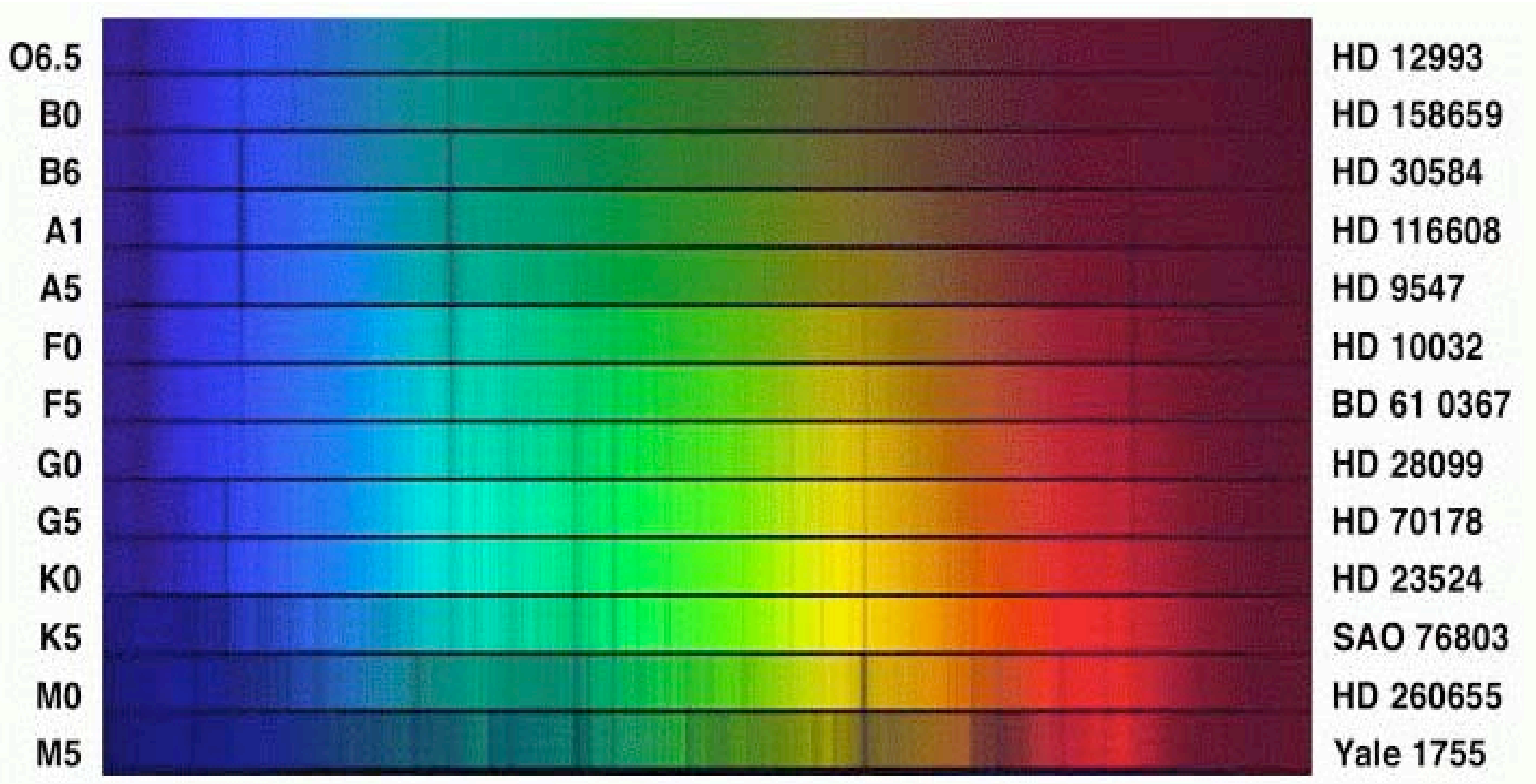
SPECTRAL CLASSIFICATION



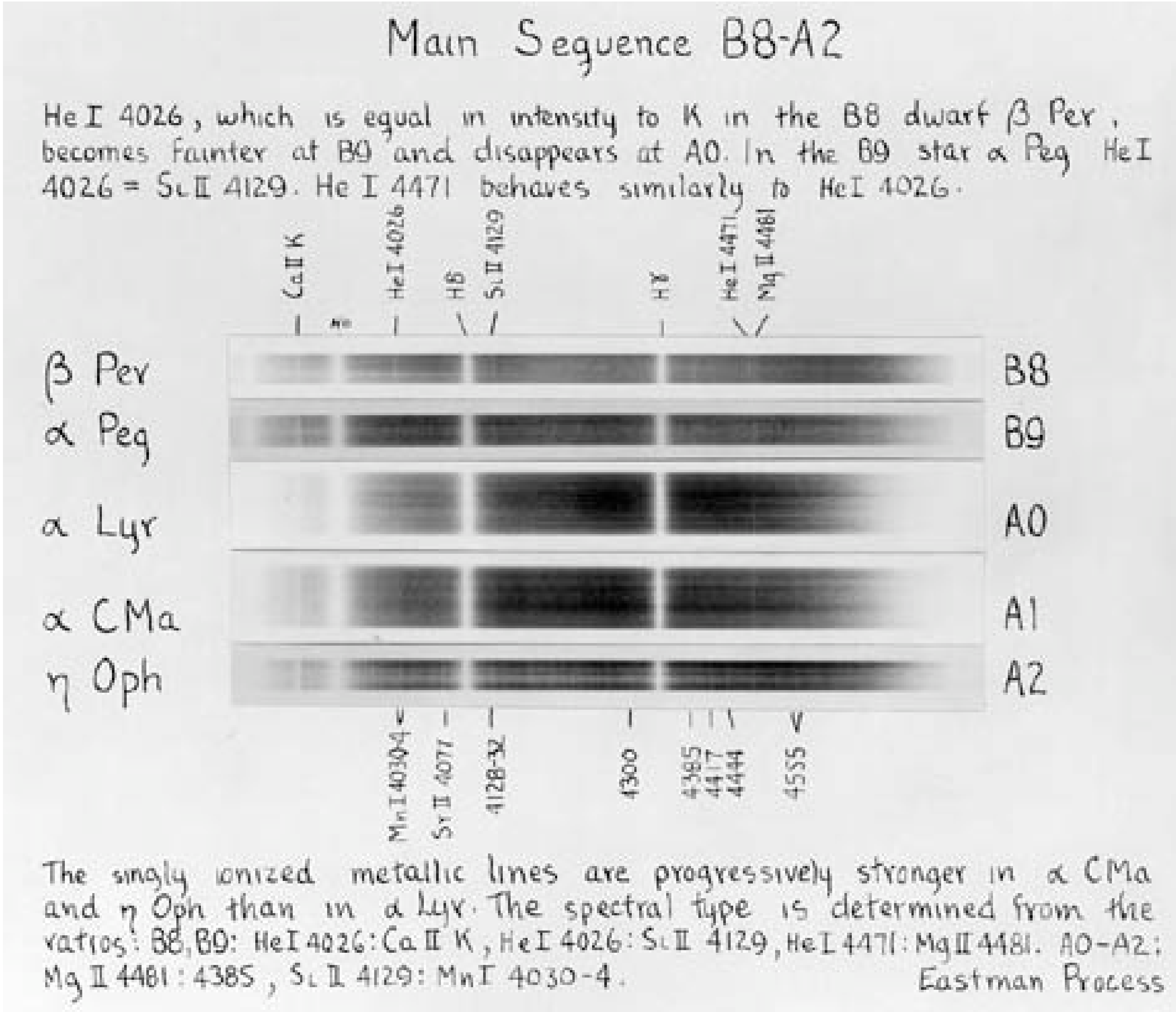
http://spiff.rit.edu/classes/phys440/lectures/spec_class/spec_class.html

The standard correlations with spectral class

Type	Color	Approximate Surface Temperature	Main Characteristics	Examples
O	Blue	> 25,000 K	Singly ionized helium lines either in emission or absorption. Strong ultraviolet continuum.	10 Lacertra
B	Blue	11,000 - 25,000	Neutral helium lines in absorption.	Rigel Spica
A	Blue	7,500 - 11,000	Hydrogen lines at maximum strength for A0 stars, decreasing thereafter.	Sirius Vega
F	Blue to White	6,000 - 7,500	Metallic lines become noticeable.	Canopus Procyon
G	White to Yellow	5,000 - 6,000	Solar-type spectra. Absorption lines of neutral metallic atoms and ions (e.g. once-ionized calcium) grow in strength.	Sun Capella
K	Orange to Red	3,500 - 5,000	Metallic lines dominate. Weak blue continuum.	Arcturus Aldebaran
M	Red	< 3,500	Molecular bands of titanium oxide noticeable.	Betelgeuse Antares

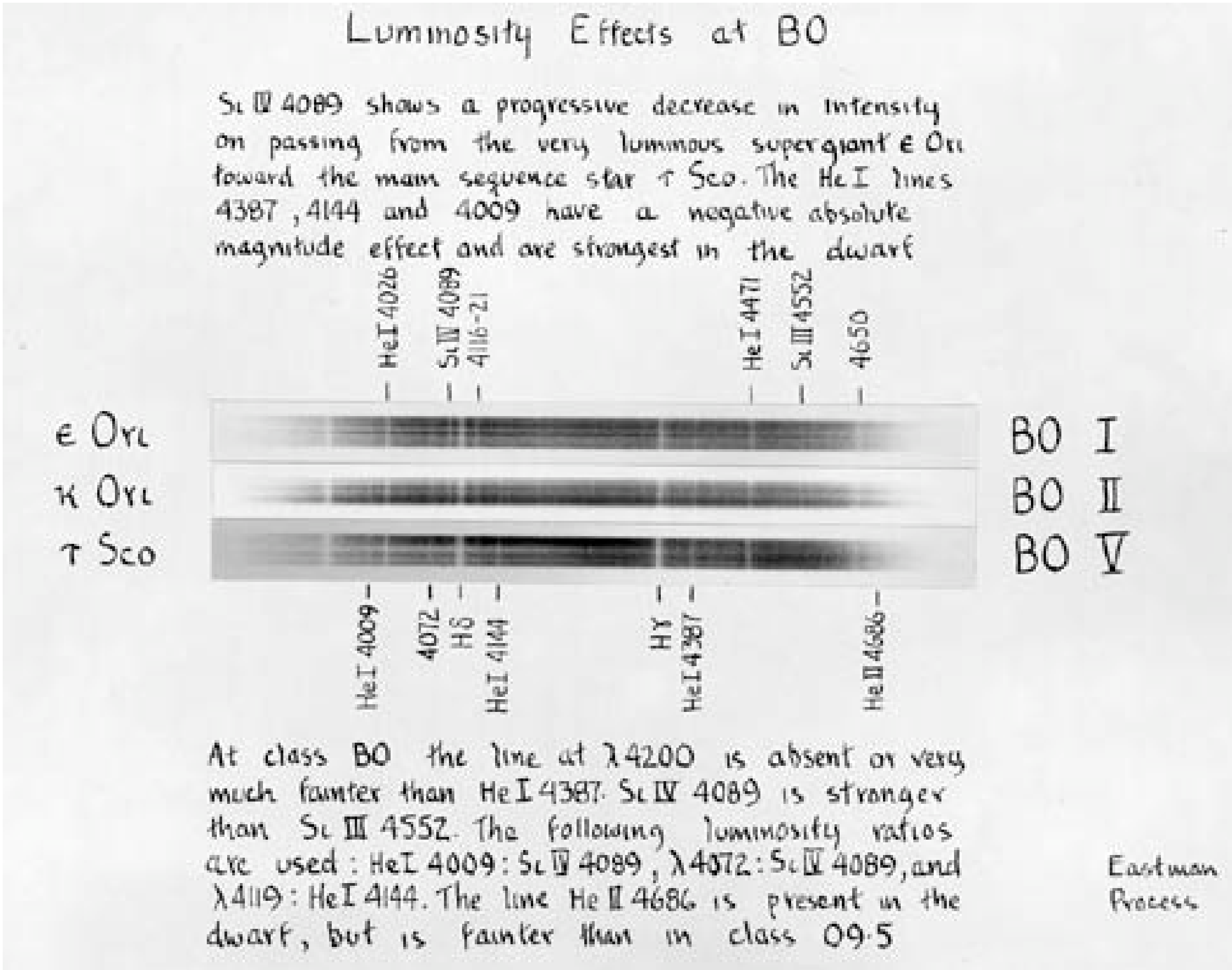
http://www.shef.ac.uk/physics/people/pacrowther/spectral_classification.html

Temperature effects are obvious



http://nedwww.ipac.caltech.edu/level5/ASS_Atlas/MK_contents.html

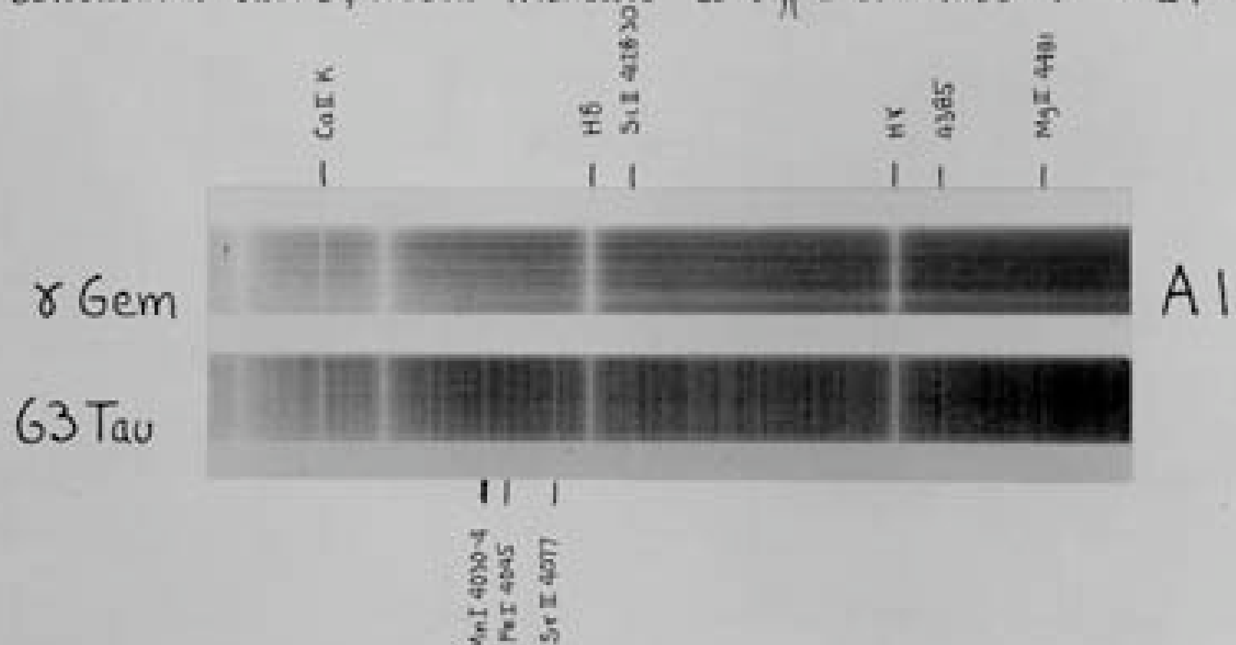
Luminoisty effects are subtle



Spectral pecularities

The "Metallic-Line Star" 63 Tauri

The K line in the spectrum of 63 Tauri has about the same intensity as in γ Geminorum (HD A0). The spectrum of the former is, however, filled with strong metallic lines which, when considered alone, would indicate a type of class F. If the



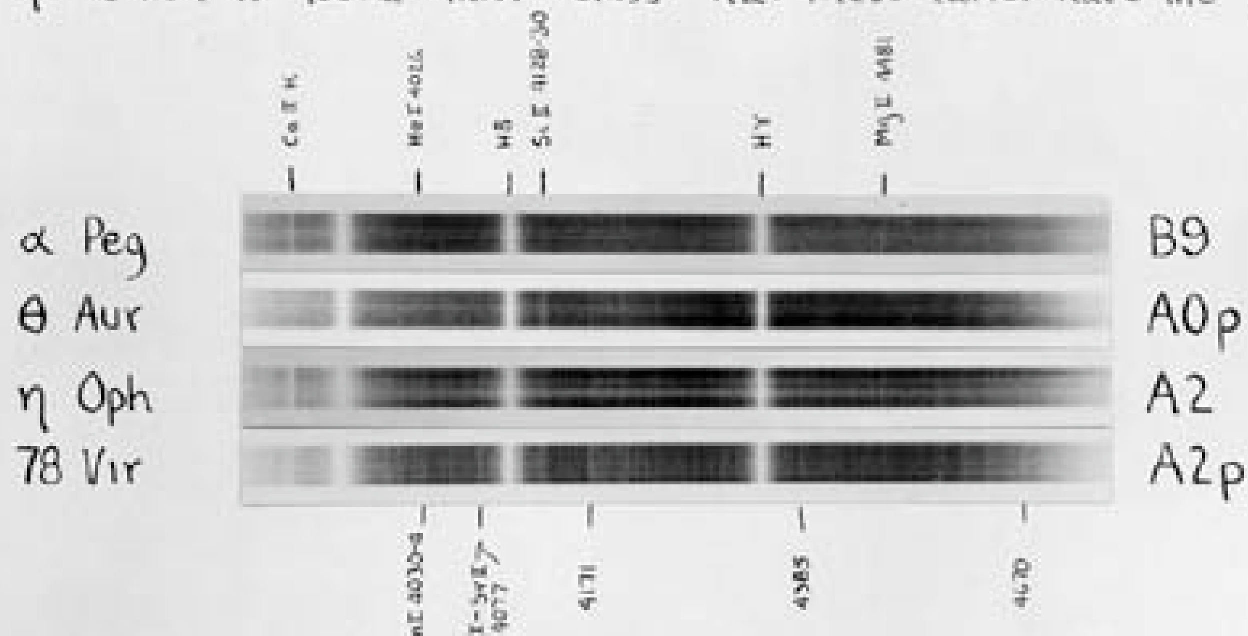
criteria of the present atlas are used a spectral type of around F2 is indicated. There is some evidence that the line ratios suggested here give a more accurate temperature classification than those using the K line. The latter appears to behave erratically in a number of A-stars. The number of "metallic-line stars" may be large, and their classification presents an important problem. For 63 Tau, M = +2·8.

Eastman Panatomic-X Film

Spectral peculiarities

Two Peculiar A Stars

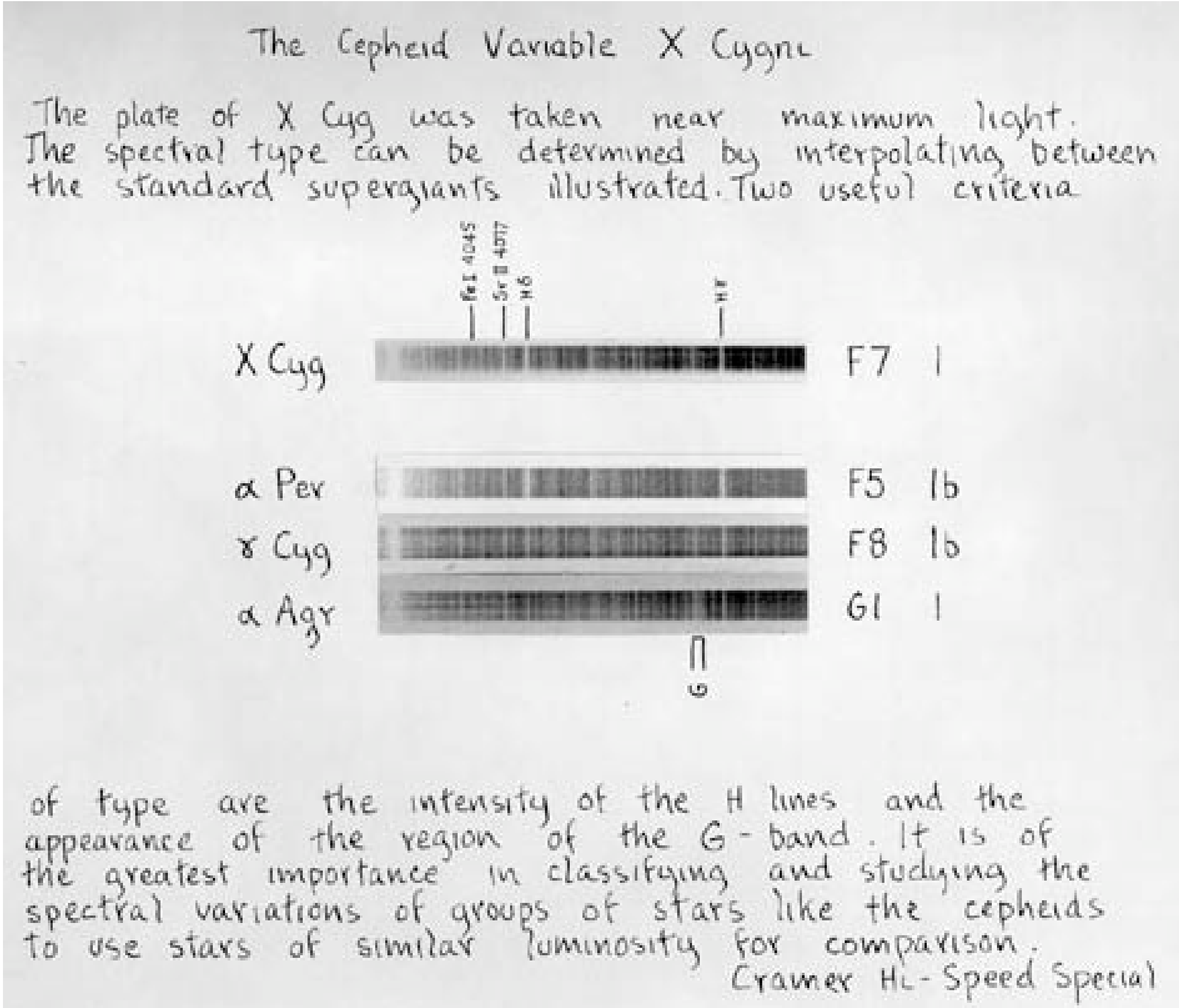
θ Aur is typical of the "silicon stars". The Si II blend at λ 4128-30 is very strong and the K line of Ca II is abnormally weak for the spectral type. The star 78 Vir is a member of the "chromium-europium group" which is found near class A2. These latter have the following



characteristics: strong lines of Cr II and Eu II, abnormally weak K-line and a tendency toward variability in the spectral lines in the case of some of the stars. The Si II lines are weak in general in this class; the strong feature near λ 4130 in 78 Vir is not due principally to Si II. The Sr II lines are strong in certain members. On low dispersion the characteristic feature of this group of stars is the blend near λ 4171; with higher dispersion it is seen to be composed of a number of fainter lines.

Eastman Process

Variable stars

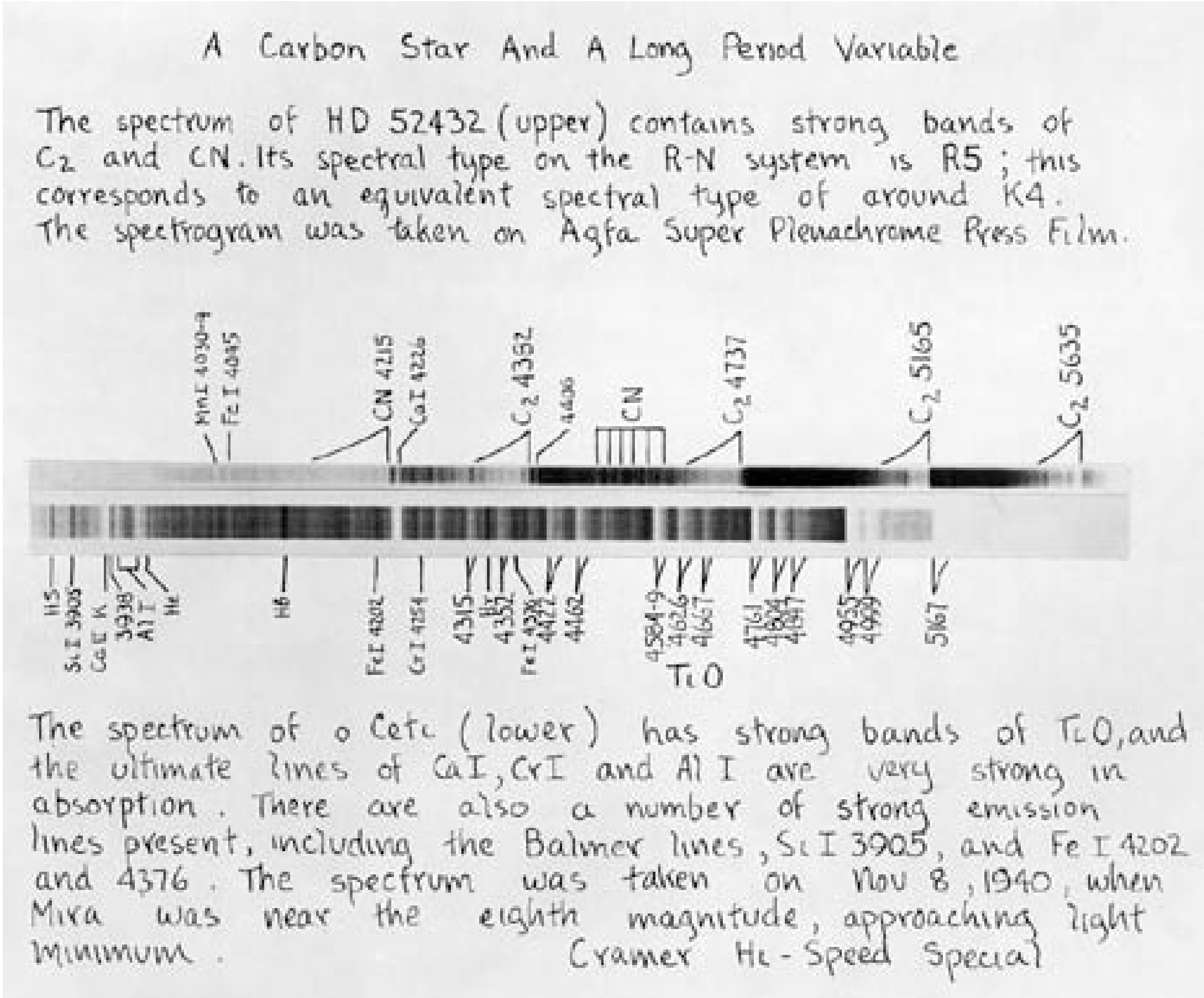


The Cepheid Variable X Cygni

The plate of X Cyg was taken near maximum light. The spectral type can be determined by interpolating between the standard supergiants illustrated. Two useful criteria of type are the intensity of the H lines and the appearance of the region of the G-band. It is of the greatest importance in classifying and studying the spectral variations of groups of stars like the cepheids to use stars of similar luminosity for comparison.

Cramer Hi-Speed Special

Abundance effects in cool stars



Electronic low-res spectral library

A Stellar Spectral Flux Library, 1150 -- 25000 A (A.J. Pickles, PASP 110, 863, 1998)

UVILIB and UVKLIB spectral libraries

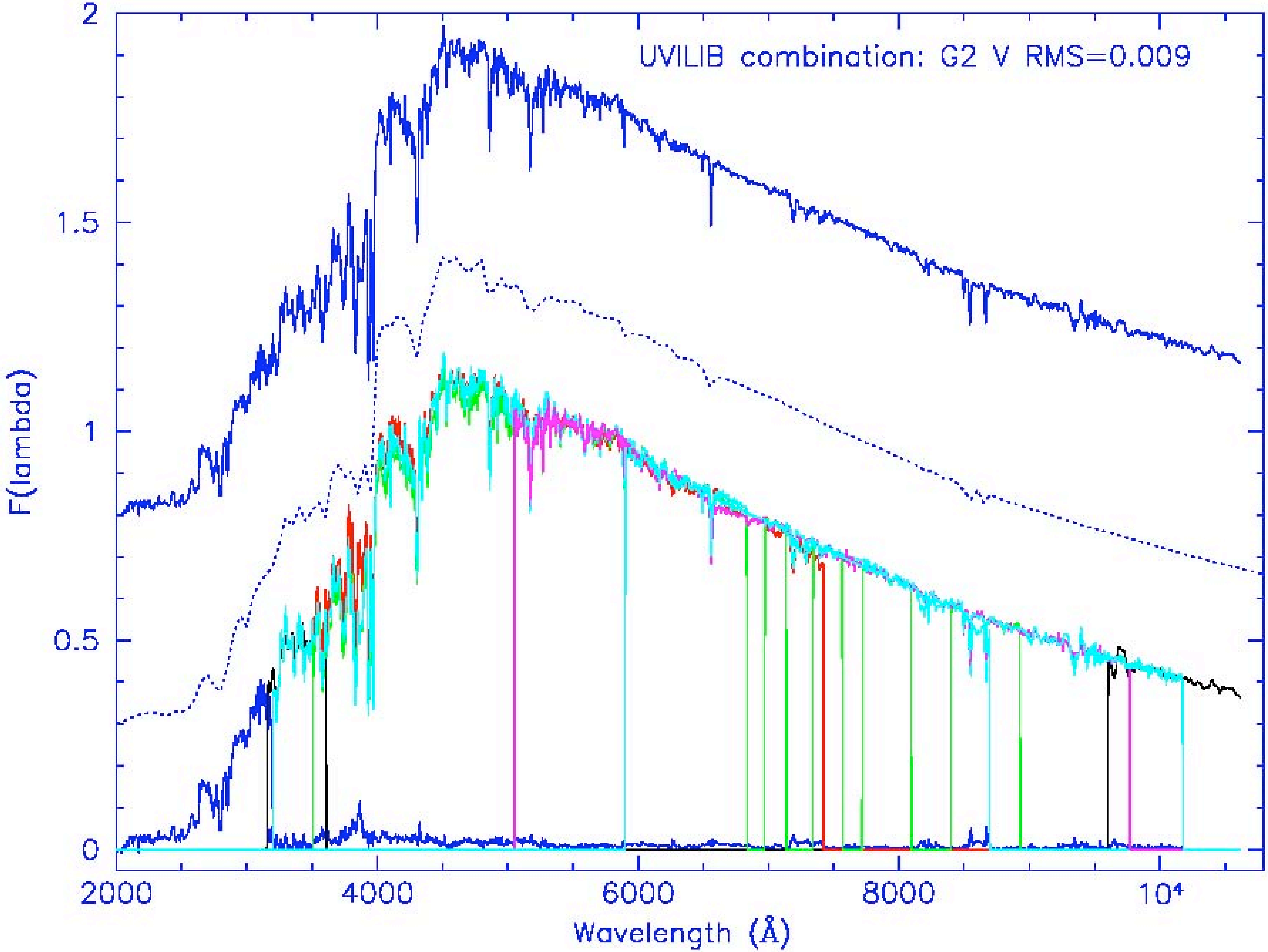
The pdf Paper and (compressed tar) Spectral libraries are available
- Select with Right mouse button to save file (as link) to local disk.

- README.HILIB   ReadMe file descriptions.
- hilib.pdf   Pdf manuscript, 2 tables, refs + 8 figures (0.5Mb)
- fig8.pdf   Emergent spectrum from solar abundance, 5 Gyr, single burst stellar population
- uvilib.tar.gz   131 spectra, 1150--10620 Angstrom (3.8Mb)
- uvklib.tar.gz   131 spectra, 1150--25000 Angstrom (6.6Mb)

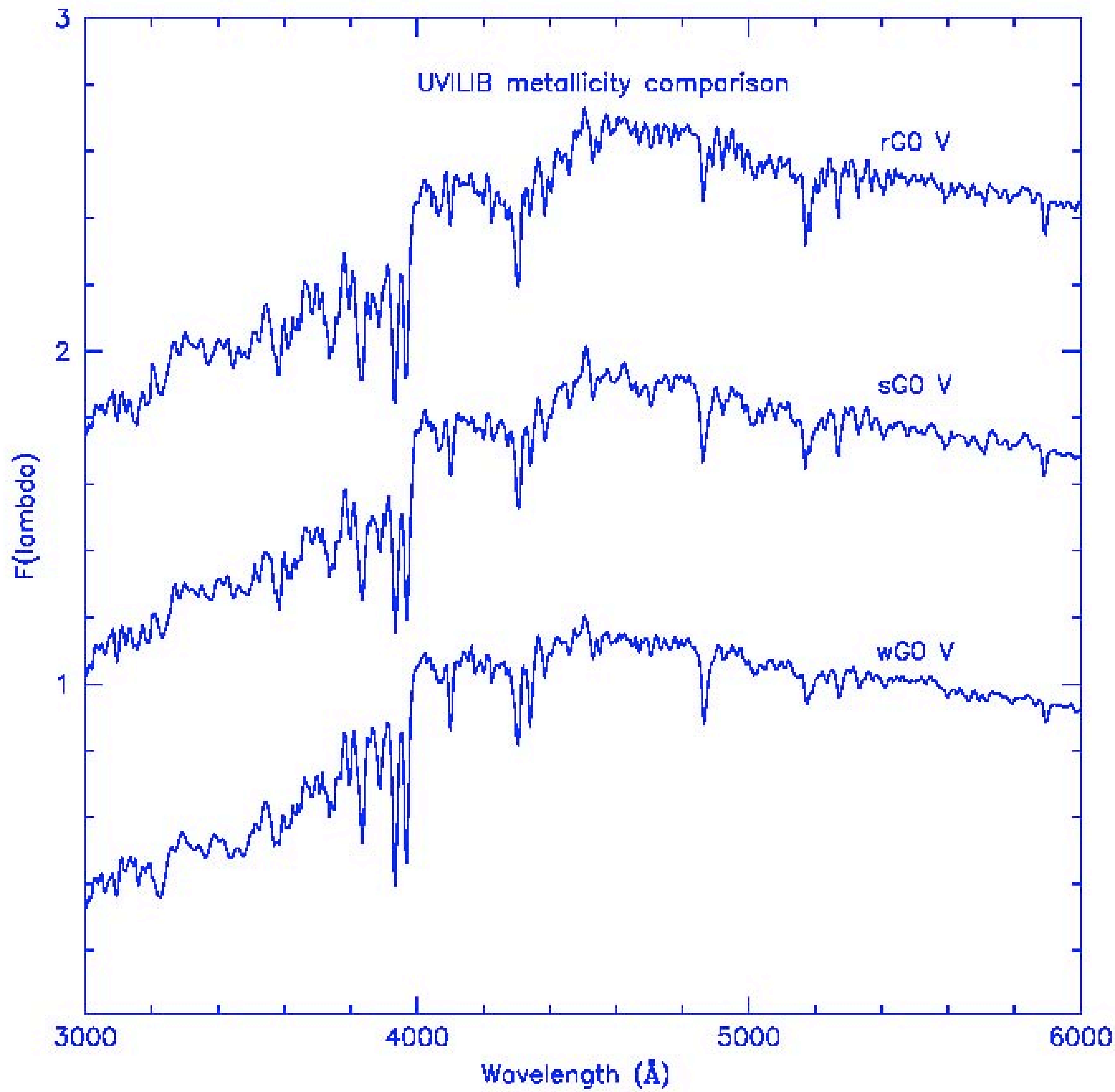
The Data tables are available as text files
- Select with Right mouse button to save file (as link) to local disk.

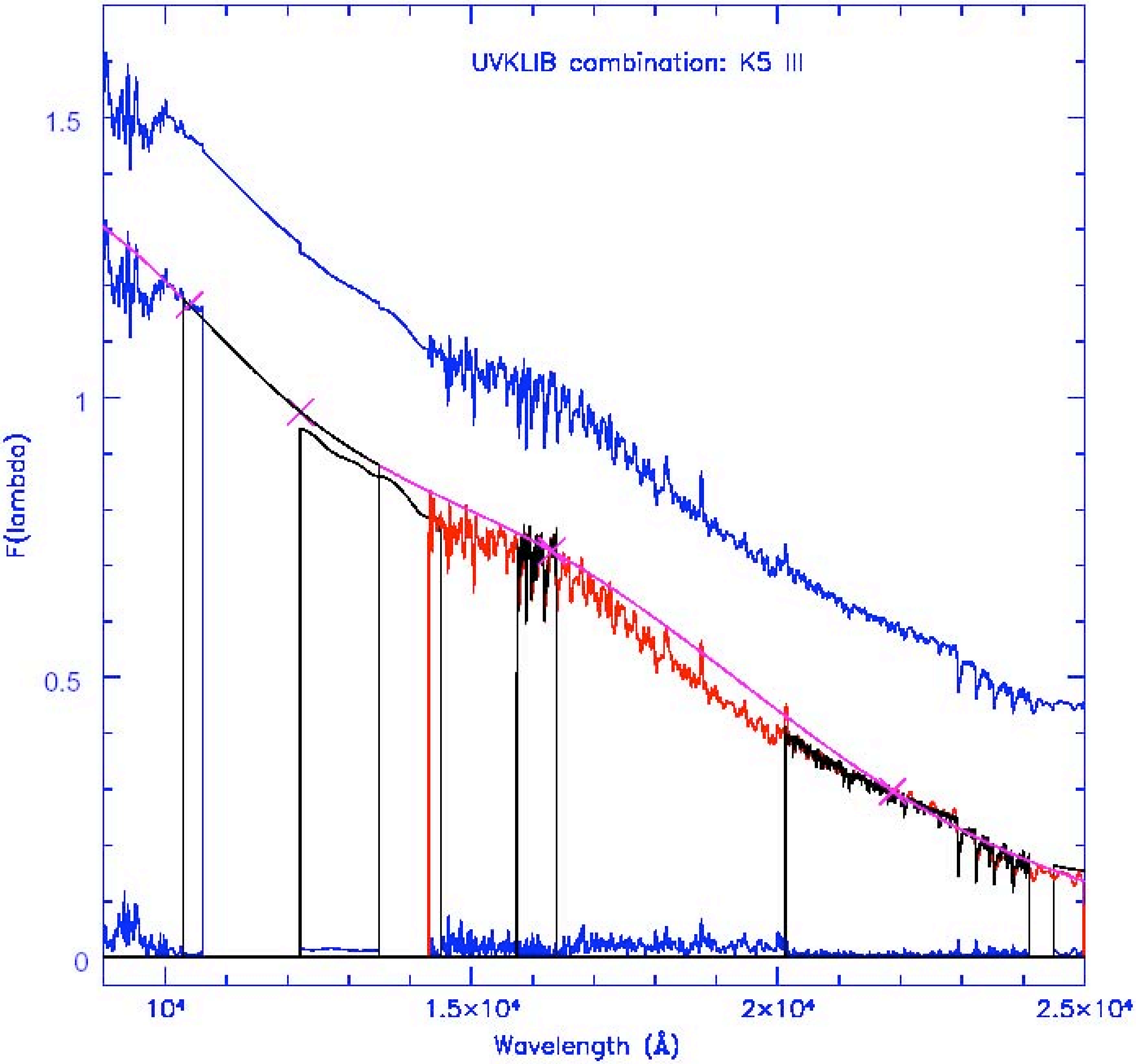
- tbl1_source.txt   Parameter summary for uv-ir digital spectral libraries.
- tbl2_comp.txt   Component summary, optical/ir photometry, bolometric corrections, combination errors.
- tbl3_sources.txt   Sources, names and types of spectra used for each library component.
- tbl4_lines.txt   Feature Bandpasses used for local equivalent widths and Magnitude indeces.
- tbl5_lew.txt   Measured LEW and magnitude indeces.
- tbl6_irstdphot.txt   Standard infrared type colors.
- tbl7_uifilt.txt   Optical filter transmission profiles.
- tbl8_jmfilt.txt   Infrared filter transmission profiles.
- hilib_tbl.tar   Tar file of 8 tables.

http://www.ifa.hawaii.edu/users/pickles/AJP/hilib.html

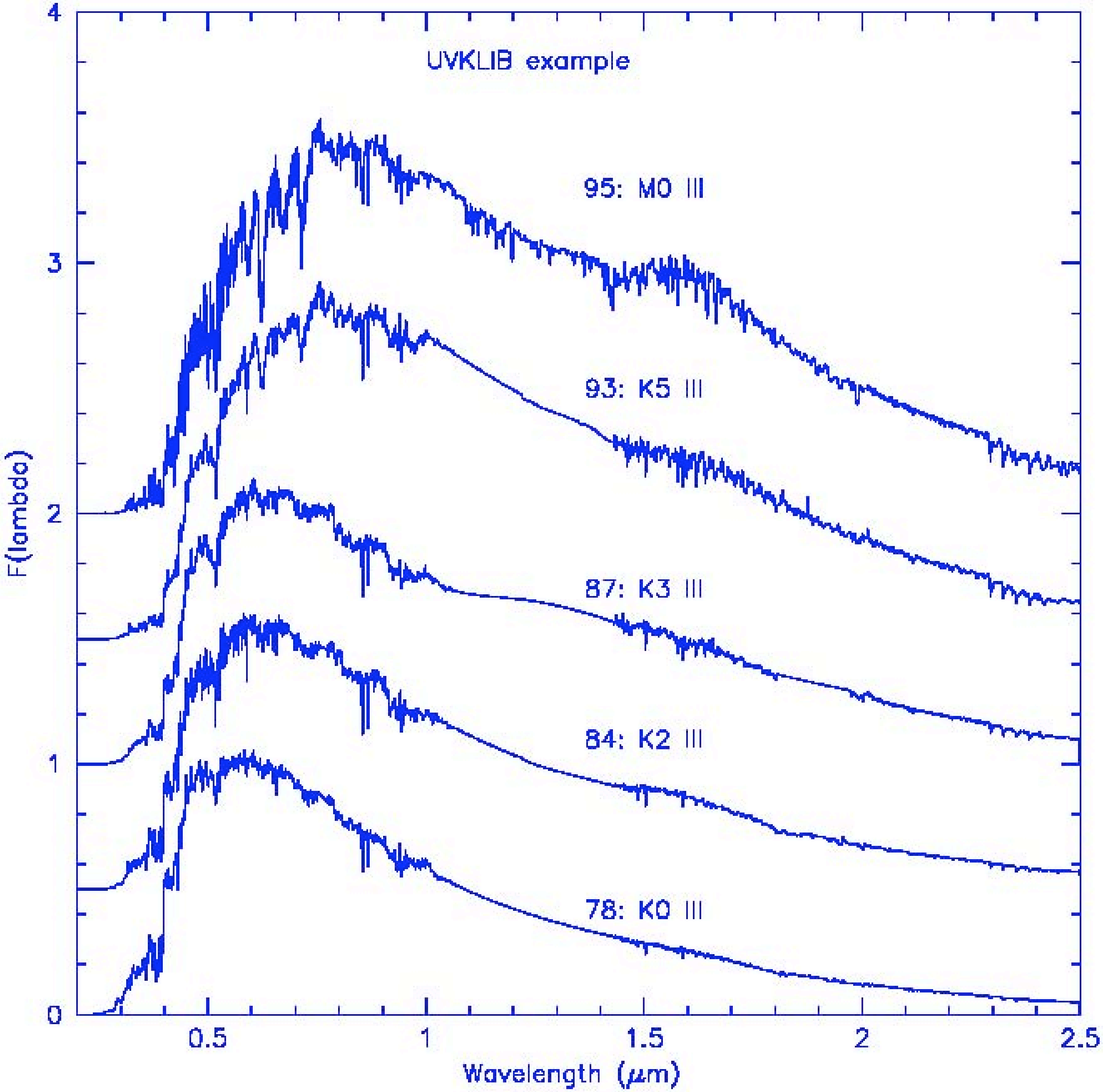


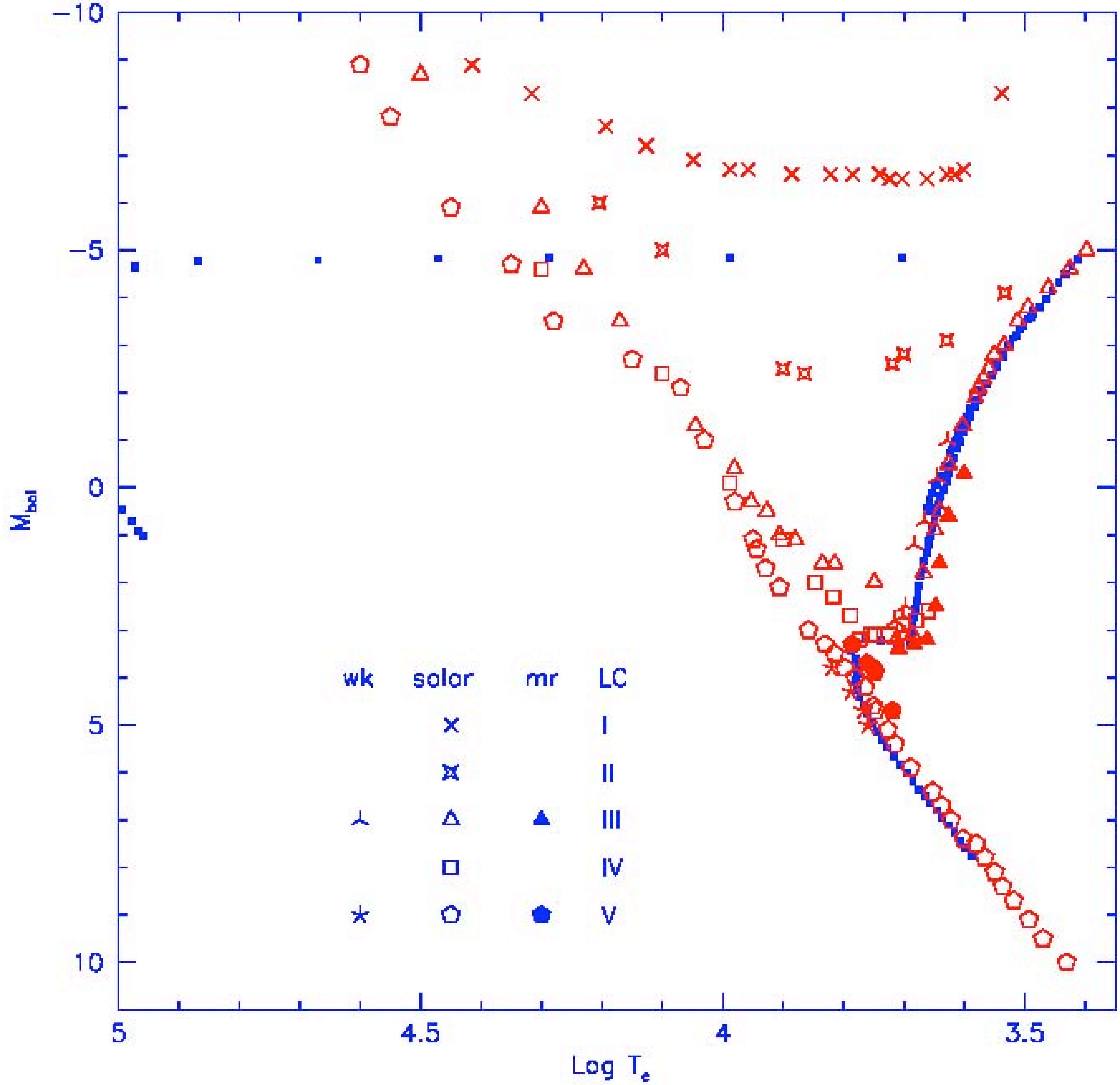
UVILIB combination: G2 V RMS=0.009
F(lambda)
Wavelength (Å)
2000
4000
6000
8000
10^4
0
0.5
1
1.5
2


UVILIB metallicity comparison
rG0 V
sG0 V
wG0 V
F(lambda)
3
2
1
3000
4000
5000
6000
Wavelength (Å)

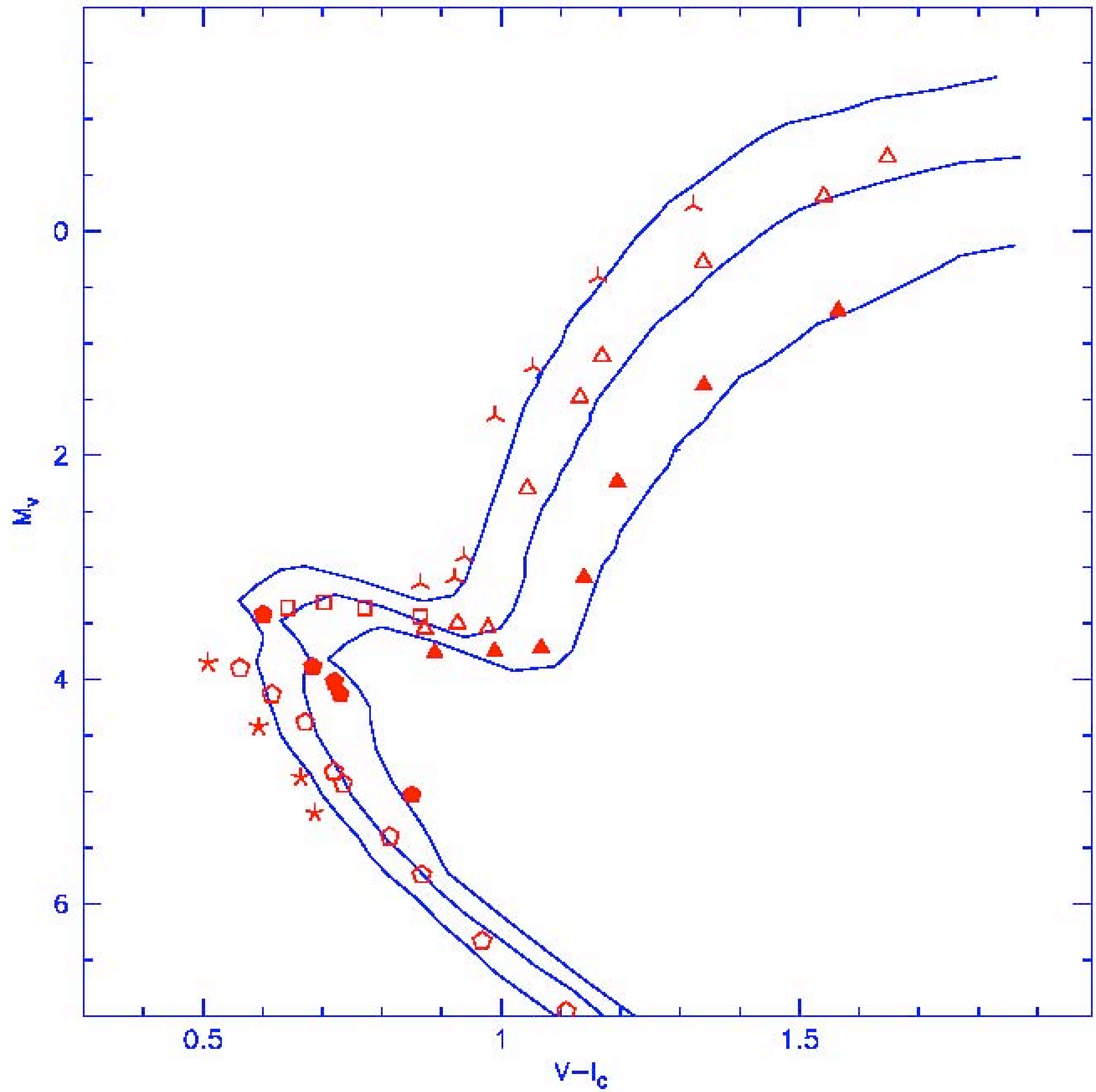


UVKLIB combination: K5 III
F(lambda)
Wavelength (Å)
0
0.5
1
1.5
10⁴
1.5×10⁴
2×10⁴
2.5×10⁴

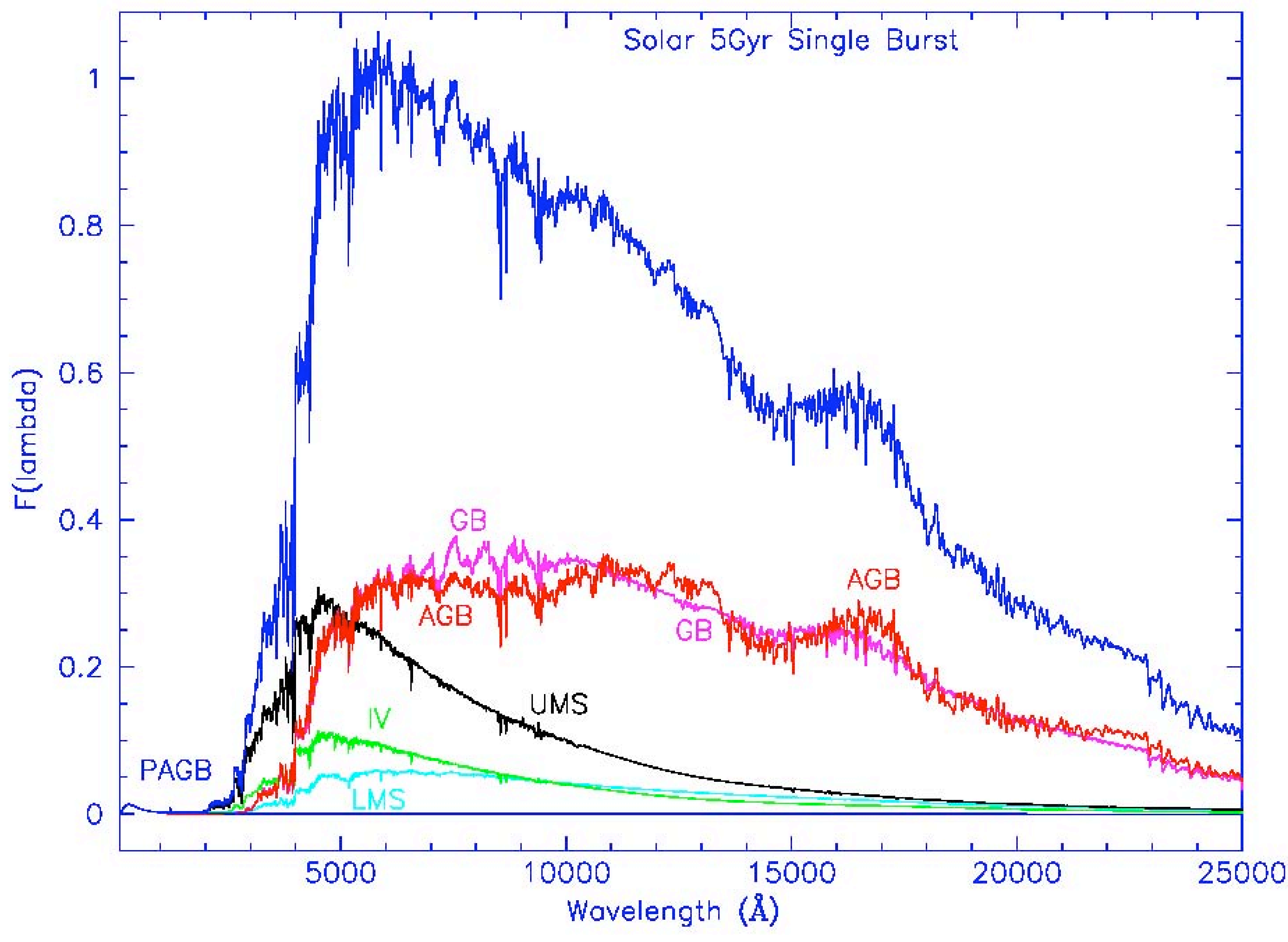

UVKLIB example
95: M0 III
93: K5 III
87: K3 III
84: K2 III
78: K0 III
F(lambda)
Wavelength (μm)
0
1
2
3
4
0.5
1
1.5
2
2.5



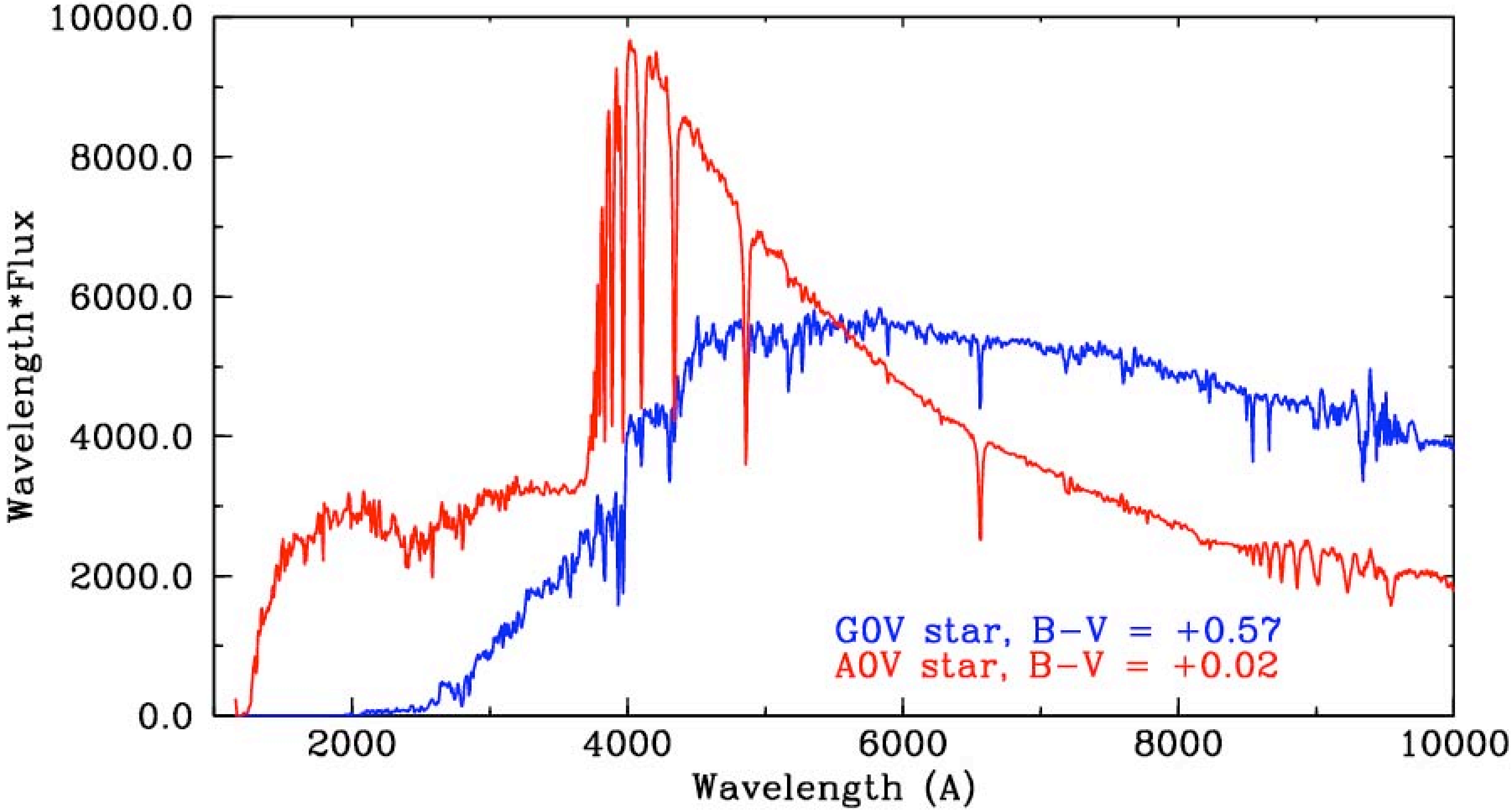
-10
-5
0
5
10
M_bol
5
4.5
4
3.5
Log T_e
wk
solar
mr
LC
I
II
III
IV
V



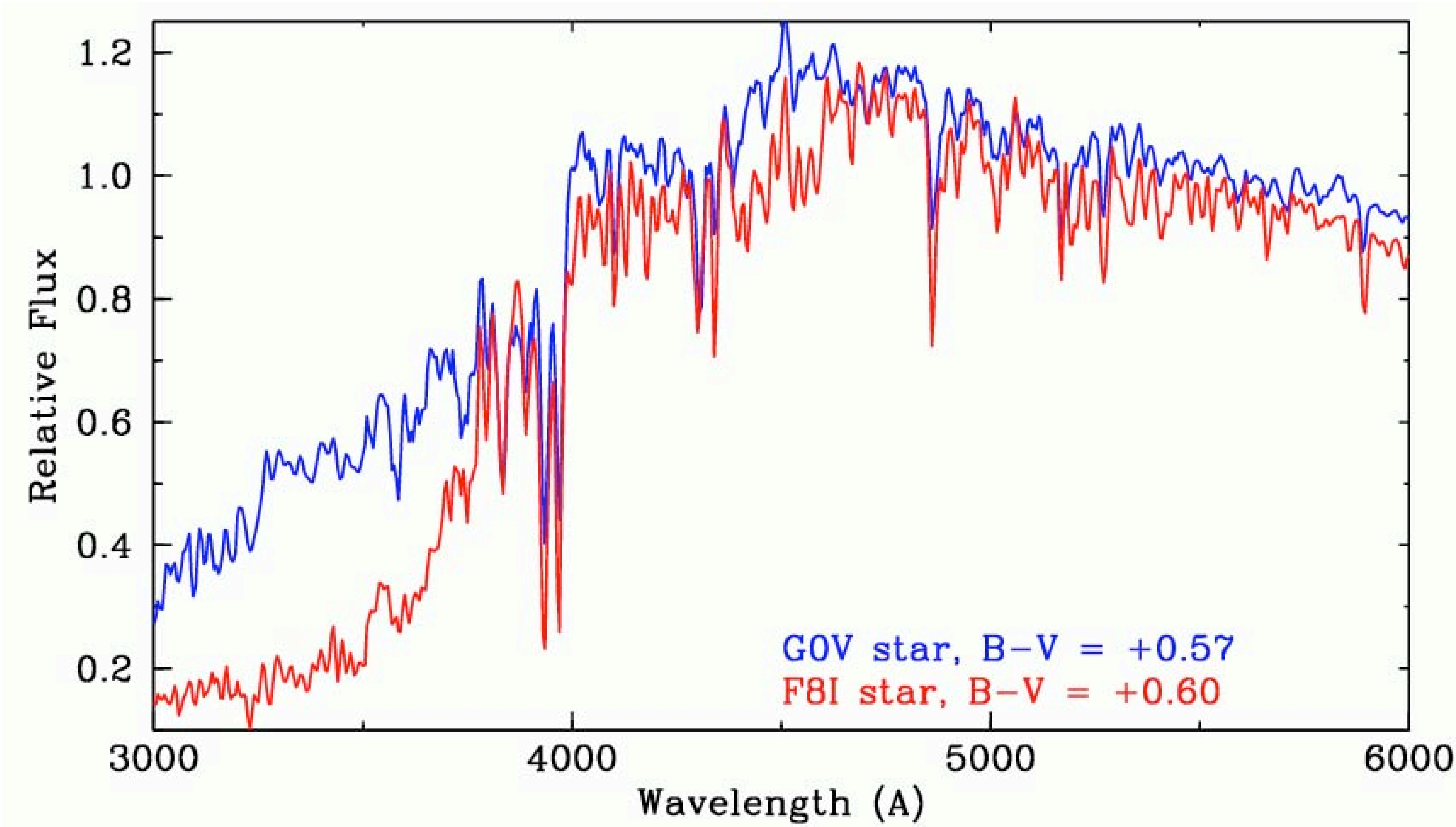
0
2
4
6
M_V
0.5
1
1.5
$V-I_C$



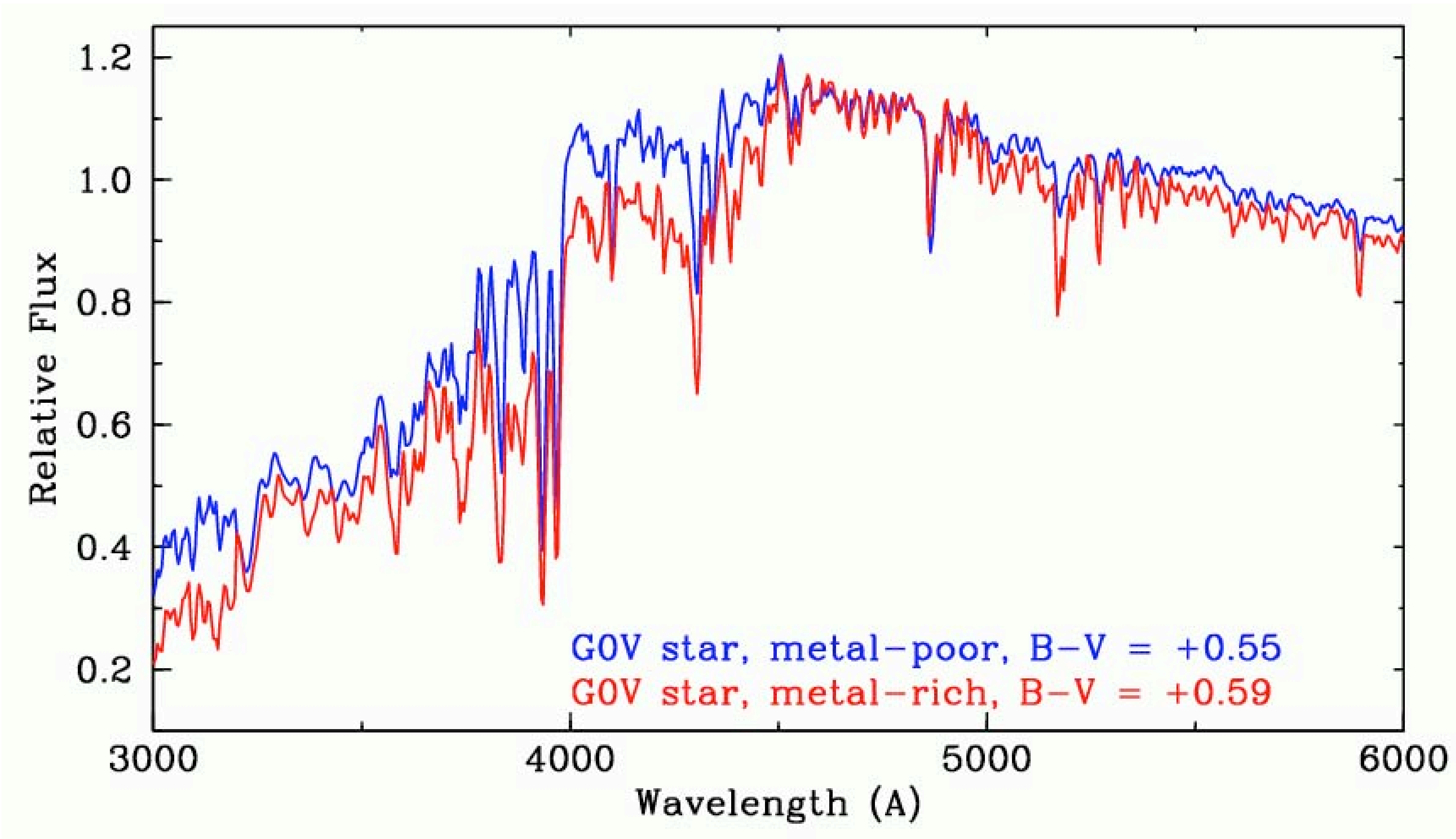
Solar 5Gyr Single Burst
F(lambda)
Wavelength (Å)
0
0.2
0.4
0.6
0.8
1
5000
10000
15000
20000
25000
GB
AGB
AGB
GB
UMS
IV
PAGB
LMS



10000.0
8000.0
6000.0
4000.0
2000.0
0.0
2000
4000
6000
8000
10000
Wavelength (A)
Wavelength*Flux
G0V star, B−V = +0.57
A0V star, B−V = +0.02



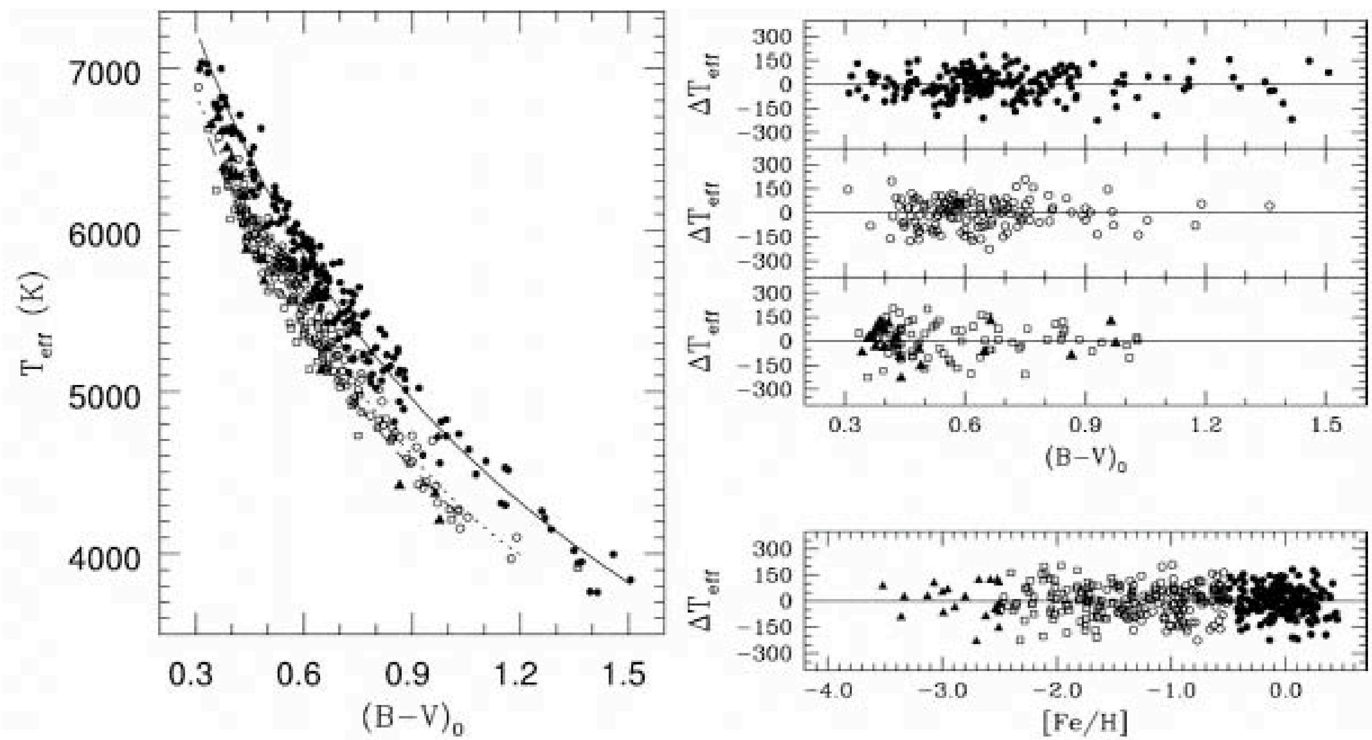
G0V star, B−V = +0.57
F8I star, B−V = +0.60
Relative Flux
Wavelength (A)
0.2
0.4
0.6
0.8
1.0
1.2
3000
4000
5000
6000



Relative Flux
1.2
1.0
0.8
0.6
0.4
0.2
3000
4000
5000
6000
Wavelength (A)
G0V star, metal-poor, B−V = +0.55
G0V star, metal-rich, B−V = +0.59

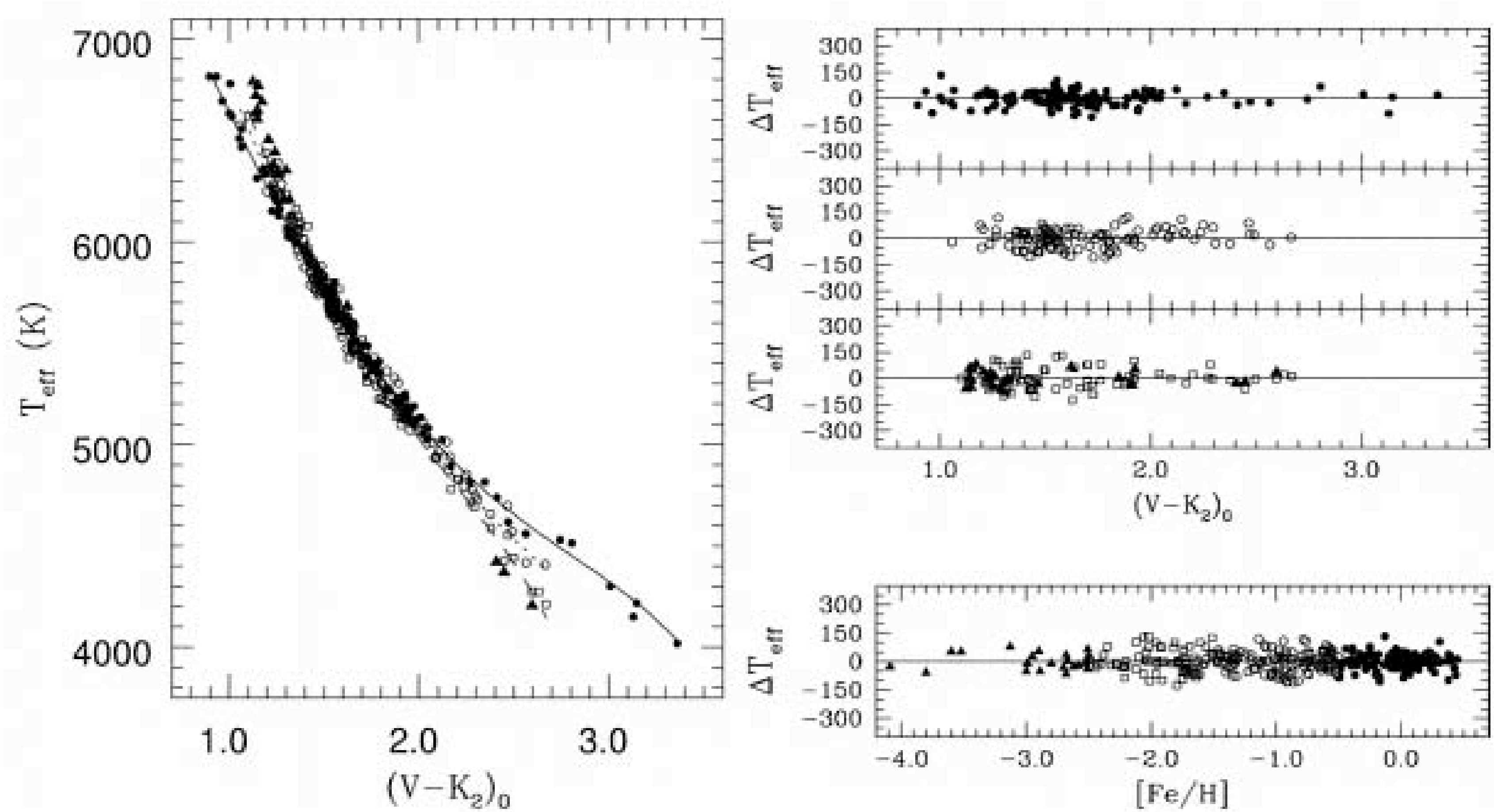
Broad-band photometry and temperatures: dwarf stars (V:)

Left: $T_{\rm eff}$ vs. $(B - V)$ observed for dwarfs in the metallicity bins $-0.5 < [\rm Fe/H] \leq +0.5$ (*filled circles*), $-1.5 < [\rm Fe/H] \leq -0.5$ (*open circles*), $-2.5 < [\rm Fe/H] \leq -1.5$ (*squares*), and $[\rm Fe/H] \leq -2.5$ (*triangles*). The lines corresponding to our calibration for [Fe/H] = 0.0 (*solid line*), -1.0 (*dotted line*), and -2.0 (*dashed line*) are also shown. *Right*: Residuals of the fit ($\Delta T_{\rm eff} = T_{\rm eff}^{\rm IRFM} - T_{\rm eff}^{\rm cal}$) as a function of color and [Fe/H].

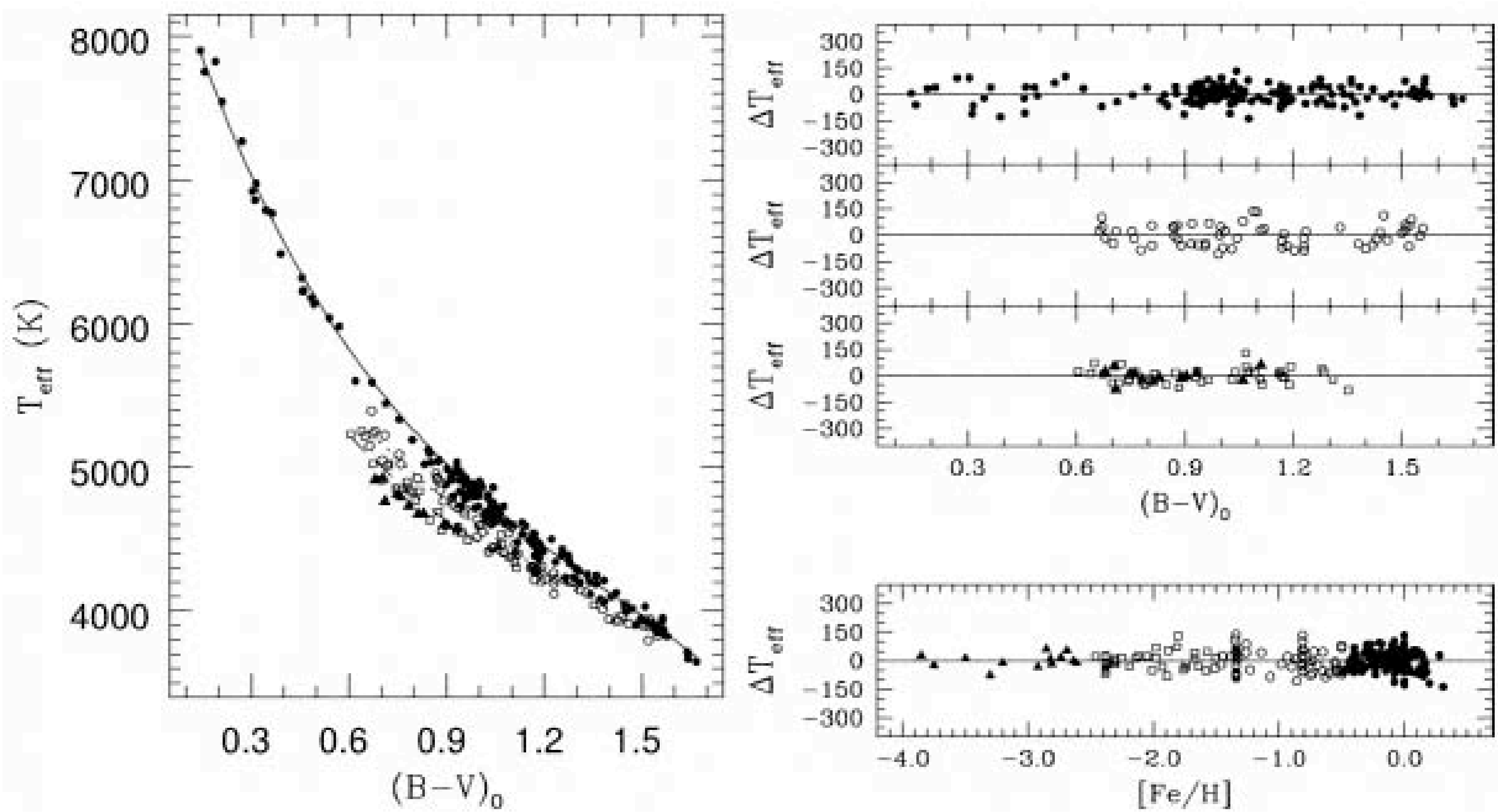


Meléndez, J.; Ramírez, I. 2005, ApJ, 626, 465

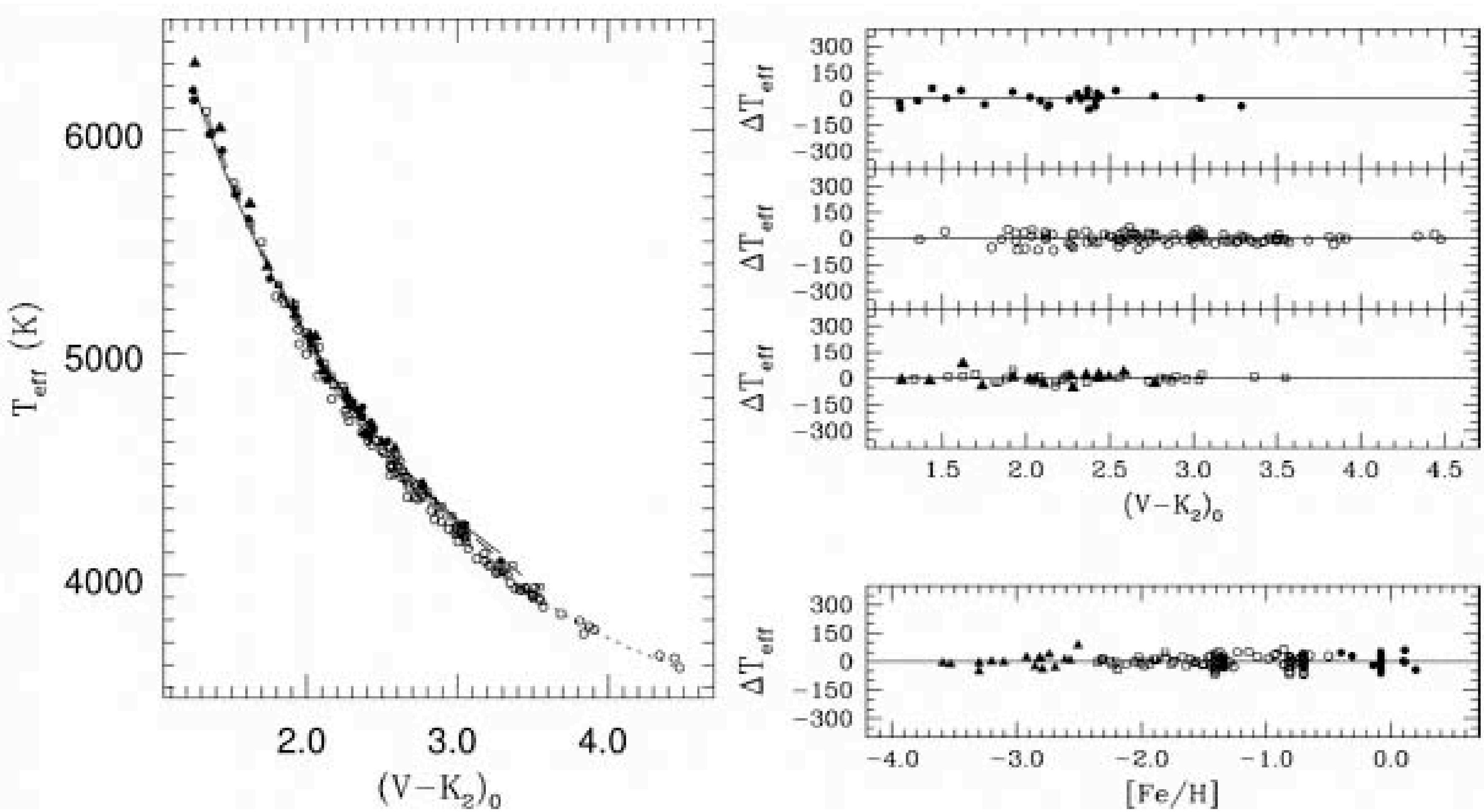
Dwarf stars (V:)



Giant stars (III:)



Giant stars (III:)



Photometric systems resource

http://obswww.unige.ch/gcpd/gcpd.html

The General Catalogue of Photometric Data

by J.-C. Mermilliod, B. Hauck, M. Mermilliod

(University of Lausanne, Switzerland)

(Version française)

WHAT'S NEW

Current status
of the data collections and recent improvements.

DATABASE

The GCPD is a comprehensive database
of photometric data for more than 80 systems, and their references.

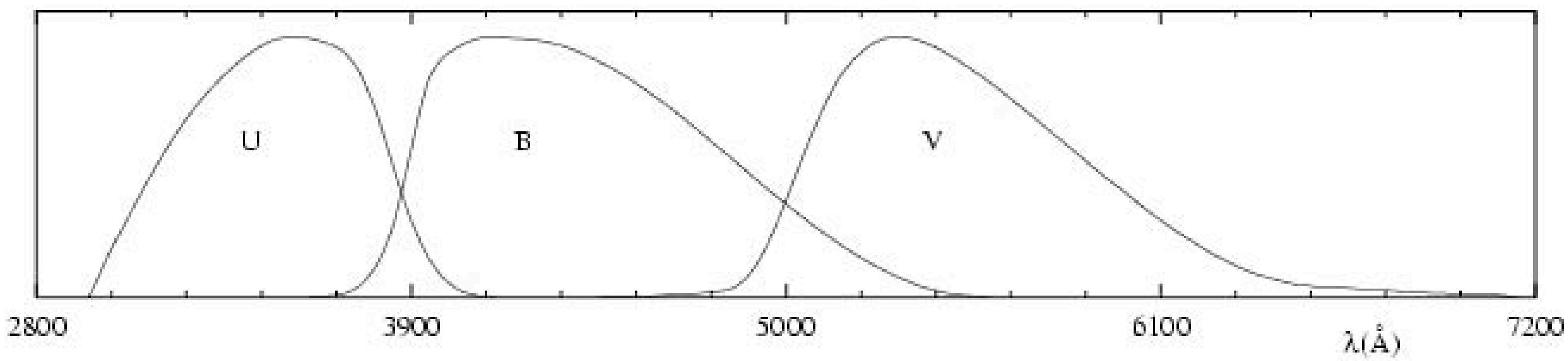
ADDED VALUE

Systematic quality controls
Uniform system of identification
Weighted mean values for the **UBV** and **uvby** systems

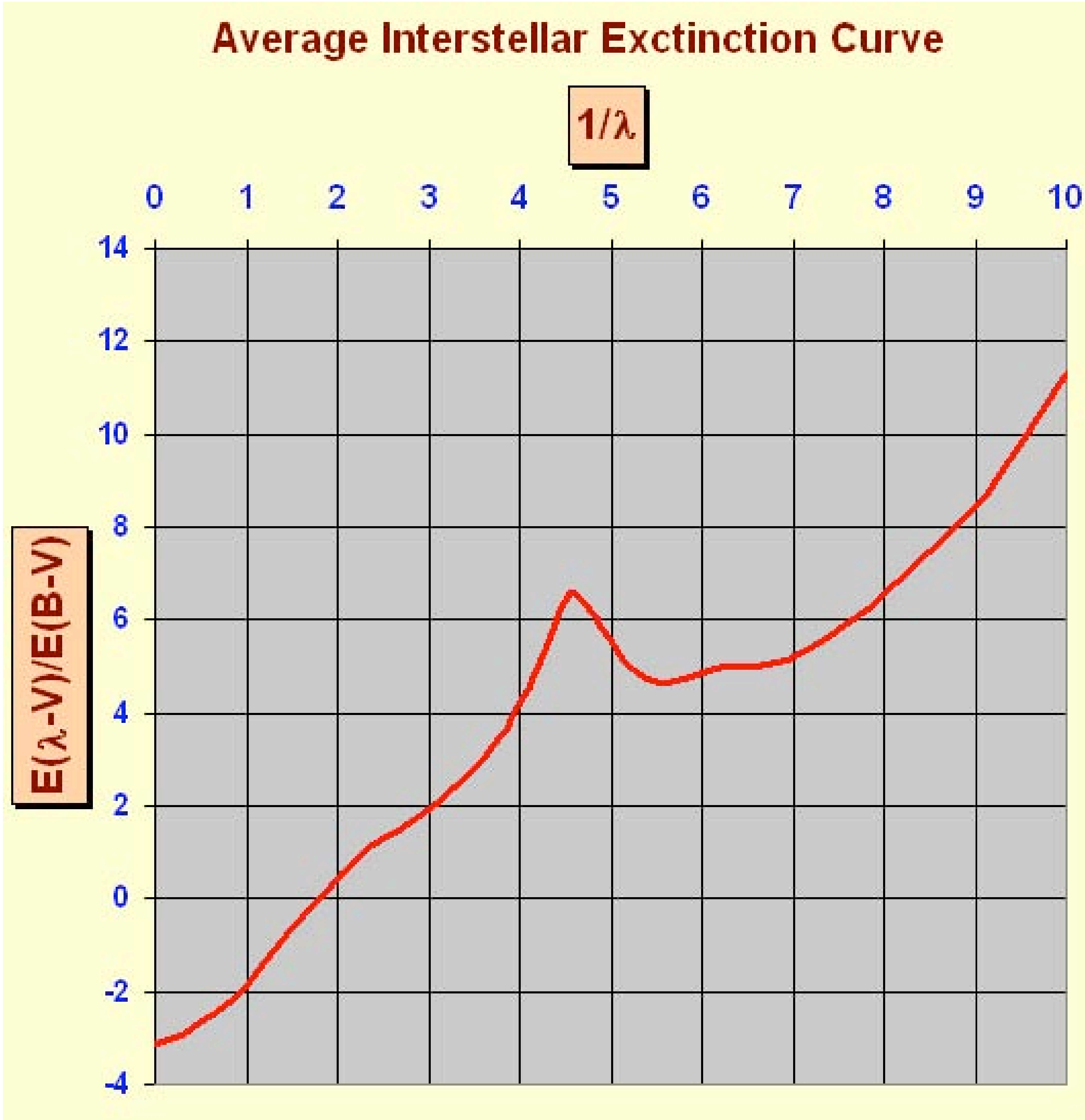
WWW ACCESS

Form to query the General Index
Form to query any photometric catalogue
Form to query the bibliographic reference files

UBV - Johnson and Morgan - 1953 (photoelectric USA version)

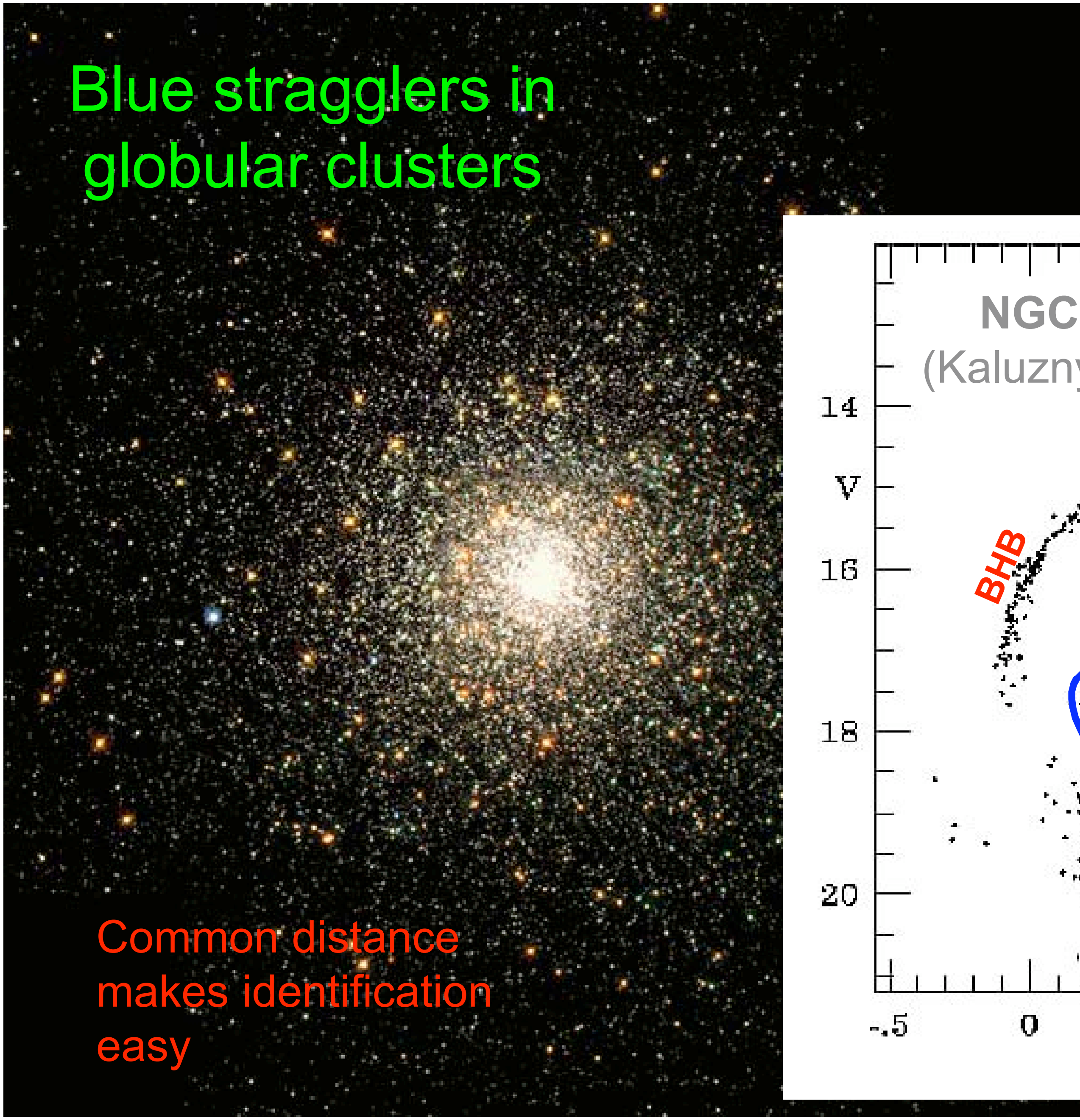


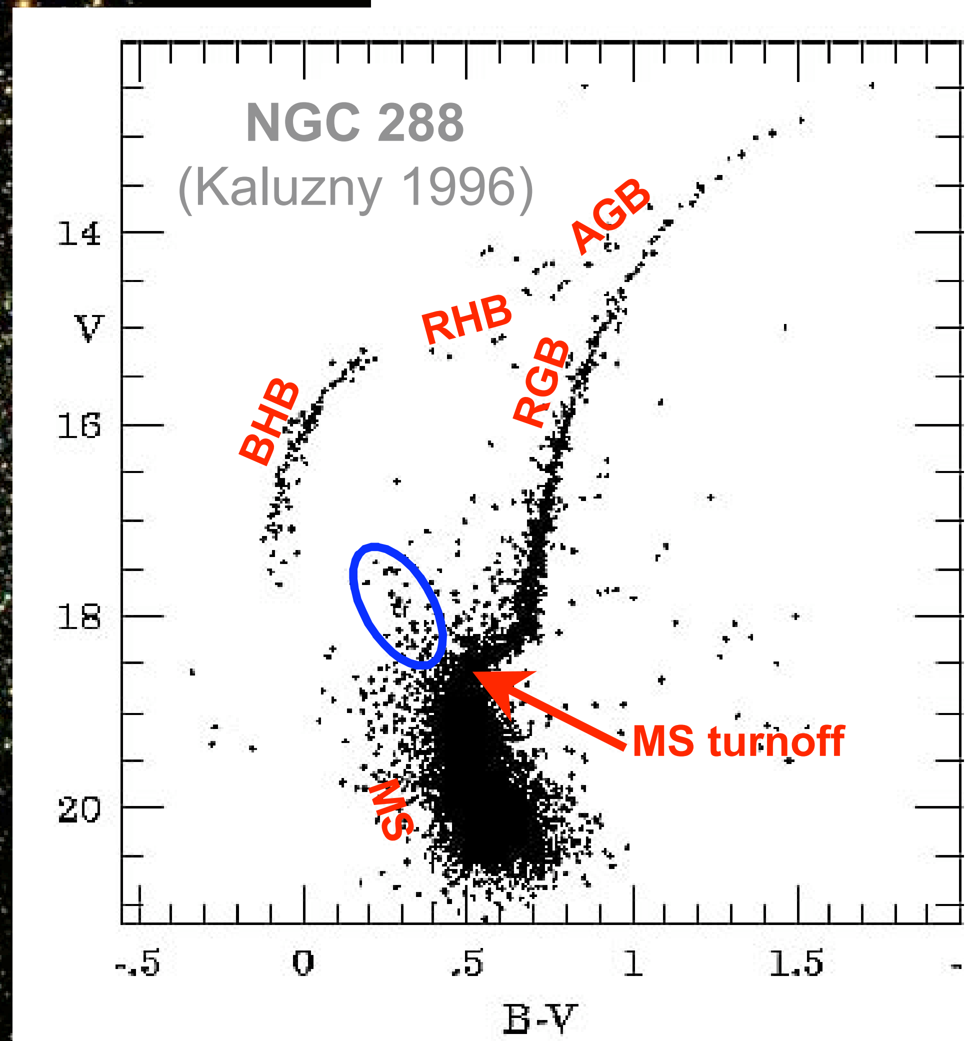
U				*B3*	*Vega*	*Sun*	*K2*	*M2*	*Carbon*
$\lambda_c = 3499$	$\lambda_o = 3502$	$\lambda_{peak} = 3550$	$\lambda_{gauss} = 3511$	3476	3536	3529	3604	3654	3567
WHM = 699	W10% = 989	W80% = 460	FWHM = 639	[683]	[675]	[671]	[588]	[488]	[686]
$W_o = 681$	$\frac{A(\lambda)}{A(V)}\vert_{5.0} = 1.36\ ^{1.34}_{1.39}$	$a = ^{0.926}_{0.941}$ $b = ^{2.082}_{1.988}$	*B3*	*WN*	*WC*	PN_{Ne}	PN^{Ne}	*Nova*	*WDA*
$\mu = 231$	$\frac{A(\lambda)}{A(V)}\vert_{3.1} = 1.61\ ^{1.58}_{1.67}$	$a = ^{0.940}_{0.950}$ $b = ^{1.998}_{1.931}$	*Sun*	3460	3477	3632	3513	3497	3446
$I_{asym} = -0.10$	$\frac{A(\lambda)}{A(V)}\vert_{2.1} = 1.96\ ^{1.89}_{2.05}$	$\frac{A(\lambda)}{E(B-V)}$:	$(4.984, 0.057)^{r=0.99}_{B3}$	$(5.286, 0.082)^{r=1.00}_{Sun}$		$(5.866, 0.070)^{r=1.00}_{M2}$			
$I_{kurt} = -0.77$	$\lambda_{eff} = 3502.8 + 54.8 \times E(B-V)$ r=1.00			$W_{eff} = 693.1 - 56.9 \times E(B-V)$ r=-0.98					
	$\lambda_{eff}(T) = 3435 + 209 \times \theta + 78 \times \theta^2 - 70 \times \theta^3$			$W_{eff}(T) = 627 + 408 \times \theta - 899 \times \theta^2 + 352 \times \theta^3$					
B				*B3*	*Vega*	*Sun*	*K2*	*M2*	*Carbon*
$\lambda_c = 4380$	$\lambda_o = 4425$	$\lambda_{peak} = 4150$	$\lambda_{gauss} = 4362$	4344	4371	4468	4569	4669	4814
WHM = 983	W10% = 1506	W80% = 642	FWHM = 928	[942]	[944]	[931]	[807]	[652]	[276]
$W_o = 988$	$\frac{A(\lambda)}{A(V)}\vert_{5.0} = 1.19\ ^{1.16}_{1.19}$	$a = ^{0.997}_{1.002}$ $b = ^{1.079}_{0.942}$	*B3*	*WN*	*WC*	PN_{Ne}	PN^{Ne}	*Nova*	*WDA*
$\mu = 361$	$\frac{A(\lambda)}{A(V)}\vert_{3.1} = 1.31\ ^{1.25}_{1.31}$	$a = ^{1.003}_{1.008}$ $b = ^{0.919}_{0.778}$	*Sun*	4386	4440	4733	4416	4715	4373
$I_{asym} = 0.44$	$\frac{A(\lambda)}{A(V)}\vert_{2.1} = 1.46\ ^{1.38}_{1.47}$	$\frac{A(\lambda)}{E(B-V)}$:	$(4.124, 0.022)^{r=0.99}_{B3}$	$(4.304, 0.028)^{r=1.00}_{Sun}$		$(4.682, 0.003)^{r=0.59}_{M2}$			
$I_{kurt} = -0.53$	$\lambda_{eff} = 4420.2 + 131.9 \times E(B-V)$ r=1.00			$W_{eff} = 1022.9 - 136.4 \times E(B-V)$ r=-0.97					
	$\lambda_{eff}(T) = 4313 + 210 \times \theta + 258 \times \theta^2 - 128 \times \theta^3$			$W_{eff}(T) = 892 + 561 \times \theta - 960 \times \theta^2 + 238 \times \theta^3$					
V				*B3*	*Vega*	*Sun*	*K2*	*M2*	*Carbon*
$\lambda_c = 5470$	$\lambda_o = 5544$	$\lambda_{peak} = 5332$	$\lambda_{gauss} = 5467$	5464	5474	5530	5577	5634	5718
WHM = 865	W10% = 1457	W80% = 488	FWHM = 843	[867]	[872]	[891]	[875]	[828]	[728]
$W_o = 898$	$\frac{A(\lambda)}{A(V)}\vert_{5.0} = 0.99\ ^{0.99}_{0.99}$	$a = ^{1.002}_{0.996}$ $b = ^{0.014}_{-0.027}$	*B3*	*WN*	*WC*	PN_{Ne}	PN^{Ne}	*Nova*	*WDA*
$\mu = 375$	$\frac{A(\lambda)}{A(V)}\vert_{3.1} = 0.99\ ^{0.99}_{0.99}$	$a = ^{0.998}_{0.991}$ $b = ^{-0.016}_{-0.057}$	*Sun*	5501	5577	5217	5592	5328	5469
$I_{asym} = 0.73$	$\frac{A(\lambda)}{A(V)}\vert_{2.1} = 0.98\ ^{0.99}_{0.99}$	$\frac{A(\lambda)}{E(B-V)}$:	$(3.104, 0.021)^{r=0.99}_{B3}$	$(3.280, 0.026)^{r=1.00}_{Sun}$		$(3.650, 0.001)^{r=0.27}_{M2}$			
$I_{kurt} = 0.58$	$\lambda_{eff} = 5539.1 + 114.3 \times E(B-V)$ r=1.00			$W_{eff} = 920.2 - 95.9 \times E(B-V)$ r=-0.98					
	$\lambda_{eff}(T) = 5450 + 129 \times \theta + 158 \times \theta^2 - 56 \times \theta^3$			$W_{eff}(T) = 851 + 176 \times \theta - 165 \times \theta^2 - 62 \times \theta^3$					



Average Interstellar Exctinction Curve
1/λ
0
1
2
3
4
5
6
7
8
9
10
14
12
10
8
6
4
2
0
-2
-4
E(λ-V)/E(B-V)

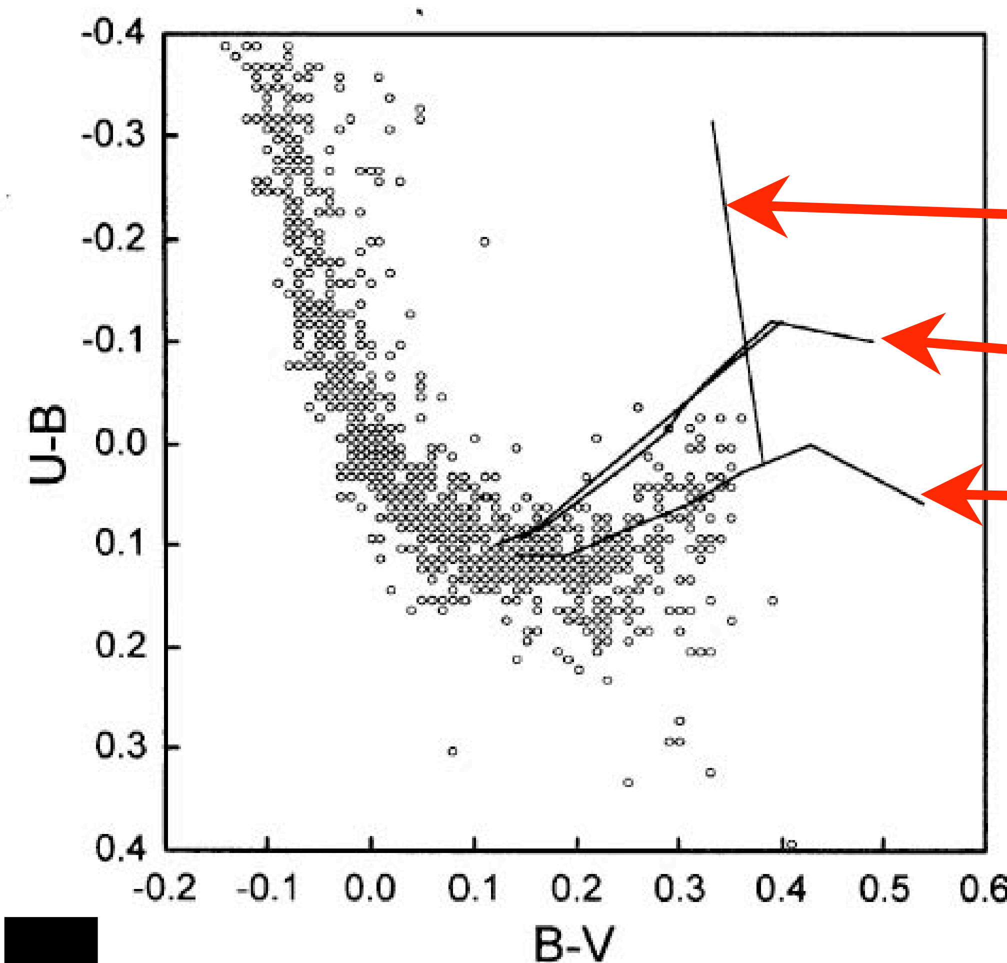
Blue stragglers in globular clusters





Common distance makes identification easy

Identifying field BMP stars: Galactic disk star color-color relation



Empirical relations:

Hot edge of metal-poor main sequence

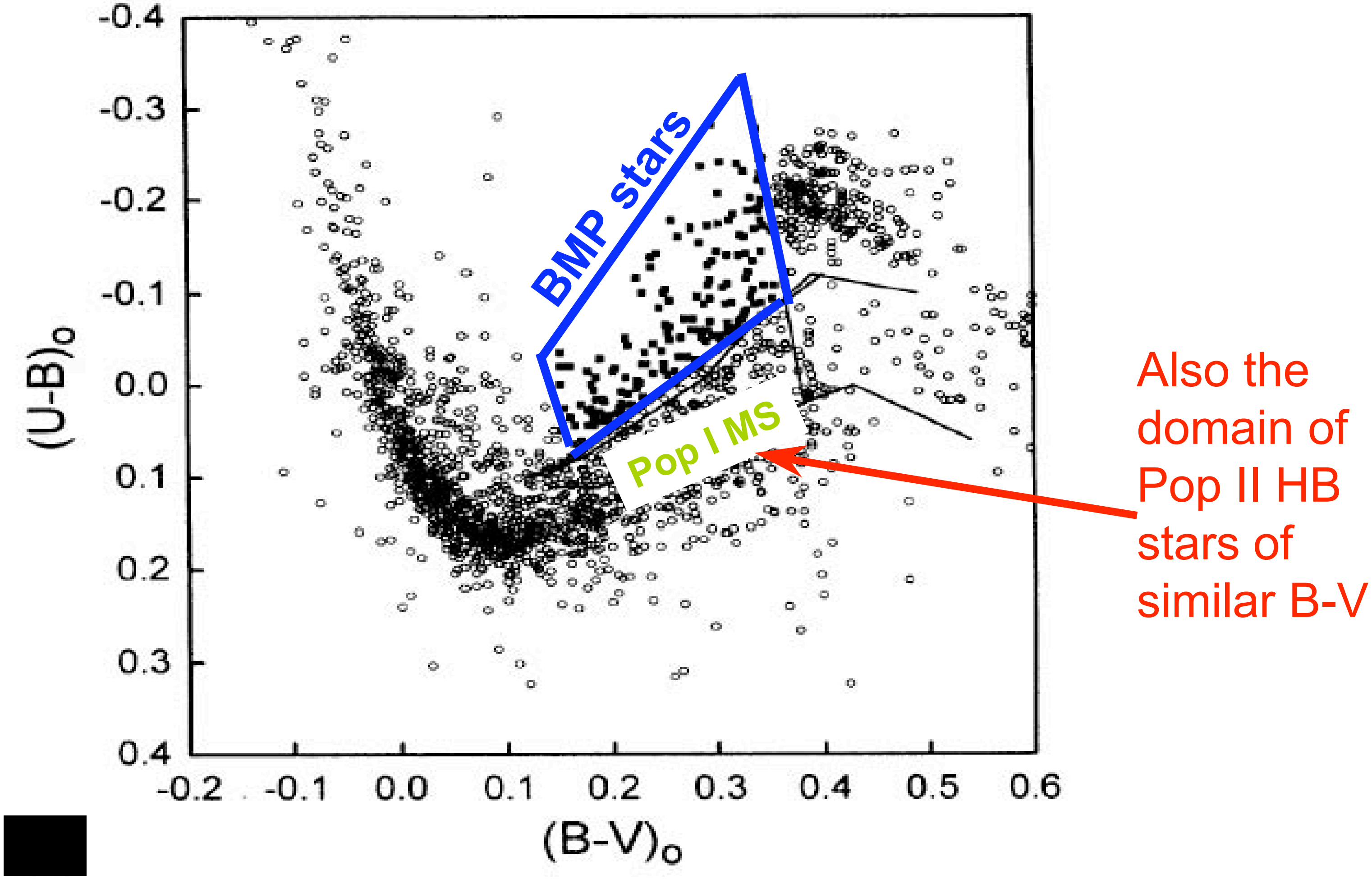
[Fe/H] ~ -1

[Fe/H] ~ 0

Points are the B8-F0 stars from the Bright Star Catalog

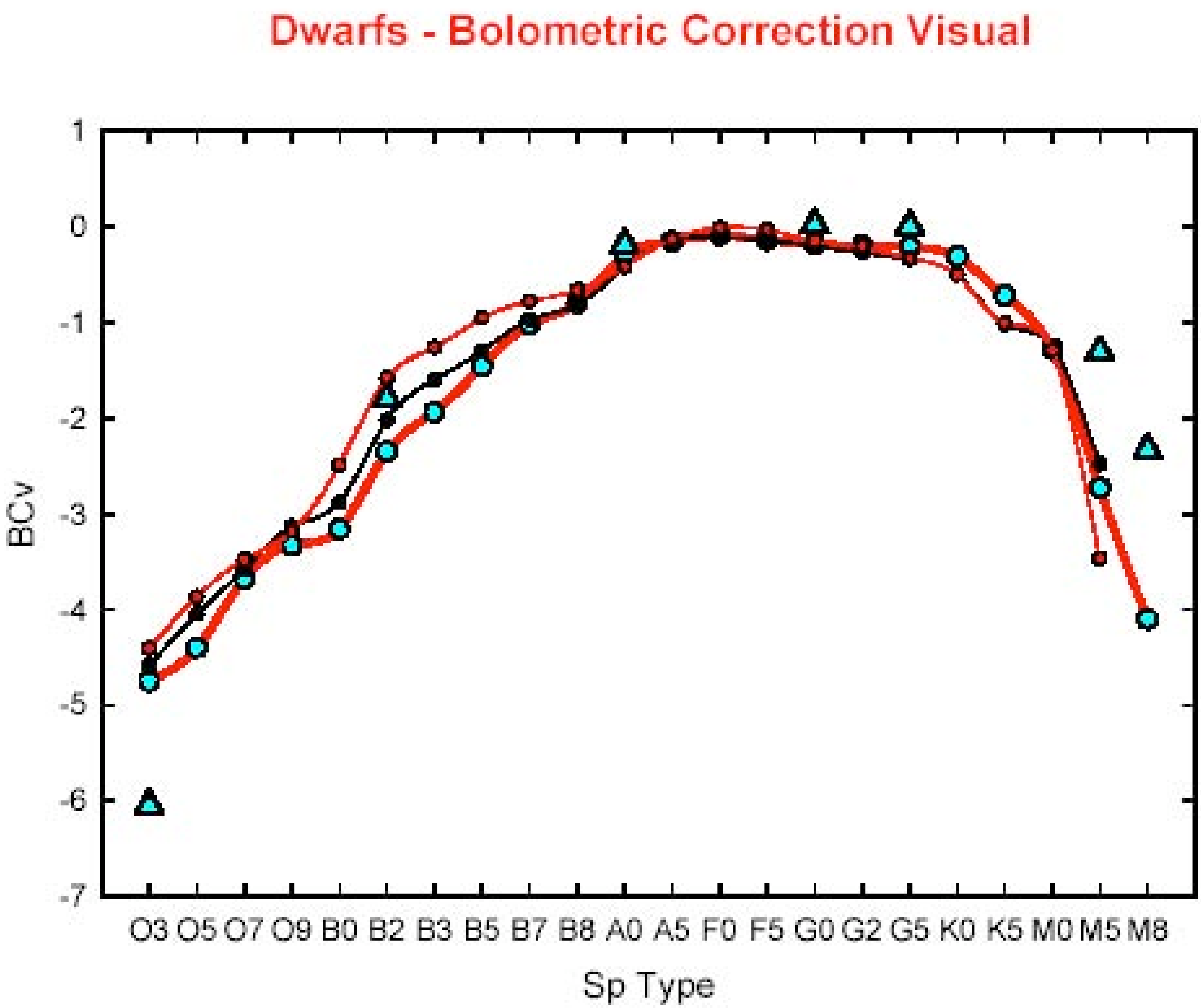
Preston et al. 1994

Identifying field BMP stars:
stars from the HK halo-star survey



"HK" Survey: Beers et al. 1985, 1992

Preston et al. 1994



Dwarfs - Bolometric Correction Visual
BCv
Sp Type
1
0
-1
-2
-3
-4
-5
-6
-7
O3 O5 O7 O9 B0 B2 B3 B5 B7 B8 A0 A5 F0 F5 G0 G2 G5 K0 K5 M0 M5 M8