

ASTROPHYSICS-OBSERVATIONAL PART III

CCD REDUCTION + ANALYSIS

PROCESS THE DATA USING IRAF

4 IMAGES M93-B.fits, M93-I.fits,
M93-V.fits, M93-R.fits

4 ~~FLATS~~ FLATS + 1 BIAS FRAME

REMEMBER TO SET FITS FILE TYPE

> reset imtype = fits.

~~noao/digiphot/apphot~~

noao/imred/ccdred.

FOR EACH COORD IN LIST —

- DETERMINES CENTRE OF STAR
- ADDS UP FLUX WITHIN APERTURE OF POINT
- ADDS UP FLUX WITHIN SURROUNDING

ANNULUS TO CALC SKY BRIGHTNESS

- SUBTRACTS SKY BRIGHTNESS TO DETERMINE STAR BRIGHTNESS.

Sal > ... /originals/extract-params.pl results-R

... I - 200 ... 500 ...
... 100 ... 200 ...

... 100 ... 200 ...

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... 100 ... 200 ...

... 100 ... 200 ...

... 100 ... 200 ...

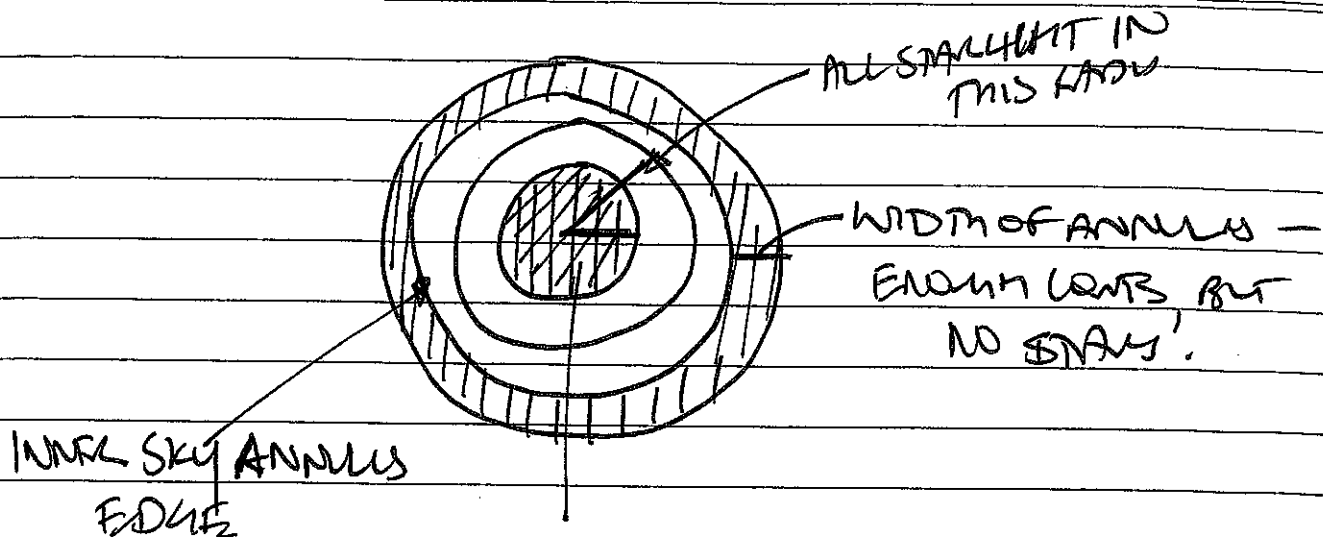
... 100 ... 200 ...

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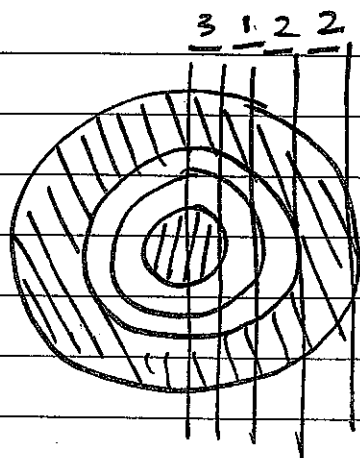
... 100 ... 200 ...



PHOTOMETRY APERTURE
 INCLUDES MOST LIGHT FROM STAR
 (EXCLUDING LIGHT FROM SKY AND NOISE STARS)

NO STELLAR LIGHT

3x4 PIXELS



FOR R;

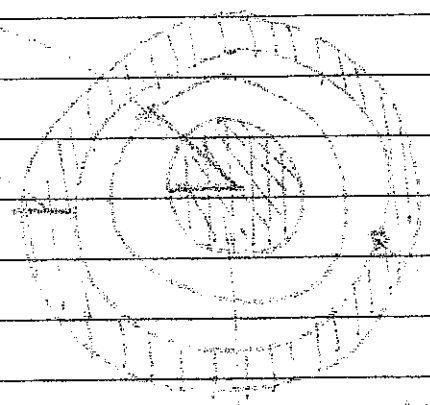
APP. RADIUS = 3
 SKY RADIUS = 6 → 8

B APP RADIUS = ~~4~~
 SKY RADIUS = 7 → 8

V APP RADIUS = 5
 SKY RADIUS = 7 → 8

I APP RADIUS = 3.5
 SKY RADIUS = 6 → 8

1. 2011/12
2. 2012/13



3. 2013/14
4. 2014/15
5. 2015/16

6. 2016/17
7. 2017/18

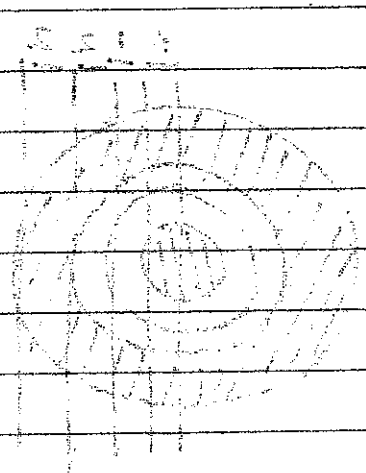
8. 2018/19

9. 2019/20

10. 2020/21

11. 2021/22

12. 2022/23



13. 2023/24

14. 2024/25

15. 2025/26

16. 2026/27

17. 2027/28

18. 2028/29

19. 2029/30

20. 2030/31

21. 2031/32

22. 2032/33

23. 2033/34

NATURE OF STARS;

$$f = 2.51^{-M+C}$$

↑ BUSINESS ↑ MAGNITUDE

NEED TO CALCULATE C FOR CALIBRATION.

FOR STANDARD STARS;

APPARENT MAGNITUDE: 52.55 FLUX

B	10.23 MAR	170397
V	10.14 MAR	241207
I	10.18 MAR	158117
R	10.15 MAR	310944

$$\rightarrow B \quad 170397 = 2.51^{-10.23+C}$$

~~170397 = 2.51^{-10.23+C}~~

~~170397 = 2.51^{-10.23+C}~~

$$\ln(170397) = \ln(2.51)^{-10.23+C}$$

$$C = \frac{\ln(170397)}{\ln(2.51)} + 10.23$$

$$= 23.32$$

$$\checkmark \quad 241207 = 2.51^{-10.14+C}$$

$$C = \frac{\ln(241207)}{\ln(2.51)} + 10.14 = 23.70$$

FLUX → MACH.

$$f = 2.51^{-m+c}$$

B	C = 23.32	
V	C = 23.70	
I	C = 23.24	
R	C = 23.97	

$$m = c - \left(\frac{\log f}{\log(2.51)} \right)$$

$$\log(2.51)^m = \log(2.51)^{c-m}$$

$$m \log(2.51) = c \log(2.51) - m \log(2.51)$$

$$2m \log(2.51) = c \log(2.51)$$

$$m = \frac{c \log(2.51)}{2 \log(2.51)}$$

log(2.51) = 0.398

$$\frac{F_{\lambda_1} \lambda_1^5}{F_{\lambda_2} \lambda_2^5} = \exp\left(\left(\frac{-hc}{kT}\right)\left(\frac{1}{\lambda_1} - \frac{1}{\lambda_2}\right)\right)$$

$$\ln\left(\frac{F_{\lambda_1} \lambda_1^5}{F_{\lambda_2} \lambda_2^5}\right) = \frac{-hc}{kT} \left(\frac{1}{\lambda_1} - \frac{1}{\lambda_2}\right)$$

$$\ln\left(\frac{F_{\lambda_2} \lambda_2^5}{F_{\lambda_1} \lambda_1^5}\right) = \frac{hc}{kT} \left(\frac{1}{\lambda_1} - \frac{1}{\lambda_2}\right)$$

flux / unit wave length

$$f = f_v 10^{-m/c}$$

$$L = f \times 4\pi r$$

$$\frac{2\pi r}{T} = v \Rightarrow r = \frac{vT}{2\pi}$$

$$L = 4\pi r^2$$

$$L = 4\pi r^2$$

$$\frac{f}{f_v} = \frac{2.57^{-m/c}}{2.57^{-m/c}}$$

$$L = 4\pi r^2$$

$$f = f_v 2.57^{-m+mv}$$

$$m_1 - m_2 \Delta m = 2.57 \log_{10}(f_2 / f_1)$$

$$f_2 = f_1 10^{(m_1 - m_2) / 2.5}$$

→ RES,

$$|K| > |I|$$

$$R = I$$

$$\lambda_1 = 10^{-9}$$

h	6.63×10^{-34}	$m^2 kg / s^2$
c	3×10^8	m / s
k	1.38×10^{-23}	$m^2 kg / s^2 / K$

$$F_{\lambda} = \frac{2\pi c^2 h}{\lambda^5} \exp\left(\frac{-hc}{k\lambda T}\right)$$

$$L = \frac{F}{4\pi r^2}$$

$$L = (4\pi r^2)$$

$$\left(\frac{F_{\lambda_1}}{F_{\lambda_2}}\right) = \frac{\lambda_2^5}{\lambda_1^5} \frac{\left(\exp\left(\frac{-hc}{k\lambda_1 T}\right)\right)}{\left(\exp\left(\frac{-hc}{k\lambda_2 T}\right)\right)}$$

$$= \frac{\lambda_2^5}{\lambda_1^5} \exp\left(\frac{-hc}{k\lambda_1 T} + \frac{hc}{k\lambda_2 T}\right)$$

$$\frac{F_{\lambda_1} \lambda_1^5}{F_{\lambda_2} \lambda_2^5} = \exp\left(\frac{-hc}{kT}\right) \left(\frac{1}{\lambda_1} - \frac{1}{\lambda_2}\right)$$

$$\log_e\left(\frac{F_{\lambda_1} \lambda_1^5}{F_{\lambda_2} \lambda_2^5}\right) = -\left(\frac{hc}{kT}\right) \left(\frac{1}{\lambda_1} - \frac{1}{\lambda_2}\right)$$

$$T = -\frac{hc}{k} \left(\frac{1}{\lambda_1} - \frac{1}{\lambda_2}\right) / \ln\left(\frac{F_{\lambda_1} \lambda_1^5}{F_{\lambda_2} \lambda_2^5}\right)$$

$$\ln(0.5) = -0.69 \quad -\ln\left(\frac{1}{x}\right) = \ln(x) / \ln(x^{-1})$$

$$\ln(2) = 0.69$$

~~3×10^5 m/s.~~

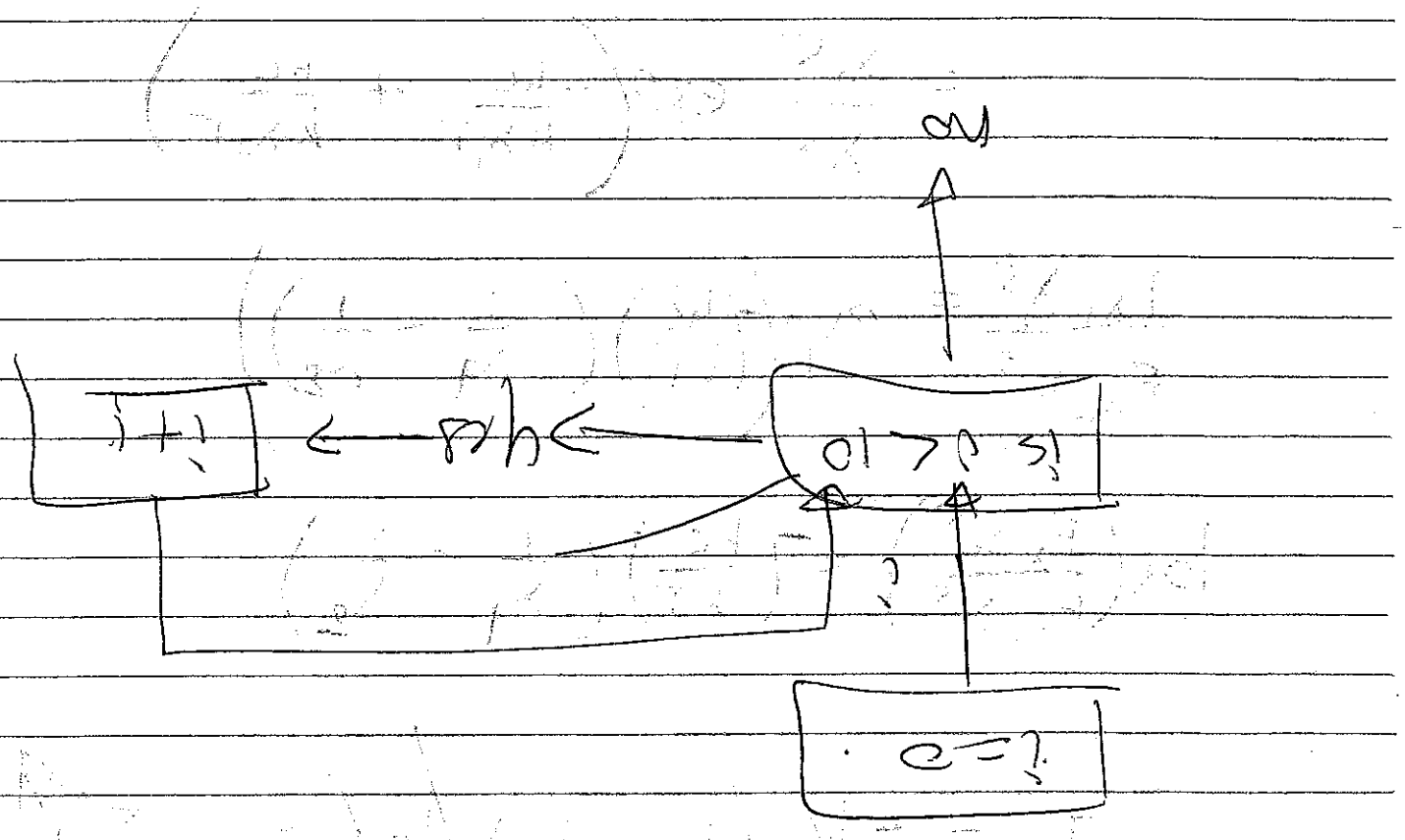
$3 \times 10^5 \times 10^9$ nm/s.

$= -\ln x$

$\frac{1}{x} = x^{-1}$

$\frac{d}{dx} x^{-1} = -1 x^{-2} = -\frac{1}{x^2}$

$\frac{d}{dx} \frac{1}{x} = -\frac{1}{x^2}$



for i < 10 . i++

$\frac{d}{dx} x^2 = 2x$

$\frac{d}{dx} x^3 = 3x^2$

$\frac{d}{dx} x^4 = 4x^3$

$\frac{d}{dx} x^5 = 5x^4$

$\frac{d}{dx} x^6 = 6x^5$

$\frac{d}{dx} x^7 = 7x^6$

$\frac{d}{dx} x^8 = 8x^7$

$\frac{d}{dx} x^9 = 9x^8$

$\frac{d}{dx} x^{10} = 10x^9$

$$\text{BRIGHTNESS } f = 2.51^{-m+c}$$

TO CONVERT MAGNITUDE \rightarrow BRIGHTNESS
WITH REFERENCE TO VEGA, NEED TO RECALCULATE.

$$\therefore m=0. \quad f = 6.3 \times 10^{-11}$$

$$\rightarrow c = \frac{\ln(6.3 \times 10^{-11})}{\ln(2.51)}$$

$$\approx -25.52$$

$$V \quad c = -26.13$$

$$I \quad c = -27.42$$

$$R \quad c = -26.67$$

USING RELEVANT C VALUE PER FILTER, CAN
CALCULATE BRIGHTNESS ACCORDING TO MAGNITUDE
CALCULATED EARLIER.

$$-2.5 \log_{10} f + c = m.$$

$$-2.5 \log_{10} f = m - c.$$

$$\log_{10} f = \frac{-m+c}{2.5}$$

$$f = 10^{(-m+c)/2.5}$$

$$= (10^{1/2.5})^{(-m+c)}$$

$$= 2.51^{-m+c}$$

PRINTED BY: J. B. ...

TO ORDER: ...

... ..

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... ..

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... ..

ASSUME $d = 1104 \text{ pc}$. TO CLUSTER.

$$\rightarrow M = m + 5 - 5 \log_{10} d.$$

HERTZSPRUNG - RUSSELL DIAGRAM

PLOT M_V VS $B - V$.

LINE OF STARS — MAIN SEQUENCE.

LUMINOSITY OF STARS

CONVERT MAGNITUDE \rightarrow ENERGY.

FILTER	λ	BRIGHTNESS OF VERA	APP. M/M _R
B	440 nm	$6.3 \times 10^{-11} \text{ W m}^{-2} \text{ nm}^{-1}$	0
V	550 nm	$3.6 \times 10^{-11} \text{ W m}^{-2} \text{ nm}^{-1}$	0
I	700 nm	$2.2 \times 10^{-11} \text{ W m}^{-2} \text{ nm}^{-1}$	0
R	880 nm	$1.1 \times 10^{-11} \text{ W m}^{-2} \text{ nm}^{-1}$	0

$$L = \frac{F}{4\pi d^2}$$

L	LUMINOSITY	W/nm
F	FLUX	$\text{W m}^{-2}/\text{nm}$
d	DISTANCE	m.

PROBLEME IN DER ANNAHME

1. $h = 0,1 \text{ m}$ \rightarrow $M = 0$

NEUTRALFASER - WIRBELDIPOL

PROT. M. NE. E. - J.

LIEFE RE. GIBT - LIEFE RE. GIBT

WIRBELDIPOL

WIRBELDIPOL - WIRBELDIPOL

PROT. M.	WIRBELDIPOL	WIRBELDIPOL	WIRBELDIPOL
0	WIRBELDIPOL	WIRBELDIPOL	WIRBELDIPOL
0	WIRBELDIPOL	WIRBELDIPOL	WIRBELDIPOL
0	WIRBELDIPOL	WIRBELDIPOL	WIRBELDIPOL
0	WIRBELDIPOL	WIRBELDIPOL	WIRBELDIPOL

WIRBELDIPOL
 WIRBELDIPOL
 WIRBELDIPOL

$$I \quad \ln(158117) = \ln(2.51)(-10.23 + C)$$

$$\rightarrow C = 23.24$$

$$R \quad \ln(310944) = \ln(2.51)(-10.23 + C)$$

$$\rightarrow C = 23.97$$

ABSOLUTE MAGNITUDE

FLUX OF A STAR AT A DISTANCE r :

$$F = \frac{L}{4\pi r^2}$$

FLUX RATIO :

$$\frac{F_2}{F_1} = 100^{(m_1 - m_2)/5}$$

$$m_1 - m_2 = -2.5 \log_{10} (F_1/F_2)$$

$$\rightarrow 100^{(m - M)/5} = \frac{F_{10}}{F} = \left(\frac{d}{10 \text{ pc}}\right)^2$$

$$\rightarrow 100^{(m - M)/5} = \frac{d^2}{100}$$

$$d^2 = \frac{100^{(m - M + 5)/5}}{100} \rightarrow d = 10^{(m - M + 5)/5}$$

$$(10 + 0.05 \cdot 10) \cdot (10 - 0.05) \cdot n = (10.05 \cdot 10) \cdot n \quad I$$

$$AS.80 = 10.05 \cdot n$$

$$(10.05 \cdot 10) \cdot (10 - 0.05) \cdot n = (10.05 \cdot 10) \cdot n \quad R$$

$$10.05 \cdot n = 10 \cdot n$$

PERCENTAGE INCREASE

PERCENTAGE INCREASE IN A QUANTITY

$$\frac{1}{100} \cdot 100 = 1$$

PERCENTAGE INCREASE

$$\frac{10.05 \cdot 10}{10} = 1.005$$

$$\frac{10.05 \cdot 10}{10} = 1.005$$

$$\frac{10.05 \cdot 10}{10} = 1.005$$

$$\frac{10.05 \cdot 10}{10} = 1.005$$

$$\frac{10.05 \cdot 10}{10} = 1.005$$