

# Determination of effective temperatures for an extended sample of dwarfs and subdwarfs (F0-K5)\*

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**Abstract.** — We have applied the InfraRed Flux Method (IRFM) to a sample of 475 dwarfs and subdwarfs in order to derive their effective temperatures with a mean accuracy of about 1.5%. We have used the new homogeneous grid of theoretical model atmosphere flux distributions developed by Kurucz (1991, 1993) for the application of the IRFM. The atmospheric parameters of the stars cover, roughly, the ranges:  $3500 \text{ K} \leq T_{\text{eff}} \leq 8000 \text{ K}$ ;  $-3.5 \leq [\text{Fe}/\text{H}] \leq +0.5$ ;  $3.5 \leq \log(g) \leq 5$ . The monochromatic infrared fluxes at the continuum, and the bolometric fluxes are derived using recent results, which satisfy the accuracy requirements of the work. Photometric calibrations have been revised and applied to estimate metallicities, although direct spectroscopic determinations were preferred when available. The adopted infrared absolute flux calibration, based on direct optical measurements of angular stellar diameters, sets the effective temperatures determined using the IRFM on the same scale than those obtained by direct methods. We derive three temperatures,  $T_J$ ,  $T_H$  and  $T_K$ , for each star using the monochromatic fluxes at different infrared wavelengths in the photometric bands  $J$ ,  $H$ , and  $K$ . They show good consistency over 4000 K, and no trend with wavelength may be appreciated. We provide a detailed description of the steps followed for the application of the IRFM, as well as the sources of the errors associated to the different inputs of the method, and their transmission into the final temperatures. We also provide comparison with previous works.

**Key words:** stars: fundamental parameters — stars: Population II — stars: subdwarfs — stars: general

## 1. Introduction

The stellar effective temperatures might be, in principle, determined following a fundamental or *direct* method based on the combination of the bolometric fluxes and the angular diameter measurements according to the equation:

$$T_{\text{eff}} = \left(\frac{4}{\sigma}\right)^{1/4} \theta^{-1/2} F_{\text{Bol}}^{1/4}, \quad (1)$$

where  $\sigma$  is the Stefan-Boltzmann constant,  $\theta$  is the angular diameter of the star, and  $F_{\text{Bol}}$  is the bolometric flux measured on the surface of the earth.

However, in practice, we need atmosphere models to perform secondary corrections to both the angular diameter measurement (limb darkening) and  $F_{\text{Bol}}$  (interstellar absorption). The Sun is obviously the only exception, since its limb darkening can be empirically determined, and its interstellar absorption is negligible. In any event, the main difficulty affecting the *direct* procedure is the limited number of stars with a reliable measurement of their angular

diameter (see for instance Table 4 from Mozurkewich et al. 1991). This problem is remarkably severe for the low main sequence, as there are no direct measurements of angular diameter for stars later than F5V, with the above mentioned exception of the Sun. For this reason, relatively large uncertainties still remain on the scale of stellar effective temperatures in the low main sequence, especially when the effect of metallicity is considered.

Thus, we are compelled to use *semi-direct* methods, which require, as a basis, atmosphere models in addition to observational information (see the review by Böhm-Vitense 1981). Among the different methods of this type the Infrared Flux Method (hereafter IRFM; Blackwell et al. 1990, and references therein) seems especially adequate to analyse the temperatures of F, G, and K stars. The IRFM has been successfully applied to different samples of population I stars (e.g. Blackwell et al. 1990; Bell & Gustafsson 1989; Saxner & Hammarbäck 1985). However, the works based on the IRFM devoted to metal poor stars (Magain 1987; Arribas & Martínez-Roger 1987, 1989) are restricted to rather limited samples.

The present paper is part of a long term programme aimed to a better definition of the scale of temperatures

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\*Table 4 is only available in electronic form at CDS Tables 1-3 are also available via ftp 130.79.128.5

**Table 1.** The calibration of  $q$ - and  $R$ - factors versus metallicity,  $\log(g)$  and effective temperature in  $\lambda_{\text{eff}}=1272.5$  nm (band  $J$ ), computed using models by Kurucz (1991, 1993). The units of  $R$ -factors are (nm)

$T_{\text{eff}}$	$\log(g)$	[Fe/H]=0.50		[Fe/H]=0.00		[Fe/H]=-1.00		[Fe/H]=-2.00		[Fe/H]=-3.00		[Fe/H]=-3.50	
		$q(J)$	$\log(R_f)$	$q(J)$	$\log(R_f)$	$q(J)$	$\log(R_f)$	$q(J)$	$\log(R_f)$	$q(J)$	$\log(R_f)$	$q(J)$	$\log(R_f)$
3500	4.00	1.0106	3.19650	1.0114	3.22780	1.0117	3.23210	1.0088	3.23328	1.0108	3.26472	—	—
3500	5.00	1.0130	3.20760	1.0126	3.23314	1.0113	3.23511	1.0091	3.23874	—	—	—	—
3750	4.00	1.0116	3.22553	1.0104	3.25863	1.0110	3.27501	1.0107	3.28205	1.0107	3.28288	1.0101	3.28121
3750	5.00	1.0138	3.23491	1.0123	3.26000	1.0115	3.27748	1.0105	3.28175	—	—	—	—
4000	4.00	1.0127	3.26154	1.0104	3.28485	1.0098	3.30107	1.0098	3.30538	1.0096	3.30527	1.0100	3.30602
4000	5.00	1.0134	3.26360	1.0118	3.28772	1.0112	3.29982	1.0103	3.30448	—	—	—	—
4250	4.00	1.0140	3.29482	1.0118	3.31003	1.0098	3.32287	1.0090	3.32065	1.0097	3.33102	1.0099	3.33284
4250	5.00	1.0143	3.30337	1.0116	3.31139	1.0100	3.32423	1.0095	3.33045	1.0095	3.33598	—	—
4500	4.00	1.0153	3.32227	1.0127	3.33544	1.0099	3.34908	1.0090	3.35719	1.0090	3.36207	1.0089	3.36356
4500	5.00	1.0154	3.32178	1.0124	3.33548	1.0095	3.34987	1.0083	3.35865	1.0083	3.36555	1.0082	3.36496
4750	4.00	1.0161	3.35022	1.0134	3.36348	1.0100	3.37006	1.0082	3.38917	1.0080	3.39460	1.0082	3.39627
4750	5.00	1.0164	3.35047	1.0131	3.36356	1.0100	3.37915	1.0080	3.38952	1.0087	3.39551	1.0085	3.39745
5000	4.00	1.0163	3.38036	1.0138	3.39394	1.0100	3.41156	1.0083	3.42288	1.0080	3.42804	1.0080	3.43060
5000	5.00	1.0170	3.38078	1.0137	3.39440	1.0101	3.41047	1.0085	3.42258	1.0085	3.42802	1.0079	3.43067
5250	4.00	1.0186	3.41261	1.0147	3.42859	1.0096	3.44617	1.0082	3.45863	1.0077	3.46469	1.0076	3.46608
5250	5.00	1.0174	3.41282	1.0140	3.42885	1.0095	3.44481	1.0083	3.45797	1.0081	3.46427	1.0081	3.46582
5500	4.00	1.0108	3.44608	1.0140	3.46098	1.0094	3.48180	1.0081	3.49427	1.0078	3.50020	1.0077	3.50134
5500	5.00	1.0173	3.44647	1.0139	3.46074	1.0094	3.48067	1.0082	3.49368	1.0079	3.50022	1.0079	3.50120
5750	4.00	1.0108	3.48326	1.0134	3.49057	1.0097	3.51767	1.0084	3.53060	1.0080	3.53513	1.0080	3.53622
5750	5.00	1.0165	3.48180	1.0133	3.49099	1.0096	3.51676	1.0081	3.53009	1.0078	3.53595	1.0077	3.53714
6000	4.00	1.0164	3.51836	1.0134	3.53296	1.0096	3.55044	1.0080	3.56496	1.0083	3.58055	1.0082	3.57064
6000	5.00	1.0167	3.51747	1.0131	3.53169	1.0097	3.55340	1.0084	3.56818	1.0080	3.57110	1.0079	3.57223
6250	4.00	1.0156	3.55598	1.0131	3.56781	1.0098	3.58846	1.0080	3.59884	1.0086	3.60324	1.0088	3.60424
6250	5.00	1.0151	3.55529	1.0131	3.56737	1.0097	3.58842	1.0088	3.60122	1.0084	3.60566	1.0082	3.60701
6500	4.00	1.0156	3.58941	1.0120	3.60338	1.0097	3.62254	1.0082	3.63828	1.0090	3.65817	1.0089	3.65708
6500	5.00	1.0144	3.58912	1.0115	3.60342	1.0095	3.62197	1.0088	3.63570	1.0085	3.64071	1.0087	3.64095
6750	4.00	1.0141	3.62508	1.0111	3.63876	1.0088	3.65663	1.0086	3.66529	1.0082	3.66896	1.0082	3.66976
6750	5.00	1.0106	3.62471	1.0106	3.63012	1.0085	3.65066	1.0080	3.66066	1.0076	3.67372	1.0077	3.67454
7000	4.00	1.0152	3.66083	1.0108	3.67340	1.0076	3.69013	1.0072	3.69826	1.0075	3.70130	1.0073	3.70200
7000	5.00	1.0117	3.66015	1.0096	3.67105	1.0072	3.69068	1.0065	3.70360	1.0059	3.70684	1.0058	3.70762
7250	4.00	1.0123	3.69604	1.0095	3.70831	1.0069	3.72062	1.0058	3.73160	1.0056	3.73384	1.0060	3.73421
7250	5.00	1.0100	3.69541	1.0073	3.70925	1.0061	3.72699	1.0050	3.73376	1.0051	3.73896	1.0047	3.73971
7500	4.00	1.0093	3.73444	1.0063	3.74712	1.0050	3.75713	1.0047	3.76413	1.0044	3.76647	1.0048	3.76670
7500	5.00	1.0075	3.73068	1.0050	3.74321	1.0037	3.75023	1.0034	3.76756	1.0032	3.77082	1.0035	3.77124
7750	4.00	1.0072	3.77085	1.0044	3.78257	1.0022	3.78767	1.0013	3.80445	1.0019	3.80677	1.0016	3.80738
7750	5.00	1.0054	3.77527	1.0035	3.77745	1.0015	3.79300	1.0020	3.79959	1.0014	3.80247	1.0016	3.80281
8000	4.00	1.0058	3.80608	1.0030	3.81799	1.0008	3.83178	1.0004	3.83765	1.0004	3.83983	1.0000	3.84044
8000	5.00	0.9997	3.80371	1.0011	3.81155	1.0000	3.82550	0.9998	3.83155	1.0000	3.83368	0.9995	3.83429
8250	4.00	1.0046	3.84277	1.0021	3.85335	0.9996	3.86656	0.9991	3.87194	0.9991	3.87373	0.9992	3.87460
8250	5.00	0.9965	3.83933	0.9952	3.85113	0.9939	3.86589	0.9932	3.87044	0.9923	3.86587	0.9924	3.86617

for F, G, and K dwarfs and subdwarfs, using the IRFM. This work is relevant to three main topics: (a) analysis of the global behaviour of atmosphere models (e.g., Magain 1987), (b) the correct interpretation of the observed HR diagram (e.g., Arribas & Martínez-Roger 1988, 1989), and (c) fine spectroscopic analysis for abundance determinations of metal poor stars (e.g., King 1994).

The general programme has been focussed on the improvement of the different factors which affect the accuracy in the definition of the temperature scale. Firstly, the sample of selected stars has been substantially enlarged compared to previous works (up to almost 500 stars). This point is particularly important in order to properly sample wide ranges in colour and metallicity. The accurate infrared photometry required for the application of the IRFM was measured for 75% of the stars in the sample (Alonso et al. 1994a, Paper I). Secondly, due to the sensitivity of the IRFM temperatures to the infrared absolute flux calibration considered, this subject was revised in Alonso et al. (1994b, Paper II). There, a new absolute

calibration for the infrared flux of Vega, which scales the IRFM temperatures to those derived by direct methods, is proposed. Thirdly, a method to obtain bolometric fluxes for metal poor stars was devised in Alonso et al. (1995, Paper III). Last, but not least, we have used the improved grid of atmosphere models computed recently by Kurucz (1991, 1993).

This paper provides detailed information on the procedure followed to derive the effective temperatures for the whole sample. The paper is laid out as follows. Section 2 explains the practical implementation of the IRFM. The theoretical and observational inputs of the method, as applied here, have been separated in order to discuss the influence of errors in the derived temperatures. Thus, Sect. 3 analyses the theoretical  $R$ - and  $q$ -factors, and the observational inputs are discussed in Sect. 4. This section also includes a description of the criteria adopted to collect the sample of stars, a revision of photometric calibrations to estimate the metallicity, and the correction of interstellar extinction. The effective temperatures are derived

**Table 2.** The same that Table 1 for  $\lambda_{\text{eff}}=1635.0$  nm (band *H*)

$T_{\text{eff}}$	$\log(g)$	[Fe/H]=0.50		[Fe/H]=0.00		[Fe/H]=-1.0		[Fe/H]=-2.0		[Fe/H]=-3.0		[Fe/H]=-3.5	
		$q(H)$	$\log(R_H)$	$q(H)$	$\log(R_H)$	$q(H)$	$\log(R_H)$	$q(H)$	$\log(R_H)$	$q(H)$	$\log(R_H)$	$q(H)$	$\log(R_H)$
3500	1.00	1.0855	3.22481	1.0710	3.28198	1.0572	3.35350	1.0558	3.40373	1.0522	3.36870	—	—
3500	5.00	1.0577	3.30845	1.0550	3.33420	1.0552	3.35579	1.0502	3.40018	—	—	—	—
3750	1.00	1.0813	3.27000	1.0795	3.30519	1.0578	3.38672	1.0480	3.41153	1.0444	3.41907	1.0418	3.42337
3750	5.00	1.0618	3.33578	1.0536	3.37807	1.0483	3.40675	1.0466	3.41506	—	—	—	—
4000	1.00	1.0725	3.33562	1.0740	3.34383	1.0556	3.39405	1.0483	3.44312	1.0370	3.47080	1.0368	3.48011
4000	5.00	1.0637	3.36533	1.0578	3.40463	1.0439	3.44771	1.0413	3.48268	—	—	—	—
4250	1.00	1.0623	3.40413	1.0629	3.40631	1.0589	3.43010	1.0458	3.47769	1.0338	3.51515	1.0306	3.52893
4250	5.00	1.0589	3.41079	1.0578	3.42979	1.0486	3.47230	1.0384	3.50456	1.0316	3.52532	—	—
4500	1.00	1.0520	3.47101	1.0522	3.47245	1.0485	3.49194	1.0416	3.52341	1.0335	3.55907	1.0318	3.56514
4500	5.00	1.0522	3.46705	1.0517	3.47403	1.0405	3.50464	1.0355	3.54761	1.0278	3.57000	1.0261	3.58300
4750	1.00	1.0426	3.53488	1.0431	3.53646	1.0410	3.55421	1.0368	3.57979	1.0328	3.59017	1.0319	3.60741
4750	5.00	1.0438	3.52861	1.0435	3.53383	1.0407	3.55524	1.0320	3.59400	1.0270	3.61848	1.0262	3.63025
5000	1.00	1.0349	3.59552	1.0348	3.59855	1.0349	3.61329	1.0318	3.63455	1.0307	3.64891	1.0305	3.64878
5000	5.00	1.0361	3.58981	1.0367	3.59330	1.0345	3.61319	1.0298	3.64271	1.0264	3.68031	1.0262	3.68277
5250	1.00	1.0277	3.65441	1.0290	3.65615	1.0303	3.67122	1.0291	3.68812	1.0287	3.69488	1.0287	3.69601
5250	5.00	1.0306	3.64750	1.0300	3.65203	1.0298	3.67091	1.0266	3.69392	1.0255	3.70304	1.0255	3.70556
5500	1.00	1.0225	3.70927	1.0238	3.71240	1.0262	3.72601	1.0261	3.73900	1.0265	3.74300	1.0267	3.74428
5500	5.00	1.0237	3.70350	1.0244	3.70933	1.0254	3.72553	1.0230	3.74358	1.0241	3.74941	1.0238	3.75138
5750	1.00	1.0185	3.78271	1.0200	3.78593	1.0224	3.79888	1.0235	3.78928	1.0240	3.79211	1.0243	3.79275
5750	5.00	1.0190	3.75695	1.0200	3.76171	1.0217	3.77618	1.0218	3.79200	1.0222	3.79566	1.0223	3.79631
6000	1.00	1.0149	3.81351	1.0165	3.81775	1.0191	3.83037	1.0204	3.83758	1.0207	3.84048	1.0208	3.84119
6000	5.00	1.0137	3.80850	1.0160	3.81377	1.0185	3.82919	1.0185	3.83904	1.0199	3.84258	1.0192	3.84330
6250	1.00	1.0125	3.86315	1.0136	3.86848	1.0163	3.87399	1.0172	3.88494	1.0174	3.88762	1.0175	3.88823
6250	5.00	1.0111	3.85858	1.0130	3.86431	1.0150	3.87745	1.0160	3.88548	1.0169	3.89860	1.0170	3.89927
6500	1.00	1.0096	3.91178	1.0108	3.91666	1.0135	3.92616	1.0144	3.93130	1.0147	3.93371	1.0147	3.93425
6500	5.00	1.0079	3.90710	1.0094	3.91263	1.0127	3.92440	1.0150	3.93008	1.0142	3.93070	1.0143	3.93454
6750	1.00	1.0074	3.95819	1.0084	3.96302	1.0111	3.97205	1.0118	3.97671	1.0119	3.97885	1.0120	3.97931
6750	5.00	1.0052	3.95350	1.0065	3.95930	1.0100	3.96970	1.0110	3.97574	1.0112	3.97820	1.0113	3.97871
7000	1.00	1.0050	4.00303	1.0067	4.00827	1.0089	4.01650	1.0092	4.02102	1.0094	4.02274	1.0094	4.02318
7000	5.00	1.0028	3.99828	1.0037	4.00433	1.0070	4.01417	1.0079	4.01958	1.0080	4.02161	1.0081	4.02200
7250	1.00	1.0043	4.04670	1.0048	4.05220	1.0070	4.05900	1.0079	4.06405	1.0074	4.06564	1.0075	4.06594
7250	5.00	1.0009	4.04182	1.0013	4.04810	1.0040	4.05571	1.0049	4.06215	1.0052	4.06412	1.0052	4.06455
7500	1.00	1.0008	4.09372	1.0002	4.09954	1.0051	4.10286	1.0055	4.10620	1.0058	4.10755	1.0058	4.10785
7500	5.00	0.9980	4.08471	0.9984	4.09078	1.0010	4.09945	1.0022	4.10385	1.0024	4.10505	1.0025	4.10597
7750	1.00	0.9991	4.13808	0.9991	4.14254	1.0010	4.15009	1.0020	4.15462	1.0016	4.15843	1.0013	4.15842
7750	5.00	0.9957	4.12825	0.9963	4.13211	0.9980	4.14000	0.9994	4.14475	1.0001	4.14807	0.9999	4.14651
8000	1.00	0.9989	4.17849	0.9974	4.18470	1.0004	4.19202	0.9997	4.19080	1.0000	4.19818	0.9998	4.19821
8000	5.00	0.9974	4.17145	0.9985	4.17332	0.9965	4.18111	0.9967	4.18485	0.9971	4.18813	0.9976	4.18814
8250	1.00	0.9985	4.21874	0.9973	4.22521	0.9980	4.23300	0.9988	4.23779	0.9988	4.24607	0.9993	4.24606
8250	5.00	0.9993	4.21363	0.9971	4.22014	0.9965	4.22567	0.9967	4.22954	0.9964	4.22578	0.9969	4.22581

in Sect. 5, where the internal consistency of the method and the uncertainties affecting  $T_{\text{eff}}$  are assessed. The final temperatures are compared to common determinations of previous works in Sect. 6. Finally, in Sect. 7, the main results are briefly summarized.

In a forthcoming paper, we will provide and discuss the calibrations  $T_{\text{eff}}$ -colours-[Fe/H], as well as the mean intrinsic colours for dwarfs and subdwarfs.

## 2. The implementation of the IRFM

The InfraRed Flux Method (Blackwell et al. 1990) uses the quotient between the bolometric flux ( $F_{\text{Bol}}$ ) and the monochromatic flux at a chosen infrared wavelength of the continuum ( $F(\lambda_{\text{IR}})$ ), both measured at the surface of the star, as indicator of  $T_{\text{eff}}$ . This quotient is the so-called observational  $R$ -factor ( $R_{\text{obs}}$ ). The theoretical counterpart derived from models,  $R_{\text{theo}}$ , is obtained as the quotient between the integrated flux ( $\sigma T_{\text{eff}}^4$ ) and the monochromatic flux at  $\lambda_{\text{IR}}$  ( $F_{\text{mod}}(\lambda_{\text{IR}})$ ), at the surface of the star. Thus

the basic equation of the IRFM reads:

$$R_{\text{obs}} = \frac{F_{\text{Bol}}}{F(\lambda_{\text{IR}})} = \frac{\sigma T_{\text{eff}}^4}{F_{\text{mod}}(\lambda_{\text{IR}}, T_{\text{eff}}, [\text{Fe}/\text{H}], g)} = R_{\text{theo}}(\lambda_{\text{IR}}, T_{\text{eff}}, [\text{Fe}/\text{H}], g), \quad (2)$$

where the explicit dependence on metallicity, surface gravity, and  $\lambda_{\text{IR}}$  is taken into account. The IRFM only requires from models the correct prediction of the continuum IR fluxes (note that the bolometric flux at the stellar surface is fixed by the value of  $T_{\text{eff}}$ ). This requirement seems relatively easier to fulfill, if compared to those demanded by other *semi-direct* methods. In particular, free-free and bound-free transitions of  $\text{H}^-$  ion, the main source of the continuum opacity in the IR for F,G and K stars, are relatively well understood. Therefore, in principle, the dependence on models is not a critical point to the IRFM, at least for spectral types earlier than late K where the IR opacity due to molecular bands is of minor importance. Another advantage of the IRFM, as explained in Sect. 4.1,

**Table 3.** The same that Table 1 for  $\lambda_{\text{eff}}=2175.0$  nm (band *K*)

$T_{\text{eff}}$	$\log(g)$	[Fe/II]=0.50		[Fe/II]=0.00		[Fe/H]=-1.0		[Fe/H]=-2.0		[Fe/H]=-3.0		[Fe/H]=-3.5	
		$q(K)$	$\log(R_K)$	$q(K)$	$\log(R_K)$	$q(K)$	$\log(R_K)$	$q(K)$	$\log(R_K)$	$q(K)$	$\log(R_K)$	$q(K)$	$\log(R_K)$
3500	4.00	1.0491	3.67077	1.0590	3.67040	1.0340	3.71124	1.0270	3.50720	1.0261	3.72061	—	—
3500	5.00	1.0415	3.67386	1.0352	3.63021	1.0316	3.71324	1.0253	3.79841	—	—	—	—
3750	4.00	1.0442	3.68243	1.0379	3.71302	1.0312	3.76496	1.0260	3.79006	1.0237	3.78449	1.0230	3.78616
3750	5.00	1.0383	3.72570	1.0330	3.75590	1.0283	3.77691	1.0250	3.78110	—	—	—	—
4000	4.00	1.0410	3.75541	1.0362	3.78628	1.0287	3.80118	1.0243	3.82875	1.0226	3.84448	1.0223	3.84980
4000	5.00	1.0362	3.77543	1.0310	3.80467	1.0281	3.83105	1.0233	3.84071	—	—	—	—
4250	4.00	1.0378	3.82777	1.0343	3.83286	1.0275	3.84872	1.0226	3.87739	1.0218	3.89322	1.0217	3.90854
4250	5.00	1.0309	3.83328	1.0293	3.84842	1.0238	3.87605	1.0221	3.88458	1.0217	3.89679	—	—
4500	4.00	1.0345	3.89709	1.0309	3.90121	1.0254	3.91256	1.0217	3.93235	1.0207	3.95498	1.0208	3.95942
4500	5.00	1.0311	3.89437	1.0274	3.90151	1.0225	3.92210	1.0211	3.94782	1.0209	3.96336	1.0211	3.96989
4750	4.00	1.0304	3.96302	1.0279	3.98679	1.0207	3.97732	1.0205	3.99602	1.0200	4.00734	1.0202	4.00900
4750	5.00	1.0277	3.95868	1.0248	3.98410	1.0216	3.97810	1.0204	4.00203	1.0207	4.01704	1.0200	4.02038
5000	4.00	1.0266	4.02373	1.0250	4.02859	1.0216	4.03988	1.0196	4.05472	1.0197	4.06150	1.0198	4.06273
5000	5.00	1.0233	4.02145	1.0225	4.02617	1.0208	4.03902	1.0198	4.05823	1.0202	4.06821	1.0204	4.06975
5250	4.00	1.0230	4.08471	1.0221	4.08505	1.0199	4.10008	1.0194	4.11123	1.0197	4.11577	1.0197	4.11661
5250	5.00	1.0212	4.05121	1.0202	4.08503	1.0197	4.08862	1.0198	4.11309	1.0198	4.11913	1.0199	4.12089
5500	4.00	1.0187	4.14173	1.0190	4.14541	1.0188	4.15745	1.0192	4.16894	1.0192	4.18040	1.0191	4.17154
5500	5.00	1.0176	4.15850	1.0178	4.14344	1.0188	4.15641	1.0196	4.16905	1.0196	4.17167	1.0194	4.17386
5750	4.00	1.0163	4.19648	1.0188	4.20054	1.0181	4.21059	1.0185	4.21878	1.0184	4.22314	1.0182	4.22382
5750	5.00	1.0133	4.19339	1.0154	4.19889	1.0181	4.20925	1.0185	4.21954	1.0185	4.22462	1.0184	4.22519
6000	4.00	1.0134	4.24928	1.0115	4.25344	1.0168	4.26189	1.0173	4.26873	1.0173	4.27494	1.0173	4.27488
6000	5.00	1.0115	4.24731	1.0134	4.25107	1.0166	4.26243	1.0177	4.27046	1.0177	4.27516	1.0179	4.27578
6250	4.00	1.0115	4.29964	1.0130	4.30374	1.0156	4.31339	1.0163	4.32077	1.0164	4.32337	1.0165	4.32378
6250	5.00	1.0092	4.30826	1.0112	4.30184	1.0145	4.31316	1.0155	4.32174	1.0161	4.32444	1.0161	4.32505
6500	4.00	1.0100	4.34713	1.0115	4.35227	1.0139	4.36310	1.0144	4.36897	1.0140	4.37136	1.0140	4.37176
6500	5.00	1.0082	4.34372	1.0092	4.35116	1.0125	4.36224	1.0133	4.37017	1.0136	4.37262	1.0135	4.37311
6750	4.00	1.0083	4.39470	1.0098	4.39897	1.0118	4.40947	1.0126	4.41564	1.0128	4.41770	1.0130	4.41810
6750	5.00	1.0040	4.39281	1.0086	4.39329	1.0103	4.41134	1.0113	4.41888	1.0118	4.41918	1.0119	4.41966
7000	4.00	1.0066	4.44101	1.0077	4.44648	1.0103	4.45648	1.0108	4.46099	1.0108	4.46230	1.0109	4.46289
7000	5.00	1.0012	4.44002	1.0037	4.44576	1.0075	4.45739	1.0087	4.46243	1.0087	4.46391	1.0089	4.46451
7250	4.00	1.0043	4.48659	1.0058	4.49174	1.0078	4.50131	1.0086	4.50533	1.0084	4.50652	1.0085	4.50682
7250	5.00	0.9982	4.48525	1.0004	4.49114	1.0041	4.50223	1.0051	4.50618	1.0053	4.50817	1.0056	4.50840
7500	4.00	0.9985	4.53501	0.9984	4.54125	1.0058	4.54527	1.0055	4.54912	1.0061	4.55019	1.0063	4.55038
7500	5.00	0.9951	4.52939	0.9973	4.53852	1.0007	4.54575	1.0015	4.54947	1.0020	4.55188	1.0021	4.55180
7750	4.00	0.9970	4.58211	0.9973	4.58901	1.0000	4.59477	1.0001	4.60170	1.0003	4.60329	1.0003	4.60361
7750	5.00	0.9918	4.57381	0.9932	4.57984	0.9969	4.58546	0.9978	4.59166	0.9980	4.59333	0.9983	4.59340
8000	4.00	0.9950	4.62493	0.9957	4.63164	0.9985	4.63932	0.9986	4.64381	0.9987	4.64527	0.9987	4.64551
8000	5.00	0.9840	4.62367	0.9883	4.62291	0.9924	4.62901	0.9936	4.63323	0.9940	4.63458	0.9941	4.63472
8250	4.00	0.9954	4.66873	0.9949	4.67282	0.9976	4.68101	0.9978	4.68481	0.9978	4.68615	0.9978	4.68639
8250	5.00	0.9818	4.66528	0.9820	4.67207	0.9851	4.68070	0.9853	4.68246	0.9891	4.67607	0.9894	4.67609

is the large sensitivity of  $R$ -factors to the effective temperature ( $R \sim T_{\text{eff}}^3$ ) and their slight dependence on the secondary atmospheric parameters. Therefore, the uncertainties in the derived effective temperature associated to errors in the gravity and metallicity assignment are small compared to those due to the determination of the bolometric and monochromatic fluxes.

The monochromatic fluxes are obtained by applying the relation

$$F(\lambda_{\text{IR}}) = q(\lambda_{\text{IR}}, T_{\text{eff}}, [\text{Fe}/\text{H}], g) [F_{\text{cal}}(\lambda_{\text{IR}}) 10^{-0.4(m-m_{\text{cal}})}] \quad (3)$$

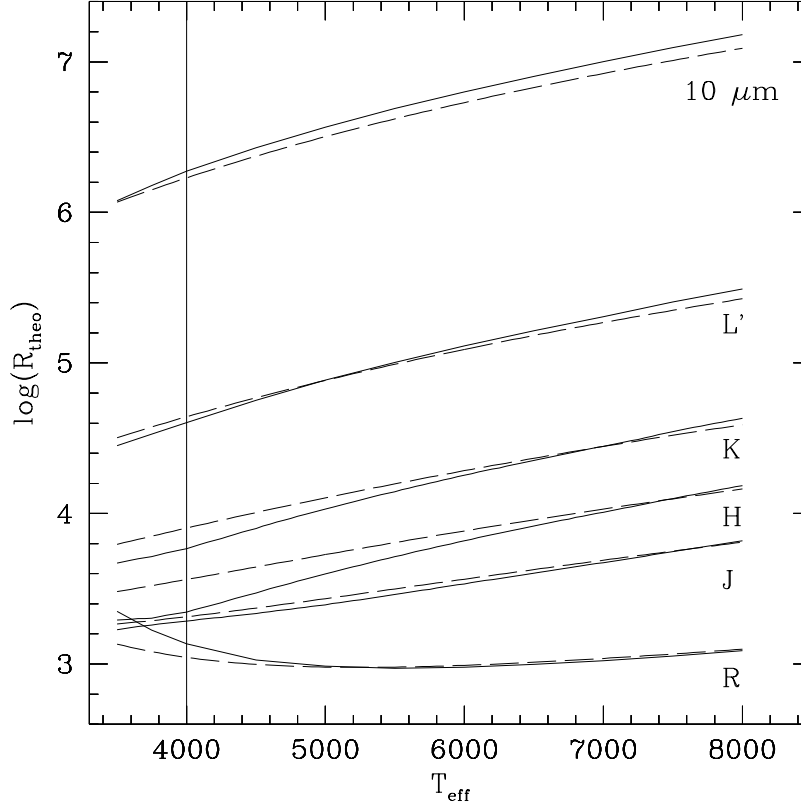
where  $m$  and  $m_{\text{cal}}$  are, respectively, the magnitudes of the problem and standard star,  $\lambda_{\text{IR}}$  is the selected wavelength at the infrared (which should be close to the maximum transmission of the photometric band),  $F_{\text{cal}}(\lambda_{\text{IR}})$  is the absolute flux of the standard star at  $\lambda_{\text{IR}}$ , and  $q(\lambda_{\text{IR}}, T_{\text{eff}}, [\text{Fe}/\text{H}], g)$  is a dimensionless factor which corrects the effect of the different curvature of the flux density distribution, across the filter window, between the stan-

dard and the problem stars (see Sect. 3.2 for further details).

**Table 5.** The influence of the reddening and the uncertainty in the Calibration of the Absolute Flux in the IR (CAFIR) on the temperatures derived using IRFM. The errors induced by the uncertainties on the absolute flux calibration are slightly overestimated, since the change in the bolometric flux has not been taken into account

Input parameter	Error	Error on $T_{\text{eff}}$ (%)				
		3500	4000	5000	6000	7500
E(B-V)	0.05 mag	2.1	1.6	2.6	3.6	4.5
CAFIR J [Fe/H]=0.0	3 %	2.75	3	2	1.4	1.2
CAFIR J [Fe/H]=-3.0	3 %	3.25	2.75	2	1.4	1.2
CAFIR H [Fe/H]=0.0	4 %	6	1.6	1.4	1.2	1.2
CAFIR H [Fe/H]=-3.0	4 %	1.75	2	1.75	1.2	1.2
CAFIR K [Fe/H]=0.0	4 %	2.4	1.4	1.4	1.2	1.2
CAFIR K [Fe/H]=-3.0	4 %	1.6	1.6	1.4	1.2	1.2
CAFIR mean	—	2.0	1.7	1.6	1.25	1.2

The separation of observational inputs and theoretical factors for the implementation of the IRFM is provided



**Fig. 1.**  $R_{\text{theo}}$  factors computed using solar metallicity models developed by Kurucz (1991). The wavelengths considered are  $\lambda_R = 790$  nm,  $\lambda_J = 1272.5$  nm,  $\lambda_H = 1635$  nm,  $\lambda_K = 2175$  nm,  $\lambda_{L'} = 3690$  nm, and a point in the far IR at  $10 \mu\text{m}$ . The dashed lines correspond to  $R_{\text{theo}}$  factors derived from blackbody flux densities. The vertical line ( $T_{\text{eff}}=4000$  K) shows the lower limit of applicability of IRFM with these models

**Table 6.** Mean accidental errors of the effective temperature derived applying the IRFM in the band K

Input parameter	Error	Error on $T_{\text{eff}}$ (%)				
		3500 K	4000 K	5000 K	6000 K	7500 K
$qR_{\text{theo}}$	5 (%)	3	1.5	1.5	1.5	1.5
$\log(g)$	0.5 dex	2	1.5	0.1	0.1	0.1
$[\text{Fe}/\text{H}]$	0.3 dex	1	0.75	0.15	0.15	0.15
Total		3.3	2	1.5	1.5	1.5

by substituting relation (3) in Eq. (2) as follows,

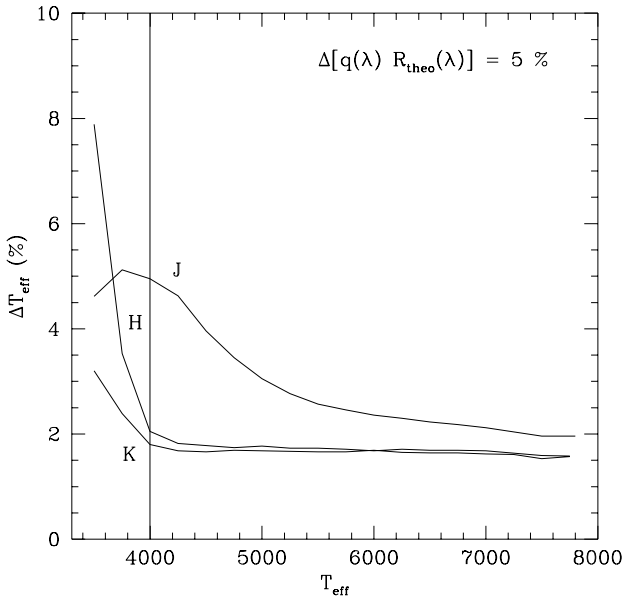
$$\frac{F_{\text{Bol}}}{F_{\text{cal}}(\lambda_{\text{IR}}, T_{\text{eff}}, [\text{Fe}/\text{H}], g) R_{\text{theo}}(\lambda_{\text{IR}}, T_{\text{eff}}, [\text{Fe}/\text{H}], g)} =$$

$$= q(\lambda_{\text{IR}}, T_{\text{eff}}, [\text{Fe}/\text{H}], g) R_{\text{theo}}(\lambda_{\text{IR}}, T_{\text{eff}}, [\text{Fe}/\text{H}], g) \quad (4)$$

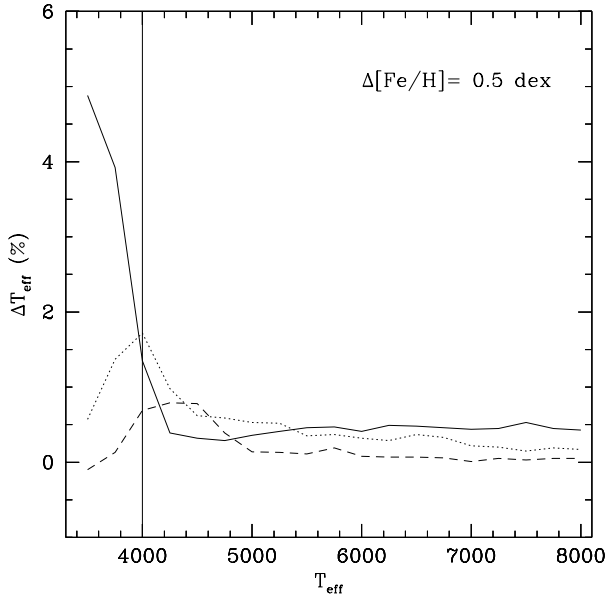
Once  $[\text{Fe}/\text{H}]$  and  $\log(g)$  are known for a certain star, the observational quantities on the left-hand side of Eq. (4) determine the star's effective temperature by comparing to the theoretical information from models on the right-hand side. It is worthy to notice that in a strict sense, models are also needed to obtain the integrated flux in order to

**Table 7.** Comparison between the temperatures derived in the present work (Col. 2) and those derived by Saxner & Hammarbäck (1985) (Col. 3). The mean difference  $T_{\text{IRFM}} - T_{\text{SH85}}$  is  $5 \pm 63$  K

Star	$T_{\text{IRFM}}$ (K)	$T_{\text{SH85}}$ (K)	$\Delta T$	$\Delta T$ (K) (%)
HR0458	6155	6140	15	0.24
HR0483	5874	5810	64	1.09
HR0937	5996	5890	106	1.77
HR1101	5998	5940	58	0.97
HR1543	6482	6470	12	0.19
HR1729	5847	5810	37	0.63
HR1983	6260	6260	0	0.00
HR2085	7013	7160	-147	-2.10
HR2852	7020	7060	-40	-0.57
HR2943	6579	6640	-61	-0.93
HR4540	6095	6120	-25	-0.41
HR4785	5867	5810	57	0.97
HR5447	6770	6760	10	0.15
HR5634	6571	6570	1	0.02
HR5868	5897	5890	7	0.12
HR5914	5774	5870	-96	-1.66
HR5933	6233	6220	13	0.21
HR8905	5954	5870	84	1.41



**Fig. 2.** Uncertainty on the IRFM temperature induced by an error of 5% in the observational quotient  $\frac{F_{\text{Bol}}}{F_{\text{cal}}(\lambda_{\text{IR}})10^{-0.4(m-m_{\text{cal}})}}$



**Fig. 3.** Uncertainty on the IRFM temperature induced by an error of 0.5 dex in  $[\text{Fe}/\text{H}]$ . Solid line: change from  $[\text{Fe}/\text{H}]=0$  to  $[\text{Fe}/\text{H}]=-0.5$ ; dotted line: change from  $[\text{Fe}/\text{H}]=-1$  to  $[\text{Fe}/\text{H}]=-1.5$ ; dashed line: change from  $[\text{Fe}/\text{H}]=-2.5$  to  $[\text{Fe}/\text{H}]=-3$

complete the missed flux in the UV and far IR, however, these corrections are small (see for instance Petford et al. (1991) and Paper II).

### 3. Model information: The $R$ - and $q$ -factors

The theoretical flux density distributions used in this work to implement the IRFM were obtained using Kurucz's (1991, 1993) new models. Blackwell and Lynas-Gray (1994) have also used them for the application of the IRFM. These models are widely described in Kurucz (1991). Here we briefly summarize their features concerning the aims of the present programme:

1. The major difference concerning opacities is the use of new iron group atomic lines, which are expected to diminish the problem of the missing opacity in the UV (Magain 1987). The computed opacities consider the effect of 58 million lines both atomic and molecular (which increases in a factor of roughly 30 the number in old models). Diatomic molecules considered include  $\text{H}_2$ ,  $\text{SiO}$ ,  $\text{CH}$ ,  $\text{NH}$ ,  $\text{OH}$ ,  $\text{MgH}$ ,  $\text{SiH}$ ,  $\text{C}_2$ ,  $\text{TiO}$ ,  $\text{CN}$  and  $\text{CO}$ . Regrettably the effects of triatomic molecules, as water vapor, are not considered. In the range 1.75–2.1  $\mu\text{m}$  the contribution to the opacity from water vapour has great influence on the IR flux of cool stars ( $T_{\text{eff}} \leq 4500$  K), specially for solar abundance. This fact sets a lower limit at late K stars for the applicability of the IRFM using these models (see Sect. 5).
2. The physics remains essentially the same that in older Kurucz's models (see Kurucz 1979a, b) since the problem of the opacity has been paid major attention. However, the new models contain slight improvements in the treatment of convection including approximative overshooting. The mixing length to scale height ratio ( $\alpha/H$ ) adopted is 1.25. The solar metal abundances are those derived by Anders & Grevesse (1989). The microturbulent velocity is 2 km/s.
3. From a practical point of view, the new models sample physical parameters in a denser grid: Abundances are sampled in 0.1 dex steps from  $[\text{Fe}/\text{H}]=1.00$  to  $[\text{Fe}/\text{H}]=-0.5$ , and in 0.5 dex steps from  $[\text{Fe}/\text{H}]=-0.5$  to  $[\text{Fe}/\text{H}]=-4.0$ . Gravities are sampled in 0.5 dex steps and temperatures in 250 K steps under 8000 K.
4. Model fluxes are sampled in 1221 points covering a wavelength interval from 9 to 160000 nm. The resolution ranges within 1 nm in the UV, 2 nm in the visible and the band J, 5 nm in the band H and 10 nm in the band K. The sampling in the near IR implies a remarkable improvement as far as previous models are concerned, which allows to avoid interpolations.

#### 3.1. $R_{\text{theo}}(\lambda_{\text{IR}})$ factors

The flux density distributions of models described in the previous section have been used to calculate  $R_{\text{theo}}(\lambda_{\text{IR}})$

**Table 8.** Comparison between the temperatures derived in the present work (Col. 2) and those derived by Magain (1987) (Col. 3). The mean difference  $T_{IRFM} - T_{M87}$  is  $112 \pm 56$  K

Star	$T_{IRFM}$ (K)	$T_{M87}$ (K)	$\Delta T$ (K)	$\Delta T$ (%)
HD19445	6050	5933	117	1.93
HD64000 <sup>(1)</sup>	5441	5370	71	1.36
HD74000	6224	6135	89	1.40
HD84937 <sup>(2)</sup>	6330	6210	120	1.90
HD94028 <sup>(3)</sup>	6001	5777	224	3.73
HD108177	6034	6026	8	0.01
HD132475	5788	5614	174	3.00
HD140283	5691	5607	84	1.47
BD +42 2667 <sup>(4)</sup>	6059	5955	104	1.71
HD201891	5909	5761	148	2.56
HD219617	6012	5918	94	1.56

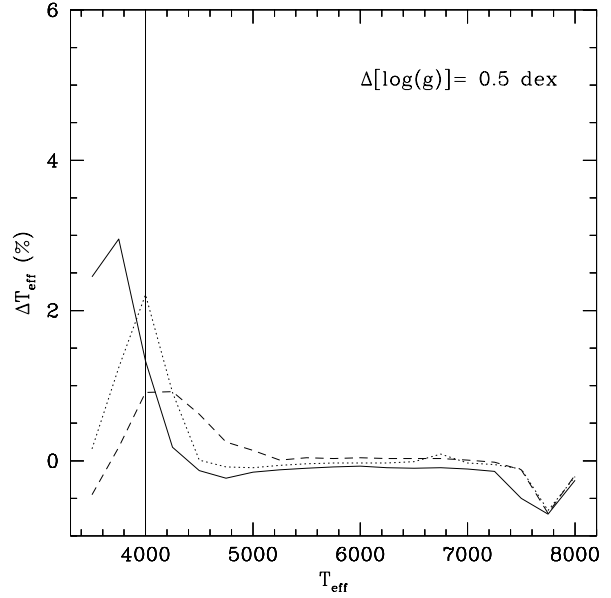
- (1) G090-025  
(2) G043-003  
(3) G058-025  
(4) G180-024

**Table 9.** Comparison between the temperatures derived in the present work (Col. 2) and those derived by Bell & Gustafsson (1989) (Col. 3). The mean difference  $T_{IRFM} - T_{BG89}$  over 4500 K is  $-49 \pm 75$  K

Star	$T_{IRFM}$ (K)	$T_{BL89}$ (K)	$\Delta T$ (K)	$\Delta T$ (%)
HR219	5817	5839	-22	-0.38
HR753	4718	4775	-57	-1.21
HR4785	5867	5861	6	0.10
HR4983	5964	6024	-60	-1.01
HR7503	5763	5826	-63	-1.09
HR7504	5767	5664	103	1.79
HR4496	5342	5552	-210	-3.93
HR7462	5227	5253	-26	-0.50
HR1325	5079	5114	-35	-0.69
HR1084	5076	5156	-80	-1.58
HR8832	4805	4896	-91	-1.89
HR8085	4323	4463	-140	-3.24
HR8086	3865	4252	-387	-10.01

factors, as defined in Eq. (2). The closest wavelengths to the effective wavelengths of the  $J$ ,  $H$ , and  $K$  photometric bands sampled by the models were selected ( $\lambda_J = 1272.5$  nm,  $\lambda_H = 1635.0$  nm and  $\lambda_K = 2175.0$  nm). The effective wavelengths were computed considering the instrumental response of the TCS system (Paper I), and the atmospheric transparency (Manduca & Bell 1979; Glass 1985; Mountain 1983). Tables 1-3 contain the theoretical values of  $\log(R)$  for these three wavelengths. Effective temperatures cover the range 3500–8250 K, surface gravities cover the range  $\log(g)=(3.5, 5.0)$ , and metallicities cover the range (0.5,  $-3.5$ ).

Figure 1 shows the  $\log(R)$  factors for solar metallicity. In addition to  $R$ -factors corresponding to the three wavelengths selected in this work, those corresponding to the  $R$  band (Johnson 1966) at  $\lambda_R = 790$  nm,  $L'$  from TCS system (Paper II) at  $\lambda_{L'} = 3690.0$  nm, and a far



**Fig. 4.** Uncertainty on the IRFM temperature induced by an error of 0.5 dex in  $\log(g)$ . Solid line:  $[\text{Fe}/\text{H}]=0.0$ ; dotted line:  $[\text{Fe}/\text{H}]=-1$ ; dashed line:  $[\text{Fe}/\text{H}]=-2$

IR point at 10004.0 nm have been also plotted to display their overall properties. The correlation of gradient  $\Delta \log(R_{\text{theo}})/\Delta T_{\text{eff}}$  with wavelength may be appreciated in the figure (i.e. the sensitivity of  $R$ -factors to temperature increases with wavelength). The relation  $\log(R_{\text{theo}}) - T_{\text{eff}}$  is double-valued for the band  $R$ , which implies that it is useless to apply the IRFM in the considered  $T_{\text{eff}}$  range.

Among the three wavelengths considered in this work, the  $R_J$  factors are the least sensitive to temperature, especially for  $T_{\text{eff}}$  lower than 5000 K. The sensitivities of the  $R_H$  and  $R_K$  are comparable, although as will be discussed in Sect. 5, temperatures lower than 4000 K derived using  $R_H$  are less reliable, due to the uncertainty associated to the minimum of the  $\text{H}^-$  opacity reached in this band. The variations induced by the change in metallicity or surface gravity are only important for  $T_{\text{eff}}$  lower than 4250 K. In particular, the variation of  $R$ -factors in the range  $\log(g) = 4 - 5$  is almost negligible. For this reason, the assignation of gravity has been done in a somewhat rough fashion, which satisfies nevertheless the accuracy requirements of this work.

### 3.2. $q(\lambda_{\text{IR}})$ factors

The use of broad band photometry to obtain the IR monochromatic fluxes requires the application of the

so-called  $q$ -factors introduced in Eq. (3), and defined as

$$q(\lambda_{\text{IR}}) = \frac{\int_{\lambda_1}^{\lambda_2} K_{\text{cal}}(\lambda, \lambda_{\text{IR}})T(\lambda)d\lambda}{\int_{\lambda_1}^{\lambda_2} K(\lambda, \lambda_{\text{IR}})T(\lambda)d\lambda}, \quad (5)$$

where  $T(\lambda)$  is the instrumental transmission of the photometric system, which includes the detector response, the optical system of the telescope and photometer, and the absorption of the atmosphere. The function  $K(\lambda, \lambda_{\text{IR}})$  is the stellar flux density normalized to the value of flux density at  $\lambda_{\text{IR}}$ , and  $(\lambda_1, \lambda_2)$  is the bandpass of the system (see Appendix 1 in Paper II for further details). The  $q$ -factors allow to cope with the problem of deriving the flux in a specific wavelength from the filter-integrated flux in the whole photometric band. An optional approach to this problem is described in Saxner & Hammarbäck (1985).

Ideally,  $q$ -factors should be determined from spectroscopic data, considering a set of stars sampling homogeneously the domain of physical parameters in  $T_{\text{eff}}$ ,  $\log(g)$  and  $[\text{Fe}/\text{H}]$ . Unfortunately the data-base of registered IR spectra is insufficient to make this approach realistic. In practice, we can rely on a grid of models to compute  $q$  factors. Tables 1-3 contain  $q$ -factors for bands  $J$ ,  $H$  and  $K$ , ordered according to temperature, gravity and metallicity. The physical parameters adopted to generate the model for the calibration star (Vega) were  $T_{\text{eff}}=9610$  K,  $\log(g)=3.95$ ,  $[\text{Fe}/\text{H}]=-0.25$ . Note that the  $q$ -factors imply secondary corrections in most of the range studied.

### 3.3. Sensitivity of $q \times R$ to the effective temperature

The separation of terms in Eq. (4) (i.e. theoretical elements in the right-handside, and observational data in the left-handside) provides a simple way of analysing the influence of errors on the derived temperatures. Tables 1-3 contain the calibration of  $R$ - and  $q$ -factors generated with Kurucz's new models as a function of temperature, metallicity and surface gravity. These relations allow to determine the errors induced by the different variables on the derived temperatures.

Figure 2 shows the error in temperature induced by a variation of 5% in factor  $q \times R$  (the theoretical counterpart to the quotient  $F_{\text{BoI}}/F(\lambda_{\text{IR}})$ ). As it may be appreciated, the change in temperatures derived using  $R_H$  and  $R_K$  factors is approximately constant over 4000 K: 1.5–2% for  $T_H$  and 1.5% for  $T_K$ . The change of  $T_J$  varies from 5% at 4000 K to 2% at 8000 K. Hence,  $R_J$  is the worse indicator of  $T_{\text{eff}}$  for the application of the IRFM, and will only be used over 5000 K.

Figure 3 shows the influence of an error of 0.5 dex in metallicity on the temperature derived applying the IRFM in the band  $K$ . Over 4200 K the average error is under 0.25%.

Figure 4 shows the influence of an error of 0.5 dex in  $\log(g)$  on the temperature derived in the band  $K$ . The changes in temperature are practically negligible between 4200 K and 7500 K. Between 4000 K and 4200 K the change amounts 1–2%. Over 7500 K the change may amount –0.5%.

## 4. Observational inputs for the IRFM

In the following paragraphs the different observational inputs which enter the application of the IRFM will be commented. First of all, we provide a description of the sample of stars collected for this program.

### 4.1. The selection of the sample

The stars of the sample were extracted mainly from three independent photometric surveys: Sandage & Kowal (1986), Carney & Latham (1987) and Schuster & Nissen (1988). These works are involved with the study of different properties of halo field stars, and provide broad band  $UBV$  and Strömrgren photometry. The selected sample of stars covers the entire range of effective temperature and metallicity observed in the main sequence of globular clusters, and intermediate and old disk clusters (i.e. late spectral types of luminosity class V and VI). The stars of the sample range practically  $0.3 < (B - V) < 1.7$ ,  $0.1 < (b - y) < 1.0$ , and  $0.0 < \delta_{0.6}(B - V) < 0.3$ , which roughly implies  $-3.5 < [\text{Fe}/\text{H}] < 0.5$ . After the measurement of IR photometry (Paper I), the stars with  $(V - K) \geq 4.2$  were discarded since the practical limit in temperatures of the models is around this value (equivalent to  $\sim 3500$  K). A subsample containing dwarfs, and all the subdwarfs from the Catalogue of Spectroscopic Abundances (Cayrel de Strobel et al. 1992) with  $[\text{Fe}/\text{H}] < 0$ , observable from the Teide Observatory ( $66^\circ > \delta > -28^\circ$ ) has also been included in order to revise the published relations  $[\text{Fe}/\text{H}] = f((b - y), m_1, c_1, \delta_{0.6}(U - B), (B - V) \dots)$ . The revisions will provide good estimates of the metallicity for the remainder of the stars of the programme (see Sect. 4.5). A number of stars in the sample are in the input catalogue of the Hipparcos mission. The sample also contains a group of metal poor stars whose parallaxes have been accurately determined (Sandage 1983; Laird et al. 1987; Van Altena et al. 1988).

The dwarfs and subdwarfs from Carney (1983a, b) not common to Paper I were incorporated in order to increase the sampling of the metallicity range for types F0-K0. It is noteworthy the good quality of Carney's photometry, and also the close similarity of TCS and CIT infrared systems. The dwarfs contained in the list of calibration stars of the TCS (Kidger 1992) not measured for this programme have also been incorporated into the sample. Some stars contained in the study of M dwarfs by Legget (1992) with  $(V - K) \leq 4.0$  were initially

**Table 10.** Comparison between the temperatures derived in the present work (Col. 2) and those derived by Blackwell & Lynas-Gray (1994) (Col. 3). The mean difference  $T_{\text{IRFM}} - T_{\text{BG89}}$  is  $-31 \pm 58$  K

Star	$T_{\text{IRFM}}$ (K)	$T_{\text{BL94}}$ (K)	$\Delta T$ (%)	$\Delta T$ (K)
HR0509	5388	5316	-1.34	72
HR0219 *	5817	6044	3.90	-227
HR0937	5996	6042	0.77	-46
HR1101	5998	5977	-0.35	21
HR1325	5079	5163	1.65	-84
HR1729	5847	5947	1.71	-100
HR5447	6770	6763	-0.10	7
HR5634	6571	6617	0.70	-46
HR5986	6158	6169	0.18	-11
HR8905	5954	6050	1.61	-96

\* This spectroscopic binary star has been discarded in the computation of the mean difference.

included in the sample, but their cool temperatures (3500–4000 K) are well under limit of validity of the models due to the problems associated to the computation of molecular opacities (Kurucz 1991). Finally, some bright population I stars from Saxner & Hammarbäck (1985) and Bell & Gustafsson (1989), and population II stars from Arribas & Martínez-Roger (1989), who provide temperatures obtained by applying the IRFM, have been included in the sample in order to make comparisons.

In summary, the final sample consists of nearly 500 stars. This number clearly surpasses that of the previous works devoted to the study of the scale of temperatures of low main sequence, especially those which analyse metallicity effects.

#### 4.2. The IR monochromatic fluxes

The determination of monochromatic fluxes at a wavelength of the IR continuum requires, from the observational side, the measurement of IR photometry for the problem stars with respect to a standard whose absolute flux be well determined. By using the results summarised in Sects. 4.2.1 and 4.2.2, we have determined the monochromatic fluxes in  $\lambda_J$ ,  $\lambda_H$  and  $\lambda_K$  for each star in the present sample, which are listed in Table 4.

##### 4.2.1. The IR photometry

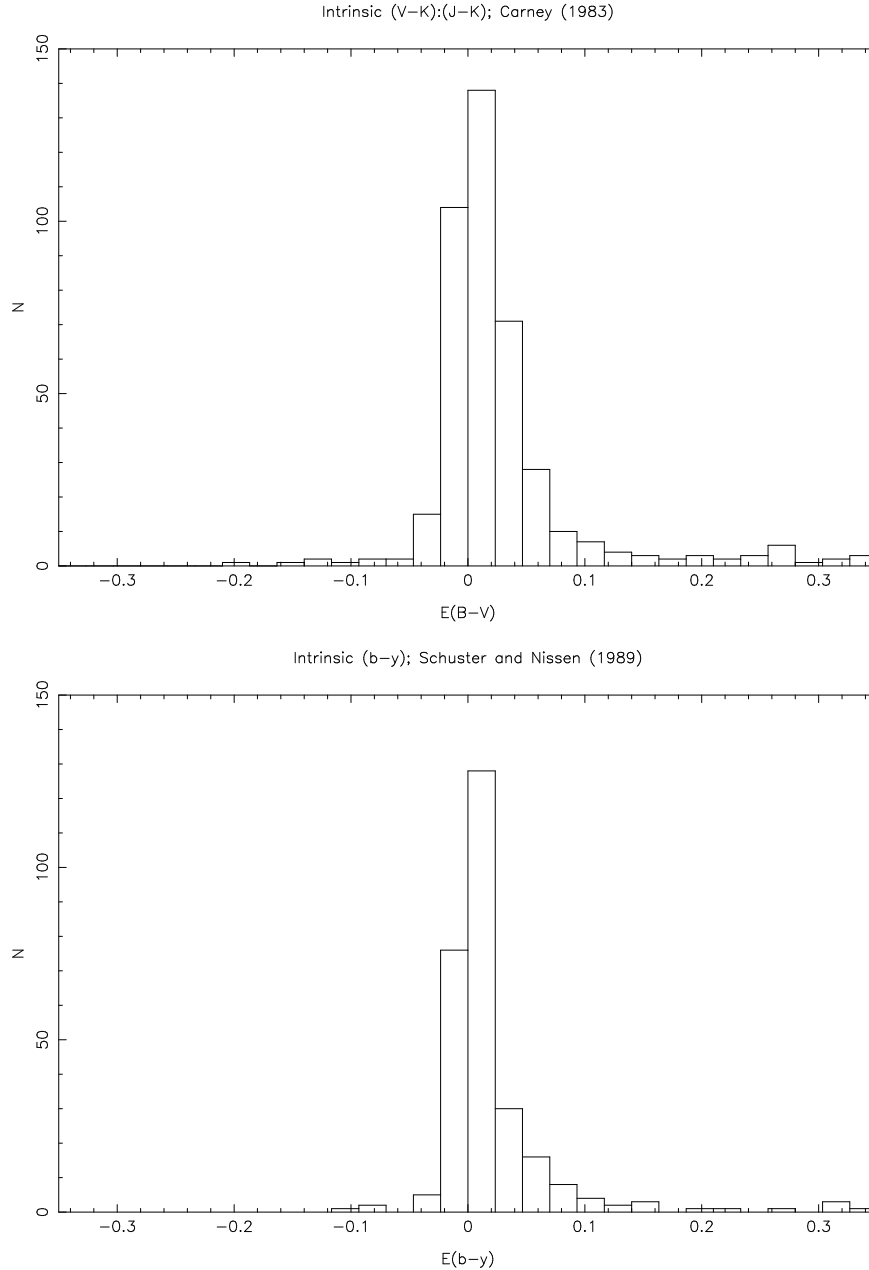
The programme of broad band photometry in the near IR is described in Paper I. There, the photometric system of the TCS was characterized and the transformation equations into/from different photometric systems were established. The  $J$ ,  $H$  and  $K$  magnitudes were measured for 75% of the stars in the sample, with an accuracy in the order of 0.02 mag. For the remainder of the stars, the photometry was obtained from the literature (Carney 1983a, b; Legget 1992; Kidger 1992; Saxner & Hammarbäck 1985; Bell & Gustafsson 1989), after checking that these works had a similar level of accuracy.

The isolated effect of the photometric errors on the  $T_{\text{eff}}$  determination can be inferred from Sect. 3.3, taking into account Eq. (4).

##### 4.2.2. The absolute calibration of the IR flux

In Paper II, a semiempirical method was devised to determine the absolute calibration of the flux of Vega in the near IR (from  $J$  to  $L'$ ). This absolute calibration sets on the same scale the temperatures derived applying the IRFM with new Kurucz's models and the mean direct temperatures derived from angular diameters measurements. When compared to the results of the only so far empirical calibration, summarised by Mountain et al. (1985, M85), a clear trend with wavelength may be appreciated (+0.2% in the band  $J$ ,  $-1.5\%$  in the band  $H$  and  $-4.5\%$  in the band  $K$ ). This point suggests that the IR fluxes for Vega by M85 are overestimated towards the longest wavelengths. However, it is worth noticing the good agreement (within 1%) with the semiempirical calibration for Vega provided by Walker & Cohen (1992), the theoretical one by Dreiling & Bell (1980) and the 'self-consistent' calibration by Blackwell et al. (1991).

The errors in the absolute IR flux calibration have different effects on the temperatures derived by mean of the IRFM, depending on the photometric band (Table 5). The errors of the absolute IR flux calibration were estimated 3% in the band  $J$ , and 4% in the bands  $H$  and  $K$ . Over 4000 K the effect of these errors is practically a shift in the zero point of the temperatures scale. Considering that the above errors correlate in the three bands, the shift in the zero point of the temperature scale would amount 1.2–1.7% over 4000 K. However if, as it is most likely, the errors in the three bands are uncorrelated, the shift of the zero point is around 0.4–0.9%. Although the indetermination of the zero point of the scale is common to all kind of methods used to derive temperatures, the method adopted in Paper II to fix the absolute calibration of the



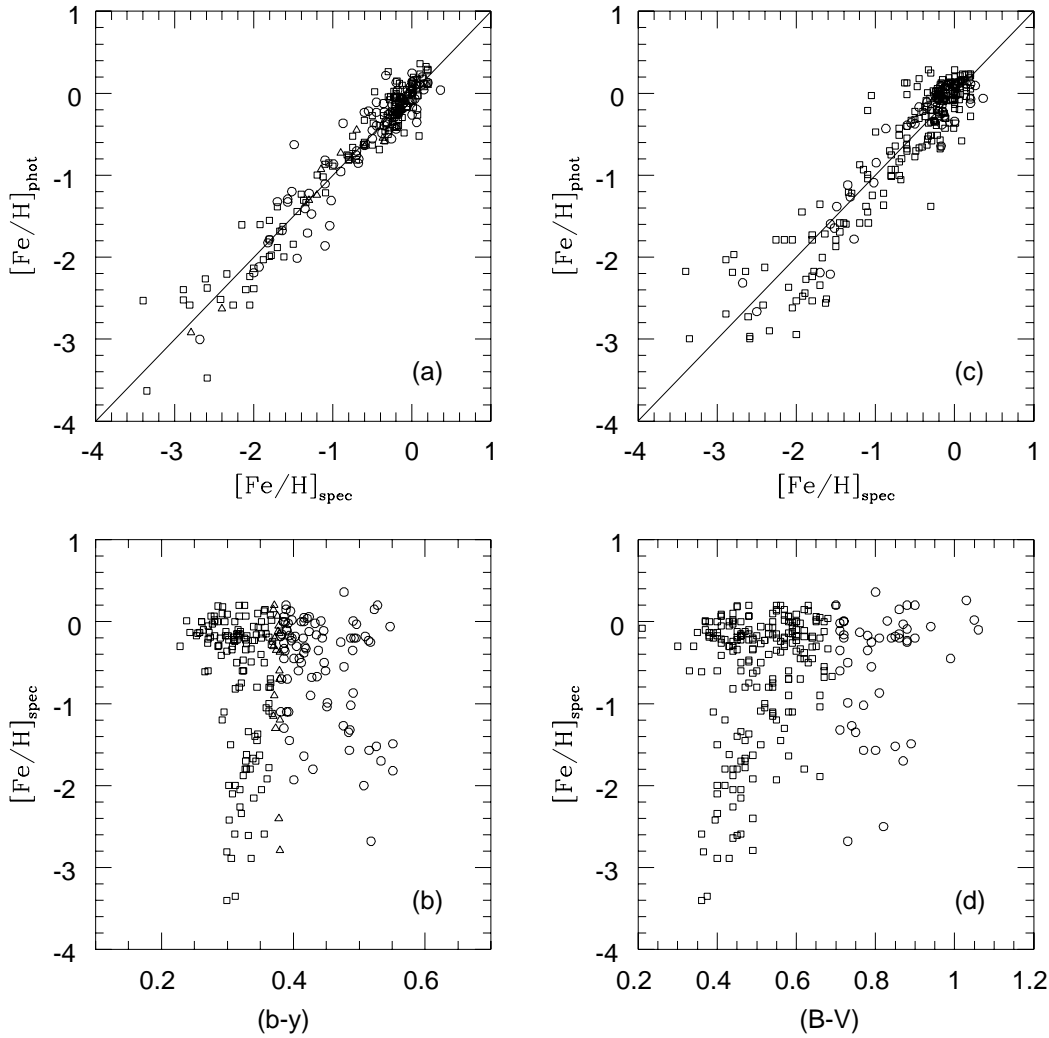
**Fig. 5.** Top: extinction histogram ( $E(B - V)$ ) obtained applying to the stars of the sample the method based on the intrinsic colours  $(V - K):(J - K)$  (Carney 1983). Bottom: extinction histogram ( $E(b - y)$ ) obtained applying to the stars of the sample the method based on the intrinsic relations Strömgren photometry- $\beta$  index (Schuster & Nissen 1989)

flux in the near IR was designed in order to minimise this error.

#### 4.3. The bolometric fluxes

For the spectral types studied in the present work, nearly all the flux arriving at the edge of the earth atmosphere passes through the atmospheric windows. Petford et al. (1988) report an accuracy of the order of 2% when compar-

ing  $F_{\text{bol}}$  derived directly from calibrated spectra to  $F_{\text{Bol}}$  obtained integrating  $UBVRI$  photometry. Therefore, the bolometric flux might be obtained from broad band photometry for each star in the sample. However, photometric calibrations of the type provided by Blackwell & Petford (1991) represent a more practical, and as accurate approach. Unfortunately, this calibrations do not include the effect of the metallicity, being only valid for Population I stars. In order to overcome this difficulty, we provided in

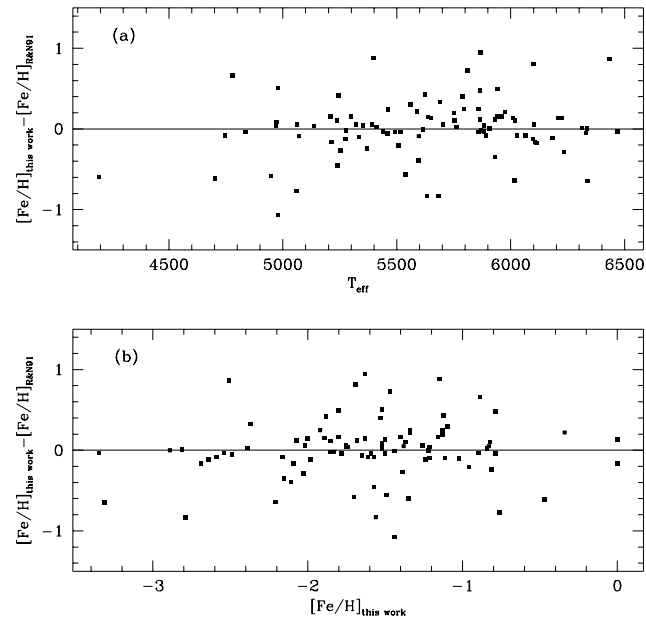


**Fig. 6.** **a)** Comparison between spectroscopic values of the metal abundance (Cayrel de Strobel et al. (1992) and Beers et al. (1991)) and values derived using the calibration by Schuster & Nissen (1989) revised according to expressions (6) and (7). Circles: calibration for F stars, squares: calibration for G stars, triangles: stars in the overlapping range of F and G calibrations. **b)** Range of colour covered by the revised calibration by Schuster & Nissen (1989). **c)** Comparison between spectroscopic values of the metal abundance (Cayrel de Strobel et al. 1992 and Beers et al. 1990) and values derived using the calibration by Carney (1979) revised according to expressions (9) and (10). Squares:  $(B - V) > 0.7$ , circles:  $(B - V) < 0.7$ . **d)** Range of colour covered by the revised calibration by Carney (1979)

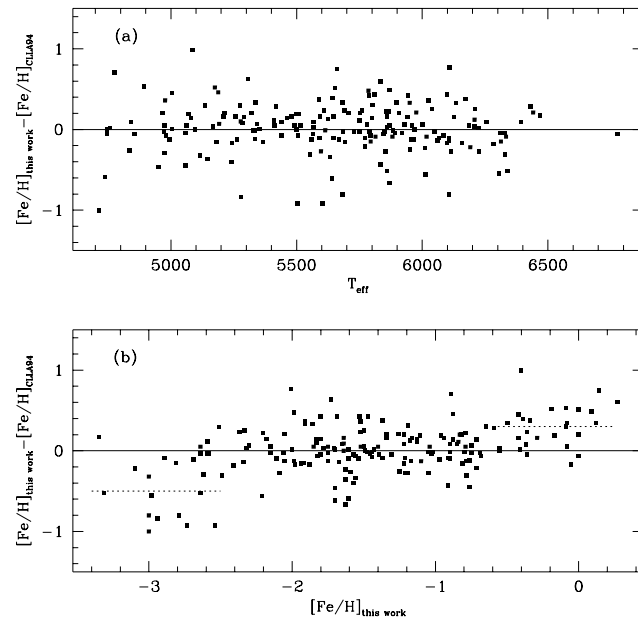
Paper III calibrations of the bolometric flux as a function of  $K$ ,  $(V - K)$  and  $[\text{Fe}/\text{H}]$  for main sequence stars of spectral types F, G and K, which grant the overall level of accuracy expected for the final temperatures derived in this work. It should be noted that these calibrations are ultimately based on the optical absolute flux calibrations of Vega by Hayes & Latham (1975) and Tüg et al. (1977), and the IR absolute flux of Paper II. The bolometric fluxes assigned to the stars in the sample are listed in Table 4.

#### 4.4. The reddening correction

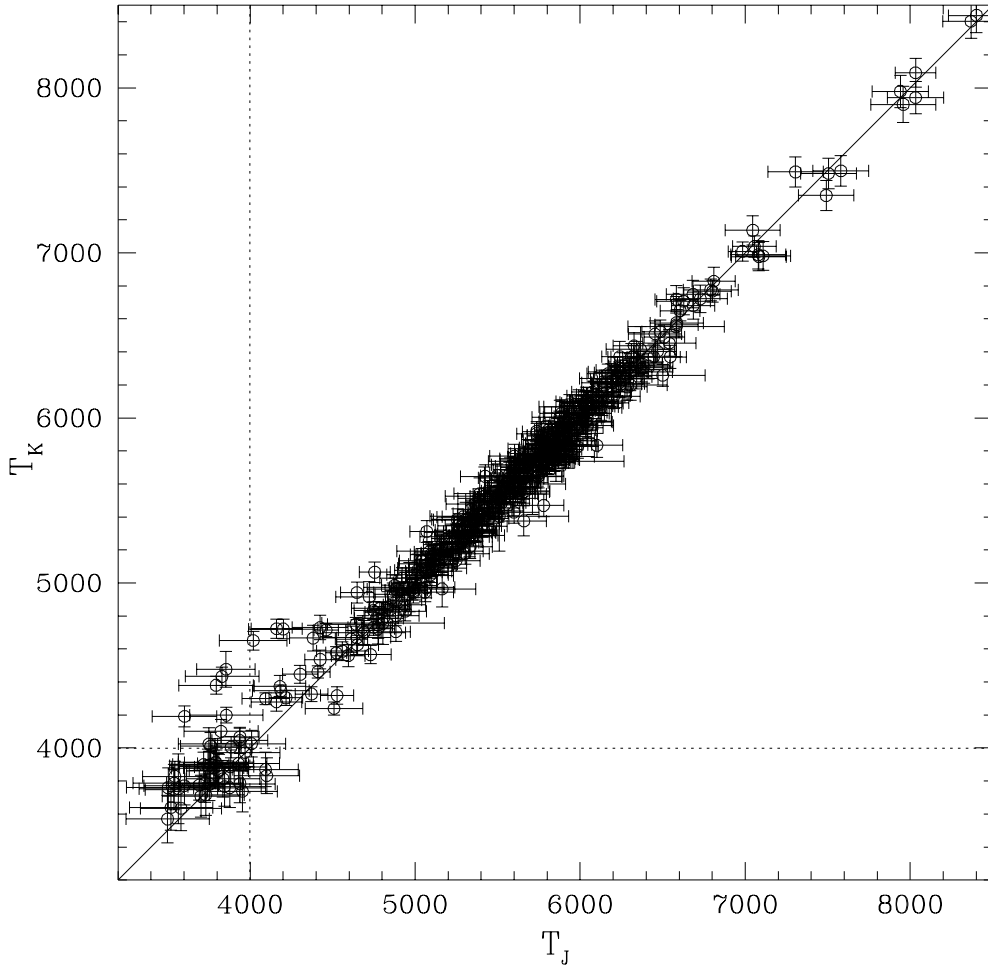
Most of the stars in the sample should not be significantly affected by the interstellar absorption, since are distributed close in the solar neighbourhood. However, in some cases reddening corrections need to be applied. Therefore,  $E(B - V)$  has been estimated for each star in the sample. When these values have been considered significant, the colours have been corrected according to the extinction law ( $A_\lambda = f(A_V, \lambda)$ ) compiled by Landolt-Börnstein (1982c). Two independent methods



**Fig. 7.** a) Differences between the metallicities adopted in this work and those derived by Ryan & Norris (1991) versus effective temperature. b) The same that in a) versus metallicity. The differences show no apparent trends either with temperature or metallicity



**Fig. 8.** a) Differences between the metallicities adopted in this work and those derived by Carney et al. (1994) versus effective temperature. b) The same that in a) versus metallicity. No trend may be appreciated with temperature. However, our  $[\text{Fe}/\text{H}]$  estimate is 0.5 dex higher for  $[\text{Fe}/\text{H}] < -2.5$ , and 0.3 dex lower for  $[\text{Fe}/\text{H}] > -0.5$



**Fig. 9.** Comparison between  $T_J$  and  $T_K$ . The dotted lines mark the lower limit ( $T_{\text{eff}} = 4000$  K) where models begin to falter due to the lacking of molecular opacity sources. It is worth notice the progressive departure of the points from the diagonal towards the cooler stars

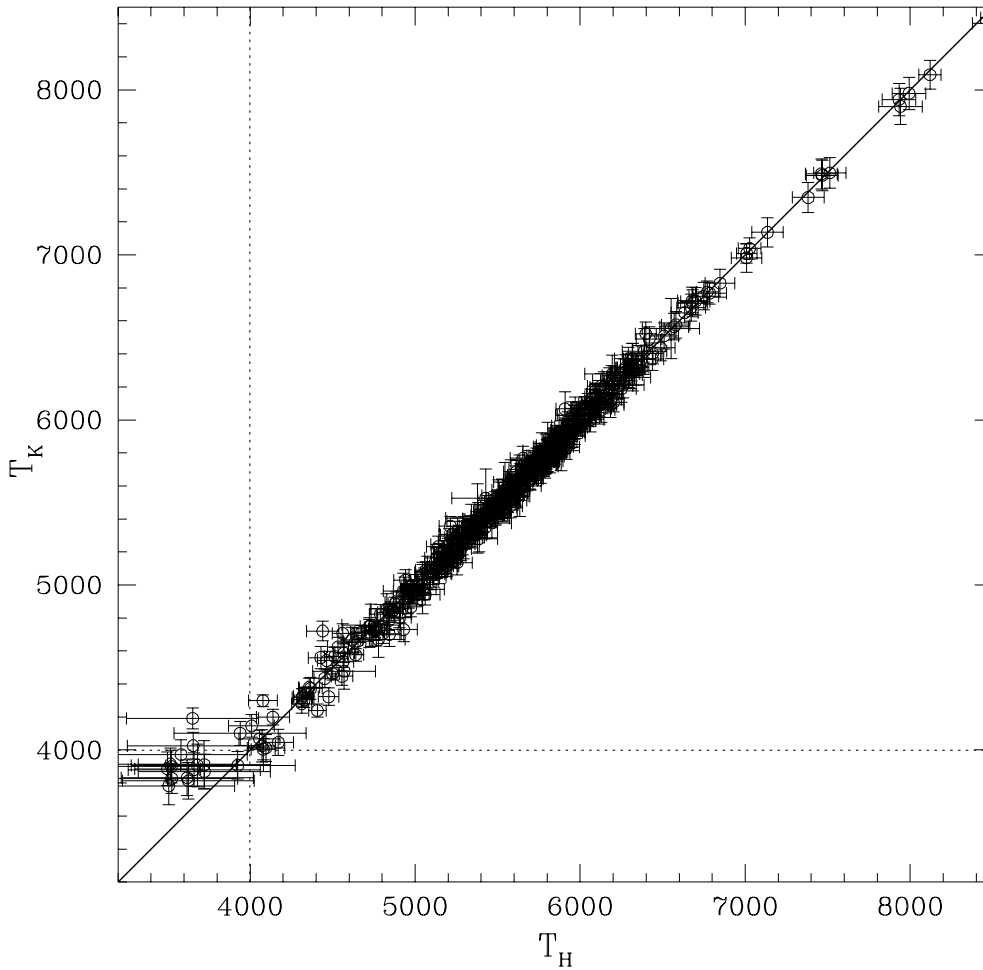
have been considered for determining  $E(B - V)$ . The first one is based on the intrinsic relation  $(V - K):(J - K)$  (Carney 1983a), considering  $E(V - K) = 2.72 E(B - V)$  (Savage & Mathis 1979). The histogram obtained with all the values within the application range is presented in Fig. 5. The second method is based on the  $\beta$  index and Strömgen photometry. Schuster & Nissen (1989) have calibrated  $E(b - y)$  with an accuracy of 0.015 mag. The result of applying this calibration to the stars of the sample is showed in the histogram of Fig. 5.

Moreover a number of stars of the sample have extinction estimations determined by other authors (Laird et al. 1987; Beers et al. 1990) based on reddening maps by Burnstein & Heiles (1982). The correlation between the different methods is acceptable for  $E(B - V) < 0.1$  mag,

over this value it worsens.

When Strömgen and  $\beta$  photometry was available the method by Schuster & Nissen (1989) was preferred, considering  $E(B - V) = 0$  for  $E(b - y) < 0.025$ , and  $E(B - V) = 1.37 E(b - y)$  otherwise (Crawford 1975). The values taken from the literature, and those determined by means of the intrinsic relation  $(V - K) : (J - K)$  were considered for the remainder of the stars. Table 4 contains the reddening value assigned to each star in the sample. Note that only a relatively reduced number of stars (about 15 percent) needed reddening correction.

The first line of Table 5 shows the change in temperature induced by  $E(B - V) = 0.05$  mag when applying the IRFM. The effect is stronger for hot stars which emit most of their flux in the visible/UV wavelength range.



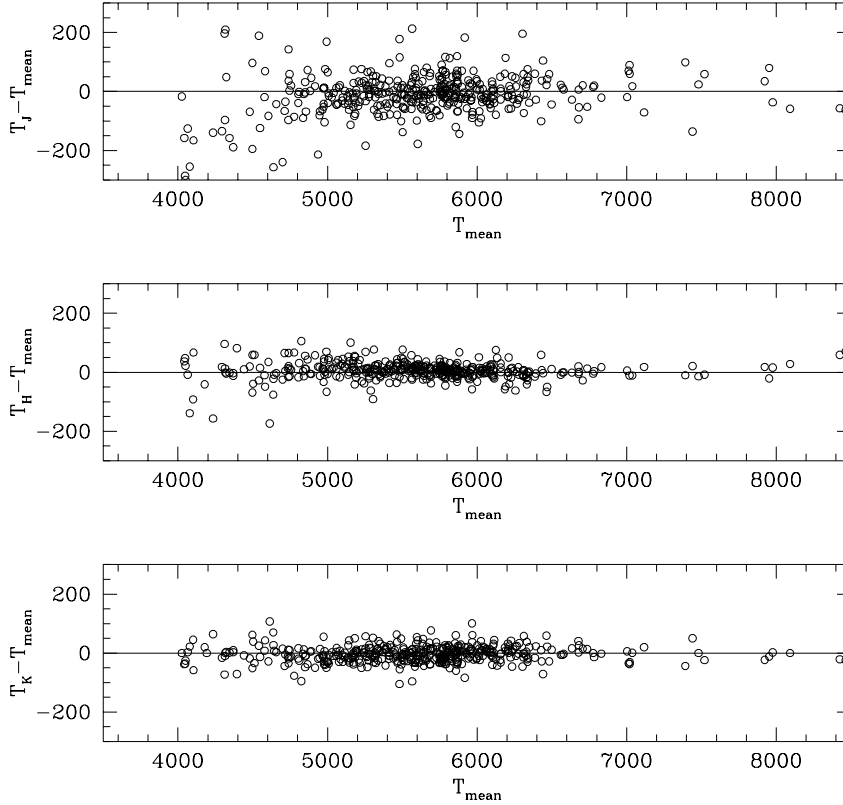
**Fig. 10.** The same that Fig. 9 for  $T_H$  and  $T_K$ . Notice the small dispersion around the diagonal line over 4000 K

#### 4.5. Metallicity and surface gravity

The effective temperature determination by means of Eq. (4) requires an estimation of the star metallicity and surface gravity. These parameters, however, need not to be very accurate as commented in Sect. 3.3. In particular, it may be concluded that 0.5 dex and 0.3 dex uncertainties in  $\log(g)$  and  $[\text{Fe}/\text{H}]$ , respectively, are sufficient to obtain temperatures within an accuracy of 2% (see Table 6). Therefore, regarding the surface gravity, it is enough to consider an average surface gravity  $\log(g)=4.5$  for the subdwarfs. However, taking into account the effect of  $T_{\text{eff}}$  on the stellar radius, we have preferred to assign  $\log(g) = 5$  for the cooler stars, and  $\log(g)=4$  for hottest population I stars. These values are compatible with those provided in the reviews by Popper (1980) and Andersen (1991) for detached binary systems formed by main sequence stars. The gravities adopted for the stars of the sample are listed in Col. 2 of Table 4.

Unfortunately, only a limited number of stars in the sample had their metal abundance determined from fine spectroscopic analysis included in the Catalogue of  $[\text{Fe}/\text{H}]$  determinations by Cayrel de Strobel et al. (1992). Therefore for the remainder of stars, photometric metallicity calibrations based on  $\delta_{0.6}(U - B)$  index (Carney 1979), and on Strömgren photometry (Schuster & Nissen 1989), were adopted.

Instead of apply directly these calibrations, we have checked their validity and accuracy. For this purpose, 252 dwarfs and subdwarfs from Cayrel de Strobel et al. (1992) were considered. For each star we assign an averaged abundance giving preference in the weights to recent data based on solid state detectors. We also included, in that group for checking the photometric calibrations, 45 dwarfs from Beers et al. (1990) common to our sample. We have found slight differences between the photometric calibrations and the spectroscopic values which are



**Fig. 11.** Differences  $T_J - T_{\text{mean}}$  (top),  $T_H - T_{\text{mean}}$  (center) and  $T_K - T_{\text{mean}}$  (bottom) versus effective temperature adopted. No apparent trend may be appreciated

commented below.

(a) *Strömgren photometry calibration.* (Schuster & Nissen 1989): 238 stars with spectroscopic determination of the abundance are within the ranges of the calibrations by Schuster & Nissen (1989). The following corrections were applied:

$$[\text{Fe}/\text{H}]_{\text{phot}}^{\text{F}} = 0.82[\text{Fe}/\text{H}]_{\text{spec}} - 0.08, \quad \sigma = 0.18, \quad \text{dex } n = 150, \quad (6)$$

$$[\text{Fe}/\text{H}]_{\text{phot}}^{\text{G}} = 0.93[\text{Fe}/\text{H}]_{\text{spec}} - 0.01, \quad \sigma = 0.21, \quad \text{dex } n = 105, \quad (7)$$

where the superindex refers to the calibration of type F and G stars. The zero correction is practically negligible, whereas the correction of the slope may imply differences of 0.3–0.5 dex. If we consider both calibrations altogether, the correction should be:

$$[\text{Fe}/\text{H}]_{\text{phot}} = 0.85[\text{Fe}/\text{H}]_{\text{spec}} - 0.04, \quad \sigma = 0.22, \quad \text{dex } n = 238. \quad (8)$$

This result agrees with the conclusion by Schuster & Nissen (1989) that their calibrations should perhaps require a slight correction to adjust the revised spectroscopic

values (they propose a multiplicative factor of correction for their calibration of 1.15 which roughly coincides with our correction).

(b) *Broad band photometry:*  $\delta_{0.6}(U - B)$  (Carney 1979): 259 stars with spectroscopic determinations are within the range of the calibration of  $\delta_{0.6}(U - B)$  index by Carney (1979). This calibration has been extended to the limit permitted by the deblanketing vectors provided by Sandage (1969). Correction differs according to colour.

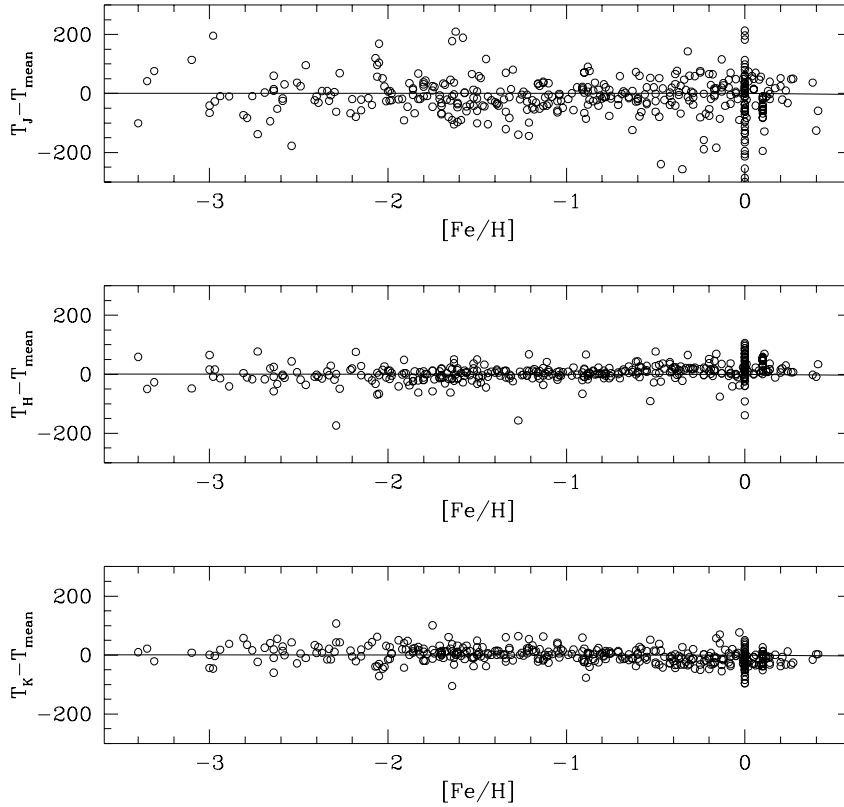
$$[\text{Fe}/\text{H}]_{\text{phot}} = 0.83[\text{Fe}/\text{H}]_{\text{spec}} - 0.02, \quad \sigma = 0.28 \text{ dex}, \quad (9)$$

$$n = 212, \quad (0.35 < (B - V) \leq 0.7),$$

$$[\text{Fe}/\text{H}]_{\text{phot}} = 1.03[\text{Fe}/\text{H}]_{\text{spec}} + 0.10, \quad \sigma = 0.25 \text{ dex}, \quad (10)$$

$$n = 48, \quad (0.7 \geq (B - V) < 1.1),$$

Figure 6 shows the comparison, after corrections, between the spectroscopic and photometric values of the abundance, and the ranges of colour and metallicity covered. Notice the loss of sensitivity, with increasing



**Fig. 12.** The same that Fig. 11 versus  $[\text{Fe}/\text{H}]$

metallicity, in both calibrations.

In summary, the metallicity has been assigned in a twofold way: Firstly, spectroscopic determined  $[\text{Fe}/\text{H}]$  (Cayrel de Strobel et al. 1992), with a mean accuracy within 0.15 dex, have been preferred. Secondly, the revised calibrations by Schuster & Nissen (1989) (accuracy within 0.2 dex) and Carney (1979) (accuracy within 0.3 dex) were applied to the stars lacking fine spectroscopic analysis.

For the M stars extracted from the compilation by Legget (1992), metallicity has been assigned according to their kinematical classification (i.e.  $[\text{Fe}/\text{H}]=0$  for young disk stars,  $[\text{Fe}/\text{H}]=-1$  for young disk to old disk transition stars, and  $[\text{Fe}/\text{H}]=-1.5$  for old disk stars).

The assigned metallicities are listed in Col. 3 of Table 4.

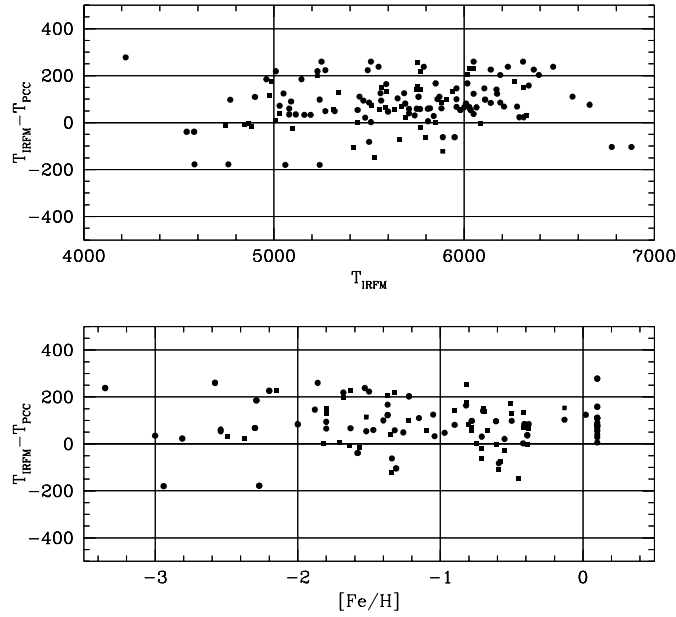
#### 4.5.1. Comparison to other determinations

Our work share 92 and 186 stars in common with the extensive surveys of Ryan & Norris (1991; R&N91) and

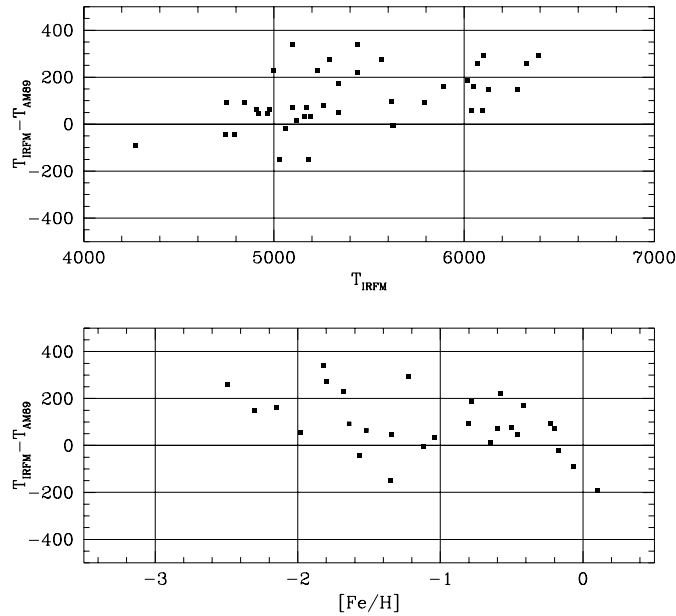
Carney et al. (1994; CLLA94) respectively. Both works provide a good basis to check the scale of metallicity adopted here.

In Fig. 7, we compare our  $[\text{Fe}/\text{H}]$  estimates to the abundances derived by R&N91 based on a calibration of the Ca II H and K line absorption. The mean difference  $[\text{Fe}/\text{H}]_{\text{This work}} - [\text{Fe}/\text{H}]_{\text{R\&N91}}$  is 0.01 dex with  $\sigma = 0.37$  dex. The scatter of the differences is compatible with the internal errors of both works. No trend of the differences may be appreciated either with temperature (Fig. 7a) or with metallicity (Fig. 7b).

The comparison of the abundances adopted by us with those derived by CLLA94, based on the cross correlation of high resolution low  $S/N$  spectra with model templates, shows a fairly good agreement in the range from  $[\text{Fe}/\text{H}]=-2.5$  to  $[\text{Fe}/\text{H}]=-0.75$ . However, noteworthy differences appear for  $[\text{Fe}/\text{H}] < -2.5$  and  $[\text{Fe}/\text{H}] > -0.5$ . The overall mean difference  $[\text{Fe}/\text{H}]_{\text{This work}} - [\text{Fe}/\text{H}]_{\text{CLLA94}}$  is 0.01 dex with  $\sigma = 0.31$  dex. No trend with temperature may be appreciated in the differences (Fig. 8a), however there exists a clear correlation with metallicity (Fig. 8b).



**Fig. 13.** Differences between the temperatures derived in this work ( $T_{\text{IRFM}}$ ) and those derived by Peterson & Carney (1979; Squares), and Carney (1983; Circles).  $T_{\text{PCC}}$  are, in average, 100 K cooler than those derived in the present work. There exists a slight trend with temperature. The differences have a slight slope amounting approximately 100 K between the extreme points of the overlapping range



**Fig. 14.** Differences between the temperatures derived in this work ( $T_{\text{IRFM}}$ ) and those derived by Arribas & Martínez-Roger (1989).  $T_{\text{AM89}}$  are, in average, 150 K cooler than those derived in the present work. There exist clear trends with temperature and metallicity. The differences may be explained taking into account the different models and absolute flux calibration of the IR flux adopted in both work

On the one hand, our  $[\text{Fe}/\text{H}]$  estimate for the most metal deficient stars ( $[\text{Fe}/\text{H}] < -2.5$ ) is 0.5 dex higher in average than  $[\text{Fe}/\text{H}]_{\text{CLLA94}}$ , which implies a difference of  $\pm 0.2\%$  in the temperature derived using the IRFM. On the other, our  $[\text{Fe}/\text{H}]$  estimate for stars with  $[\text{Fe}/\text{H}] > -0.5$  is 0.3 dex lower in average, which implies a difference of  $\pm 0.4\%$  in temperatures derived using the IRFM.

## 5. The temperatures determination

According to the procedure described in previous sections, we have derived three effective temperatures for each sample star by applying the IRFM in the IR wavelengths considered (Eq. 4). The individual values  $T_J$ ,  $T_H$  and  $T_K$ , with their errors are listed in Table 4.

Figures 9 and 10 present the comparison between the temperatures obtained in the three different bands taking  $T_K$  as a reference. The individual errorbars allow to appreciate that the dispersion is compatible with the estimated errors derived from the uncertainties in the input parameters of the IRFM. As expected, the uncertainties are greater for temperatures obtained from  $R_J$  factors, due to the lesser sensitivity of the IRFM in this band, and the greater photometric error in the measurement of  $J$ . The consistency of  $T_J$ ,  $T_H$  and  $T_K$  is good over 4000 K, however under this temperature there exist noteworthy discrepancies due to the fact that  $R_J$ - and  $R_H$ -factors lose their sensitivity to temperature in this range.

The final temperature was derived as the mean of  $T_J$ ,  $T_H$  and  $T_K$  weighted with the inverse of their errors:

$$\overline{T}_{\text{IRFM}} = \frac{\frac{T_J}{(\Delta T_J)} + \frac{T_H}{(\Delta T_H)} + \frac{T_K}{(\Delta T_K)}}{\left[\frac{1}{\Delta T_J} + \frac{1}{\Delta T_H} + \frac{1}{\Delta T_K}\right]}. \quad (11)$$

In order to estimate the error of the mean temperature, a linear transmission of the errors was considered, given that the errors in each band are not totally independent:

$$\Delta T_{\text{IRFM}} = \frac{3}{\left[\frac{1}{\Delta T_J} + \frac{1}{\Delta T_H} + \frac{1}{\Delta T_K}\right]}, \quad (12)$$

where the error in the temperature of each band is defined by

$$\begin{aligned} (\Delta T_i)^2 = & \left[\frac{\Delta T_i}{\Delta[q(\lambda_i)R(\lambda_i)]}\right]^2 (\Delta[q(\lambda_i)R(\lambda_i)])^2 \\ & + \left[\frac{\Delta T_i}{\Delta[\text{Fe}/\text{H}]}\right]^2 (\Delta[\text{Fe}/\text{H}])^2 \\ & + \left[\frac{\Delta T_i}{\Delta \log(g)}\right]^2 (\Delta \log(g))^2 \end{aligned} \quad (13)$$

Over 5000 K, the temperatures in the three bands enter the average with similar weight. In that range, the assignation of weights automatically takes into account the unlike sensitivity of the IRFM in the different bands

and the individual quality of IR photometry. However, under 5000 K only  $T_H$  and  $T_K$  has been considered in the average, since  $R_J$  is a very insensitive indicator of temperature for the cooler stars. Under 4000 K, only  $T_K$  has been considered. This is due to the fact that the coolest models show in the band  $H$  a local maximum of flux which is not observed in IR spectra (Langon & Rocca-Volmerange 1992). The mean error in the final temperatures is around 1–2%. Notice however, that the uncertainties in the temperatures derived under 4000 K are greater than the errors determined from Eq. (12) due to the difficulties of models in this range caused by the absence of important sources of opacity associated to some molecules. Likewise, the IRFM is difficult to apply at temperatures over 8000 K (five stars of the sample have such high temperatures) because as these stars emit a substantial proportion of energy at short wavelengths, the correction for interstellar extinction and the determination of the bolometric flux are rather uncertain. For these reasons, the temperatures outside the range  $4000 \text{ K} < T_{\text{eff}} < 8000 \text{ K}$  have a lower level of accuracy (perhaps a most adequate estimation is the duplication of the size of the errorbars quoted in Table 4 for these temperatures).

We show in Figs. 11 and 12 the differences of  $T_J$ ,  $T_H$  and  $T_K$  from the mean temperature adopted. Over 4000 K they follow approximately a normal distribution both with effective temperature and metallicity.

## 6. Comparison with other determinations

In this section, we provide the comparison of our temperatures with those derived by other authors for common stars of the sample. Furthermore a detailed analysis of the scale of temperatures derived from the present work will be done in a subsequent paper by considering the mean relations  $T_{\text{eff}}: [\text{Fe}/\text{H}]$  and photometric colours  $UBVR IJHK$  and  $wby-\beta$ .

The Sun and Procyon, the only dwarfs later than F5 whose diameters has been measured by optical methods, are included in the sample. The agreement between their IRFM temperatures and the direct ones is excellent. In fact, the IRFM provides 6579 K for Procyon, close to the direct temperature (6510 K) obtained considering its angular diameter (Hanbury-Brown et al. 1974; Mozurkewich et al. 1991) and its bolometric flux (Code et al. 1976). Regarding the Sun, the value derived from the IRFM determination is 5763 K. This good agreement is a consequence of the procedure followed for scaling the effective temperatures obtained from the IRFM, since the absolute calibration in the near IR was established on the basis of empirical diameters measurements. In addition, it is worthy to notice that the mean temperatures of solar analogue stars (spectral types G0/2V,  $[\text{Fe}/\text{H}] \sim 0$ ,  $(B - V) \sim$

0.63) is close to the solar value ( $5743 \pm 100$  K vs. 5780 K for the Sun), and the same for stars of types F3/5V,  $[\text{Fe}/\text{H}] \sim -0.05$ ,  $(B - V) \sim 0.43$  similar in their features to Procyon ( $6578 \pm 150$  K vs. 6510 K).

The works by Peterson & Carney (1979), and Carney (1983a) (hereafter PCC), based on spectrophotometric analysis, contain respectively 43 and 64 stars common to our sample whose range of temperatures and metallicities is similar to that analysed in the present programme. Figure 13 shows the difference  $T_{\text{IRFM}} - T_{\text{PCC}}$  versus temperature and metallicity. PCC temperatures are, in average, 100 K cooler than those derived in the present work. No significant trend of the differences with metallicity may be appreciated. However there could exist a slight slope along the axis of temperatures amounting approximately 100 K between the extreme points of the overlapping range. This difference is compatible with the uncertainty of the zero point. The different models considered might also explain the observed discrepancies.

There are 18 stars common to the work by Saxner & Hammarbäck (1985, SH85) devoted to F stars and based on the application of the IRFM. The good agreement is noteworthy as can be appreciated from Table 7. The differences are compatible with the errors of both works, and the average residuals only amount  $5 \pm 63$  K ( $T_{\text{SH85}}$  are cooler).

The work by Magain (1987) based on the IRFM presents 11 stars in the metallicity range  $(-1, -3)$ . The mean difference  $T_{\text{IRFM}} - T_{\text{M87}}$  is  $112 \pm 56$  K (Table 8) which implies a shift of 1.9% in the zero point of the temperature scale. This work adopts the IR absolute flux calibration provided by SH85 which is very close to ours ( $+0.3\%$  in  $J$  and  $+1.8\%$  in  $K$ ), so the differences of the models considered in each work should account for the shift of the zero.

There are 28 stars common to the work by Arribas y Martínez-Roger (1989, AM89), based on the application of the IRFM using the empirical absolute flux calibration of the IR flux of Vega derived by Mountain et al. (1985), and models by Kurucz (1979) and Gustafsson et al. (1975). The systematic differences found both with temperature and metallicity (Fig. 14) may be explained taking into account that the models used in the present work include new opacities, and also to the problems of the IR absolute flux calibration derived by Mountain et al. (1985) as described in Paper II.

Bell & Gustafsson (1989, BG89) present 13 dwarfs common to the present sample. BG89 temperatures are based on the IRFM corrected using IR synthetic colours. Over 4500 K the differences listed in Table 9 are compatible with a zero point shift of 56 K ( $T_{\text{BB89}}$  are hotter). For

the coolest stars, where models loses reliability, differences are stronger. The discrepancies are explained taking into account the differences in the bolometric fluxes considered in both works (see Paper III).

Blackwell & Lynas-Gray (1994, BLG94) have recently applied the IRFM using the new Kurucz's models to a sample of Population I stars. Although only 11 dwarfs are common to the present sample and consequently possible systematic differences are difficult to ascertain, that work is a good source for comparison, given that the main difference respect to the present work is the IR absolute flux calibration. BLG94 adopt the theoretical calibration of the IR flux of Vega provided by Dreiling & Bell (1980), which differ less than 1% in all the bands from that adopted here. Table 10 shows the differences. In average,  $T_{\text{BLG94}}$  are 31 K hotter than ours (the spectroscopic binary HR 219 has been discarded in the mean), this shift in temperature ( $\sim 0.6\%$ ) is compatible with the slight difference in the bolometric fluxes (around 1.5%), as analysed in Paper III.

## 7. Summary

The IRFM has been applied to a sample of approximately 500 main sequence stars later than F0, which cover the metallicity range  $(0.5, -3.5)$ . Near IR monochromatic fluxes have been used in order to derive  $T_J$ ,  $T_H$  and  $T_K$  for each star. The uncertainties of the input parameters needed to apply the IRFM and the induced errors on the three temperatures derived have been computed. The consistency of the temperatures derived in the three different bands is fairly good over 4000 K. The final temperature for each star in the sample has been derived considering the mean of  $T_J$ ,  $T_H$  and  $T_K$  weighted with the inverse of their errors. From the analysis of the systematic errors associated to the uncertainty of the absolute flux calibration in the near IR, the expected indetermination of the zero point of the scale of temperatures should be around 1%. However the good agreement between the IRFM and direct temperatures for the Sun and Procyon suggests a lower uncertainty. The mean estimated precision for the final temperatures, considering the effect of both systematic and accidental errors, is around 1.5%. The comparison with other works shows slight discrepancies which may be explained considering the differences induced by the improvements adopted in the application of the IRFM: The new atmosphere models, the absolute IR flux calibration and the determination of the bolometric fluxes.

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## References

- Alonso A., Arribas S., Martínez-Roger C., 1994a, *A&A* 282, 684 (Paper I)
- Alonso A., Arribas S., Martínez-Roger C., 1994b, *A&AS* 107, 365 (Paper II)
- Alonso A., Arribas S., Martínez-Roger C., 1995, *A&A* 297, 197
- Anders E., Grevesse N., 1989, *Geochim. Cosmochim. Acta* 53, 197
- Andersen J., 1991, *A&A Rev.* 3, 91
- Arribas S., Martínez-Roger C., 1987, *A&A* 178, 107
- Arribas S., Martínez-Roger C., 1988, *A&A* 206, 63
- Arribas S., Martínez-Roger C., 1989, *A&A* 215, 305
- Beers T.C., Preston G.W., Shectman S.A., Kage J.A., 1990, *AJ* 100, 849
- Bell R.A., Gustafsson B., 1989, *MNRAS* 236, 653
- Blackwell D.E., Petford A.D., Arribas S., Haddock D.J., Selby M.J., 1990, *A&A* 232, 396
- Blackwell D.E., Lynas-Gray A.E., Petford A.D., 1991, *A&A* 245, 567
- Blackwell D.E., Petford A.D., 1991, *A&A* 250, 459
- Blackwell D.E., Lynas-Gray A.E., 1994, *A&A* 282, 899
- Böhm-Vitense E., 1981, *ARA&A* 19, 295
- Burnstein D., Heiles C., 1982, *AJ* 87, 1165
- Carney B.W., 1979, *ApJ* 233, 211
- Carney B.W., 1982, *AJ* 87, 1527
- Carney B.W., 1983a, *AJ* 88, 610
- Carney B.W., 1983b, *AJ* 88, 623
- Carney B.W., Latham D.W., 1987, *AJ* 92, 116
- Carney B.W., Latham D.W., Laird J.B., Aguilar L.A., 1994, *AJ* 107, 2240
- Cayrel de Strobel G., Hauck B., François P., Thevénin F. Friel E., Mermilliod M., Borde S., 1992, *A&AS* 95, 273
- Code A.D., Davis J., Bless R.C., Hanbury-Brown R., 1976, *ApJ* 203, 417
- Crawford D.L., 1975, *AJ* 80, 955
- Dreiling L.A., Bell R.A., 1980, *ApJ* 241, 736
- Glass I.S., 1985, *Irish. A. J.* 17, 1
- Gustafsson B., Bell R.A., Ericksson K., Nordlung Å., 1975, *A&A* 42, 407
- Hanbury-Brown R., Davis J., Allen L.R., 1974, *MNRAS* 167, 121
- Hayes D.S., Latham D.W., 1975, *AJ* 197, 593
- Kidger M., 1992, Carlos Sánchez Telescope Technical note series. Supplement to technical note # 16. Calibration star programme results
- King J.R., 1994, *AJ* 107, 1165
- Kurucz R.L., 1979a, *ApJS* 40, 1
- Kurucz R.L., 1979b, in: Philip A.G. Davis (ed.), *Problems of Calibration of Multicolor Photometric Systems*, Dudley Obs. Rep. No. 14, p. 363
- Kurucz R.L., 1991, *Precision photometry: Astrophysics of the Galaxy*. In: Davis Philip A.G., Uggren A.R. and Janes K.A. (eds.). L. Davis Press, Schenectady
- Kurucz R.L., 1993, *Atmosphere models*, (Private communication)
- Lançon A., Rocca-Volmerange B., 1992, *A&ASS* 96, 593
- Laird J.B., Carney B.W., Latham D.W., 1987, *AJ* 95, 1843
- Landolt-Börnstein, 1982c, *New Series*, Gp VI, Vol. 2, *Astronomy and Astrophys.*, Subvolume C. Springer, Berlin-Heidelberg-New York
- Leggett S.K., 1992, *ApJS* 82, 351
- Magain P., 1987, *A&A* 181, 323
- Manduca A., Bell R.A., 1979, *PASP* 91, 848
- Mountain C.M., 1983, Ph. D. Thesis, Imperial College of Science and Technology, University of London
- Mountain C.M., Leggett S.K., Selby M.J., Blackwell D.E., Petford A.D., 1985, *A&A* 151, 399
- Mozurkewich D., Johnston K.J., Simon R.S., et al., 1991, *AJ* 101, 2207
- Peterson R.C., Carnew B.W., 1979, *ApJ* 231, 762
- Petford A.D., Blackwell D.E., Booth A.J., et al., 1988, *A&A* 203, 341
- Popper D.M., 1980, *ARA&A* 18, 115
- Ryan S.G., Norris J.E., *AJ* 101, 1835
- Sandage A., 1969, *ApJ* 158, 1115
- Sandage A., 1983, *AJ* 88, 1159
- Sandage A., Kowal C., 1986, *AJ* 91, 1140
- Savage B.D., Mathis J.S., 1979, *ARA&A* 17, 13
- Saxner M., Hammarbäck G., 1985, *A&A* 151, 372
- Schuster W.J., Nissen P.E., 1988, *A&AS* 73, 225
- Schuster W.J., Nissen P.E., 1989, *A&A* 221, 65
- Tüg H., White N.M., Lockwood G.W., 1977, *A&A* 61, 67
- Van Altena W.F., Lee J.T., Hanson R.B., Lutz T.E., 1988, "Calibration of Stellar Ages". In: Davis Philip A.G. (ed.). L. Davis Press, Schenectady, New York, p. 175
- Walker R.G., Cohen M., *An atlas of selected calibrated stellar spectra*. NASA Contractor Report 177604, September 1992. NASA Ames Research Center, Moffett Field, California 94035-1000

**Table 4.** The input parameters needed to the application of the IRFM for each star of the sample. Column 1: Identification, the Glclac number has been preferred when available HD, BD, HR and GJ numbers were used otherwise. The stars are ordered in right ascension. Column 2: Surface gravity. Column 3: Metallicity. Column 4: Bolometric flux in ( $\text{erg cm}^{-2} \text{s}^{-1}$ ). Column 5: Interstellar reddening. Column 6: Monochromatic flux in the band  $J$  in ( $10^2 \text{ erg cm}^{-2} \text{s}^{-1} \text{ nm}^{-1}$ ). Column 7:  $q$ -factor in the band  $J$ . Column 8: Temperature derived in the band  $J$  (units are K). Column 9: Error in  $T_J$  computed considering errors in  $F_{\text{Bol}}$ ,  $F_J$ ,  $\log(g)$  and  $[\text{Fe}/\text{H}]$ . Columns 10-13: The same that Cols. 6-9 for the band  $H$ . Columns 14-17: The same that Cols. 6-9 for the band  $K$ . Column 18: The weighted mean temperature derived from  $T_J$ ,  $T_H$  and  $T_K$ . Temperatures in brackets have not been considered in the mean as explained in Sect. 5. Column 19: Mean error computed considering linear transmission of errors from Cols. 9, 13 and 17. Temperatures under 4000 K are given in parentheses without estimation of the total error because of the uncertainties of the model fluxes in this range

ID	$\log(g)$	$[\text{Fe}/\text{H}]$	$F_{\text{Bol}}$	$F_J$	$q_J$	$T_J$	$\Delta T_J$	$F_H$	$q_H$	$T_H$	$\Delta T_H$	$F_K$	$q_K$	$T_K$	$\Delta T_K$	$T_{\text{mean}}$	$\Delta T_{\text{mean}}$
800	4.34	0.00	1.056e-10	0.00	1.00	5762	166	2.293e-12	1.018	5768	94	8.104e-11	1.016	5742	66	5743	167
HD140133	4.00	0.00	1.121e-10	0.42	1.011	7046	355	1.397e-12	1.006	7135	74	7.152e-13	1.006	7137	66	7137	167
GJ717-309	5.00	0.00	1.100e-10	0.32	1.012	5738	186	4.397e-12	1.054	6444	300	1.987e-12	1.034	3911	147	3911	167
HD11193	4.00	0.00	3.242e-10	0.32	1.062	6366	371	1.291e-12	0.975	8494	700	1.709e-13	1.049	4104	103	4104	120
HR66	4.00	0.00	1.030e-10	0.32	1.000	5729	135	3.915e-11	1.075	5939	128	2.209e-11	1.035	4149	66	4149	91
HR66	4.00	0.00	1.030e-10	0.32	1.000	5729	135	3.915e-11	1.075	5939	128	2.209e-11	1.035	4149	66	4149	91
GJ50-053	4.50	0.00	1.071e-10	0.32	1.014	5729	135	3.915e-11	1.075	5939	128	2.209e-11	1.035	4149	66	4149	91
GJ50-053	4.50	0.00	1.071e-10	0.32	1.014	5729	135	3.915e-11	1.075	5939	128	2.209e-11	1.035	4149	66	4149	91
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GJ50-053	4.50	0.00	1.071e-10	0.32	1.014	5729	135	3.915e-11	1.075	5939	128	2.209e-11	1.035	4149	66	4149	91
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GJ50-053	4.50	0.00	1.071e-10	0.32	1.014	5729	135	3.915e-11	1.075	5939	128	2.209e-11	1.035	4149	66	4149	91
GJ50-053	4.50	0.00	1.071e-10	0.32	1.014	5729	135	3.915e-11	1.075	5939	128	2.209e-11	1.035	4149	66	4149	91
GJ50-053	4.50	0.00	1.071e-10	0.32	1.014	5729	135	3.915e-11	1.075	5939	128	2.209e-11	1.035	4149	66	4149	91
GJ50-053	4.50	0.00	1.071e-														

Table 4. continued

ID	log(L)	[Fe/H]	$F_{\text{Bal}}$	E(B-V)	F <sub>r</sub>	q <sub>v</sub>	T <sub>r</sub>	$\Delta T_r$	F <sub>H</sub>	q <sub>H</sub>	T <sub>H</sub>	$\Delta T_H$	F <sub>K</sub>	q <sub>K</sub>	T <sub>K</sub>	$\Delta T_K$	T <sub>mean</sub>	$\Delta T_{\text{mean}}$
G076-042	4.50	-1.56	1.413e-11	0.00	4.420e-13	1.009	5574	131	2.427e-13	1.024	5638	77	8.922e-14	1.019	5686	70	5634	84
HR1081	4.50	0.03	1.008e-08	0.00	3.856e-10	1.014	5989	142	—	—	—	—	9.176e-11	1.023	5046	62	5078	86
HR1101	4.50	-0.12	1.186e-09	0.00	4.476e-10	1.013	6083	137	—	—	—	—	2.914e-11	1.015	5981	74	5998	101
G080-015	4.50	0.00	5.979e-10	0.00	4.422e-12	—	<3500	—	—	—	—	—	7.310e-13	1.029	4542	56	4503	56
G006-034	4.50	-0.71	8.984e-10	0.00	1.776e-11	1.011	5779	123	2.058e-12	1.024	4464	57	7.310e-13	1.017	5803	72	5788	87
HD24288	4.50	-2.07	3.502e-11	0.05	6.156e-12	1.012	[3566]	238	9.657e-12	1.051	5798	79	1.965e-12	1.025	3753	211	(3753)	—
HR23329	4.50	-1.64	1.833e-10	0.04	5.881e-12	1.009	[4823]	108	3.448e-13	1.022	5834	79	2.030e-13	1.018	5827	72	5866	87
HR1325	4.50	-0.17	5.311e-09	0.00	2.077e-10	1.013	5087	94	1.294e-10	1.036	4828	101	1.427e-12	1.021	4854	93	4842	97
G004-016	4.50	-1.91	5.588e-11	0.00	1.519e-12	1.009	5998	94	7.974e-13	1.019	6048	84	4.881e-11	1.024	5030	74	5040	84
VB 17	4.50	0.10	1.145e-10	0.00	2.936e-12	1.015	5502	150	2.112e-12	1.022	5619	77	8.089e-13	1.017	6044	75	6034	74
VA 60	4.50	0.10	1.613e-10	0.00	5.241e-12	1.014	5668	152	2.737e-12	1.019	5794	79	1.026e-12	1.015	5746	71	5743	90
VA 79	4.50	0.10	1.602e-10	0.00	1.773e-11	1.012	6624	163	8.370e-12	1.006	6749	89	3.037e-12	1.006	6750	83	6736	102
VA 215	4.50	0.10	5.828e-10	0.00	1.382e-11	1.012	6627	163	6.590e-12	1.007	6682	80	2.368e-12	1.007	6707	83	6681	102
VB 49	4.50	0.10	1.351e-10	0.00	4.206e-12	1.014	5800	154	2.173e-12	1.017	5900	80	8.056e-13	1.014	5870	72	5868	91
VA 315	4.50	0.10	4.206e-10	0.00	1.057e-11	1.012	6454	161	5.136e-12	1.009	6509	87	1.870e-12	1.009	6509	80	6498	99
VA 548	5.00	0.10	3.241e-11	0.00	1.558e-12	1.013	[4003]	107	1.056e-12	1.050	4557	64	4.911e-13	1.029	4447	55	4498	59
VA 560	4.50	0.10	6.937e-11	0.00	2.696e-12	1.015	5097	127	1.561e-12	1.030	5235	72	5.941e-13	1.021	5173	64	5180	84
VA 624	4.50	0.10	2.092e-10	0.00	5.859e-12	1.014	6035	157	2.849e-12	1.014	6118	83	1.000e-12	1.012	6093	75	6091	90
VA 682	4.50	0.10	9.660e-11	0.00	3.328e-12	1.015	5485	150	1.848e-12	1.023	5543	76	7.123e-13	1.018	5455	67	5494	86
VA 712	5.00	0.10	4.372e-11	0.00	2.098e-12	1.015	5082	138	1.263e-12	1.032	5147	71	4.860e-13	1.022	5072	63	5102	81
VA 747	5.00	0.10	4.622e-11	0.00	1.713e-12	1.014	[4994]	136	1.052e-12	1.038	5057	70	4.084e-13	1.023	4973	61	5009	79
VA 748	4.50	0.10	1.781e-10	0.00	3.616e-12	1.014	5769	134	2.536e-12	1.035	5847	79	1.104e-12	1.015	5805	72	5816	91
VA 778	5.00	-0.32	3.398e-11	0.00	2.100e-12	1.015	5095	135	1.240e-12	1.031	5193	72	4.770e-13	1.022	5115	63	5140	81
G008-050	4.50	0.04	1.307e-09	0.00	1.283e-12	1.012	[4883]	89	8.627e-14	1.041	4895	110	3.439e-14	1.026	4702	60	4740	76
HR1536	4.50	0.00	1.374e-08	0.00	4.031e-11	1.014	5830	148	2.177e-11	1.018	5830	81	8.030e-12	1.015	5812	61	5822	61
HR1543	4.50	0.00	6.623e-11	0.00	3.341e-10	1.012	<3500	162	—	—	<3500	—	6.234e-11	1.011	6494	80	6482	107
G1182	5.00	0.00	4.091e-12	0.00	4.091e-12	—	<3500	—	—	—	<3500	—	1.227e-11	1.024	3639	136	(3639)	—
G084-029	4.50	-2.01	3.404e-11	0.00	8.901e-13	1.009	6084	107	4.718e-13	1.019	6099	76	1.704e-13	1.016	6141	78	6110	82
G096-020	4.50	-1.05	3.738e-11	0.00	9.760e-13	1.010	6168	126	5.028e-13	1.018	6208	73	1.798e-13	1.015	6268	58	6222	77
G084-037	4.50	-1.19	3.633e-11	0.02	1.056e-12	1.008	5830	83	5.747e-13	1.021	5840	53	2.079e-13	1.018	5886	62	5852	64
HR1729	4.50	0.00	3.509e-09	0.00	1.060e-10	1.013	5862	155	—	—	—	—	2.112e-11	1.016	5840	72	5817	98
G086-039	4.50	-1.61	8.291e-12	0.03	3.479e-13	1.009	[4642]	172	2.248e-13	1.038	4723	56	8.501e-14	1.021	4750	40	4739	64
G096-038	4.50	-0.03	5.281e-12	0.03	2.131e-13	1.014	[4938]	101	1.417e-13	1.039	4886	68	5.231e-14	1.025	4898	60	4892	64
G099-015	5.00	-1.50	7.424e-10	0.00	3.687e-11	1.011	[3954]	211	3.514e-11	—	<3500	—	1.242e-11	1.027	3737	123	(3737)	—
HR1825	4.00	-0.20	9.735e-10	0.00	2.717e-11	1.013	5110	95	2.168e-11	1.050	5287	47	8.282e-12	1.020	5269	89	5254	109
G102-020	4.50	-1.39	2.479e-11	0.02	8.779e-13	1.009	5221	120	5.150e-13	1.029	5267	125	1.927e-13	1.032	3822	109	(3822)	—
G191-051	5.00	0.00	7.424e-10	0.00	2.687e-11	1.012	[4101]	198	3.262e-11	1.054	[3619]	300	1.249e-11	1.032	3822	109	(3822)	—
HR1883	4.00	-0.16	9.574e-09	0.00	2.511e-10	1.012	6277	159	—	—	—	—	4.745e-11	1.014	6251	77	6260	104
LTT2437	4.00	0.06	8.301e-09	0.18	1.701e-10	1.010	7083	167	1.308e-14	1.017	5917	80	4.968e-15	1.015	5834	72	5918	92
HR2683	4.00	-1.26	5.712e-11	0.00	1.978e-12	1.009	5280	166	1.158e-12	1.028	5328	92	4.323e-13	1.020	5320	72	5319	113
G103-054	4.50	-1.74	4.691e-11	0.03	8.886e-13	1.008	5375	176	5.129e-13	1.027	5336	68	1.808e-13	1.020	5359	60	5353	77
G102-047	4.50	0.00	5.798e-10	0.00	2.956e-11	1.012	[3826]	223	2.505e-13	1.027	5375	300	9.868e-12	1.034	3814	112	(3814)	—
G098-056	4.50	-1.32	4.465e-12	0.00	2.939e-12	1.009	5293	162	1.606e-13	1.027	5375	74	6.148e-14	1.019	5400	45	5376	72
G098-058	4.50	-1.86	3.307e-11	0.05	2.939e-12	1.008	5323	184	1.706e-12	1.026	5487	53	6.284e-13	1.019	5523	43	5510	56
G101-033	4.50	-0.37	2.452e-11	0.00	8.795e-13	1.012	5288	161	5.271e-13	1.029	5286	67	1.955e-13	1.020	5281	65	5284	82
G101-034	4.50	-1.83	2.030e-11	0.10	6.771e-13	1.008	5357	133	4.210e-13	1.028	5227	74	1.531e-13	1.020	5305	49	5289	72
HD45281	4.50	0.00	1.206e-11	0.00	2.385e-12	1.014	5587	153	1.247e-12	1.020	5739	79	4.565e-13	1.018	5738	72	5703	91
HD45282	5.00	-1.04	1.875e-10	0.00	6.783e-12	1.010	5187	175	4.116e-12	1.051	5190	72	1.531e-12	1.020	5198	103	5193	59
HR2424	4.00	0.00	1.138e-09	0.00	1.516e-11	1.002	8402	171	6.117e-12	0.997	8334	107	2.253e-12	0.995	8439	103	8464	120
G106-053	4.50	-0.26	3.172e-11	0.00	1.323e-12	1.012	[4787]	172	8.531e-13	1.039	4806	58	3.212e-13	1.024	4847	40	4855	47
HR2383	4.00	0.00	6.905e-10	0.00	8.216e-12	1.001	8764	171	3.252e-12	0.996	8913	110	1.210e-12	0.995	8786	107	8825	124
G105-049	5.00	-1.60	1.085e-10	0.00	5.952e-12	1.009	<3500	—	5.326e-12	—	<3500	—	1.972e-12	1.021	4834	52	(3586)	—
G105-050	4.50	-1.59	1.140e-11	0.01	4.658e-13	1.009	[4747]	118	2.903e-12	1.036	4841	69	1.112e-13	1.021	4834	52	4837	59
G103-050	5.00	-3.00	5.458e-12	0.03	2.389e-13	1.013	[4647]	205	1.562e-13	1.042	4778	161	6.188e-14	1.016	4669	108	4713	120
G192-043	4.50	-1.56	2.133e-11	0.00	5.721e-13	1.009	6041	188	2.983e-13	1.018	6093	101	1.697e-13	1.016	6099	82	6085	111
HR2550	4.50	-0.88	1.437e-09	0.03	3.196e-11	1.009	6685	130	1.176e-11	1.011	6673	88	5.175e-12	1.011	6681	82	6678	96
G110-021	4.50	-1.50	2.908e-11	0.00	1.432e-12	1.011	[4069]	206	1.176e-12	1.050	[2655]	300	4.176e-13	1.024	4026	81	(4026)	—
G088-010	4.50	-2.20	5.230e-12	0.00	1.477e-13	1.008	5887	108	7.972e-14	1.021	5876	80	2.992e-14	1.018	5851	54	5850	74

Table 4. continued

ID	log(g)	[Fe/H]	F <sub>bol</sub>	E(B-V)	F <sub>T</sub>	$\Delta T_1$	F <sub>H</sub>	g <sub>T</sub>	T <sub>1</sub>	$\Delta T_1$	F <sub>H</sub>	g <sub>H</sub>	T <sub>H</sub>	$\Delta T_1$	F <sub>K</sub>	g <sub>K</sub>	T <sub>K</sub>	$\Delta T_1$	T <sub>mean</sub>	$\Delta T_{mean}$
G087-033	5.00	-1.50	6.77e-11	0.00	3.864e-12	1.011	3500	253	3.276e-12	1.023	3350	1.023	3570	144	1.245e-12	1.029	3570	144	(3570)	—
G107-063	5.00	0.00	6.27e-11	0.00	3.284e-12	1.012	3779	182	2.854e-12	1.031	3661	1.031	3880	102	1.079e-12	1.034	3880	102	(3880)	—
G089-014	4.50	-1.85	1.932e-11	0.00	5.736e-13	1.008	5804	126	3.044e-13	1.021	5881	1.021	5885	73	1.122e-13	1.018	5885	73	5881	75
G088-027	4.50	-2.21	1.466e-11	0.00	3.994e-13	1.009	5848	162	2.092e-13	1.020	6030	1.020	6030	84	1.723e-14	1.017	6030	84	6015	87
HR2852	4.50	-0.31	5.517e-09	0.00	1.113e-10	1.009	7080	186	—	—	—	—	—	—	1.969e-11	1.009	6989	86	7020	113
G080-003	4.50	-1.89	2.202e-11	0.04	6.419e-13	1.008	5762	199	3.593e-13	1.022	5770	1.022	5770	118	1.287e-13	1.018	5813	108	5786	132
G088-032	4.50	-2.59	1.309e-11	0.00	3.431e-13	1.008	6191	86	1.803e-13	1.017	6206	1.017	6206	65	6.568e-14	1.018	6222	65	6208	67
HR2883	4.50	-0.08	1.212e-09	0.00	3.457e-11	1.010	5899	186	1.847e-11	1.019	5897	1.019	5897	75	8.838e-12	1.017	5929	75	5928	101
G088-041	4.50	-0.08	3.124e-10	0.00	9.706e-12	1.013	5776	154	5.207e-12	1.019	5818	1.019	5818	79	1.973e-12	1.018	5750	71	5781	90
HR2882	4.50	-0.88	2.228e-11	0.00	8.170e-13	1.010	5150	282	4.914e-13	1.031	5192	1.031	5192	81	1.828e-13	1.020	5194	72	5188	100
W5058	4.50	-1.15	1.067e-11	0.00	3.643e-13	1.009	5949	118	2.077e-13	1.027	5411	1.027	5411	74	7.703e-14	1.019	5420	72	5400	81
HR2943	4.50	-0.05	1.844e-07	0.00	4.400e-09	1.011	6085	182	1.602e-09	1.034	6579	1.034	6579	81	7.908e-10	1.010	6570	81	6579	100
G112-036	4.50	-0.88	7.552e-11	0.06	2.812e-12	1.010	5103	208	1.782e-12	1.034	5065	1.034	5065	61	6.562e-13	1.021	5090	49	5082	72
G112-038	4.50	-1.50	1.567e-10	0.00	8.307e-12	1.011	3602	245	3.076e-12	1.034	3500	1.034	3500	118	2.569e-12	1.026	3772	118	(3772)	—
G112-043	4.50	-1.61	2.402e-11	0.01	6.448e-13	1.009	6023	110	3.370e-13	1.018	6085	1.018	6085	66	1.252e-13	1.017	6069	66	6065	83
G091-011	5.00	0.00	2.098e-11	0.00	3.769e-12	1.007	3500	—	1.196e-12	1.067	3926	1.067	3926	348	4.708e-13	1.034	3907	84	(3907)	—
HR3029	4.00	0.00	2.098e-11	0.00	3.769e-12	1.007	7491	168	1.764e-12	1.008	7382	1.008	7382	91	6.477e-13	1.003	7348	91	7392	110
HR3064	4.00	0.00	2.328e-09	0.00	7.342e-11	1.014	5738	153	4.001e-11	1.020	5740	1.020	5740	70	1.492e-11	1.017	5711	70	5727	89
G090-025	4.50	-1.82	1.493e-10	0.00	4.831e-12	1.008	3422	101	2.771e-12	1.025	5448	1.025	5448	69	5.448e-12	1.020	5443	69	5441	68
G090-026	4.50	-1.61	2.518e-12	0.00	8.603e-14	1.009	5306	206	4.972e-14	1.037	5341	1.037	5341	147	1.828e-14	1.020	5385	105	5353	142
G112-084	4.50	-0.65	3.293e-10	0.00	1.229e-11	1.011	5118	122	7.448e-12	1.032	5161	1.032	5161	73	2.836e-12	1.021	5117	71	5134	82
ED65583	4.50	-0.60	4.745e-10	0.00	1.720e-11	1.011	5226	79	1.028e-11	1.030	5251	1.030	5251	49	8.300e-12	1.020	5244	55	5242	59
HD68037	4.00	-0.42	5.973e-10	0.00	1.797e-11	1.011	5809	170	1.018e-11	1.024	5847	1.024	5847	76	8.849e-12	1.018	5885	68	5812	87
G184-022	4.50	-1.64	3.539e-11	0.00	9.987e-13	1.009	5877	170	5.195e-13	1.020	5985	1.020	5985	112	1.905e-13	1.016	6004	102	5967	122
HR3176	4.00	0.00	2.038e-11	0.00	6.436e-13	1.014	5762	153	3.435e-13	1.019	5707	1.019	5707	70	1.270e-11	1.016	5775	71	5781	90
G231-034	5.00	-1.75	2.841e-11	0.00	9.877e-13	1.009	5235	80	5.666e-13	1.027	5200	1.027	5200	76	2.115e-13	1.020	5230	74	5208	82
HR3262	4.00	-0.50	4.024e-11	0.00	1.866e-11	1.011	6216	86	3.170e-11	1.014	6245	1.014	6245	84	1.114e-11	1.014	6285	57	6242	70
HD70968	4.50	-0.04	4.024e-11	0.05	1.821e-11	1.013	4560	186	1.311e-12	1.059	4569	1.059	4569	84	4.877e-13	1.023	4587	57	4579	60
G115-040	4.50	-1.13	1.518e-09	0.00	5.960e-11	1.011	6246	139	2.007e-11	1.014	6282	1.014	6282	84	7.407e-13	1.013	6273	77	6275	96
HR3277	4.00	0.00	5.794e-10	0.00	2.781e-13	1.010	8657	99	1.627e-13	1.049	4761	1.049	4761	67	1.231e-14	1.022	4722	55	4740	62
G090-014	4.50	-0.76	2.657e-11	0.00	1.003e-12	1.011	5071	127	2.806e-12	1.096	8863	1.096	8863	109	1.021e-12	1.025	8772	107	8763	123
HD74000	4.50	-2.00	3.896e-11	0.00	9.886e-13	1.008	6231	159	5.189e-13	1.017	6236	1.017	6236	84	1.924e-13	1.021	6209	77	6224	96
G090-018	4.50	-1.31	5.078e-11	0.00	1.082e-12	1.008	6791	167	3.856e-13	1.010	6771	1.010	6771	87	1.937e-13	1.011	6776	87	6776	84
G046-005	4.50	-1.70	9.626e-12	0.00	3.755e-13	1.009	4882	174	2.319e-13	1.033	4938	1.033	4938	71	8.715e-14	1.020	4964	84	4950	84
G009-031	4.50	-0.85	1.328e-11	0.00	4.300e-13	1.010	5843	96	2.405e-13	1.024	5861	1.024	5861	61	8.944e-14	1.018	5873	45	5869	61
HR3578	4.50	-1.05	1.278e-09	0.00	3.950e-11	1.010	5663	100	2.139e-11	1.022	5735	1.022	5735	72	7.823e-12	1.018	5763	66	5727	77
G009-036	4.50	-1.18	4.757e-12	0.00	1.507e-12	1.009	5471	187	8.249e-14	1.024	5643	1.024	5643	106	3.076e-14	1.019	5636	97	5625	120
G114-026	4.50	-1.47	3.832e-11	0.00	1.157e-12	1.009	5768	83	6.270e-13	1.022	5805	1.022	5805	79	2.297e-13	1.018	5835	49	5809	66
G115-049	4.50	-1.86	6.573e-12	0.00	1.792e-13	1.009	5867	106	8.852e-14	1.021	5926	1.021	5926	80	3.597e-14	1.017	5958	50	5950	72
G047-026	5.00	-1.50	7.438e-11	0.00	4.360e-12	—	3500	—	3.506e-12	—	3500	—	3500	—	1.364e-12	1.029	3572	144	(3573)	—
G046-031	4.50	-1.65	3.072e-12	0.00	9.700e-14	1.009	6303	265	5.314e-14	1.017	6195	1.017	6195	166	1.880e-14	1.015	6278	114	6267	160
ED80218	4.50	-0.79	1.265e-11	0.00	3.643e-13	1.010	5897	143	2.012e-13	1.020	5853	1.020	5853	69	7.388e-14	1.017	5864	92	5866	93
G041-034	4.50	0.00	5.927e-10	0.00	1.659e-11	1.012	6046	157	8.517e-12	1.016	6106	1.016	6106	82	3.149e-12	1.014	6089	75	6087	94
HR3750	4.00	-0.31	1.984e-09	0.00	1.554e-12	1.014	5180	144	9.118e-13	1.039	5237	1.039	5237	43	3.498e-13	1.022	5182	54	5215	65
HR3775	4.00	-0.01	1.410e-08	0.00	6.419e-11	1.012	6387	82	3.553e-11	1.023	6339	1.023	6339	55	6.840e-11	1.017	6304	59	6311	62
G195-034	5.00	-2.89	1.016e-11	0.00	2.593e-10	1.012	6328	176	1.846e-10	1.011	6339	1.011	6339	55	6.840e-11	1.017	6304	97	6338	88
G048-029	4.50	-2.81	5.485e-12	0.00	1.491e-13	1.009	5991	240	1.289e-13	1.018	6292	1.018	6292	84	4.509e-14	1.015	6371	69	6338	89
HD83769	4.00	-2.66	2.444e-11	0.00	4.671e-13	1.008	6240	108	3.308e-14	1.021	5908	1.021	5908	54	2.855e-14	1.015	6067	103	5966	93
G045-003	4.50	-2.49	1.983e-10	0.00	5.463e-13	1.008	6584	130	2.277e-13	1.016	6317	1.016	6317	57	8.489e-14	1.015	6371	94	6312	80
BP 444 1910	4.50	-2.40	1.938e-11	0.00	3.253e-12	1.003	6555	144	1.719e-12	1.016	6312	1.016	6312	68	9.463e-14	1.013	6379	83	6378	97
G048-029	4.50	-2.07	1.571e-11	0.00	3.241e-13	1.008	6053	157	1.733e-13	1.019	6061	1.019	6061	82	6.365e-14	1.017	6070	75	6063	83
G161-082	4.50	-0.60	2.998e-10	0.00	8.779e-12	1.011	5439	80	4.923e-12	1.035	5506	1.035	5506	76	1.873e-14	1.017	5483	45	5485	63
HR84740	4.50	-1.38	8.476e-12	0.00	1.609e-13	1.009	5348	188	9.218e-14	1.027	5395	1.027	5395	108	8.356e-12	1.019	5403	82	5389	111
G198-040	5.00	-1.00	1.376e-09	0.00	3.161e-12	1.009	5259	108	1.926e-12	1.029	5188	1.029	5188	54	7.133e-13	1.020	5241	119	(5241)	—
G1378-2	5.00	-1.00	6.844e-11	0.00	4.091e-12	—	3500	—	6.456e-11	—	3500	—	3500	—	1.233e-12	1.020	3637	136	(3637)	—
G1385	5.00	-1.00	7.859e-11	0.00	4.776e-12	—	3500	—	3.777e-12	—	3500	—	3500	—	1.444e-12	1.021	3580	143	(3580)	—

Table 4. continued

ID	log(g)	[Fe/H]	$F_{\text{Bal}}$	$E(B-V)$	$F_U$	$g_1$	$T_U$	$\Delta T_U$	$F_H$	$g_H$	$T_H$	$\Delta T_H$	$F_K$	$g_K$	$T_K$	$\Delta T_K$	$T_{\text{mean}}$	$\Delta T_{\text{mean}}$
G044-006	4.30	-0.78	2.275e-10	0.00	7.103e-12	1.010	5658	100	3.964e-12	1.023	5684	48	1.453e-12	1.018	5683	70	5668	86
HR4030	4.00	-0.03	1.108e-09	0.00	3.643e-11	1.014	5602	151	1.987e-11	1.022	5654	77	6.891e-12	1.016	5669	71	5692	89
HR4039	4.50	-0.19	1.256e-09	0.00	3.596e-11	1.012	6008	156	1.877e-11	1.016	6028	81	6.091e-12	1.014	6033	74	6020	89
G055-017	4.50	1.48	1.590e-12	0.00	5.314e-14	1.009	5297	138	2.233e-14	1.028	5297	73	1.199e-14	1.018	5845	66	5225	80
G053-041	4.50	-1.39	1.089e-11	0.00	3.167e-13	1.009	5808	139	6.936e-13	1.021	5860	68	6.328e-14	1.018	5845	65	5844	80
HR4098	4.00	-0.23	3.005e-10	0.00	2.299e-11	1.012	5737	59	4.726e-11	1.021	5737	59	4.726e-11	1.019	5693	58	5715	72
G162-068	4.50	-0.81	1.868e-11	0.00	6.419e-13	1.010	5761	80	3.763e-13	1.028	5730	80	1.396e-13	1.019	5371	45	5368	55
G044-030	4.50	-1.02	8.947e-12	0.00	3.135e-13	1.010	5285	103	6.819e-13	1.023	5341	59	6.729e-14	1.019	5349	45	5334	61
G1400AB	5.00	-1.50	1.441e-10	0.00	8.461e-12	1.000	<3500		6.969e-12				2.647e-12	1.029	3570	144	(3570)	
G119-032	4.50	-1.86	2.297e-11	0.00	6.592e-13	1.008	5810	139	1.636e-13	1.022	5804	89	1.330e-13	1.018	5837	149	5815	119
G058-023	4.50	-1.04	3.046e-11	0.00	1.022e-12	1.009	5412	95	5.924e-13	1.027	5423	58	2.222e-13	1.019	5405	83	5413	64
G196-047	4.50	-1.64	2.752e-12	0.00	8.338e-14	1.009	5659	137	5.118e-14	1.026	5465	119	7.078e-14	1.020	5378	91	5481	112
G058-025	4.50	-1.50	1.458e-10	0.00	3.911e-12	1.009	6008	181	2.122e-12	1.020	5969	117	6.873e-13	1.017	6027	113	6001	131
G055-044	4.50	-1.00	4.919e-11	0.00	2.596e-12	1.011	[4181]	427	1.704e-12	1.037	4367	69	6.591e-13	1.029	4373	66	4370	67
G1410	5.00	-1.00	1.275e-10	0.00	8.838e-12	1.011	[3582]	246	6.005e-12	1.056	<3500		2.267e-12	1.030	3634	136	(4634)	
G119-052	5.00	-0.20	1.173e-09	0.00	6.598e-11	1.012	[3525]	195	5.277e-11	1.036	[3525]	300	1.978e-11	1.032	3828	91	(3828)	
G178-011	5.00	-1.50	3.202e-10	0.00	6.175e-11	1.011	[3939]	213	5.785e-12	1.055	[3907]	300	5.471e-12	1.027	3696	128	(3696)	
G101-004	4.50	-2.30	1.020e-11	0.06	3.562e-12	1.008	5174	84	2.151e-13	1.028	4844	63	1.391e-14	1.020	5203	42	5192	56
G056-022	4.30	-0.89	1.278e-12	0.00	8.298e-14	1.010	4691	250	3.296e-14	1.039	4844	63	1.391e-14	1.023	4700	73	4777	88
G119-064	4.30	-1.71	3.507e-11	0.00	3.256e-12	1.009	6388	108	4.698e-13	1.017	6193	71	1.690e-13	1.016	6238	92	6206	88
G1421A	5.00	-1.50	5.951e-11	0.00	1.403e-12	1.009	<3500		2.696e-12		<3500		1.005e-12	1.029	3714	126	(3714)	
G1421B	5.00	-1.22	5.715e-11	0.00	1.396e-12	1.010	<3500		7.825e-12	1.015	6388	185	2.856e-13	1.015	6416	139	6393	155
G147-086	4.00	-0.12	9.014e-10	0.00	1.396e-12	1.010	6657	208	7.087e-13	1.015	6388	185	2.856e-13	1.015	6416	139	6393	155
G230-065	4.00	-0.39	4.003e-12	0.00	1.248e-13	1.012	5711	422	9.286e-13	1.029	5693	172	3.513e-13	1.017	5633	152	5659	168
G056-036	4.50	-1.03	1.446e-10	0.00	8.619e-12	1.011	[3456]	227	7.182e-14	1.023	5633	132	2.646e-12	1.023	3378	144	(3378)	
HR4421	4.50	-0.81	1.231e-09	0.00	2.841e-11	1.009	6693	127	6.289e-13	1.020	5913	90	1.536e-13	1.019	5938	79	5918	93
HD101177	4.00	-0.13	7.558e-10	0.00	2.479e-11	1.013	5599	151	1.485e-11	1.025	5486	75	5.618e-12	1.019	5428	67	5463	86
HR4498	4.50	-0.14	2.099e-09	0.00	7.696e-11	1.013	5256	146					1.592e-12	1.020	5822	66	5842	91
HR4501	4.50	-0.82	1.381e-09	0.00	3.576e-11	1.010	6225	127	1.825e-11	1.043	6288	84	6.818e-12	1.020	6290	78	6266	92
G121-012	4.50	-1.17	1.966e-11	0.00	5.538e-13	1.009	5926	109	2.939e-13	1.019	5966	50	1.084e-13	1.017	5970	120	5957	80
HR4533	4.00	0.12	9.014e-10	0.00	2.385e-11	1.013	6300	96	1.195e-11	1.011	6319	55	4.883e-12	1.011	6309	51	6311	62
G176-053	4.50	-1.54	3.136e-11	0.00	9.877e-13	1.009	5556	136	5.096e-13	1.024	5590	57	2.039e-13	1.019	5607	45	5593	64
HR4540	4.00	0.21	9.419e-09	0.00	2.099e-10	1.014	6074	116	1.373e-10	1.014	6115	68	5.076e-11	1.012	6088	70	6096	80
HD103095	4.50	-1.35	8.381e-10	0.00	3.182e-11	1.009	5009	91	1.957e-11	1.033	5040	65	7.413e-12	1.021	5031	50	5029	65
G122-066	4.00	0.00	5.406e-10	0.00	2.919e-11	1.010	[3794]	227	1.976e-11	1.058	4358	63	7.282e-12	1.032	4350	54	4370	58
HD104636	4.00	0.00	1.473e-10	0.00	2.680e-12	1.010	7103	166	1.441e-12	1.007	7008	92	5.309e-13	1.008	6982	86	7019	105
HD104674	4.00	0.00	9.870e-11	0.00	5.270e-12	1.010	[8330]	223	3.415e-12	1.034	4452	64	1.287e-12	1.032	4454	55	4442	59
HR4623	4.00	-0.60	6.467e-09	0.00	1.326e-10	1.008	6984	86	6.266e-11	1.006	7009	62	2.262e-11	1.006	7009	58	7003	67
HD105601	4.00	0.00	3.941e-10	0.00	5.403e-12	1.006	7505	163	2.451e-12	1.001	7487	97	8.785e-13	1.009	7481	92	7481	111
HD105755	4.00	-1.08	1.014e-11	0.00	3.072e-12	1.010	5795	126	1.673e-12	1.022	5807	53	6.196e-13	1.018	5809	48	5806	63
G011-044	4.50	-1.80	1.011e-11	0.00	2.788e-13	1.008	5933	174	1.514e-13	1.020	5925	98	5.521e-14	1.018	5964	85	5943	108
G012-041	4.50	-1.40	2.429e-11	0.00	6.788e-13	1.009	5931	84	3.609e-13	1.029	5966	69	1.330e-13	1.017	5974	50	5960	65
G197-049	5.00	-1.50	8.821e-11	0.00	5.141e-12	1.010	<3500		4.310e-12		<3500		1.626e-12	1.029	3565	143	(3565)	
HR4657	4.50	-0.78	9.749e-10	0.00	2.554e-11	1.010	6196	127	1.320e-12	1.016	6209	63	4.637e-12	1.014	6215	77	6208	82
G012-023	4.50	-1.13	1.300e-12	0.00	4.346e-14	1.009	6420	238	2.515e-14	1.027	5427	205	8.697e-15	1.019	5526	176	5463	203
HD106965	4.00	0.00	1.750e-10	0.00	3.226e-12	1.009	7305	167	1.413e-12	1.001	7462	97	6.054e-12	1.010	7431	92	7441	110
HR4688	4.00	0.38	7.545e-10	0.00	1.999e-11	1.015	6380	119	9.922e-12	1.010	6341	64	3.634e-12	1.010	6327	59	6343	73
HD107906	4.00	0.00	8.515e-11	0.00	2.391e-12	1.011	[4019]	205	1.811e-12	1.047	4036	66	6.675e-13	1.029	4051	57	4044	61
HR4689	4.00	0.11	7.021e-09	0.00	9.097e-11	1.003	8861	137	3.534e-11	1.067	8759	109	1.270e-11	1.091	8687	106	8690	116
G337-062	4.00	-0.39	1.862e-10	0.01	6.520e-12	1.012	5365	148	3.478e-12	1.028	5347	74	1.478e-12	1.020	5289	65	5323	84
G059-018	4.50	-1.16	2.949e-11	0.05	1.011e-12	1.009	5381	212	6.102e-13	1.029	5283	113	2.285e-13	1.020	5207	129	5299	141
HD107908	4.50	0.00	7.956e-11	0.00	3.016e-12	1.014	5186	74	1.770e-12	1.029	5234	49	6.639e-13	1.023	5207	43	5205	52
G013-025	4.50	-1.98	3.875e-11	0.00	1.008e-12	1.008	6698	157	5.381e-13	1.018	6082	82	1.878e-13	1.017	6101	75	6097	94
G013-043	4.00	-0.50	7.260e-11	0.00	2.548e-12	1.011	5337	147	1.489e-12	1.028	5386	74	5.665e-13	1.020	5313	66	5338	85
HR4785	4.50	-1.50	5.319e-09	0.00	1.550e-10	1.012	<3500		4.814e-12		<3500		3.192e-12	1.016	5855	72	5867	99
G012-039	4.50	-2.69	1.002e-10	0.00	5.689e-12	1.008	6111	192	6.424e-14	1.019	<3500		1.832e-12	1.029	3576	144	(3576)	
G055-024	4.50	-2.69	4.653e-12	0.00	1.195e-13	1.008	6111	192	6.424e-14	1.019	<3500		2.321e-14	1.017	6133	83	6108	83

Table 4. continued

ID	log(L)	Fe/H	F <sub>Red</sub>	E(B-V)	F <sub>I</sub>	q <sub>I</sub>	T <sub>I</sub>	ΔT <sub>I</sub>	F <sub>H</sub>	q <sub>H</sub>	T <sub>H</sub>	ΔT <sub>H</sub>	F <sub>K</sub>	q <sub>K</sub>	T <sub>K</sub>	ΔT <sub>K</sub>	T <sub>mean</sub>	ΔT <sub>mean</sub>
G059-027	4.50	-2.34	1.255e-11	0.00	3.232e-13	1.008	6115	180	1.718e-13	1.018	6117	105	6.383e-14	1.017	6092	117	6107	127
G060-026	4.50	-1.24	3.568e-11	0.00	1.243e-12	1.009	5281	76	7.432e-13	1.029	5274	47	2.780e-13	1.010	5273	42	5275	52
G237-072	4.50	0.97	5.414e-11	0.00	1.687e-12	1.010	5648	152	9.482e-13	1.022	5648	77	3.502e-13	1.018	5651	70	5647	89
G014-006	5.00	0.00	2.593e-10	0.00	1.505e-11	1.013	[3639]	133	1.322e-11	—	<3630	—	4.626e-12	1.035	3748	121	(3748)	—
HD111980	4.00	-1.12	1.273e-10	0.02	3.987e-12	1.009	5611	148	2.226e-12	1.024	5628	67	8.287e-13	1.018	5625	40	5624	71
G060-048	4.50	-1.92	8.448e-12	0.00	2.452e-12	1.008	5777	92	1.337e-13	1.021	5794	51	4.933e-14	1.019	5815	99	5795	74
HD112758	4.50	-0.29	2.994e-10	0.00	1.134e-11	1.013	5118	119	6.968e-12	1.022	5136	62	2.629e-12	1.022	5103	39	5116	59
G060-057	4.50	0.00	1.520e-10	0.00	7.562e-12	1.012	[4094]	199	6.428e-12	1.054	[3723]	300	2.515e-12	1.022	3870	104	(3870)	—
G014-022	4.50	0.62	7.247e-11	0.01	2.579e-12	1.014	5372	80	1.457e-12	1.025	5436	49	4.429e-13	1.019	5414	50	5413	57
G014-024	4.50	-2.02	2.418e-11	0.00	9.176e-14	1.008	4922	137	5.552e-14	1.030	4941	71	2.063e-14	1.020	5029	64	4974	81
G060-066	4.50	-0.17	3.814e-11	0.00	1.286e-12	1.013	5490	124	7.357e-13	1.024	5511	57	2.731e-13	1.018	5495	63	5500	67
G014-032	4.50	-1.58	1.669e-10	0.00	4.874e-12	1.040	4513	63	1.850e-12	1.021	4513	63	1.850e-12	1.021	4598	56	4541	59
G063-005	4.50	-0.34	9.037e-11	0.00	2.811e-12	1.012	5637	179	1.647e-12	1.023	5605	78	6.221e-13	1.018	5553	69	5590	91
G063-006	4.50	0.00	7.138e-12	0.00	2.911e-13	1.012	[3719]	154	3.490e-13	1.023	<3600	—	1.218e-13	1.034	3900	75	(3900)	—
G061-038	4.50	-0.78	3.204e-11	0.00	1.084e-12	1.010	5504	244	5.080e-13	1.025	5528	148	2.231e-13	1.019	5512	120	5516	161
G063-009	4.50	0.10	3.241e-09	0.00	1.355e-10	1.014	5944	155	6.114e-11	1.016	5977	81	2.687e-11	1.014	5962	71	5964	93
G014-039	4.50	-0.80	3.356e-10	0.00	9.760e-12	1.009	5867	124	5.246e-12	1.020	5884	62	1.851e-12	1.017	5891	53	5884	66
G014-045	4.50	-0.22	2.633e-12	0.00	1.110e-13	1.009	[4395]	173	6.206e-13	1.039	4429	70	2.807e-12	1.021	4360	68	4496	89
G062-030	4.50	-0.75	1.855e-11	0.00	8.579e-13	1.011	[4411]	133	6.206e-13	1.028	4600	41	2.696e-13	1.028	4462	37	4460	39
G164-067	4.50	0.00	3.600e-11	0.00	1.252e-12	1.011	5533	100	7.408e-13	1.028	5549	77	2.726e-13	1.020	5349	50	5341	70
G063-026	4.50	0.00	1.748e-10	0.00	6.046e-12	1.014	5452	101	3.314e-12	1.023	5494	76	1.254e-12	1.018	5498	68	5504	79
G063-040	4.50	-1.70	3.754e-12	0.00	4.400e-14	1.009	5900	149	5.489e-14	1.020	5988	55	2.042e-14	1.018	5978	63	5970	74
G014-054	4.50	-2.05	1.242e-12	0.00	1.051e-13	1.008	5163	205	2.942e-14	1.032	4928	122	1.108e-14	1.024	4961	108	4994	134
G062-040	4.50	0.12	2.899e-10	3.00	9.407e-12	1.014	5672	223	5.128e-12	1.020	5697	52	1.904e-12	1.017	5673	47	5682	60
HD118100	4.50	-0.07	9.545e-11	3.00	5.029e-12	1.012	[3856]	201	3.834e-12	1.026	4138	100	1.419e-12	1.032	4199	47	4179	64
G062-052	4.50	-1.16	1.351e-11	0.00	4.780e-13	1.009	5243	120	2.913e-13	1.030	5215	49	1.104e-13	1.020	5187	54	5209	63
G165-019	4.50	-1.50	1.588e-10	0.00	8.606e-12	—	<3500	—	7.576e-12	—	<3500	—	2.768e-12	1.028	3658	133	(3658)	—
G064-012	4.50	-3.35	7.998e-12	0.02	1.806e-13	1.009	6510	123	9.592e-14	1.015	6418	77	3.401e-14	1.014	6490	74	6468	87
G063-046	4.50	-0.83	5.014e-11	0.00	1.551e-12	1.010	5682	52	8.352e-13	1.022	5706	52	3.140e-13	1.018	5721	56	5705	61
G062-062	4.50	-0.08	1.399e-10	0.00	4.076e-12	1.013	5968	134	3.229e-12	1.018	5900	68	3.079e-13	1.015	5881	69	5898	82
G165-039	4.50	-1.50	6.926e-11	0.00	3.566e-12	1.011	[3753]	231	3.135e-12	—	<3500	—	1.070e-12	1.025	3878	103	(3878)	—
G064-037	4.50	-2.41	2.726e-11	0.00	6.721e-13	1.009	6259	98	3.300e-13	1.010	6273	37	2.326e-13	1.015	6316	80	6282	72
HD128710	4.50	-1.75	7.656e-12	0.00	2.902e-13	1.009	[4981]	92	1.801e-13	1.032	6439	56	6.935e-14	1.020	4959	63	4971	62
W8296	4.50	-2.51	1.047e-10	0.01	2.413e-13	1.009	6469	113	1.250e-13	1.015	6439	56	4.634e-14	1.015	6404	63	6432	70
G166-022	4.50	-1.32	1.479e-10	0.00	4.400e-12	1.009	5746	153	2.429e-12	1.022	5754	78	8.877e-13	1.018	5786	71	5768	90
G135-047	4.00	-1.65	1.590e-10	0.00	5.203e-13	1.009	5483	77	2.937e-13	1.026	5479	49	1.117e-13	1.019	5452	44	5457	53
G065-042	4.00	-0.38	1.851e-11	0.00	9.546e-12	1.011	[3970]	210	8.064e-12	1.052	[3582]	300	2.837e-12	1.024	3972	88	(3972)	—
G166-027	4.00	-0.28	8.617e-10	0.00	5.919e-13	1.012	5634	91	3.322e-13	1.023	5633	58	1.262e-12	1.018	5575	45	5608	59
G166-028	4.00	-1.50	8.692e-11	0.00	5.483e-12	1.012	<3500	—	1.876e-12	1.022	3663	52	5.725e-12	1.018	3583	143	(3583)	—
HD128681	4.50	-1.98	5.623e-11	0.00	4.865e-12	1.011	[3921]	232	4.382e-12	—	<3500	—	1.385e-12	1.028	3639	136	(3639)	—
G178-030(3)	4.50	0.00	1.377e-12	0.00	1.776e-12	1.008	5516	102	9.360e-13	1.025	5546	51	3.758e-13	1.019	5547	46	5541	59
HR5447	4.00	-0.51	4.328e-09	0.00	6.389e-14	1.012	[4424]	168	3.612e-14	1.037	4831	83	1.510e-14	1.027	4730	74	4825	78
HR5455	4.00	-0.29	8.726e-10	0.00	9.644e-11	1.009	6728	163	4.824e-11	1.010	6679	88	1.722e-11	1.009	6722	83	6707	102
G201-005	4.50	-2.64	7.370e-12	0.00	2.252e-11	1.011	6311	144	1.129e-11	1.013	6351	89	4.088e-12	1.012	6369	83	6349	99
G066-018	4.50	-0.35	2.088e-12	0.00	1.763e-13	1.008	6343	102	9.249e-14	1.016	6320	97	3.387e-14	1.016	6319	144	6328	111
HD128659	4.50	-0.88	6.484e-11	0.05	6.670e-14	1.011	[4382]	142	6.473e-14	1.048	4617	67	2.352e-14	1.028	4660	79	4639	73
HD178-041	4.50	-2.64	2.579e-12	0.00	1.887e-12	1.010	5854	411	1.076e-12	1.022	5762	94	4.028e-13	1.018	5737	122	5763	141
HD129653	4.00	0.00	3.032e-10	0.00	7.169e-14	1.008	3868	84	3.906e-14	1.022	5884	54	1.568e-14	1.018	5799	107	5859	75
G066-022	4.50	-1.11	2.944e-11	0.00	4.684e-12	1.008	7940	170	1.987e-12	1.038	7993	102	7.135e-13	1.021	7979	98	7977	116
G1563-1	4.50	-1.00	6.899e-11	0.00	7.752e-13	1.010	5030	135	4.648e-13	1.032	5112	110	1.070e-13	1.021	5085	78	5071	102
G168-045	4.50	-2.33	3.726e-11	0.01	2.563e-12	1.012	[3796]	226	3.088e-12	—	<3500	—	1.071e-12	1.027	3488	101	(3488)	—
G068-030	4.50	-1.30	1.077e-11	0.01	2.768e-13	1.008	6012	108	5.293e-13	1.019	6034	55	1.931e-13	1.017	6058	75	6037	73
HR5534	4.00	0.20	1.204e-09	0.00	3.479e-11	1.014	6044	85	1.826e-11	1.015	6025	69	6.790e-12	1.013	5985	63	6019	71
G151-010	4.50	-0.50	4.609e-11	0.00	1.065e-12	1.012	5249	219	9.375e-13	1.027	5286	111	2.657e-12	1.020	5280	78	5311	114
G200-062	4.50	-0.56	2.352e-10	0.00	8.950e-12	1.012	5067	107	5.441e-12	1.033	5127	71	2.091e-12	1.022	5092	47	5098	67
HR5588	4.50	0.01	1.970e-09	0.00	8.945e-11	1.013	[4522]	63	6.088e-11	1.047	4640	49	2.394e-11	1.027	4577	38	4605	43
HD132474	4.50	-1.53	1.190e-10	0.03	3.393e-12	1.003	5854	127	1.136e-12	1.023	5767	66	7.136e-13	1.018	5779	44	5788	68
G167-011(4)	4.50	-0.14	5.024e-12	0.00	1.826e-14	1.013	(5277)	—	1.626e-14	1.023	4561	63	5.568e-15	1.026	4707	58	4837	60

Table 4. continued

ID	log(g)	[Fe/H]	$F_{\text{rad}}$	$E(B-V)$	$F_I$	$q_I$	$T_I$	$\Delta T_I$	$F_H$	$q_H$	$T_H$	$\Delta T_H$	$F_K$	$q_K$	$T_K$	$\Delta T_K$	$T_{\text{mean}}$	$\Delta T_{\text{mean}}$
HR2634	4.00	0.05	2.75e-09	0.00	6.617e-11	1.012	6584	130	3.27e-11	1.009	6570	87	1.191e-11	1.008	6565	81	6571	95
HD134169	4.00	-1.15	2.380e-10	0.00	6.771e-12	1.010	5896	81	1.733e-12	1.022	5855	81	1.983e-12	1.018	5856	92	5870	84
HD134439	4.50	-1.52	7.493e-11	0.00	2.894e-12	1.009	4932	88	8.73e-12	1.033	4984	59	6.823e-13	1.020	4967	41	4974	48
HD134440	4.50	-1.57	5.606e-11	0.00	2.313e-12	1.009	4749	102	1.516e-12	1.038	4742	42	5.871e-13	1.021	4732	50	4746	40
G015-013	4.50	-1.88	4.471e-12	0.07	1.533e-13	1.008	5279	108	9.339e-14	1.028	5206	111	3.481e-14	1.020	5245	95	5244	104
LT176079	4.50	-1.89	8.181e-12	0.00	2.520e-13	1.008	5594	121	1.410e-13	1.024	5614	47	5.087e-14	1.019	5687	70	5639	84
G015-023	4.50	-1.42	1.276e-11	0.00	4.607e-13	1.009	5152	107	2.753e-13	1.030	5184	46	1.040e-14	1.020	5176	65	5175	67
G015-024	4.50	-1.44	7.769e-12	0.00	2.413e-13	1.009	5604	106	1.365e-12	1.024	5618	46	5.631e-14	1.019	5616	52	5614	62
HR1758	4.00	0.01	6.049e-10	0.00	1.347e-11	1.010	6810	131	3.965e-12	1.005	6848	90	2.327e-12	1.006	6829	84	6831	98
G112-035	4.00	0.00	1.087e-12	0.00	1.394e-13	1.014	5502	90	7.326e-11	1.024	5498	60	9.95e-11	1.019	5478	51	5491	63
HR2630	4.00	-0.13	1.297e-09	0.00	2.815e-11	1.010	6802	119	1.398e-11	1.007	6785	101	5.110e-11	1.008	6768	65	6782	88
HD140283	4.00	-2.37	3.359e-10	0.00	1.141e-11	1.008	5639	146	6.454e-12	1.025	5676	66	2.879e-12	1.018	5689	47	5681	66
HR5868	4.50	0.05	4.514e-09	0.00	1.346e-10	1.014	5913	155	—	—	—	—	2.657e-11	1.015	5889	73	5897	59
G016-013	4.50	-0.86	2.880e-11	0.00	9.573e-13	1.016	5451	119	5.331e-13	1.025	5520	37	1.981e-13	1.019	5526	94	5507	63
HR5901	4.00	0.00	4.061e-09	0.00	1.704e-10	1.014	4810	118	1.115e-10	1.040	4842	48	4.287e-11	1.028	4855	59	4811	68
HR5914	4.00	-0.37	3.900e-09	0.00	1.187e-10	1.012	5769	114	6.530e-11	1.020	5789	69	2.430e-11	1.017	5761	76	5774	82
HR5933	4.00	-0.32	7.590e-09	0.00	2.013e-10	1.012	6221	159	—	—	—	—	3.707e-11	1.014	6238	77	6233	104
G240-002	4.50	-0.78	1.840e-12	0.03	5.052e-14	1.008	5364	177	2.866e-14	1.025	5579	71	1.051e-14	1.020	5479	73	5502	90
G016-025	4.50	-2.48	3.597e-10	0.00	1.155e-11	1.010	5576	151	6.616e-12	1.024	5560	76	2.470e-12	1.018	5541	68	5555	87
HR5968	4.00	-0.17	1.871e-09	0.00	5.752e-11	1.013	5794	117	3.150e-11	1.020	5793	71	1.177e-11	1.016	5753	64	5777	78
G240-002	4.50	-2.48	4.397e-11	0.03	1.565e-12	1.008	5124	135	8.747e-13	1.027	5274	91	3.403e-13	1.020	5229	73	5235	94
HD143921	4.50	0.23	6.497e-09	0.00	1.802e-10	1.014	6168	104	9.167e-11	1.013	6188	62	3.443e-11	1.011	6126	57	6158	69
G016-028	4.50	-1.63	4.580e-12	0.03	1.650e-13	1.009	5143	113	9.772e-14	1.030	5184	72	3.828e-14	1.020	5114	63	5146	78
G180-024	4.50	-0.67	3.248e-11	0.00	8.630e-13	1.009	6038	180	4.597e-13	1.019	6062	119	1.689e-13	1.017	6072	114	6059	128
HD144515	4.50	-1.81	1.645e-10	0.00	6.502e-12	1.011	4940	128	4.273e-12	1.038	4910	88	1.672e-12	1.022	4828	60	4867	64
G225-057	3.00	-1.46	2.405e-10	0.00	1.390e-11	1.009	<3500	—	1.173e-11	1.032	<3500	—	4.308e-12	1.029	3578	142	(3578)	—
G184-042	4.50	-1.50	7.903e-12	0.01	2.986e-13	1.009	6015	187	1.782e-13	1.032	5092	95	6.888e-14	1.029	5050	78	5059	105
HR1936	4.50	-2.92	9.232e-09	0.00	3.102e-10	1.012	3804	188	1.924e-10	1.028	<3500	—	7.798e-11	1.034	3862	105	(3862)	—
G180-058	4.50	-2.92	9.232e-09	0.00	3.102e-10	1.012	3804	188	1.924e-10	1.028	<3500	—	7.798e-11	1.034	3862	105	(3862)	—
G017-021	4.00	-0.75	3.387e-12	0.00	1.001e-11	1.010	5834	99	3.406e-12	1.020	5855	69	1.890e-12	1.017	5857	47	5831	62
HD149144	4.50	-1.79	2.566e-11	0.00	8.456e-13	1.008	5408	149	4.964e-13	1.028	5365	74	1.893e-13	1.020	5344	66	5364	85
G017-025	3.00	-1.34	4.561e-11	0.00	1.784e-12	1.009	4904	86	1.096e-12	1.034	4979	49	1.898e-13	1.021	4855	43	4966	46
HR6189	4.00	-0.63	7.847e-10	0.00	2.159e-11	1.011	6046	129	1.150e-11	1.017	6046	77	4.269e-12	1.016	6028	65	6038	83
HR6228(5)	4.50	0.00	4.097e-09	0.00	1.681e-10	1.014	4878	101	1.400e-10	1.064	4478	62	5.697e-11	1.031	4323	53	4394	57
G017-037(6)	4.50	-2.29	1.276e-12	0.00	5.957e-14	1.010	209	209	3.697e-14	1.036	4440	89	1.283e-14	1.020	4721	60	4614	74
HD152154	4.50	-1.70	5.618e-11	0.13	2.007e-12	1.009	5163	100	1.113e-12	1.027	5229	83	4.173e-13	1.020	5329	63	5289	81
HD153147	4.50	-1.26	5.376e-11	0.07	1.789e-12	1.009	5530	150	9.780e-13	1.024	5614	76	3.558e-13	1.019	5660	68	5622	87
G19-038	5.00	-1.30	1.440e-10	0.00	7.509e-12	1.011	3731	233	6.439e-12	—	<3500	—	2.434e-12	1.027	3717	125	(3717)	—
HD156026	4.50	0.00	2.807e-09	0.00	1.886e-11	1.011	4217	172	1.434e-11	1.059	4327	61	5.442e-12	1.031	4304	45	4314	52
HR6289	4.00	-0.23	1.267e-09	0.00	6.158e-11	1.011	4167	172	4.539e-11	1.023	4343	42	1.709e-12	1.029	4347	36	4345	39
HD157069	4.00	-0.58	4.420e-10	0.00	1.417e-11	1.014	5543	150	2.324e-11	1.025	5625	78	2.832e-12	1.018	5684	47	5662	65
G181-045	4.50	-0.84	2.609e-12	0.01	1.269e-13	1.010	5279	120	7.694e-14	1.050	5257	62	2.877e-14	1.020	5248	57	5258	71
G182-007	4.50	-0.19	1.759e-10	0.00	6.508e-12	1.013	5204	108	2.878e-12	1.031	5193	47	1.513e-12	1.022	5143	48	5175	58
G019-024	4.50	0.40	5.758e-10	0.00	3.129e-11	1.012	3939	115	2.056e-11	1.068	4037	124	9.468e-12	1.037	4068	51	4065	72
G019-025	4.50	-1.52	6.878e-12	0.02	2.615e-13	1.009	4900	108	1.612e-13	1.033	5013	71	6.256e-14	1.020	4939	61	4977	75
G181-046	4.50	-0.76	3.851e-11	0.01	1.411e-12	1.011	5268	120	8.047e-13	1.028	5355	52	2.998e-13	1.020	5347	54	5334	65
HR1-047	4.50	-0.88	1.115e-10	0.00	3.324e-12	1.011	5801	178	1.818e-12	1.021	5810	93	6.808e-13	1.017	5781	62	5794	93
HR6538	4.00	0.00	6.433e-10	0.00	2.017e-11	1.015	5761	153	1.081e-11	1.019	5788	73	4.036e-12	1.016	5758	71	5770	90
G139-043	5.00	0.00	1.615e-10	0.00	8.852e-12	1.012	3702	235	7.662e-12	—	<3500	—	2.693e-12	1.033	3708	127	(3708)	—
G019-037	4.50	-0.59	1.588e-10	0.00	5.539e-12	1.011	4340	80	3.114e-12	1.028	5444	75	1.150e-12	1.019	5446	45	5418	62
HR6556	4.00	0.00	3.710e-08	0.00	9.736e-10	1.009	7958	197	2.496e-10	0.993	7941	132	9.079e-11	1.019	7900	110	7923	138
G170-016	4.50	-1.25	3.493e-11	0.00	9.733e-13	1.001	5948	81	5.950e-13	1.020	5849	52	1.931e-13	1.017	5960	68	5952	65
G020-008	5.00	-2.59	3.126e-11	0.01	8.688e-13	1.008	5866	83	4.714e-12	1.021	5866	68	1.723e-13	1.018	5820	75	5801	75
G182-015	4.50	-0.71	1.246e-11	0.00	2.813e-12	1.011	5732	133	2.064e-13	1.024	5777	58	1.407e-13	1.017	5785	71	5771	94
G020-019	4.50	-2.79	2.318e-11	0.10	7.038e-13	1.008	5599	136	3.824e-13	1.024	5671	58	1.407e-13	1.013	5717	44	5682	63
G014-021	4.50	-2.29	4.866e-11	0.05	1.769e-12	1.008	5083	89	1.034e-13	1.028	5146	48	3.870e-13	1.020	5168	64	5146	63
HD161903	4.00	0.00	2.306e-10	0.00	3.994e-12	1.006	7380	189	1.423e-12	1.000	7513	97	6.597e-13	0.999	7497	93	7521	111
HD162208	4.00	0.00	2.521e-10	0.00	3.780e-12	1.003	8033	170	1.890e-12	0.988	7932	101	6.019e-13	0.998	7941	88	7953	115
HR6628	4.00	0.00	2.985e-09	0.01	3.780e-11	0.987	8588	137	1.443e-11	0.989	8845	109	5.161e-12	0.987	8928	116	8794	116

Table 4. continued

ID	log(K)	[Fe/H]	$F_{\text{red}}$	E(B-V)	$F_{\text{I}}$	$g_{\text{I}}$	$T_{\text{I}}$	$\Delta T_{\text{I}}$	FH	qH	TH	$\Delta T_{\text{H}}$	FK	qK	TK	$\Delta T_{\text{K}}$	$T_{\text{mean}}$	$\Delta T_{\text{mean}}$
G183-011	4.50	-2.05	3.70e-11	0.00	8.83e-13	1.009	6546	97	4.43e-13	1.014	6438	68	1.667e-13	1.015	6370	68	6441	76
G154-054	4.50	0.00	9.95e-12	0.02	3.40e-13	1.014	5486	102	1.93e-13	1.024	5501	75	7.342e-14	1.018	5442	45	5469	66
G154-056	4.50	-1.50	4.11e-11	0.02	1.871e-12	1.009	5486	102	1.93e-13	1.024	5501	75	7.342e-14	1.018	5442	45	5469	66
HR6752	4.50	-0.91	1.908e-09	0.00	3.144e-10	1.013	[4900]	69	1.980e-11	1.056	5023	70	2.771e-13	1.019	5542	94	5493	111
G020-024	4.50	-0.91	1.908e-09	0.00	3.144e-10	1.013	[4900]	69	1.980e-11	1.056	5023	70	2.771e-13	1.019	5542	94	5493	111
HR6806	4.50	-0.25	8.975e-11	0.00	2.289e-13	1.010	6386	113	7.726e-13	1.014	6386	64	5.971e-14	1.012	6523	70	6404	77
G140-046	4.50	-1.44	2.171e-11	0.00	8.540e-13	1.009	4876	78	2.677e-11	1.037	4864	74	8.719e-12	1.021	4931	70	4947	74
G021-006(7)	4.50	0.00	4.098e-12	0.00	2.020e-13	1.011	(4161)	154	1.196e-13	1.043	4749	67	4.507e-14	1.027	4723	58	4735	62
HR6844	4.50	0.17	3.557e-10	0.00	1.176e-11	1.009	7056	128	3.582e-12	1.004	7037	69	2.703e-12	1.003	7059	65	7038	80
GJ710	5.00	0.00	3.105e-11	0.00	4.241e-12	1.012	[3652]	218	7.862e-12	1.055	[3600]	300	1.381e-12	1.032	3886	102	(3888)	—
HR6647	4.50	0.00	8.240e-10	0.00	1.368e-11	1.013	5997	154	1.363e-11	1.033	5110	79	5.186e-12	1.016	5761	71	5781	90
G181-019	4.50	-0.40	1.565e-12	0.10	6.586e-14	1.012	[4155]	94	3.873e-14	1.053	5110	79	5.186e-12	1.016	5761	71	5781	90
HD171620	4.50	-2.39	2.174e-11	0.05	7.738e-13	1.008	5107	110	4.617e-13	1.028	5130	77	1.738e-12	1.020	5164	64	5138	67
G206-034	4.50	-0.65	2.956e-10	0.00	6.960e-12	1.011	6097	126	3.629e-12	1.016	6113	82	1.366e-12	1.019	6111	68	6109	86
G207-037	4.00	-3.10	8.169e-12	0.04	2.137e-12	1.013	6305	223	1.163e-13	1.014	6143	82	4.158e-14	1.012	6189	92	6191	109
G208-029	4.50	-0.27	1.576e-10	0.00	4.802e-12	1.015	5885	124	2.604e-12	1.017	5842	59	8.702e-13	1.018	5899	46	5835	65
G021-022	4.00	-0.45	3.247e-11	0.00	1.750e-12	1.011	5509	150	9.839e-13	1.024	5550	76	3.669e-12	1.018	5523	68	5531	87
G184-020	4.50	-1.63	1.418e-11	0.00	3.865e-13	1.009	5906	180	2.211e-13	1.021	5847	69	8.092e-14	1.018	5876	60	5869	82
G021-022	4.50	-2.11	3.593e-12	0.10	1.108e-13	1.008	5377	124	6.252e-14	1.034	5382	105	2.427e-12	1.019	5625	134	5593	120
G184-020	5.00	-1.50	1.602e-10	0.00	8.238e-12	1.011	[3793]	227	6.958e-12	1.035	[3518]	300	2.427e-12	1.026	3760	120	(3760)	—
G022-069	4.50	-0.48	2.615e-11	0.00	6.418e-12	1.011	[3504]	253	5.518e-12	1.035	<3500	—	1.867e-12	1.028	3760	120	(3760)	—
HR7236	4.00	0.00	8.963e-09	0.00	9.025e-13	1.012	5386	80	5.024e-13	1.025	5497	76	1.847e-13	1.018	5503	68	5485	74
HR7260	4.00	0.00	1.031e-09	0.00	1.083e-10	1.001	8715	171	4.141e-11	1.096	8981	110	1.496e-11	1.093	8927	108	8910	124
G022-020	4.50	-1.21	5.932e-11	0.00	3.406e-11	1.014	5591	142	1.875e-11	1.022	5629	67	7.066e-12	1.018	5653	67	5603	81
HD181007	4.50	-2.27	3.022e-11	0.00	1.929e-12	1.003	5498	102	1.045e-12	1.024	5608	52	3.805e-13	1.019	5651	71	5597	70
G125-004	4.50	-0.42	9.168e-11	0.00	2.075e-12	1.003	[4651]	127	1.373e-12	1.033	4633	64	5.230e-13	1.021	4625	57	4582	60
G022-024	4.50	-0.47	2.074e-11	0.00	3.623e-12	1.012	[4665]	276	2.230e-12	1.035	5045	131	8.634e-13	1.023	4975	149	5004	139
HR7373	4.00	0.41	2.368e-08	0.00	9.407e-13	1.011	[4660]	74	6.184e-13	1.045	4675	66	2.656e-13	1.025	4715	39	4700	49
HR7388	4.00	0.24	8.744e-10	0.00	3.584e-11	1.017	6030	125	4.552e-11	1.023	6072	84	4.741e-12	1.013	6074	90	6082	97
G125-013	4.50	-0.87	2.304e-11	0.00	6.274e-13	1.010	5875	170	3.579e-13	1.020	5901	82	1.321e-13	1.017	5901	96	5896	105
G092-008	5.00	-1.50	4.473e-11	0.00	2.553e-12	1.000	<3500	—	2.147e-12	1.020	<3500	—	8.071e-13	1.028	3509	141	(3599)	—
HD338528	4.50	-2.68	5.255e-11	0.00	1.258e-12	1.008	6341	160	6.683e-13	1.016	6298	74	2.427e-13	1.016	6309	58	6310	81
G208-029	4.00	0.00	1.021e-10	0.00	2.445e-12	1.012	6282	292	1.214e-12	1.009	6550	174	4.433e-13	1.010	6559	182	6559	205
HD184439	4.00	-0.69	6.206e-10	0.00	1.891e-11	1.011	5748	116	1.036e-11	1.022	5759	59	3.835e-12	1.018	5745	44	5750	62
G023-005	5.00	-0.25	4.012e-09	0.00	6.130e-12	1.011	<3500	—	5.321e-12	1.022	<3500	—	1.914e-12	1.027	3697	128	(3697)	—
HR7462	4.50	0.14	1.121e-10	0.00	1.437e-10	1.013	5303	147	—	—	—	—	3.382e-11	1.022	5177	64	5227	89
HR7503	4.50	0.08	9.969e-10	0.00	3.460e-11	1.014	5803	154	1.893e-11	1.019	5780	78	7.122e-12	1.015	5730	71	5763	90
HR7504	4.50	0.00	1.125e-10	0.00	2.766e-11	1.014	5814	154	1.592e-11	1.019	5780	78	5.714e-12	1.016	5733	71	5767	80
HD188262	4.50	-1.00	1.125e-10	0.00	7.431e-12	1.014	[3846]	222	6.471e-12	1.038	<3500	—	2.277e-12	1.028	3766	119	(3766)	—
HD18810	4.00	-1.80	8.512e-11	0.00	1.281e-11	1.014	[4882]	143	8.209e-12	1.038	4806	70	5.604e-12	1.019	4802	61	4830	65
G023-020	4.00	-1.83	7.187e-12	0.00	2.627e-12	1.008	5596	166	1.526e-12	1.036	5544	78	5.604e-12	1.019	5575	160	5564	121
HD18928	4.00	-1.30	2.306e-10	0.00	2.438e-13	1.008	5260	205	1.470e-13	1.028	5257	112	5.416e-14	1.020	5306	100	5278	126
G022-049	5.00	0.00	5.222e-12	0.00	8.878e-12	1.003	5744	147	3.983e-12	1.024	5639	52	1.480e-12	1.019	5649	59	5663	87
HR7670	4.00	0.26	1.431e-09	0.00	2.815e-13	1.011	[3654]	177	1.717e-13	1.050	4570	69	6.777e-14	1.030	4477	109	4511	129
G186-011	4.00	-0.18	3.929e-10	0.00	1.519e-11	1.015	5621	121	2.705e-11	1.022	5579	76	1.043e-11	1.017	5539	68	5572	83
G024-003	4.50	-1.78	1.901e-11	0.00	5.393e-13	1.008	5850	196	9.926e-12	1.038	4894	69	3.737e-12	1.024	4970	61	5001	75
HD227638	5.00	-0.87	9.290e-11	0.00	3.511e-12	1.008	5850	196	2.294e-12	1.021	5859	66	1.088e-13	1.018	5863	74	5859	89
GJ782	5.00	-1.50	1.477e-10	0.00	7.853e-12	1.011	[3792]	230	6.395e-12	1.055	[3792]	300	2.255e-12	1.025	3900	99	(3900)	—
HD345957	4.50	-1.45	8.043e-11	0.00	2.256e-12	1.009	5805	84	1.322e-12	1.022	5743	68	4.901e-13	1.018	5750	52	5788	65
GJ784	5.00	-1.50	4.379e-10	0.00	2.673e-11	1.009	<3500	—	2.185e-11	1.022	<3500	—	8.456e-13	1.029	3562	145	(3562)	—
G024-013	4.50	-1.10	2.534e-11	0.00	8.193e-12	1.009	5523	120	4.561e-13	1.025	5572	51	1.708e-13	1.019	5558	70	5588	71
HD132901	4.50	-1.13	9.745e-11	0.00	2.778e-12	1.010	5790	154	1.618e-12	1.022	5746	78	6.035e-13	1.018	5733	71	5750	90
G186-026	4.50	-3.40	1.491e-11	0.01	3.352e-13	1.008	6327	128	1.638e-13	1.014	6487	80	1.092e-14	1.015	6428	79	6428	94
HD229274	4.50	-2.46	7.292e-11	0.00	2.288e-12	1.008	5510	420	1.384e-12	1.026	5378	193	5.162e-13	1.020	5404	210	5414	243
GJ798	5.00	-1.50	1.732e-10	0.00	9.278e-12	1.011	[3640]	250	7.923e-12	1.026	<3500	—	2.816e-12	1.026	3786	116	(3786)	—
BD +4 4251	4.50	-1.80	4.144e-11	0.00	1.172e-12	1.008	5842	154	6.473e-13	1.021	5829	79	2.145e-13	1.018	5798	72	5819	91
G034-015	4.00	-1.37	1.294e-10	0.00	3.511e-12	1.009	6023	125	1.886e-12	1.019	6012	55	6.945e-13	1.017	6019	74	6017	96
HR7914	4.00	0.00	7.128e-10	0.00	2.213e-11	1.013	5781	154	1.211e-11	1.020	5768	78	4.504e-12	1.017	5745	71	5761	90

Table 4. continued

ID	$\log(g)$	$[Fe/H]$	$F_{B-V}$	$E(B-V)$	$F_J$	$g_I$	$T_I$	$\Delta T_I$	$F_H$	$g_H$	$T_H$	$\Delta T_H$	$F_K$	$g_K$	$T_K$	$\Delta T_K$	$T_{mean}$	$\Delta T_{mean}$
G231-019	5.00	-1.50	3.455e-11	0.00	1.867e-11	1.001	<3500	126	1.036e-11	1.066	4060	73	6.120e-12	1.028	3630	137	(3630)	81
G209-041	5.00	0.00	6.271e-11	0.00	3.292e-12	1.011	[3485]	126	1.036e-11	1.066	4060	73	6.120e-12	1.028	3630	137	(3630)	81
HR7994	4.00	0.00	2.413e-11	0.00	2.413e-11	1.013	5749	153	1.037e-11	1.018	5688	77	5.810e-12	1.015	5839	70	5686	89
G210-048	4.00	0.09	6.305e-10	0.00	1.877e-11	1.014	5627	143	1.021e-11	1.018	5872	85	3.810e-12	1.015	5839	67	5870	88
G025-015	4.50	-0.48	3.270e-10	0.00	9.859e-12	1.011	5799	102	2.038e-12	1.021	5751	56	2.073e-12	1.017	5447	56	5747	50
HR0881	4.50	-0.03	3.715e-09	0.00	1.740e-10	1.012	[4372]	99	1.333e-11	1.056	4319	59	5.042e-11	1.029	4327	46	4323	60
HR8066	5.00	-0.18	2.220e-09	0.00	1.173e-10	1.012	[3610]	180	1.037e-10	—	<3500	—	3.620e-11	1.032	3865	97	(3865)	—
G067-037	5.00	-1.50	4.091e-10	0.00	2.066e-11	1.011	[3876]	219	1.798e-11	—	<3500	—	6.830e-11	1.026	3759	120	(3759)	—
G188-018	5.00	-1.50	2.241e-09	0.00	1.168e-10	1.011	[3726]	233	1.036e-10	—	<3500	—	3.645e-11	1.026	3786	116	(3786)	—
HD201891	4.50	-1.22	3.162e-10	0.00	8.942e-12	1.009	5905	127	4.845e-12	1.020	5905	68	1.780e-12	1.017	5914	49	5909	70
HD201889	4.00	-1.10	1.727e-10	0.00	5.300e-12	1.010	5670	137	3.001e-12	1.024	5643	71	1.132e-11	1.019	5669	69	5663	84
GJ225	5.00	-1.50	1.422e-09	0.00	8.148e-11	—	<3500	—	7.106e-11	—	<3500	—	2.576e-11	1.028	5592	142	(3592)	—
BD +04 4674	4.50	-0.90	1.118e-10	0.00	3.271e-12	1.010	5842	154	1.857e-12	1.021	5762	78	6.926e-13	1.018	5747	71	5771	90
G025-029	4.50	-0.80	1.118e-10	0.00	3.271e-12	1.010	5842	154	1.857e-12	1.021	5762	78	6.926e-13	1.018	5747	71	5771	90
G026-012	4.50	-1.27	4.843e-11	0.00	2.339e-12	1.010	[4095]	143	1.740e-12	1.018	4078	88	6.389e-13	1.024	4288	36	4235	51
G026-011	4.50	-2.64	4.490e-12	0.04	1.107e-13	1.008	6245	127	6.107e-14	1.016	6127	82	2.171e-14	1.016	6204	77	6185	91
G126-019	4.50	-2.06	4.728e-11	0.00	1.681e-12	1.012	5833	126	1.026e-12	1.029	5277	64	3.915e-13	1.021	5220	72	5267	81
G214-001	4.50	-2.06	4.854e-12	0.04	1.368e-13	1.008	5849	124	7.681e-14	1.022	5797	86	9.242e-14	1.018	5754	71	5762	86
G188-029	4.50	-0.05	6.413e-11	0.03	1.756e-12	1.012	6160	152	9.058e-13	1.014	6160	99	3.244e-13	1.013	6157	85	6159	94
G215-020	5.00	-1.50	4.695e-11	0.00	2.024e-12	1.008	<3500	135	2.241e-12	1.027	5276	55	2.938e-14	1.028	3635	136	(3635)	—
G188-030	4.50	-1.99	1.268e-11	0.01	4.340e-13	1.008	5273	135	7.809e-13	1.027	5276	55	2.938e-14	1.028	3635	136	(3635)	—
G018-016	4.50	-1.50	1.605e-10	0.00	9.017e-12	1.010	<3500	119	8.820e-13	1.027	5410	74	3.301e-13	1.029	3580	143	(3580)	—
G018-028	4.50	-0.84	4.468e-11	0.00	1.491e-12	1.011	5357	118	2.160e-13	1.021	5313	68	7.414e-14	1.020	5356	59	5204	75
HR8455	4.50	-0.32	9.753e-10	0.00	3.390e-11	1.011	5079	125	7.017e-13	1.022	5630	100	2.612e-13	1.018	5923	97	5941	106
G126-062	4.50	-1.80	4.695e-11	0.00	1.277e-12	1.009	5979	125	7.017e-13	1.022	5630	100	2.612e-13	1.018	5923	97	5941	106
G195-063(8)	4.50	-1.49	4.005e-12	0.06	1.519e-13	1.005	(5003)	104	6.626e-14	1.020	5725	79	2.457e-14	1.018	5738	71	5730	83
HD211476	4.50	0.05	4.157e-10	0.00	1.284e-11	1.014	5912	84	6.729e-12	1.018	5864	79	2.960e-12	1.018	5832	45	5862	67
HR3541	4.00	0.00	3.754e-09	0.00	2.668e-11	1.000	6032	123	2.824e-11	0.992	6120	67	8.460e-12	0.989	6092	87	6092	87
G018-039	4.50	-1.34	2.006e-11	0.00	5.388e-13	1.009	6046	137	2.977e-13	1.020	5965	50	1.106e-13	1.017	5934	71	5976	62
G027-036	4.50	-1.32	1.506e-11	0.00	4.403e-13	1.009	5748	123	2.428e-13	1.022	5782	79	9.169e-14	1.018	5752	71	5762	86
HR2883	4.00	0.00	7.287e-11	0.00	4.280e-12	1.000	<3500	—	3.442e-12	—	<3500	—	1.349e-12	1.029	3870	144	(3570)	—
G067-003	4.50	-0.09	4.944e-09	0.00	9.312e-11	1.001	8811	171	3.654e-11	1.096	8994	110	1.348e-11	1.095	8878	108	8906	124
G027-044	4.50	-0.09	4.944e-09	0.00	9.312e-11	1.001	8811	171	3.654e-11	1.096	8994	110	1.348e-11	1.095	8878	108	8906	124
G156-065	4.50	-0.42	1.753e-10	0.00	5.503e-12	1.010	5664	152	1.116e-12	1.022	5746	73	3.702e-13	1.021	5248	65	5273	60
G1884	5.00	-1.50	4.288e-10	0.00	2.309e-11	1.012	5595	145	3.197e-12	1.023	5599	65	1.866e-12	1.018	5585	59	5592	76
G028-043	4.50	-1.75	2.349e-11	0.00	1.255e-12	1.008	<3500	—	2.309e-11	—	<3500	—	7.142e-12	1.027	3746	121	3746	121
HR8832	4.50	0.00	2.044e-09	0.00	8.690e-11	1.013	[4765]	133	—	—	—	—	2.843e-13	1.020	5078	97	5061	98
G190-015	5.00	-3.00	1.240e-11	0.01	4.481e-13	1.008	5074	176	2.602e-13	1.028	5131	73	1.007e-13	1.020	5116	76	5115	92
G273-001	5.00	-1.63	1.537e-10	0.00	4.299e-12	1.009	5907	131	2.176e-12	1.019	6063	80	6.534e-13	1.032	3775	92	(3775)	—
G218-037	5.00	0.00	3.632e-11	0.00	2.002e-12	1.012	[3693]	116	1.799e-12	—	<3500	—	6.534e-13	1.032	3775	92	(3775)	—
G029-023	4.50	-2.02	2.387e-11	0.00	6.158e-13	1.009	6126	126	3.265e-13	1.013	6129	82	1.241e-13	1.017	6062	75	6102	30
G217-007	5.00	0.00	1.061e-10	0.00	5.513e-12	1.011	3330	248	4.814e-12	1.063	[3681]	300	1.807e-12	1.024	3907	130	3980	130
HR8905	4.00	-0.12	4.612e-09	0.00	1.335e-10	1.013	5982	156	—	—	—	—	2.637e-11	1.016	5941	73	5954	89
G217-008(9)	4.50	-1.91	1.817e-11	0.01	3.094e-13	1.008	(6845)	130	2.432e-13	1.018	6183	82	0.323e-14	1.017	6091	75	6134	70
G273-068	5.00	0.00	1.897e-10	0.00	9.914e-12	1.012	(3824)	224	7.452e-12	1.037	[3940]	300	2.799e-12	1.030	4101	72	4101	72
G029-043	5.00	0.00	4.606e-11	0.00	2.497e-12	1.012	[3752]	184	1.888e-12	1.056	4096	113	7.527e-13	1.023	4012	83	4048	96
G190-034	4.50	-0.01	7.043e-11	0.00	2.537e-12	1.014	5320	147	1.484e-12	1.027	5341	92	5.598e-13	1.021	5301	65	5318	91
G029-047	4.50	0.00	9.468e-11	0.00	5.148e-12	1.012	[3754]	180	4.540e-12	—	<3500	—	1.698e-12	1.035	3781	99	(3781)	—
HD221950	4.50	-0.70	1.426e-09	0.00	3.527e-11	1.010	6370	160	1.854e-11	1.014	6397	84	6.827e-12	1.014	6296	78	6311	97
HD221889	4.00	0.02	3.686e-11	0.00	8.590e-12	1.014	5248	146	2.280e-12	1.032	5181	71	8.456e-13	1.021	5135	63	5174	82
G158-020	4.50	-0.30	2.612e-11	0.00	8.138e-13	1.010	5443	119	5.026e-13	1.028	5459	75	1.899e-13	1.010	5422	67	5440	82
G158-093	4.50	-0.59	1.201e-10	0.00	3.466e-12	1.011	5919	127	1.926e-12	1.020	5849	67	1.139e-13	1.017	5837	72	5840	82
LT16059	4.50	0.00	7.738e-12	0.00	2.407e-13	1.014	3779	123	1.474e-13	1.023	5641	76	5.630e-14	1.019	5410	68	5666	63
BD +16 4148	4.50	0.00	1.428e-11	0.00	5.777e-13	1.014	[4935]	128	3.688e-13	1.037	4975	69	1.446e-13	1.024	4867	60	4917	64
G251-054	4.50	-1.73	2.841e-11	0.00	9.877e-13	1.008	5255	146	5.657e-13	1.027	5300	73	2.115e-13	1.020	3500	86	3508	84

NOTES TO TABLE 4:

- (1) SB501: Wrong  $F_J$ , ( $J=11.22$ ).
- (2) G036-050: The error in  $F_J$  is greater than 10 %, hence no  $T_J$  is provided.
- (3) G178-030: Very faint star,  $J=11.63$ ,  $H=11.31$  and  $K=11.127$ .
- (4) G167-011: The error in  $F_J$  is greater than 20 %. The faintest star of the sample ( $J=12.99$ ).
- (5) HR2228: Wrong  $F_J$ .
- (6) G017-037: Very faint star,  $J=11.706$ ,  $H=11.300$  and  $K=11.297$ .
- (7) G021-006: Wrong  $F_J$ , ( $J=10.38$ ).
- (8) G126-063: Faint star,  $J=10.69$ ,  $H=10.64$  and  $K=10.59$ .
- (9) G217-008: Wrong  $F_J$ .