.00 | 104873 | 39731 | 65142 | -12,03465272 |
| 1.5174436107881 | 90.00 | 133081 | 40507 | 92574 | -12,41622257 |
| 1.54087640922653 | 90.00 | 108079 | 44296 | 63783 | -12,01176236 |
| 1.56524748310094 | 90.00 | 106069 | 39760 | 66309 | -12,0539312 |
| 1.5919298579273 | 90.00 | 115462 | 39250 | 76212 | -12,2050584 |
| 1.61847251090708 | 90.00 | 107040 | 63520 | 43520 | -11,59672222 |
| 1.64619703104047 | 90.00 | 118472 | 45370 | 73102 | -12,15982315 |
| 1.67506297484767 | 90.00 | 127541 | 46544 | 80997 | -12,27117233 |
| 1.70521107305407 | 90.00 | 115179 | 51928 | 63251 | -12,00266849 |
| 1.73668953519671 | 90.00 | 106794 | 96564 | 10230 | -10,02468908 |
| 1.76951133518203 | 90.00 | 137489 | 81008 | 56481 | -11,87975594 |
| 1.80384786035215 | 90.00 | 129819 | 91787 | 38032 | -11,45037291 |
| 1.8396614908475 | 90.00 | 103113 | 95966 | 7147 | -9,635309455 |
| 1.8771534451465 | 90.00 | 139759 | 93370 | 46389 | -11,66603753 |
| 1.91635259405086 | 90.00 | 126456 | 92373 | 34083 | -11,33134454 |
| 1.95732351805898 | 90.00 | 105125 | 95091 | 10034 | -10,00368524 |
| 2.00027733758181 | 90.00 | 110201 | 94175 | 16026 | -10,51206285 |
| 2.04510796130696 | 90.00 | 138538 | 95746 | 42792 | -11,57840646 |
| 2.09213334494225 | 90.00 | 138891 | 96576 | 42315 | -11,56623586 |

## RED FILTER

| Airmass | Exposure Time | Total Flux | Background Flux | N (I-B) | Instrumental Magnitude (mλ) |
|---|---|---|---|---|---|
| 1.08212870052286 | 15.00 | 954603 | 882657 | 71946 | -12,14251663 |
| 1.08711957003033 | 15.00 | 928049 | 853731 | 74318 | -12,17773503 |
| 1.09236678005413 | 15.00 | 889423 | 861363 | 28060 | -11,12021917 |
| 1.09789371625774 | 15.00 | 940696 | 862537 | 78159 | -12,23244749 |
| 1.10369382630275 | 15.00 | 917234 | 703311 | 213923 | -13,3256437 |

| | | | | | |
|---|---|---|---|---|---|
| 1.10977061485483 | 15.00 | 955026 | 788079 | 166947 | -13,05644655 |
| 1.1161519997457 | 15.00 | 874990 | 745369 | 129621 | -12,78168842 |
| 1.12281684504084 | 15.00 | 848152 | 751748 | 96404 | -12,46023764 |
| 1.22980717903711 | 15.00 | 821912 | 716240 | 105672 | -12,55989982 |
| 1.13708767818299 | 15.00 | 815162 | 609085 | 206077 | -13,28507381 |
| 1.14693377373101 | 15.00 | 876387 | 595574 | 28081 | -11,12103142 |
| 1.1549704854849 | 15.00 | 841227 | 593242 | 247985 | -13,48606353 |
| 1.163344314887369 | 15.00 | 805996 | 626401 | 179595 | -13,1357356 |
| 1.23708767818299 | 15.00 | 742680 | 675325 | 67355 | -12,0709246 |
| 1.14693377373101 | 15.00 | 734588 | 705145 | 29443 | -11,17245515 |
| 1.1549704854849 | 15.00 | 716709 | 712574 | 4135 | -9,041188785 |
| 1.16334431488739 | 15.00 | 781994 | 753188 | 28806 | -11,14870739 |
| 1.1720899853495 | 15.00 | 819914 | 707224 | 113690 | -12,63930567 |
| 1.18116401654229 | 15.00 | 788938 | 732277 | 56661 | -11,88321059 |
| 1.19063482008142 | 15.00 | 703126 | 692786 | 10340 | -10,03630135 |
| 1.20048451831142 | 15.00 | 692170 | 632254 | 59916 | -11,94385703 |
| 1.21072377153422 | 15.00 | 682123 | 444834 | 237289 | -13,43819402 |
| 1.22138743923745 | 15.00 | 787070 | 433746 | 353324 | -13,87043285 |
| 1.23246206159984 | 15.00 | 788470 | 336024 | 452446 | -14,13891688 |
| 1.24397440145308 | 15.00 | 578241 | 298709 | 279532 | -13,61607883 |
| 1.25594214438274 | 15.00 | 547378 | 267577 | 279801 | -13,61712316 |
| 1.2683674636151 | 15.00 | 434629 | 276700 | 157929 | -12,99615471 |
| 1.28129707821461 | 15.00 | 321709 | 253006 | 68703 | -12,09243925 |
| 1.29471643172193 | 15.00 | 278515 | 242277 | 36238 | -11,39791055 |
| 1.3102106232238 | 15.00 | 285269 | 245991 | 39278 | -11,48537341 |
| 1.32518833069349 | 15.00 | 218975 | 205409 | 13566 | -10,33112953 |
| 1.34076249417966 | 15.00 | 260693 | 220520 | 40173 | -11,50983566 |
| 1.35697583821085 | 15.00 | 293466 | 163544 | 129922 | -12,78420674 |
| 1.37380643681653 | 15.00 | 172574 | 133094 | 39480 | -11,49094286 |
| 1.39135728074782 | 15.00 | 140586 | 133764 | 6822 | -9,584779288 |
| 1.40959003771174 | 15.00 | 186212 | 140825 | 45387 | -11,64232869 |
| 1.42856821857818 | 15.00 | 162872 | 105054 | 57818 | -11,90515766 |
| 1.44833259331555 | 15.00 | 177719 | 150192 | 27527 | -11,09939721 |
| 1.46886320871633 | 15.00 | 135698 | 112457 | 23241 | -10,91563703 |
| 1.49029278096603 | 15.00 | 159466 | 139173 | 20293 | -10,76836564 |
| 1.51256321239633 | 15.00 | 148255 | 109420 | 38835 | -11,47305827 |
| 1.53579231778994 | 15.00 | 143861 | 110848 | 33013 | -11,29671248 |
| 1.55997518861154 | 15.00 | 117523 | 23696 | 93827 | -12,43081958 |
| 1.58515654570537 | 15.00 | 135417 | 110081 | 25336 | -11,00934513 |
| 1.61271770668566 | 15.00 | 176002 | 138163 | 37839 | -11,44484913 |
| 1.64014766650215 | 15.00 | 186847 | 139528 | 146959 | -12,91799047 |
| 1.66881899987195 | 15.00 | 138088 | 132050 | 6038 | -9,452232772 |
| 1.69867286116314 | 15.00 | 147944 | 142497 | 5447 | -9,340393438 |
| 1.72984950474656 | 15.00 | 152706 | 141520 | 11186 | -10,12168704 |
| 1.76240731806846 | 15.00 | 147877 | 145639 | 2238 | -8,374650205 |
| 1.79637266134082 | 15.00 | 144070 | 118346 | 25724 | -11,02584625 |
| 1.83191869.92432 | 15.00 | 182048 | 145095 | 36334 | -11,40078303 |
| 1.90782992080278 | 15.00 | 217511 | 145714 | 71797 | -12,14026574 |
| 1.94845914512095 | 15.00 | 147315 | 127302 | 20013 | -10,75328049 |
| 1.9909179134164 | 15.00 | 151140 | 130558 | 20582 | -10,78371893 |
| 2.0354013392463 | 15.00 | 115902 | 111238 | 4664 | -9,171896354 |
| 2.08185104713183 | 15.00 | 123385 | 107940 | 15445 | -10,47196978 |
| 2.13062747935943 | 15.00 | 134352 | 120622 | 13730 | -10,34417634 |

**SOURCE CODE FOR GRAPH: AIR MASS VS. TOTAL FLUX:**

```
import numpy as np

import matplotlib.pyplot as plt

# Load the data from the first text file

data1 = np.loadtxt('C:\\Users\\27672\\Documents\\BLUE FILTER.txt', delimiter=',')
```

```
# Load the data from the second text file

data2 = np.loadtxt('C:\\Users\\27672\\Documents\\INDIGO FILTER.txt', delimiter=',')

# Load the data from the third text file

data3 = np.loadtxt('C:\\Users\\27672\\Documents\\VIOLET FILTER.txt', delimiter=',')

# Extract x and y columns for the first dataset (BLUE FILTER)

x1 = data1[:, 0]

y1 = data1[:, 2]

y1 = np.sort(y1)[::-1]  # Sort and reverse the y values

x1 = np.linspace(min(x1), max(x1), len(y1))  # Adjust x accordingly

slope1, intercept1 = np.polyfit(x1, y1, 1)  # Line of best fit

y_fit1 = slope1 * x1 + intercept1

# Extract x and y columns for the second dataset (INDIGO FILTER)

x2 = data2[:, 0]

y2 = data2[:, 2]

y2 = np.sort(y2)[::-1]  # Sort and reverse the y values

x2 = np.linspace(min(x2), max(x2), len(y2))  # Adjust x accordingly

slope2, intercept2 = np.polyfit(x2, y2, 1)  # Line of best fit

y_fit2 = slope2 * x2 + intercept2

# Extract x and y columns for the third dataset (VIOLET FILTER)

x3 = data3[:, 0]

y3 = data3[:, 2]

y3 = np.sort(y3)[::-1]  # Sort and reverse the y values

x3 = np.linspace(min(x3), max(x3), len(y3))  # Adjust x accordingly

slope3, intercept3 = np.polyfit(x3, y3, 1)  # Line of best fit

y_fit3 = slope3 * x3 + intercept3

# Plot the data points and lines of best fit

plt.plot(x1, y1, marker='o', linestyle='-', color='b', label='BLUE FILTER Data Points')

plt.plot(x1, y_fit1, color='r', label='BLUE FILTER Line of Best Fit')

plt.plot(x2, y2, marker='s', linestyle='-', color='g', label='INDIGO FILTER Data Points')
```

```
plt.plot(x2, y_fit2, color='orange', label='INDIGO FILTER Line of Best Fit')
plt.plot(x3, y3, marker='d', linestyle='-', color='brown', label='VIOLET FILTER Data Points')
plt.plot(x3, y_fit3, color='purple', label='VIOLET FILTER Line of Best Fit')
# Add titles and labels
plt.title("Airmass Vs. Total Flux")
plt.xlabel("Airmass")
plt.ylabel("Total Flux (10^6)")
plt.legend()
plt.grid(True)
# Display the slope and intercepts for all plots
plt.text(0.05, 0.95, f'BLUE FILTER:\nSlope: {slope1:.4f}\nIntercept: {intercept1:.4f}',
    transform=plt.gca().transAxes, fontsize=8, verticalalignment='top',
    bbox=dict(facecolor='white', alpha=0.5))
plt.text(0.05, 0.85, f'INDIGO FILTER:\nSlope: {slope2:.4f}\nIntercept: {intercept2:.4f}',
    transform=plt.gca().transAxes, fontsize=8, verticalalignment='top',
    bbox=dict(facecolor='white', alpha=0.5))
plt.text(0.05, 0.65, f'VIOLET FILTER:\nSlope: {slope3:.4f}\nIntercept: {intercept3:.4f}',
    transform=plt.gca().transAxes, fontsize=8, verticalalignment='top',
    bbox=dict(facecolor='white', alpha=0.5))

# Adjust layout to prevent overlap
plt.tight_layout()
# Display the plot
plt.show()
```

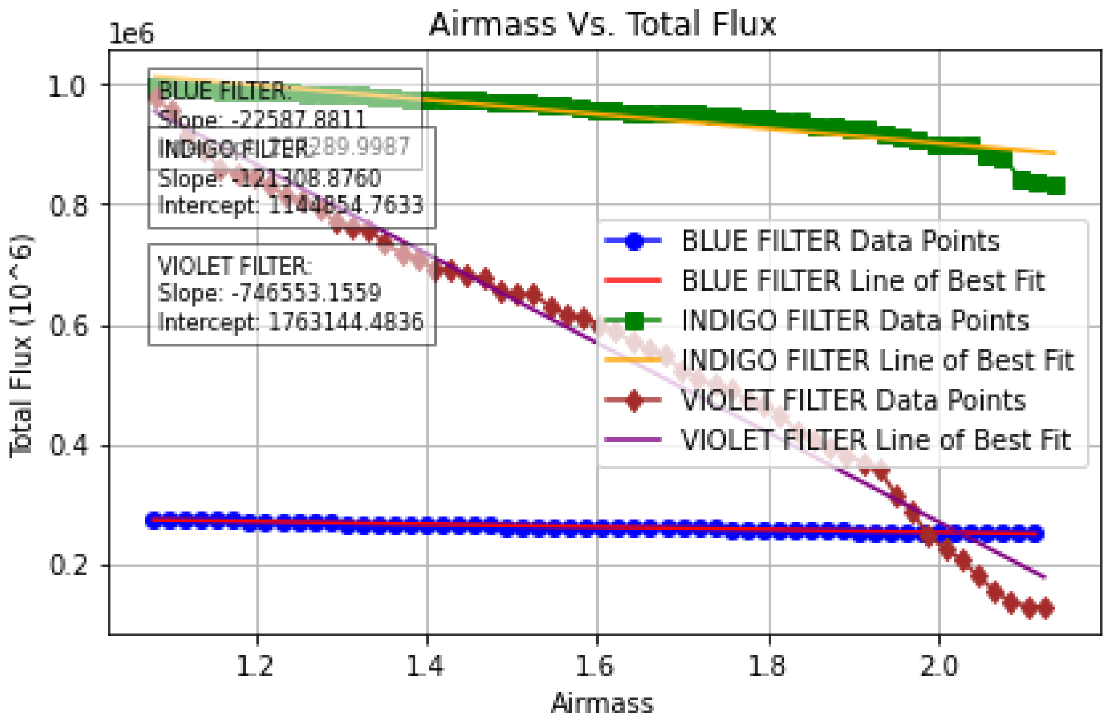


Figure 2: The graph of AIR MASS VS. TOTAL FLUX

- The above graph indicates the relationship between the AIRMASS and the TOTAL FLUX for our star known as (BD-124523).
- From the graph we got the following:
  1. BLUE FILTER:
     SLOPE=-22578.8811
     Y-INTERCEPT=2972289.9987
  2. INDINGO FILTER:
     SLOPE=-121308.8760
     Y-INTERCEPT=1144854.7633
  3. VIOLET FILTER:
     SLOPE=-746553.1559
     Y-INTERCEPT=1763144.4836
- From the above graph we notice that the slopes for all the filters are negative and they have been recorded together with the Y-intercept,which are too large because of the large values of the Total flux.

**SOURCE CODE FOR THE GRAPH: AIRMASS Vs. INSTRUMENTAL MAGNITUDE:**

```
import numpy as np

import matplotlib.pyplot as plt

# Load the data from the first text file

data1 = np.loadtxt('C:\\Users\\27672\\Documents\\BLUE FILTER.csv', delimiter=',')
```

```
# Load the data from the second text file

data2 = np.loadtxt('C:\\Users\\27672\\Documents\\INDIGO FILTER1.csv', delimiter=',')

# Load the data from the third text file

data3 = np.loadtxt('C:\\Users\\27672\\Documents\\VIOLET FILTER1.csv', delimiter=',')

# Extract x and y columns for the first dataset (BLUE FILTER)

x1 = data1[:, 0]

y1 = data1[:, 5]

y1 = np.sort(y1)[::-1]  # Sort and reverse the y values

x1 = np.linspace(min(x1), max(x1), len(y1))  # Adjust x accordingly

slope1, intercept1 = np.polyfit(x1, y1, 1)  # Line of best fit

y_fit1 = slope1 * x1 + intercept1

# Extract x and y columns for the second dataset (INDIGO FILTER)

x2 = data2[:, 0]

y2 = data2[:, 5]

y2 = np.sort(y2)[::-1]  # Sort and reverse the y values

x2 = np.linspace(min(x2), max(x2), len(y2))  # Adjust x accordingly

slope2, intercept2 = np.polyfit(x2, y2, 1)  # Line of best fit

y_fit2 = slope2 * x2 + intercept2

# Extract x and y columns for the third dataset (VIOLET FILTER)

x3 = data3[:, 0]

y3 = data3[:, 5]y3 = np.sort(y3)[::-1]  # Sort and reverse the y values

x3 = np.linspace(min(x3), max(x3), len(y3))  # Adjust x accordingly

slope3, intercept3 = np.polyfit(x3, y3, 1)  # Line of best fit

y_fit3 = slope3 * x3 + intercept3

# Plot the data points and lines of best fit

plt.plot(x1, y1, marker='o', linestyle='-', color='b', label='BLUE FILTER Data Points')

plt.plot(x1, y_fit1, color='r', label='BLUE FILTER Line of Best Fit')


plt.plot(x2, y2, marker='s', linestyle='-', color='g', label='INDIGO FILTER Data Points')
```

```
plt.plot(x2, y_fit2, color='orange', label='INDIGO FILTER Line of Best Fit')


plt.plot(x3, y3, marker='d', linestyle='-', color='brown', label='VIOLET FILTER Data Points')
plt.plot(x3, y_fit3, color='purple', label='VIOLET FILTER Line of Best Fit')
# Add titles and labels
plt.title("Airmass Vs. Instrumental Magnitude")
plt.xlabel("Airmass")
plt.ylabel("Instrumental Magnitude")
plt.legend()
plt.grid(True)
# Display the slope and intercepts for all plots
plt.text(0.05, 0.95, f'BLUE FILTER:\nSlope: {slope1:.4f}\nIntercept: {intercept1:.4f}',
    transform=plt.gca().transAxes, fontsize=8, verticalalignment='top',
    bbox=dict(facecolor='white', alpha=0.5))
plt.text(0.05, 0.85, f'INDIGO FILTER:\nSlope: {slope2:.4f}\nIntercept: {intercept2:.4f}',
    transform=plt.gca().transAxes, fontsize=8, verticalalignment='top',
    bbox=dict(facecolor='white', alpha=0.5))
plt.text(0.05, 0.65, f'VIOLET FILTER:\nSlope: {slope3:.4f}\nIntercept: {intercept3:.4f}',
    transform=plt.gca().transAxes, fontsize=8, verticalalignment='top',
    bbox=dict(facecolor='white', alpha=0.5))
# Adjust layout to prevent overlap
plt.tight_layout()
# Display the plot
plt.show()
```

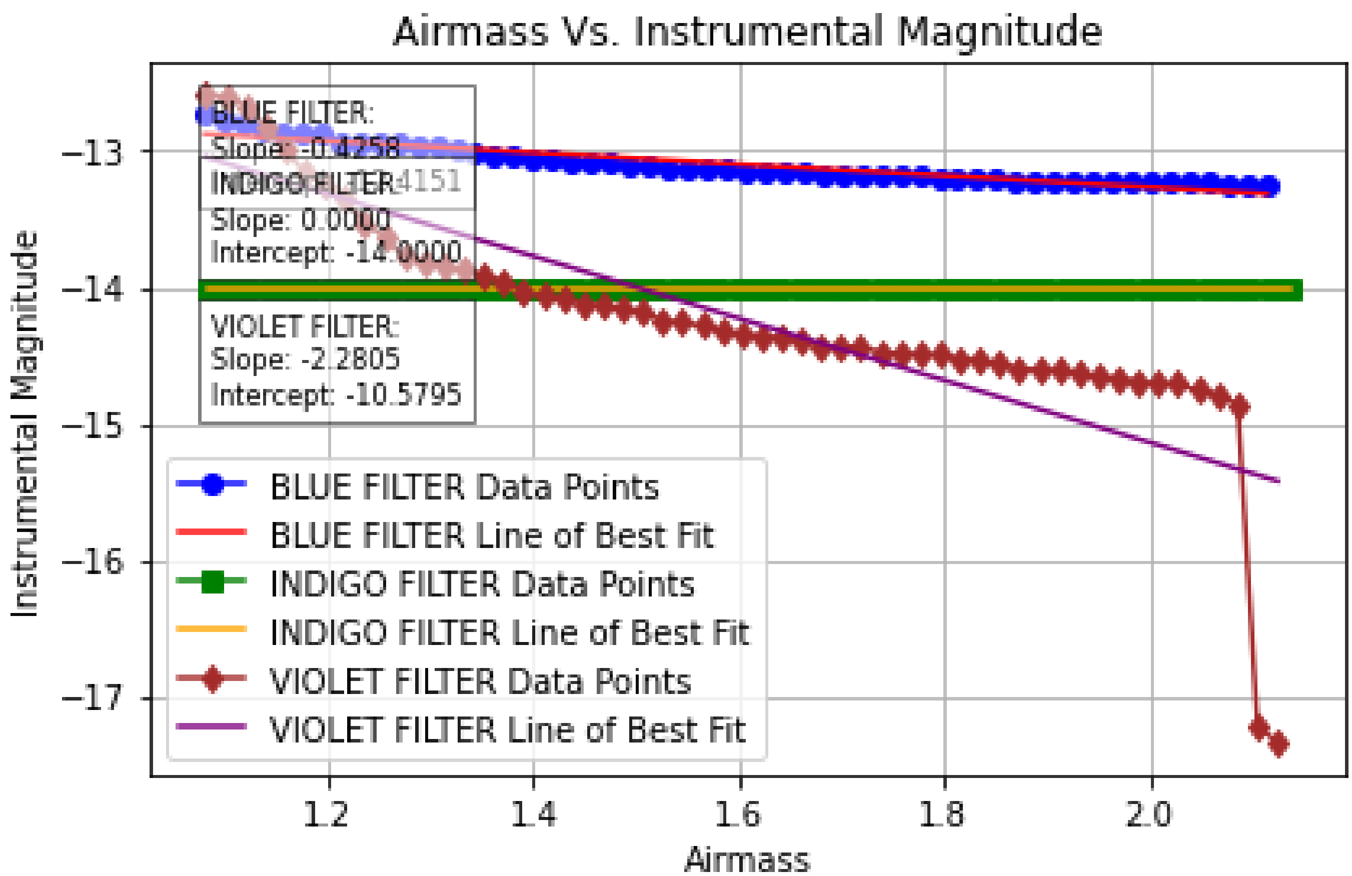


Figure 3:The graph of AIRMASS Vs. INSTRUMENTAL MAGNITUDE

- The above graph indicates instrumental magnitude for all the filters in our experiment was found by the use for the following formula: $INSTRUMENTAL\ MAGNITUDE = -2.5Log(total\ flux(I) - background\ flux(B))$
- In the formula above we substituted the values that we got during data collection for the total flux(I), which we got by placing the ring from the prompt image probe on top of our targeted star known as (BD-124523),and also subtracting the background flux (**B**)from it which we acquired by placing the same ring on the position that is in the absence of any star.
- By the above method we managed to calculate the INSTRUMENTAL MAGNITUDE for all the 5 filters that we used, and managed to plot the graph above.
- From the graph we got the following:
    1. 1.BLUE FILTER:
    SLOPE=-0.4258
    Y-INTERCEPT=-1.4151
    2. INDINGO FILTER:
    SLOPE=0.0000
    Y-INTERCEPT=1144854.7633
    3. VIOLET FILTER:
    SLOPE=--2.2805

Y-INTERCEPT=-10.5795

- From the above graph we notice that the slopes for most filters are negative,except for the INDIGO FILTER and they have been recorded together with the Y-intercept,which are found to be negative as well.

## CONCLUSION:

In our Atmospheric Extrication (Airmass) experiment, we found that the instrumental magnitude of celestial objects slightly fluctuates over time due to atmospheric changes, and the total flux of light from these objects decreases as the Airmass increases. This means that as objects get closer to the horizon, more of their light is absorbed or scattered by the atmosphere. To get clearer and more accurate observations, it’s best to observe objects when they're higher in the sky, where the atmospheric effects are less significant

## REFERENCES:


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3.Yusuf, M., Yap, F., Ramadhan, S., Jatmiko, A.T.P., Ramadhan, D.G., Perhati, T., Arwinata, H.I., Satya, L., Premadi, P.W., Louk, A.C. and Putra, M., 2024, June. Atmospheric extinction coefficients and night sky brightness at ITB-Undana remote telescope site. In Journal of Physics: Conference Series (Vol. 2773, No. 1, p. 012005). IOP Publishing.