Chapter 3

The CAMERA

The camera consist of a filter wheel mounted directly on the telescope and the CCD mounted beneath it. The CCD is mounted at the f/7 focus.

3.1 Camera Filter Wheel

The automated filter wheel (Fig. 3.1) has eight positions for 2 inch round or square filters (whose thickness is less than 8 mm). The wheel is absolutely encoded and a filter change is very rapid (a few seconds) and it is the most commonly used instrument now. If you change filters in the wheel, be sure to change the list on the "Filter Agent" window. In order to move the automated wheel one uses the "Filter Agent" window (sec. 3.2.1) on the desktop of the pi computer. However, usually this is not required since it is moved to the desired position by the "Remote Wise Commander" window on mizpe-cdr.

Note that when the automated filter wheel is in a "right" position, an "In Detent" indication is in the lower status bar of the "Filter Agent" . If this is not the case then the filter wheel needs to be adjusted. This is done by switching the wheel power supply off (using the black switch on its electric cable), moving the wheel by hand to the right positions according to the white marks, switching the power supply on again, and then reseting the position in the "Filter Agent" as indicated in section 3.2.1.

Sometimes, usually when operating an electrical system in the dome - like moving the dome or the platform, the wheel gets out of its "right" place in which case it need to be reset as indicated above.

A list of available 50mm filters is given in Table 3.1.

Another filter wheel at the Wise Observatory is one with 4 positions for filters which are 3 inches wide. The operation of this wheel is the same as the one with 8 positions and it was used for the SITe CCD which was a large CCD. The filters available for the 4 positions filter wheel are listed in Table 3.2.

Table 3.1: Available 50mm filters

Filter	$\lambda_{central}$	FWHM	Remarks
U	-	-	Bessell - purchased in 2007
B	-	-	Bessell - purchased in 1997
V	-	-	Bessell - purchased in 1997
R	-	-	Bessell - purchased in 1997
I	-	-	Bessell - purchased in 1997
Z	-	-	Blue cutoff + CCD response - purchased in 1987 from RGO
I_{new}	8100	1400	Cousins - purchased in 1997 from Custom Scientific
Red J-T	6400	1400	accepted from Arlin Crotts in 1995
Continuum	5300	144	(WB16) Kris Davidson's Crab Nebula filter
u'	-	-	SDSS filter - purchased in 2010
g'	-	-	SDSS filter - purchased in 2010
r'	-	-	SDSS filter - purchased in 2010
i'	-	-	SDSS filter - purchased in 2010
z'	-	-	SDSS filter - purchased in 2010
Stromgren v	4113	180	peak=51% at 25 degree Celsius
Stromgren b	4676	181	peak=65% at 25 degree Celsius
Stromgren y	5488	230	peak=65% at 25 degree Celsius
H_α v=0 km/sec	6562.8	25	with the Stromgren set
H_βW	4874	134	peak=64% at 25 degree Celsius; with the Stromgren set
H_βN	4865	30	peak=52% at 25 degree Celsius; with the Stromgren set
Continuum	6447	54	(H_α1), Microcoatings, peak=64.4%
H_α v=0 km/sec	6562	50	(H_α2), Microcoatings, peak=67.5%
H_α v=1050	6586	48	(H_α3), Microcoatings, peak=66%
H_α v=2150	6610	55	(H_α4), Microcoatings, peak=69.7%
H_α v=4390	6659	60	RGO 67, peak=46%
H_α v=6240	6700	53	(H_α5), Microcoatings, peak=70%
H_α	6635	55	(H_α6), peak=55%
H_α	6697	55	(H_α7), peak=60%
H_α	6760	60	(H_α8), peak=55%
H_α	6800	65	(H_α9), peak=40%
$\sim H_\beta$	4883	32	RGO 53
He II, N III	4697	53	BARR associates - #2
He I	5874	62	BARR associates - #1
[S II]	6736	75	BARR associates #6
[O III]	5150	-	from Edmund Scientific - December 1995
Na I, He I	5890	-	from Edmund Scientific - December 1995
Continuum	6200	-	from Edmund Scientific - December 1995

The observer should specify when a filter change or a filter-wheel change is required, since this operation is done only in daytime.

Some issues about the filters:

Filter	$\lambda_{central}$	FWHM	Remarks
U	-	-	RGO 1 - Schott UG2
-	-	-	RGO - Schott UG2 - round
B	-	-	RGO 3 - Schott
V	-	-	RGO 6 - Schott
V	-	-	RGO - Schott - GG495 + BG18
R	-	-	RGO 8 - Schott OG570
I	-	88	RGO 9 - Schott
-	5800	-	RGO OG590 - Schott
-	-	-	RGO 11 - Schott
-	-	-	RGO 14 - Schott + Anti-Red Leak
Polaroid	-	-	0 degrees with a hole
Polaroid	-	-	60 degrees with a hole
Polaroid	-	-	120 degrees with a hole
Polaroid	-	-	RGO - Schott
Continuum	5107	29	RGO 59 - Schott - round
Continuum	5295	88	IR - 5300 - 7mm thick - round
METHANE	-	-	Ω890BP30 - 35006/9418 - round × two filters
-	4363	18	Heliotek (0745)
#65.1315	-	-	GG495
U	-	-	Johnson/Cousins - purchased in 1987 from RGO - DEFECT
B	-	-	Johnson/Cousins - purchased in 1987 from RGO - some flaws
V	-	-	Johnson/Cousins - purchased in 1994 from RGO - some flaws
R	-	-	Cousins - purchased in 1987 from RGO - some flaws
I_{old}	-	-	Pseudo-Johnson - purchased in 1987 from RGO - some flaws
43162	4420	-	CWL - Edmond Scientific - DEFECT
-	5165	50	RGO - Schott - DEFECT
-	5165	-	RGO - DEFECT
-	5165	-	RGO - DEFECT
-	-	-	Schott BG18 6mm - DEFECT
H_β	4851	10	RGO 40 - Schott - DEFECT
[O III]	5010	40	RGO 56 - DEFECT
Continuum	5077	40	RGO 58 - DEFECT
Continuum	4919	38	RGO 54 - some flaws
H_β	4863	42	RGO 52 - some flaws
Continuum	4960	30	RGO 55 - NOT FOUND

Notes:

(a) The five Bessell filters UBVRI and the five SDSS filters u'g'r'i'z' are square and have the same thickness of 5 mm, hence when setting the telescope focus for one of them it will be good for the others. However the Z filter is thicker (~7 mm, same as all the old Johnson filters) than the above filters, hence if the telescope focus was set with one of the above five it will not be in focus for the Z, and vice versa. The same applies for using the round H_α filters or the I_{new} filter - all of them have the same focus position as the five Bessell filters. Thus, with the Z filter one needs to move the position of the focus by 10 steps up if it was originally focused with one of the five Bessell filters or with any of the other H_α filters. For the other filters it is advised to focus the telescope with the filter you need to use during the night.

(b) The filters are 2 inch round or square and their thickness is no more then 7 mm (in order to be used in the FOSC. For use in the CAMERA the thickness limit is 8 mm).

(c) A thorough study of the H_α filter set was done by Oded Spector in September 2006 (see the web site below).

(d) There is a set of UBVRI Bessell filters, which are of 3 inches square, which were purchased for the SITe filter wheel (4 positions wheel) in September 2000 from Omega Optical.
(e) Transmission curves of the common filters as well as the H_α filters study by Oded Spector are available at http://wise-obs.tau.ac.il/observations/filters

Table 3.2: Available 3" filters

Filter	$\lambda_{central}$	FWHM	Remarks
U	-	-	Bessell - purchased in 2000 from Omega filters
B	-	-	Bessell - purchased in 2000 from Omega filters
V	-	-	Bessell - purchased in 2000 from Omega filters
R	-	-	Bessell - purchased in 2000 from Omega filters
I	-	-	Bessell - purchased in 2000 from Omega filters
ON 26	-	-	Schott 2mm
UV	-	-	Schott 2mm
UG 1	-	-	Schott 2mm - 813573
BG 18	-	-	Schott 3mm - 16530
BG 23	-	-	Blue - Schott 3mm - 333101
BG 37	-	-	Schott 3/4mm + GG385 2mm (B)
BG 38	-	-	Schott 3mm
GG 495	-	-	Yellow - Schott 2mm - 16335
RG 715	-	-	Schott 2mm - 16442
RG 610	-	-	Red - Schott 2mm

The narrow-bands filters are about 70–100 Å wide, this is about 10-15 narrower than broad-band filters (e.g.,the R-band). The exposure times usedare usually longer by a factor of 2-4for H_α than for theR-band. This allows detecting point-like Halpha sources of EW$\sim$10–100 with sufficient signal-to-noise within galaxies.

H_α5 and H_α7 are practically the same.

H_α9 is aimed for targets with 11000 km per sec, but not recommended to use since it distorts point sources.

The H_α filters are of different band-widths, so they have different sensitivity to the twilight sky. You may find the following list, with the filters in order of exposure (from the least sensitive to the most sensitive):

Flat Field - Filter order (for sunset) U, Ha2, Ha3, Ha9, Ha4, Ha5, Ha8, Ha7, Ha6, RGO67, Ha1, WB16, B, V, R, I, clear

The first filter (U) should be imaged at around sunset. If sky is clear, you can start it's

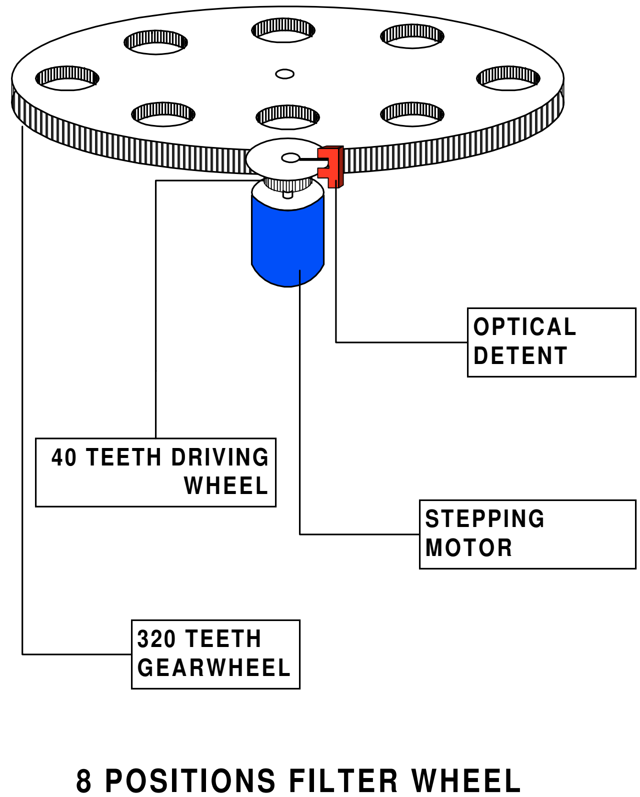

Figure 3.1: Camera filter wheel.

flat field, when the sun is at about -1 deg. Many of the H_α filters are very close in sensitivity to each other, so don't count of taking more than 4 or 5 filters' flats. After the H-alpha filters there's some gap before filter B.

3.2 pi2006 computer

3.2.1 Filter Agent

This window is used to control the automated filter wheel position (sec. 3.1). The program was written in July 2010 by Eli Ochayon and Roy Rozenman as their project toward their B.Eng. degree. The "Filter Agent" program is a Delphi interface which operate an Arduino Mega device through a Java script. This Arduino Mega device controls the operation of the filter wheel and is located in a black box connected to the filter wheel power supply and connected to the computer via USB cable. The USB port is marked on the computer in green color.

Under normal working conditions the "Filter Agent" window is continuously running on the pi2006 computer and the user only turns on and off the power supply of the filter wheel at the beginning and end of the night, respectively. If there are no problems The "Filter Agent" should not be closed at the end of the night, thus no need to open it in the evening.