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 ~~BIASES~~ FLATS + 1 BIAS FRAME.

& REMEMBER TO SET FITS FILES TYPE

> reset imtype = fits.

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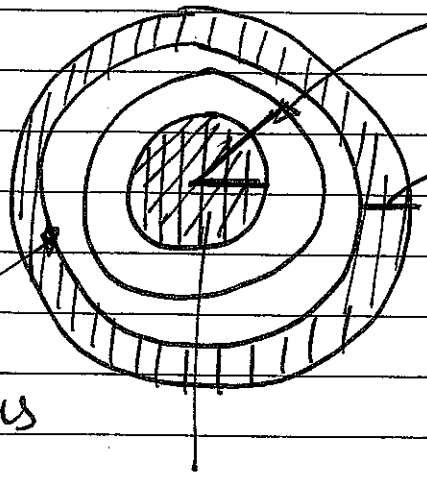
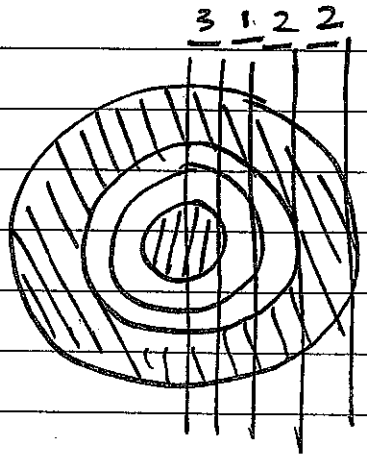
noao / digiphot / apphot noao/imred/ccdred.

FOR EACH COORD IN LIST —
- DETERMINES CENTRE OF STAR
- ADDS UP FLUX WITHIN ~~APERATURE~~ 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_B





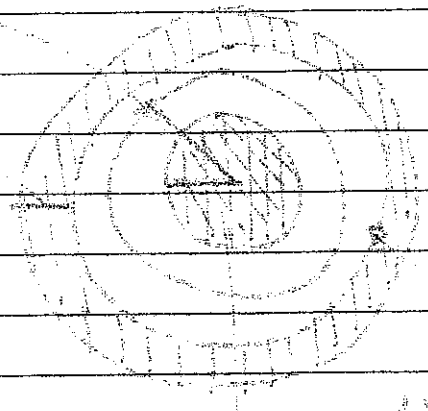
For R;

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



NATURE OF STARS;

$f = 2.51^{-M+C}$ ← NEED TO CALCULATE C FOR CALIBRATION.

f: BRIGHTNESS, M: MAGNITUDE

FOR STANDARD STAR;

	APPARENT MAGNITUDE:	FLUX
B	10.23 mag	170397
V	10.14 mag	241207
I	10.18 mag	158117
R	10.15 mag.	310944

→ B $170397 = 2.51^{-10.23+C}$

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

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

$$= 23.32$$

V $241207 = 2.51^{-10.23+C}$

$$C = \frac{\ln(241207)}{\ln(2.51)} + 10.23 = 23.70$$

FLUX → mag.

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

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

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

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

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

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

Flux / unit wavelength

$f = f_v 10^{-m/2.5}$

$L = \frac{f \times 4\pi r^2}{4\pi R^2 \sigma T^4}$

$L = 4\pi R^2 \sigma T^4$

$\frac{f}{f_v} = \frac{2.5^{-m+c}}{2.5^{-m+c_v}}$

$f = f_v \, 2.5^{-m+m_v}$

$m_1 - m_2 \Delta m = 2.5 \log_{10}(f_2/f_1)$

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

→ RED.

$|R| > |I|$.

$R - I$ $\lambda_1 = \times 10^{-9}$.

h 6.63×10^{-34} $m^2 kg/s^2 k$

c 3×10^8 m.

K 1.38×10^{-23}. $m^2 kg/s^2/k$

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

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

$L = f 4\pi r^2$

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

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

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

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

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

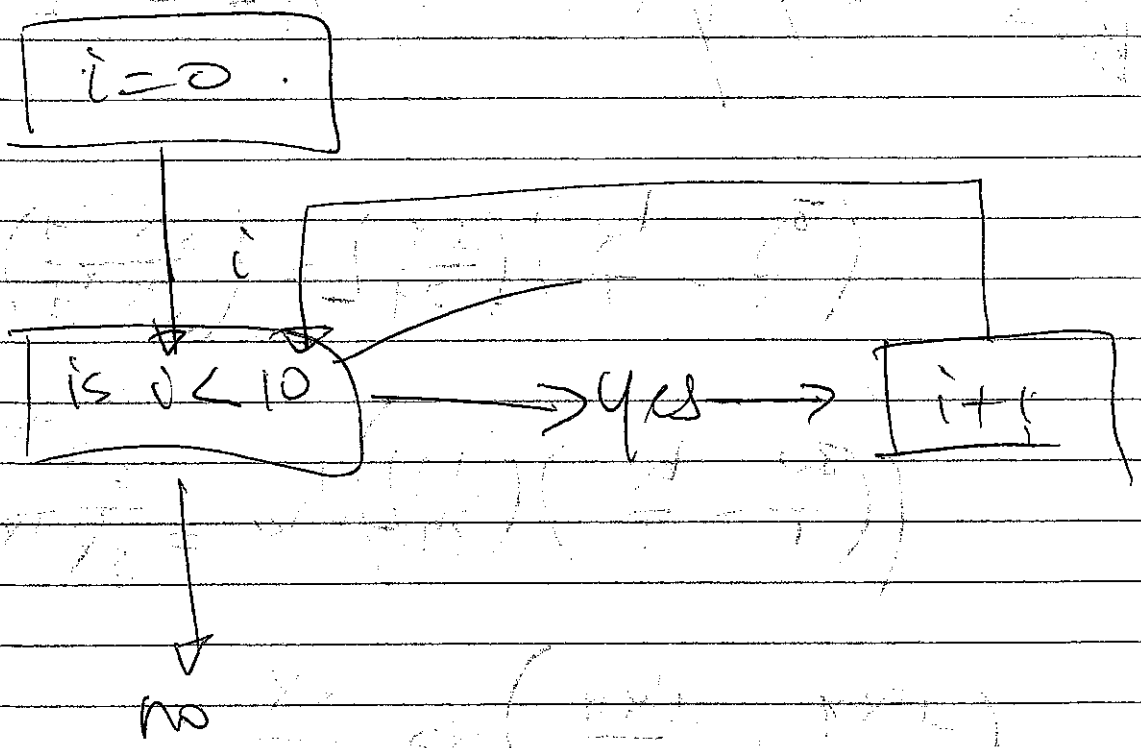
$=$

$\ln(0.5) = -0.69$ $\quad -\ln\left(\frac{1}{x}\right) = \ln(2) \quad \ln\left(x^{-1}\right)$

$\ln(2) = 0.69.$ $\quad = -\ln x$

$\frac{3\times10^5 \text{ m/s}}{3\times10^5 \times 10^9 \text{ nm/s}}$

for i<10 . i++



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

TO CONVERT MAGNITUDE → BRIGHTNESS WITH RESPECT TO VEGA, NEED TO RECALCULATE C.

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

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

$$= -25.52$$

V $C = -26.13$

I $C = -27.42$

R $C = -26.67$

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

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

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

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

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

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

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

ASSUME $d = 1104$ 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 → ENERGY.

FILTER	λ	BRIGHTNESS OF VEGA	APP. MAG
B	440 nm	6.3×10^{-11} Wm^{-2}nm^{-1}	0
V	550 nm	3.6×10^{-11} Wm^{-2}nm^{-1}	0
I	700 nm	2.2×10^{-11} Wm^{-2}nm^{-1}	0
R	880 nm	1.1×10^{-11} Wm^{-2}nm^{-1}	0

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

L	LUMINOSITY	W/nm
F	FLUX	W m^2/nm
d	DISTANCE	m

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

$\rightarrow C = 23.24$

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

$\rightarrow C = 23.97$

ABSOLUTE MAGNITUDE

FLUX OF A STAR AT A DISTANCE r :

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

FLUX RATIO :

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

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

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

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

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