The extended mean extinction law

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Interstellar extinction

We apply the mean extinction law of Savage and Mathis (1979) to our data but we must extend it to longer wavelengths because we have to inspect our programme stars in an interval as broad as possible for stellar, circumstellar, and interstellar extinction and reemission of radiation which might affect the intrinsic spectra in the range $380 \lesssim \lambda[\mathrm{nm}] \lesssim 900$ (e.g., thermal reemission of radiation at longer wavelengths). Even though the interstellar extinction is low in the near-infrared, we must compute it in order to correct the near-infrared $(JHKLM)_{ESO}$ photometric data. The MIDAS table INSTEXNM (or INSTEXAN in cases where the wavelengths are expressed in [Å]) contains the $\frac{a_{ie}(\lambda)}{E_{B-V}}$s of Savage & Mathis (1979), Seaton (1979), and Howarth (1983). This table does not list data redward of 1090 [nm], so an extended version, called NEWINTEXNM.TBL, is used instead. The latter is based on the observed mean extinction law of Savage & Mathis (1979) and on the theoretical extinction law of Steenman and Thé (1989, 1991). This theoretical extinction law has been calculated for single scattering using an $n(a) \propto a^{-3.5}$ interstellar grain size distribution with a lower size cutoff of $a_- = 4$ [nm], an upper size cutoff of $a_+ = 220$ [nm], and a graphite abundance which is 1.12 times the silicate abundance (this gives the best fit to the Savage and Mathis $R = 3.1$ mean extinction law). The main features of the extinction law are tabulated in Table 1 (see also Draine and Lee, 1984).

The extended mean extinction law is computed for the spectral range $100 \leq \lambda[\mathrm{nm}] \leq 250000$. For $100 \leq \lambda[\mathrm{nm}] < 800$ we apply the mean observational extinction law, from 1000 [nm] up its theoretical extension, and within the interval $800 \leq \lambda[\mathrm{nm}] < 1000$ a smoothed transfer.

At short wavelengths, the extinction is mainly caused by the Mie-scattering of interstellar graphite and silicate, at longer wavelengths it is predominantly the result of the absorption by graphite and silicate. The results are displayed in Fig. 1 and listed in Table 2. The Johnson $(UB)_j$, the Cousins $(VRI)_c$ and the ESO $(JHKLMN)_{ESO}$ passbands are also indicated in Fig. 1.

In addition, there are faint 1) atomic absorption lines, 2) molecular absorption lines, 3) diffuse interstellar absorption bands and 4) diffuse recombination emission lines. Because of the relatively small distances of the programme stars we will neglect the influence of interstellar absorption lines and bands.

Usually, stellar spectra and colours are reddened by interstellar matter. Fig. 1 shows, however, that 1) IUE spectra are blued at shorter wavelengths and reddened at longer wavelengths, 2) there is a weak interstellar blueing present in the ESO $(L-N)$ and $(M-N)$ colours, and 3) an IRAS spectrum will be somewhat blued at its infrared end and reddened at its far-infrared end.

Table 1. Absorption and scattering by interstellar dust.

	spectral region [nm]	band centre [nm]
graphite particles	214 - 225	217.5
graphite resonance	6310 - 6500	6330
asymmetric Si -O stretch	8500 - 13000	9650
graphite resonance	11510 - 11530	11520
asymmetric Si -O stretch	15000 - 26000	18200

Data retrieval

The extended mean extinction law can be retrieved from the Strasbourg Astronomical Data Centre (CDS) by anonymous FTP from node 130.79.128.5, file pub/A+AS/105/311/table6.Z Reprints of this document can be accessed by WWW. Point your Web browser at the URL http://www.astro.uva.nl/fluks

References

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Howarth, I.D. 1983, MNRAS, 203, 301
Savage, B.D., and Mathis, J.S. 1979, ARA&A, 17, 73
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Table 2. The extended mean extinction law. A: the observations; B: the overlap between obvervations and theory; and C: the theoretical extension.

λ [nm]	$\frac{a_{ie}(\lambda)}{E_{B-V}}$	λ [nm]	$\frac{a_{ie}(\lambda)}{E_{B-V}}$	λ [nm]	$\frac{a_{ie}(\lambda)}{E_{B-V}}$	λ [nm]	$\frac{a_{ie}(\lambda)}{E_{B-V}}$	λ [nm]	$\frac{a_{ie}(\lambda)}{E_{B-V}}$	λ [nm]	$\frac{a_{ie}(\lambda)}{E_{B-V}}$	λ [nm]	$\frac{a_{ie}(\lambda)}{E_{B-V}}$
A:				C:									
100	14.400	540	3.169	1000	1.229	3900	0.079	7000	0.035	11450	0.105	19000	0.069
110	11.729	550	3.096	1020	1.187	4000	0.076	7100	0.034	11500	0.104	19200	0.068
120	10.197	560	3.029	1040	1.144	4100	0.073	7200	0.034	11510	0.109	19400	0.067
130	9.198	570	2.966	1060	1.102	4200	0.070	7300	0.034	11515	0.117	19600	0.066
140	8.447	580	2.905	1080	1.062	4300	0.067	7400	0.034	11520	0.126	19800	0.065
150	8.136	590	2.848	1100	1.025	4400	0.064	7500	0.035	11525	0.114	20000	0.064
160	8.120	600	2.792	1120	0.991	4500	0.062	7600	0.039	11530	0.105	22000	0.053
170	7.871	610	2.739	1140	0.958	4600	0.060	7700	0.043	11540	0.100	24000	0.046
180	7.751	620	2.688	1160	0.927	4700	0.058	7800	0.048	11550	0.099	26000	0.040
190	7.995	630	2.639	1180	0.897	4800	0.056	7900	0.053	11600	0.097	28000	0.036
200	8.620	640	2.591	1200	0.867	4900	0.055	8000	0.060	11650	0.095	30000	0.032
210	9.325	650	2.544	1220	0.839	5000	0.053	8100	0.068	11700	0.094	32000	0.029
215	9.612	660	2.498	1240	0.812	5100	0.051	8200	0.076	11800	0.090	34000	0.026
217	9.675	670	2.452	1260	0.786	5200	0.050	8300	0.086	11900	0.087	36000	0.024
218	9.681	680	2.407	1280	0.762	5300	0.048	8400	0.096	12000	0.084	38000	0.023
219	9.666	690	2.362	1300	0.739	5400	0.047	8500	0.105	12200	0.078	40000	0.021
220	9.632	700	2.317	1320	0.717	5500	0.046	8600	0.114	12400	0.073	42000	0.019
225	9.293	710	2.271	1340	0.699	5600	0.045	8700	0.124	12600	0.068	44000	0.018
230	8.861	720	2.225	1360	0.677	5700	0.044	8800	0.134	12800	0.063	46000	0.016
240	7.985	730	2.179	1380	0.657	5800	0.043	8900	0.143	13000	0.059	48000	0.016
250	7.290	740	2.132	1400	0.637	5900	0.043	9000	0.152	13200	0.055	50000	0.015
260	6.762	750	2.086	1420	0.618	6000	0.042	9100	0.159	13400	0.052	52000	0.014
270	6.322	760	2.040	1440	0.600	6100	0.041	9200	0.167	13600	0.049	54000	0.012
280	6.051	770	1.995	1460	0.583	6200	0.040	9300	0.174	13800	0.046	56000	0.012
290	5.823	780	1.950	1480	0.566	6300	0.038	9400	0.180	14000	0.045	58000	0.011
300	5.618	790	1.906	1500	0.551	6310	0.037	9500	0.184	14200	0.045	60000	0.011
310	5.431			1600	0.479	6320	0.038	9600	0.187	14400	0.045	62000	0.010
320	5.260			1700	0.418	6330	0.038	9700	0.187	14600	0.047	64000	0.010
330	5.101	B:		1800	0.368	6340	0.038	9800	0.184	14800	0.049	66000	0.009
340	4.952	800	1.862	1900	0.327	6350	0.038	9900	0.181	15000	0.050	68000	0.008
350	4.816	810	1.818	2000	0.292	6360	0.038	10000	0.176	15200	0.051	70000	0.008
360	4.708	820	1.775	2100	0.262	6370	0.038	10100	0.171	15400	0.053	72000	0.008
370	4.622	830	1.734	2200	0.237	6380	0.038	10200	0.166	15600	0.055	74000	0.007
380	4.548	840	1.694	2300	0.215	6390	0.038	10300	0.161	15800	0.056	76000	0.007
390	4.477	850	1.657	2400	0.197	6400	0.038	10400	0.155	16000	0.058	78000	0.006
400	4.400	860	1.621	2500	0.181	6410	0.038	10500	0.150	16200	0.060	80000	0.006
410	4.324	870	1.587	2600	0.168	6420	0.038	10600	0.145	16400	0.061	82000	0.006
420	4.254	880	1.554	2700	0.156	6430	0.038	10700	0.139	16600	0.063	84000	0.006
430	4.184	890	1.523	2800	0.145	6440	0.038	10800	0.133	16800	0.065	86000	0.005
440	4.105	900	1.493	2900	0.136	6450	0.038	10900	0.127	17000	0.066	88000	0.005
450	4.015	910	1.465	3000	0.127	6460	0.038	11000	0.122	17200	0.067	90000	0.005
460	3.921	920	1.437	3100	0.119	6470	0.038	11050	0.120	17400	0.069	92000	0.005
470	3.824	930	1.409	3200	0.112	6480	0.038	11100	0.118	17600	0.070	94000	0.005
480	3.724	940	1.382	3300	0.106	6490	0.038	11150	0.116	17800	0.070	96000	0.004
490	3.625	950	1.356	3400	0.100	6500	0.038	11200	0.114	18000	0.071	98000	0.004
500	3.526	960	1.330	3500	0.095	6600	0.037	11250	0.113	18200	0.071	100000	0.004
510	3.430	970	1.304	3600	0.091	6700	0.037	11300	0.110	18400	0.071	150000	0.002
520	3.337	980	1.279	3700	0.086	6800	0.036	11350	0.108	18600	0.070	200000	0.001
530	3.250	990	1.254	3800	0.082	6900	0.035	11400	0.107	18800	0.070	250000	0.001

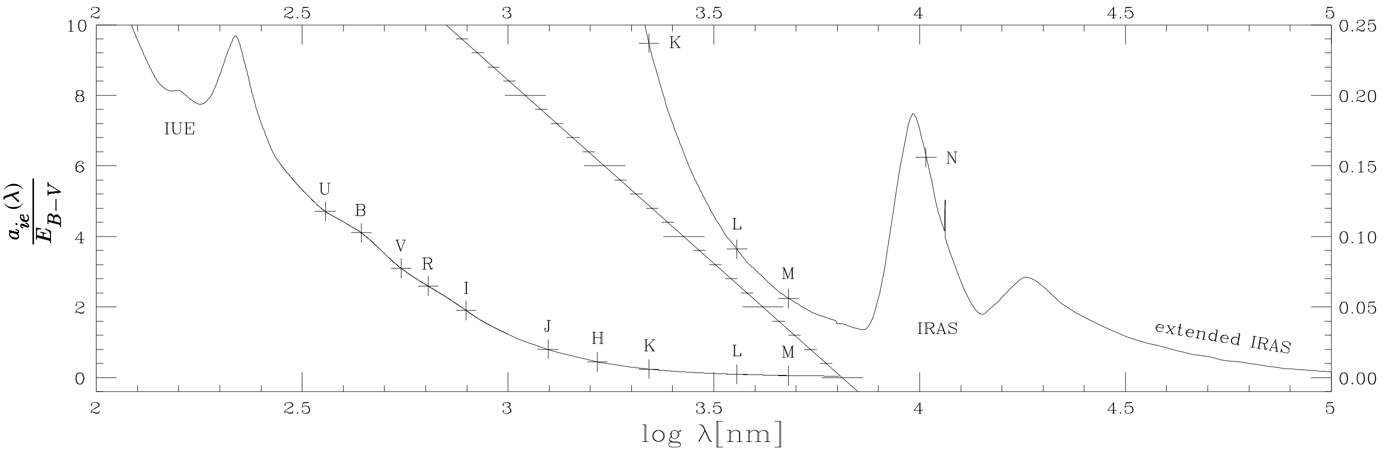

Fig. 1. The extended mean interstellar extinction law, based on the Savage and Mathis (1979) data, and its theoretical extension (Steenman and Thé 1989, 1991)