Appendix B

Colour correction factors for LWS, TIMMI2, MIRSI and MIRLIN filters

B.1 LWS at Keck 1 filters and color correction factors

Using measured transmission profiles for the filters installed at the LWS (see Fig B.1) provided to us by the instrument specialists (Campbell & Wirth, personal communication, 2000), we have calculated the color correction factors – listed in Table B-1 – as a function of the black body temperature between 100 and 550 K. For the range of temperature displayed by NEAs (~300-500 K) color correction factors turn out to be no larger than a few percent.

λ_C	Black Body temperature (K)									
(μm)	**100**	**150**	**200**	**250**	**300**	**350**	**400**	**450**	**500**	**550**
4.80	0.79	0.92	0.97	0.99	1.00	1.01	1.01	1.01	1.01	1.01
8.00	1.10	1.08	1.06	1.04	1.03	1.02	1.01	1.01	1.00	1.00
8.90	1.04	1.06	1.06	1.06	1.06	1.05	1.05	1.05	1.04	1.04
9.80	1.10	1.07	1.04	1.03	1.01	1.00	1.00	0.99	0.99	0.98
10.70	0.98	1.02	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01
11.70	1.11	1.06	1.02	1.00	0.98	0.97	0.96	0.96	0.95	0.95
12.50	1.05	1.03	1.02	1.01	1.00	1.00	0.99	0.99	0.99	0.99
17.90	1.01	1.01	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.99
17.60	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01
20.00	1.05	1.03	1.02	1.02	1.01	1.01	1.01	1.01	1.00	1.00

Table B-1 Color correction factors for the LWS filters based on the measured filter transmission curves. The first line indicates the black-body temperature. The left-most column is the filter effective wavelength λ_C.

The LWS web page (http://www2.keck.hawaii.edu/inst/lws/filters.html) gives parameters for each filter available to the observing community. For convenience, filter effective wavelengths and bandwidths are reported here in Table B-2.

It is instructive to compare the color correction factors calculated with the measured transmission of the filters and those obtained assuming the filter transmission to be a window function centered on λ_C and of width $\Delta\lambda=(\lambda_{max}-\lambda_{min})$ i.e.

$$\begin{cases} T(\lambda) = 1.0 \text{ for } \lambda \in [\lambda_{\min}, \lambda_{\max}] \\ T(\lambda) = 0.0 \text{ otherwise} \end{cases} \quad \text{(B-7-1)}$$

Table B-3 lists color correction factors for the LWS filters using the window transmission function. The difference with respect to the color corrections of Table B-1 is of a few percent.

λ_C (μm)	λ_{min} (μm)	λ_{max} (μm)
4.80	4.40	5.00
8.00	7.50	8.20
8.90	8.40	9.20
9.80	9.40	10.20
10.70	10.00	11.40
11.70	11.20	12.20
12.50	12.00	13.00
17.90	16.90	18.90
17.60	17.30	18.20
20.00	19.20	20.80

Table B-2 LWS filters parameters. λ_C is the effective wavelength The filter bandwidth is given in term of λ_{min} and λ_{max} .

λ_C	Black body temperature (K)									
(μm)	**100**	**150**	**200**	**250**	**300**	**350**	**400**	**450**	**500**	**550**
4.80	0.79	0.95	1.00	1.02	1.03	1.03	1.02	1.02	1.02	1.01
8.00	1.01	1.02	1.02	1.02	1.01	1.01	1.00	1.00	1.00	1.00
8.90	1.01	1.02	1.02	1.01	1.01	1.01	1.00	1.00	1.00	1.00
9.80	1.02	1.02	1.01	1.01	1.01	1.00	1.00	1.00	1.00	1.00
10.70	1.01	1.03	1.02	1.01	1.01	1.00	1.00	1.00	0.99	0.99
11.70	1.02	1.02	1.01	1.01	1.00	1.00	1.00	1.00	0.99	0.99
12.50	1.02	1.02	1.01	1.00	1.00	1.00	1.00	1.00	0.99	0.99
17.90	1.02	1.01	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.99
17.60	1.01	1.01	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.99
20.00	1.01	1.01	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.99

Table B-3 Color correction factors for the LWS filters based on simplified filters parameters. The first line indicates the black-body temperature. The left-most column is the filter effective wavelength.

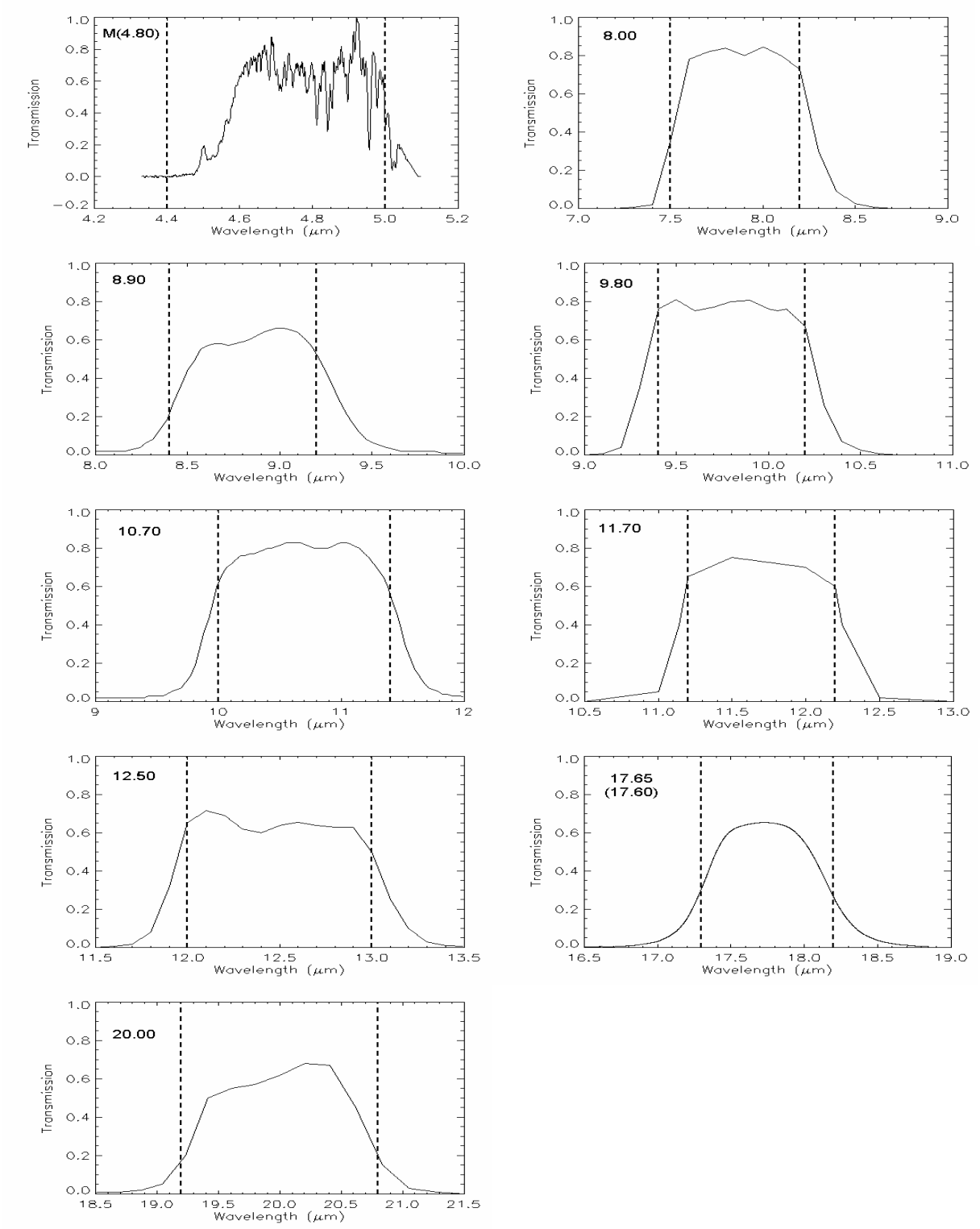

Fig B.1 Transmission curves for the filters installed at the LWS (Wirth & Campbell, personal communication, 2000). In the case of the M filter, the curve is the product of the transmission of the filter with that of the atmosphere and the optics of the instrument.

B.2 TIMMI2 filters and color correction factors

Filter Name	Blue cut (μm)	Blue (50%)	Red (50%)	Red cut (μm)
L	3.6	3.73	4.11	4.13
M	4.3	4.36	4.91	4.99
N1	7.79	7.99	9.2	9.46
N2	9.43	9.74	11.33	11.78
N7.9	7.18	7.42	8.11	8.62
N8.9	7.9	8.29	9.07	9.46
N9.8	8.76	9.1	10.02	10.49
N10.4	9.46	9.8	10.82	11.21
N11.9	10.61	10.99	12.19	12.5
SiC	10.13	10.67	12.93	13.34
N12.9	11.54	11.62	12.79	12.98
[NeII]	12.57	12.68	12.9	13.02
Q1	17.04	17.35	18.15	18.48

Table B-4 TIMMI2's filters available in imaging mode. Note that not all filters have been used in this study.

Table B-5 and Table B-6 report color correction factors for the filters installed at the TIMMI2. Filter parameters were obtained from the TIMMI2 web page (http://www.ls.eso.org/lasilla/Telescopes/360cat/timmi/html/modes.html) and for convenience reproduced here in Table B-4. A window function was assumed to represent the filter transmission curve T(λ). However, while in Table B-5 the filter bandwidth was defined by using the blue and the red cut-off values, in Table B-6 the 50% value of the filters transmission limits were used. Note the slight difference in the final results by a few percent.

	Black body temperature (K)									
Filter name	**100**	**150**	**200**	**250**	**300**	**350**	**400**	**450**	**500**	**550**
L	0.60	0.85	0.96	1.00	1.02	1.03	1.03	1.03	1.02	1.02
M	0.68	0.90	0.99	1.02	1.03	1.03	1.03	1.02	1.02	1.02
N1	0.92	1.02	1.03	1.03	1.03	1.02	1.01	1.00	1.00	0.99
N2	0.96	1.03	1.04	1.03	1.02	1.01	1.00	0.99	0.99	0.98
N7.9	0.90	1.01	1.03	1.03	1.03	1.02	1.01	1.01	1.00	1.00
N8.9	0.94	1.02	1.03	1.03	1.02	1.02	1.01	1.00	1.00	0.99
N9.8	0.97	1.03	1.03	1.03	1.02	1.01	1.00	1.00	0.99	0.99
N10.4	0.99	1.03	1.03	1.02	1.01	1.01	1.00	1.00	0.99	0.99
N11.9	1.01	1.03	1.02	1.02	1.01	1.00	1.00	0.99	0.99	0.99
SiC	0.96	1.04	1.04	1.03	1.02	1.01	0.99	0.99	0.98	0.97
N12.9	1.02	1.02	1.01	1.01	1.00	1.00	1.00	0.99	0.99	0.99
[NeII]	1.01	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Q1	1.02	1.01	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.99

Table B-5 Color correction factors calculated for TIMMI2's filters. A window function as of Eq. 3-19 was used. The width of the window was defined by the red and the blue cut-off values of the filters (see Table B-4)

	Black body temperature (K)									
Filter name	**100**	**150**	**200**	**250**	**300**	**350**	**400**	**450**	**500**	**550**
L	0.79	0.95	1.00	1.02	1.02	1.02	1.02	1.02	1.02	1.02
M	0.80	0.95	1.00	1.02	1.02	1.02	1.02	1.02	1.02	1.01
N1	0.98	1.02	1.03	1.02	1.02	1.01	1.01	1.00	1.00	1.00
N2	1.00	1.03	1.02	1.02	1.01	1.00	1.00	1.00	0.99	0.99
N7.9	1.00	1.02	1.02	1.02	1.01	1.01	1.01	1.00	1.00	1.00
N8.9	1.01	1.02	1.02	1.01	1.01	1.01	1.00	1.00	1.00	1.00
N9.8	1.02	1.02	1.02	1.01	1.01	1.00	1.00	1.00	1.00	1.00
N10.4	1.02	1.02	1.02	1.01	1.01	1.00	1.00	1.00	1.00	0.99
N11.9	1.02	1.02	1.01	1.01	1.00	1.00	1.00	0.99	0.99	0.99
SiC	1.00	1.03	1.03	1.02	1.01	1.00	1.00	0.99	0.99	0.98
N12.9	1.02	1.02	1.01	1.01	1.00	1.00	1.00	0.99	0.99	0.99
[NeII]	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Q1	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table B-6 Color correction factors calculated for TIMMI2 filters assuming a window transmission function which limits were defined at the 50% level of the actual filters transmission (see Table B-4).

B.3 MIRLIN filters and color correction factors

Filter name	**λ_C (μm)**	**$\Delta\lambda$ (μm)**	**Flux for 0 Mag (Jy)**
N	10.79	5.66	33.4
Q-s	17.90	2.00	12.4
N0	7.91	0.76	60.9
N1	8.81	0.87	49.4
N2	9.69	0.93	41.1
N3	10.27	1.01	36.7
N4	11.70	1.11	28.5
N5	12.49	1.16	25.1
Q0	17.20	0.60	13.4
Q1	17.93	0.45	12.3
Q2	18.64	0.52	11.4
Q3	20.81	1.65	9.2
Q5	24.48	0.76	6.7

Table B-7 Filters available at MIRLIN and calculated in-band flux for a zero magnitude-star. Note that not all filters have been used in this study.

Table B-7 lists relevant information for the filters available for MIRLIN. Table B-8 shows color correction factors evaluated by means of Eq 3-18 for black bodies temperatures between 100 and 550 K assuming a window function centered on λ_C and of width $\Delta\lambda$ for $T(\lambda)$.

λ_C (μm)	Black body temperature (K)									
	100	**150**	**200**	**250**	**300**	**350**	**400**	**450**	**500**	**550**
10.79	0.67	1.00	1.10	1.10	1.08	1.05	1.02	1.00	0.98	0.96
17.90	1.02	1.01	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.99
7.91	1.00	1.02	1.02	1.02	1.01	1.01	1.01	1.00	1.00	1.00
8.81	1.01	1.02	1.02	1.02	1.01	1.01	1.00	1.00	1.00	1.00
9.69	1.02	1.02	1.02	1.01	1.01	1.00	1.00	1.00	1.00	0.99
10.27	1.02	1.02	1.02	1.01	1.01	1.00	1.00	1.00	1.00	0.99
11.70	1.02	1.02	1.01	1.01	1.00	1.00	1.00	1.00	0.99	0.99
12.49	1.02	1.02	1.01	1.01	1.00	1.00	1.00	0.99	0.99	0.99
17.20	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
17.93	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
18.64	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
20.81	1.01	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.99
24.48	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table B-8 Color correction factors obtained for the selection of filters listed in Table B-7. A window function centered at λ_C and of width $\Delta\lambda$ was assumed for the filter transmission.

B.4 MIRSI filters and color correction factors

Table B-9 shows relevant filter parameters of MIRSI filters and relative color correction factors evaluated for black body temperatures between 100 and 550 K assuming a window function centered on λ_C and of width $\Delta\lambda$ for the filter transmission function.

λ_C	$\Delta\lambda$	Black body temperature (K)									
(μm)	(μm)	**100**	**150**	**200**	**250**	**300**	**350**	**400**	**450**	**500**	**550**
4.90	0.98	0.54	0.83	0.95	1.01	1.03	1.03	1.04	1.03	1.03	1.02
7.80	0.78	1.00	1.02	1.02	1.02	1.01	1.01	1.01	1.00	1.00	1.00
8.70	0.87	1.01	1.02	1.02	1.02	1.01	1.01	1.00	1.00	1.00	1.00
9.80	0.98	1.02	1.02	1.02	1.01	1.01	1.00	1.00	1.00	1.00	0.99
10.30	1.03	1.02	1.02	1.02	1.01	1.01	1.00	1.00	1.00	1.00	0.99
10.60	4.85	0.72	1.01	1.08	1.08	1.07	1.04	1.02	1.00	0.98	0.97
11.70	1.17	1.02	1.02	1.01	1.01	1.00	1.00	1.00	0.99	0.99	0.99
12.50	1.25	1.02	1.02	1.01	1.01	1.00	1.00	1.00	0.99	0.99	0.99
18.40	1.85	1.02	1.01	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.99
19.00	4.94	1.04	1.03	1.01	0.99	0.98	0.97	0.97	0.96	0.96	0.95
20.90	8.78	1.07	1.06	1.02	0.98	0.96	0.94	0.93	0.92	0.91	0.90

Table B-9 Color correction factors obtained for the filters available for MIRSI. A window function centered at λ_C and of width $\Delta\lambda$ was assumed for the filter transmission.

Since color corrections were found to be only a few percent for all the instruments that have been used in this study, they were not applied to correct the final monochromatic flux densities of the asteroids.