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OLD STELLAR POPULATIONS. V. ABSORPTION FEATURE INDICES FOR THE COMPLETE LICK/IDS SAMPLE OF STARS[1]

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ABSTRACT

Twenty-one optical absorption features, 11 of which have been previously defined, are automatically measured in a sample of 460 stars. Following Gorgas et al., the indices are summarized in fitting functions that give index strengths as functions of stellar temperature, gravity, and [Fe/H]. This project was carried out with the purpose of predicting index strengths in the integrated light of stellar populations of different ages and metallicities, but the data should be valuable for stellar studies in the Galaxy as well. Several of the new indices appear to be promising indicators of metallicity for old stellar populations. A complete list of index data and atmospheric parameters is available in computer-readable form.

Subject headings: galaxies: stellar content — stars: abundances — stars: atmospheres — stars: fundamental parameters

1. INTRODUCTION

Understanding the physical origin of prominent absorption features in the integrated light of galaxies requires knowledge of how the same features vary among Galactic stars with temperature, gravity, and abundance. This can be accomplished completely theoretically, empirically, or by some mixture of the two. Studies of absorption-line features based primarily on theoretical work include those of Mould (1978), Johnson, Mould, & Bernat (1982), Tripicco & Bell (1990), Gulati, Malagnini, & Morossi (1991), and Barbuy, Erdely-Mendes, & Milone (1992). Primarily empirical studies include those of Spinrad & Taylor (1969, 1971), Aaronson et al. (1978), Cohen (1978), Mould & McElroy (1978), Peletier (1989), Buzzoni, Gariboldi, & Mantegazza (1991), and Faber et al. (1985).

The present article summarizes a two-decade-long effort by the authors and our colleagues to quantify the strengths of strong absorption-line features of Galactic stars as measured in the 4000–6000 Å region. All stars were observed at Lick Observatory between 1972 and 1984 using the Cassegrain spectrograph and the image dissector scanner (IDS; Robinson & Wampler 1972), which is to say, the same instrument and the same detector the entire time. Previous papers in this series have presented subsets for particular scientific reasons (Faber et al. 1985; Burstein, Faber, & González 1986; Gorgas et al. 1993, hereafter G93). The first two of these papers defined and measured 11 absorption feature indices for 147 K giant field and cluster stars. These indices constitute the "Lick/IDS" system, some of which have been widely adopted, most notably Mg_2.

G93 both extended the Faber et al. sample to include field and cluster dwarf stars and supplemented the K giant sample to produce a sample of 312 stars that span a range in temperature, gravity, and metallicity appropriate for old integrated stellar populations of early-type galaxies. Rather than attempt to define stellar groups, G93 adopted *polynomial fitting functions* to specify the behavior of the 11 Lick features as functions of $V-K$ color (the temperature indicator), log g, and [Fe/H]. As opposed to stellar groups, these fitting functions permit straightforward and smooth interpolation of the strengths of these 11 indices as functions of the physical properties of stars. In particular, these fitting functions are easy to use to construct stellar population models of integrated stellar populations (Worthey 1992, 1994).

The purpose of the present article is to complete this survey and present all of the stellar data we have obtained. The original 11 (and 10 new, see below) Lick/IDS indices are measured in an additional 148 stars that were not included in previous studies. For easy reference, all indices for all stars are collected here.

We also cast an eye forward to the construction of model stellar populations. There are two improvements to G93 that are necessary before it is safe to make a galaxy model. The first of these is to fix a few minor errors in G93, as noted later in the article. The second improvement is to include types of stars that are not included in G93. Stars not included are (1) M dwarfs (cool dwarfs were not included in some index fitting functions), (2) M giants, (3) BAF supergiants, and (4) stars hotter than $V-K=0.95$, including hot main-sequence stars, some horizontal-branch stars, and a smattering of hot supergiants. From a stellar population perspective, M giants are needed for old, metal-rich populations, and hot stars are needed for populations between 0.5 and 2 Gyr old and for populations with blue horizontal branches. Supergiants are useful to make sure that the fitting functions extrapolate correctly toward the lowest values of log g. The latest M dwarfs are added for completeness. (They do not contribute significantly to either the total light contribution or feature strengths in any population. For outré initial mass functions they will

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become more important if their relative numbers are increased by a factor of several tens.)

We have also defined 10 new feature indices that supplement the original list of 11 and have measured these indices for 460 stars. Together, these data represent the bulk of the information we can extract from the Lick/IDS stellar spectra, which themselves constitute a nearly unique database in astronomy. The whole Lick/IDS sample contains nearly 1000 spectra—the 460 stars of this paper, nearly 500 galaxies, and 35 globular clusters—obtained on an internally self-consistent system using the same spectrograph and detector.

The rest of the article is organized as follows. Section 2 describes the data set and discusses the indices and their errors. Section 3 gives two sets of fitting functions (one set derived as a function of $V-K$ in exact analog to G93 for the 10 new indices, and one set derived as a function of T_e for all 21 indices) as well as separate relations for M giants and M dwarfs. Notes on individual indices are given here. In § 4 a short discussion and summary are given. In the Appendix the complete list of all index measurements is tabulated for 460 stars. For most of the new stars, values of T_e, log g, and [Fe/H] are also tabulated, along with the appropriate references. A summary of all stellar indices and stellar parameters is available in computer-readable form (see below).

2. OBSERVATIONS

2.1. *Absorption-Line Measurements*

A full description of the method of observation is given in Burstein et al. (1984) and Faber et al. (1985) and is not repeated here. To summarize, the spectra were obtained between 1972 and 1984 using the red-sensitive IDS and Cassegrain spectrograph on the 3 m Shane telescope at Lick Observatory. The spectra cover roughly 4000–6400 Å, with a resolution of roughly 8 Å and were not fluxed, but were divided by a quartz-iodide tungsten lamp. Line-strength standard stars were observed nightly to enable time-invariant calibration.

Absorption strengths are expressed in terms of "indices," in which a "feature" bandpass is defined centered on the feature of interest, flanked to the blue and red by "continuum" bandpasses that are really pseudocontinua. The pseudocontinuum bandpasses are defined by three criteria: the need to be located near the feature bandpass, the need to be in regions of less absorption than that of the feature being measured, and the need for relative insensitivity to stellar velocity dispersion broadening. This last mandates a minimum length for bandpass definitions. At the Lick/IDS spectral resolution there is no "true" continuum in late-type stars, hence the designation "pseudo." The bandpasses that define the 21 absorption feature indices are given in Table 1.

The wavelengths appearing in Table 1 are uncertain to 2–3 Å owing to uncertainties in the IDS wavelength calibration (§ 2.2). The wavelength definitions of indices 9–16 have been refined through a cross-correlation with CCD spectra with precise wavelength calibrations and index errors which are between 2 and 10 times smaller than IDS errors (González 1993). The indices in common with Faber et al. (1985) (indices 9 and 11–15) have been shifted 1–3 Å. Residual uncertainty of 1–2 Å remains in indices 9–16 because wavelength shifts of this size generally introduce negligible changes in the indices. Details are available from S. M. F. if a reader is interested in matching the system exactly.

Included in Table 1 are the 11 indices previously defined in Faber et al. (1985), as well as 10 indices newly defined here. Briefly, the new indices are:

- CN: CN_2 and the original index, now called CN_1, both measure the strength of the CN λ4150 absorption band. The two measurements differ only in the placement of the blue pseudocontinuum bandpass, which in the case of CN_2 excludes Hδ. CN_2 may be more useful for stellar populations with hot stars.
- Ca: Ca4227 is dominated by Ca I λ4227 absorption. Ca4455 is a blend of many elements, including Ca, Fe, Mn, Ti, Zr, V, and Ni.
- Fe: Fe4383, Fe4531, Fe4668, and Fe5015 are blends of many metallic lines, dominated by those from Fe-peak elements, and are measured by feature bandpasses of ∼50 Å width, somewhat wider than those used in our system for other atomic indices (e.g., Fe5270 or Fe5335).
- Fe: Fe5406, Fe5709, and Fe5782 are also primarily due to absorption from Fe-peak elements, and are measured with feature bandpasses of width 20–30 Å (similar to those of Fe5270 or Fe5335). Fe5782 has a smaller contribution from Fe and larger contributions from Cu, Cr, and Mg.

In total, the Lick indices measure six different molecular bands (CN4150, G band, MgH, MgH + Mg *b*, and two TiO bands) and 14 different blends of atomic absorption lines. With the addition of the 10 new indices, we believe that we have extracted essentially all of the useful information that can be obtained from the Lick spectra in terms of measurement of absorption features.

A problem in measuring IDS indices is caused by unpredictable wavelength shifts and stretches amounting to 1–3 Å in the individual spectra. In previous papers, each index in each spectrum was centered in wavelength by visual inspection. For this paper, all indices were measured by an automatic measuring program developed by J. J. G. The program proceeded by locating Na D (centroid assumed at 5894 Å) and the G band (centroid assumed at 4306 Å) and removing any global wavelength shift and stretch. Next, local wavelength shifts were calculated for each index by cross-correlating the star spectrum with a template spectrOm in the region around each index. Three stellar templates were used: an F star, a K giant, and an early M giant. These three templates were sufficient for all stars except the latest M giants. For these few stars, whose spectra are completely dominated by molecular absorption, we performed no cross-correlation tuning.

Once each index was centered, it was measured according to the following scheme. Two pseudocontinuum bandpasses were defined on either side of a central bandpass. A line representing the continuum was drawn between midpoints of the two flanking bandpasses, and the flux difference between this line and the central bandpass flux determines the index. Indices are defined in two ways. Molecular bands are expressed in magnitudes, while atomic features are expressed in angstroms

TABLE 1

INDEX DEFINITIONS

	Name	Index Bandpass	Pseudocontinua	Units	Measures	Error[1]	Notes
01	CN_1	4143.375-4178.375	4081.375-4118.875 4245.375-4285.375	mag	CN, Fe I	0.021	
02	CN_2	4143.375-4178.375	4085.125-4097.625 4245.375-4285.375	mag	CN, Fe I	0.023	2
03	Ca4227	4223.500-4236.000	4212.250-4221.000 4242.250-4252.250	Å	Ca I, Fe I, Fe II	0.27	2
04	G4300	4282.625-4317.625	4267.625-4283.875 4320.125-4336.375	Å	CH, Fe I	0.39	
05	Fe4383	4370.375-4421.625	4360.375-4371.625 4444.125-4456.625	Å	Fe I, Ti II	0.53	2
06	Ca4455	4453.375-4475.875	4447.125-4455.875 4478.375-4493.375	Å	Ca I, Fe I, Ni I, Ti II, Mn I, V I	0.25	2
07	Fe4531	4515.500-4560.500	4505.500-4515.500 4561.750-4580.500	Å	Fe I, Ti I, Fe II, Ti II	0.42	2
08	Fe4668	4635.250-4721.500	4612.750-4631.500 4744.000-4757.750	Å	Fe I, Ti I, Cr I, Mg I, Ni I, C_2	0.64	2
09	Hβ	4847.875-4876.625	4827.875-4847.875 4876.625-4891.625	Å	Hβ, Fe I	0.22	3
10	Fe5015	4977.750-5054.000	4946.500-4977.750 5054.000-5065.250	Å	Fe I, Ni I, Ti I	0.46	2,3
11	Mg_1	5069.125-5134.125	4895.125-4957.625 5301.125-5366.125	mag	MgH, Fe I, Ni I	0.007	3
12	Mg_2	5154.125-5196.625	4895.125-4957.625 5301.125-5366.125	mag	MgH, Mg *b*, Fe I	0.008	3
13	Mg *b*	5160.125-5192.625	5142.625-5161.375 5191.375-5206.375	Å	Mg *b*	0.23	3
14	Fe5270	5245.650-5285.650	5233.150-5248.150 5285.650-5318.150	Å	Fe I, Ca I	0.28	3
15	Fe5335	5312.125-5352.125	5304.625-5315.875 5353.375-5363.375	Å	Fe I	0.26	3
16	Fe5406	5387.500-5415.000	5376.250-5387.500 5415.000-5425.000	Å	Fe I, Cr I	0.20	2,3
17	Fe5709	5698.375-5722.125	5674.625-5698.375 5724.625-5738.375	Å	Fe I, Ni I, Mg I Cr I, V I	0.18	2
18	Fe5782	5778.375-5798.375	5767.125-5777.125 5799.625-5813.375	Å	Fe I, Cr I Cu I, Mg l	0.20	2
19	Na D	5878.625-5911.125	5862.375-5877.375 5923.875-5949.875	Å	Na I	0.24	
20	TiO_1	5938.375-5995.875	5818.375-5850.875 6040.375-6105.375	mag	TiO	0.007	
21	TiO_2	6191.375-6273.875	6068.375-6143.375 6374.375-6416.875	mag	TiO	0.006	

[1] Typical rms error per observation for stars; a factor of 1.2 larger than bright standard star errors. See text.
[2] A new index. See text.
[3] Wavelength definition has been refined. See text.

of equivalent width. Explicitly, in a pseudocontinuum (P) bandpass, we calculate the average bandpass flux from the spectrum:

$$F_P = \int_{\lambda_1}^{\lambda_2} F_\lambda d\lambda / (\lambda_2 - \lambda_1) . \quad (1)$$

The local continuum for the index ($F_{C\lambda}$) is then the run of flux defined by drawing a straight line from the midpoint of the blue continuum level to the midpoint of the red continuum level.

An equivalent width is then

$$\mathrm{EW} = \int_{\lambda_1}^{\lambda_2} \left(1 - \frac{F_{I\lambda}}{F_{C\lambda}}\right) d\lambda , \quad (2)$$

and an index measured in magnitudes is

$$\mathrm{Mag} = -2.5 \log \left[\left(\frac{1}{\lambda_2 - \lambda_1} \right) \int_{\lambda_1}^{\lambda_2} \frac{F_{I\lambda}}{F_{C\lambda}} d\lambda \right] , \quad (3)$$

where $F_{I\lambda}$ and $F_{C\lambda}$ are the fluxes per unit wavelength in the index passband and the straight-line continuum flux in the index passband, respectively.[6]

[6] Note that these definitions differ slightly from those of Burstein et al. (1984). In that scheme, the continuum line was drawn, and the value at the midpoint of the index bandpass was adopted as the continuum flux. In the present scheme, an integration is performed. The two methods yield the same result except for asymmetric indices with highly sloping continua. This effect is small compared to other systematic sources of error (§ 2.2).

The locations of the 21 index passbands and their flanking pseudocontinua are tabulated in Table 1 and illustrated against IDS spectra of various classes of stars in Figure 1. In order of decreasing temperature, the stars in Figure 1 are HR 7141 (A5 V), HR 660 (G0 V), HR 6018 (K0 III), and HR 2905 (M0 III). The spectra have not been fluxed or flattened and appear with arbitrary zero-point shifts and scaling factors. The figure is intended to communicate a rough picture of the overall index behavior with temperature.

2.2. *Error Estimates*

In the IDS, light fell on a series of image tube photocathodes that amplified the signal by about 10^5. The amplified light then fell on a phosphor screen, which held the image long enough to be digitized by an amplifier discriminator, processed, and stored (Robinson & Wampler 1972). Each incident photon was detected as a burst of (typically seven) electrons in the output spectrum. Observational errors (more properly called "uncertainties") arise from three main sources: (1) photon statistics, (2) the statistics of the amplification process that created the final burst of electrons, and (3) flat-fielding errors.

Let us ignore the last factor for a moment and consider only the first two. If each output burst covered only *one* channel, then the noise from factors 1 and 2 would clearly be independent from channel to channel, and total IDS noise would be white, with amplitude due mainly to photon shot noise plus a slight excess due to random variations in burst amplification. Output bursts are *not* confined to a single channel, however, but rather cover about seven channels (9 Å) FWHM. (Burst width is in fact the determining factor in spectral resolution.) Thus, IDS spectra consist of lumpy bursts whose arrival is governed by photon statistics, plus random channel-to-channel Poisson noise due to the amplification statistics within each burst. The net noise spectrum thus consists of two components: quasi-white noise at high frequencies reflecting random channel-to-channel noise within bursts, plus a peak at low frequencies representing the correlated shot noise of the individual photon lumps. This two-component noise spectrum is illustrated in Faber & Jackson (1976).

The height of the low-frequency peak is governed by the average number, N, of detected electrons per burst. Larger N produces a higher peak. However, as long as N alone varies, the shape of the IDS noise power spectrum will remain constant. This means that the noise amplification at high frequencies (channel-to-channel noise) will be a valid indicator of overall noise amplitude. This channel-to-channel noise is particularly easy to measure since it is at such high frequencies that it is well removed from any signal.

Accordingly, we constructed a parameter G that gives a measure of the quality of the spectrum based on how much power is present at high spatial frequencies. For each spectrum, we took the Fourier transform of a particular spectral region that has only mild absorption features, measured the power at high frequencies, and divided by the mean of the region. Since that is a measure of noise, we took the inverse to define G, a goodness parameter. G is related to the signal-to-noise ratio (S/N), but S/N is difficult to estimate for the IDS spectra given their noise characteristics. G was calibrated by considering multiply observed objects (with independent error estimates) with varying spectrum quality. With this crude relation, G gives a statistical σ for each observation, even when the object is observed only once. The G parameter is not trustworthy enough to supply more than crude guesses as to spectrum quality. Photon statistics (and G) are generally unimportant for all but the faintest stars, which comprise less than 10% of the total star sample. These are mainly in NGC 188 and the globular clusters.

Now consider noise source 3: flat-fielding errors. The cathodes of the IDS system had small sensitivity variations on a scale of a few channels, fortuitously comparable to the burst width. Imperfect magnetic shielding caused the electron images to wander as the telescope was pointed, introducing flat-fielding errors of a few percent. The resultant bumps and wiggles in the spectrum unfortunately look like real signal: that is, smooth from channel to channel but with a width comparable to the electron bursts. *Flat-fielding errors are the dominant source of noise for bright stars.* Since they introduce little added noise at high frequencies, the G parameter is useless as an estimator of spectrum quality for such stars. The effect is to put a ceiling on the quality of IDS spectra, even where S/N is excellent.

A good way to estimate this ceiling is to consider the statistics for the nine bright standard K giant stars observed throughout the project: HR 489, 1805, 2002, 2600, 3905, 6018, 6770, 7429, and 7576. There are between 40 and 80 observations of each of these stars, and standard deviations are reliably calculated for them. These errors represent the best the IDS can achieve and are multiplied by 1.2 to represent the typical IDS star. The typical errors are reported in Table 1. These typical errors are a little less than the average errors quoted in Table 3 of Faber et al. (1985) and Table 1 of G93, because they were estimated in a slightly more robust way (not because using the automatic measurement program is a dramatic improvement).

In addition, there are four more sources of error: (1) mild light spillage from one slit (object) to the other (sky), (2) the use of a changing assortment of nongray neutral density filters for bright objects, including all standard stars (affects mainly Mg_1 and Mg_2), (3) slight variations in instrumental focus or resolution from run to run, and (4) large-scale variations in the shape of the calibration lamp from run to run. Effects of the last two items can be largely removed using the standard stars: Differences between the mean and the mean-over-one-run standard star indices reveal the presence of systematic variations. In some cases, statistically significant differences were found, and these run corrections were applied to all stellar observations in that run. This is equivalent to putting each run's "system" on to the "system" defined by the entire history of the IDS. (The standard deviations in Table 1 were computed *after* the application of run corrections.) Run corrections nullify changes in overall instrumental response over time, which would otherwise contribute to the errors in the broader indices.

By virtue of their large numbers, the standard stars yield a very good estimate of the expected *minimum* error of a single observation. Errors above normal caused by poor photon statistics are noted in the tables in the Appendix. Errors are also sometimes larger for stars with jagged spectral features such as

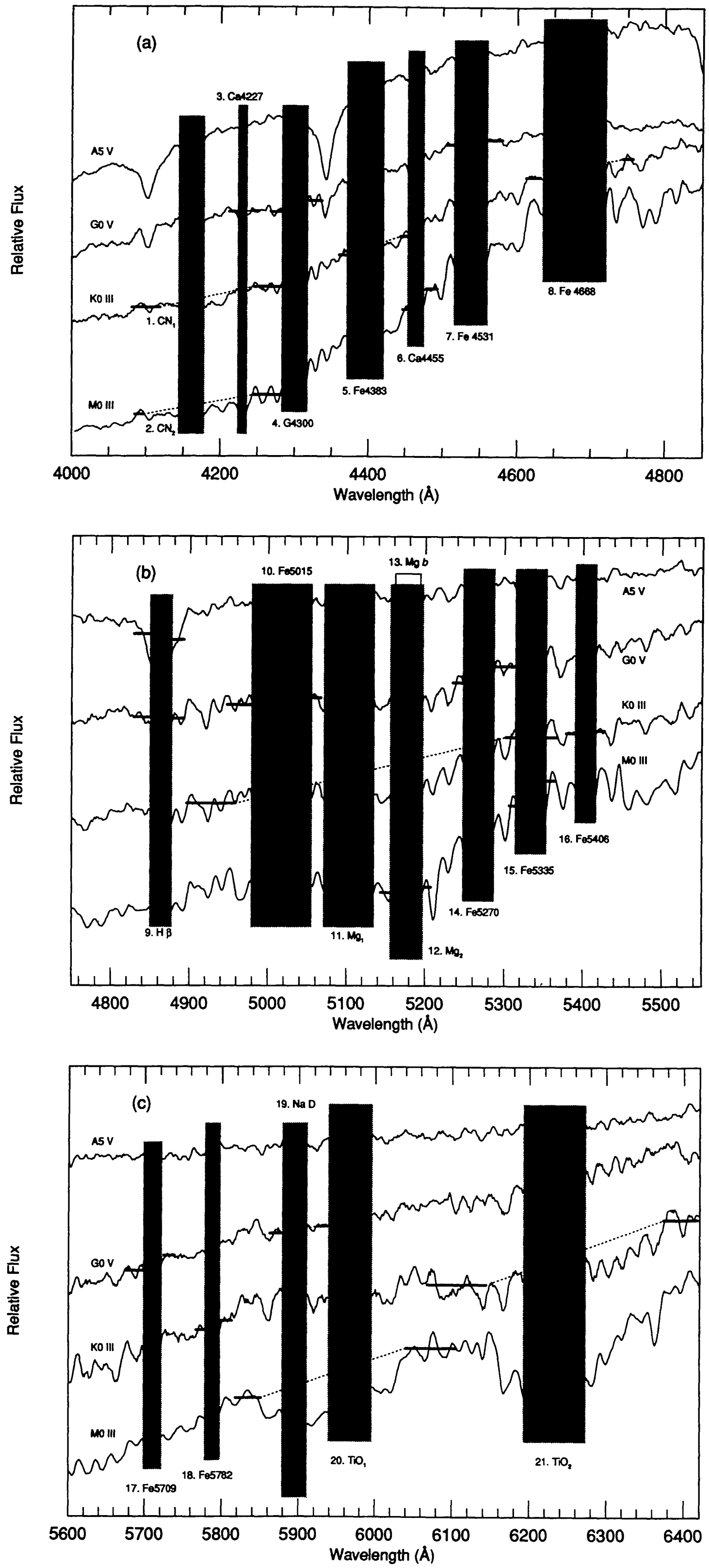


FIG. 1.—Three panels show the (*a*) blue third, (*b*) middle third, and (*c*) red third of typical IDS stellar spectra. Fluxes are arbitrarily scaled and shifted in zero point for display purposes and are not flux-calibrated, but retain the IDS instrumental spectral response. Index passbands are shown as shaded boxes. An indication of placement of pseudocontinua is shown as heavy lines connected by dotted lines on one of the four spectra for each index. In (*a*) note that CN_1 shares the same index passband as CN_2 even though the pseudocontinuum definitions differ. In (*b*) note that Mg *b* has nearly the same index passband as Mg_2, but it is slightly narrower. It is shown as an outline instead of a shaded box to distinguish it from Mg_2. Also, Mg_1 and Mg_2 share the same pseudocontinuum definition, although the index passbands differ. In (*b*), notice that Hβ as we define it is too narrow to accurately measure real Hβ strength in early A stars.

TiO bandheads or huge Balmer lines. For indices that straddle these spectral regions, tiny wavelength errors can cause large errors in the indices. For M stars, Mg_1 and Mg *b* are the indices primarily affected. For A stars, G4300 is affected because of its proximity to Hγ. The indices were designed with galaxies in mind and are not optimized for measuring features in very hot or very cool stars. For example, note the too-close continuum passbands for Hβ in the A5 star in Figure 1: the whole index starts to fall in.

A final note on systematic errors stems from the history of the measuring program. The entire collection of stars was remeasured using J. J. G.'s automatic program, and new standard star means and run corrections were derived using *every* standard star observation. The number of standard star observations more than doubled from Faber et al. (1985), so the new standard star means were slightly different for the original 11 indices. However, we wished the newly measured results for these indices to conform precisely in the mean to the already published system. Therefore small additive corrections (always less than the Table 1 standard deviations, and often zero) were applied to the newly measured 11 original indices to transform them back to the published system. There was some evidence that a multiplicative tilt also applies to CN_1, but the slope was of dubious significance. At its worst, this slope will cause an error of 0.007 mag in CN-weak stars, if it is real. The essential point for authors wishing to duplicate the present system is that small additive zero-point corrections will in general be necessary. Authors should observe some of our well-observed standard stars for this purpose (see González 1993, for an example of a successful transformation).

2.3. *Index Results*

Index measurements are tabulated for the Lick/IDS 460-star sample in the Appendix. For the reader's convenience, all indices for each star are listed even if the values have already been published. The discerning reader will notice that, for previously published stars, the listed indices are *exactly* those published, even though they were remeasured as part of this work. The old values were adopted since only very small systematic differences were found between the old and the new system of indices. For the 11 original indices in the new stars, the newly measured values were modified by small additive adjustments to match the old system, as described above. For all new indices, of course, the new measurements define the system.

We will provide corrections for velocity broadening in a future paper which deals with the Lick/IDS galaxy sample.

2.4. *Physical Parameters for Stars*

Since we are using the methods of G93 (to summarize the index data in polynomial fitting functions) we need to know the temperatures, gravities, and [Fe/H] values for the new stars. The details of the literature search and parameter derivations are found in the Appendix.

This paper considers hotter stars than G93, for which $V-K$ (used by G93) is not an appropriate temperature indicator. To broaden the approach and yet utilize all stars in G93, we adopt a pair of transformations and use $V-K$ and T_e interchangeably when deriving fitting functions. For giants, we adopt the calibration of Ridgway et al. (1980, hereafter RJWW). For dwarfs, the calibration of Johnson (1966) appears robust at all metallicities (Veeder 1974; Carney 1983; Saxner & Hammarbäck 1985). For hot stars we always use T_e directly. The $V-K$ transformations are shown in Figures 2 and 3.

The entire collection of 21 indices for 460 stars and all derived atmospheric parameters is available in computer-readable form from the NSS-DCA Astronomical Data Center (adcrequest@nssdca.gsfc.nasa.gov), from G. W. (worthey@astro.lsa.umich.edu), and on the AAS CD-ROM (vol. 3). The distribution includes a bibliography and a short description of how the indices are measured.

3. FITTING FUNCTIONS

The final goal of this article is to present fitting functions for 21 indices that give the index strength as a function of stellar atmospheric parameters. First, polynomial functions are fitted as a function of effective temperature (in the form $\Theta_e = 5040/T_e$), log *g*, and [Fe/H]. We fitted two sets of functions in this way; one for warm stars (up to 13,260 K), the other for cool stars (down to 3570 K). Second, the stellar sample is treated in a manner analogous to that of G93, and FGK stars are fitted as functions of $V-K$, log *g*, and [Fe/H] for the 10 new indices that are *not* found in G93. Illustrations of these 10 new indices are shown, and the behavior of individual indices is discussed. Finally, polynomial approximations for the coolest dwarfs and giants (down to about 2300 K) are tabulated.

3.1. Θ_e *Fitting Functions*

Polynomial functions in Θ_e ($= 5040/T_e$), log *g*, and [Fe/H] were fitted through all available stars between $T_e = 3750$ and 13,260 K. Two separate polynomial functions are used for each index to cover the range of temperature. The regions of

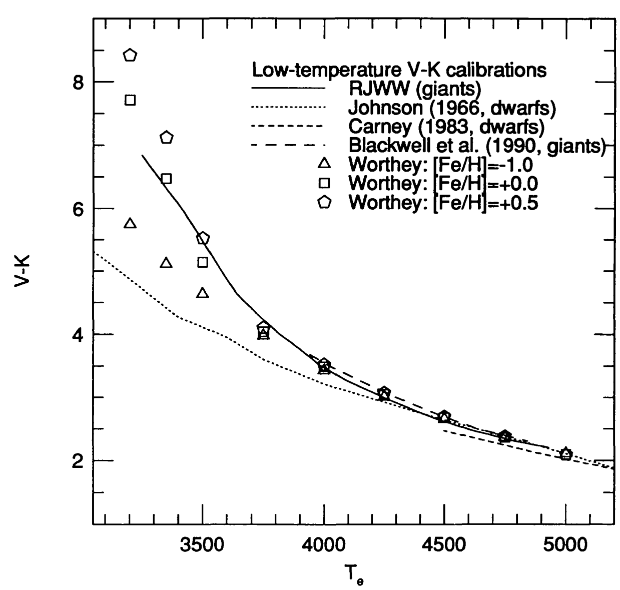


FIG. 2.—Temperature, $V-K$ calibrations for cool stars. There appears to be good agreement among the various empirical calibrations. Model colors are also shown for log $g = 1.0$. Model fluxes are from Kurucz (1992, hereafter K92) and Bessell et al. (1989) for $T_e = 3500$ and below and are described fully in Worthey (1992, 1994). See text for adopted calibrations.

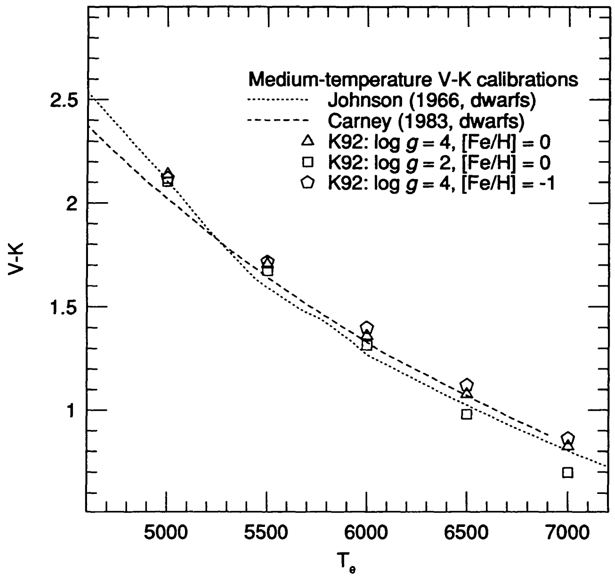


FIG. 3.—Temperature, $V-K$ calibrations for warm stars. There appears to be a good consensus for the calibration among the various empirical calibrations. Colors from K92 model fluxes also agree well for different metallicities. Notice that the model colors show a distinct gravity dependence at higher temperatures. The dispersion in the different calibrations suggests a precision of ±50 K for stars hotter than 4000 K, and ±70 K for stars cooler than that. A typical measurement error in $V-K$ is about ±0.1 mag, which leads to an error of ±90 K at 5000 K. See text for adopted calibrations.

validity are from 3570 to 5160 K for the cool functions (Table 2), and from 5040 to 13,260 K for the hot functions (Table 3). There is a small region of temperature overlap that insures a relatively smooth transition between the two regimes. Cool stars were fit with polynomials in $\log \Theta_e$, hot stars with polynomials in Θ_e. In two cases (the cool fits for TiO_1 and TiO_2), indices are expressed in exponential form, that is, in a form $I = C_1 + \exp(P(\Theta_e, \log g, [Fe/H]))$, where P indicates a polynomial. This is noted in Table 2.

The coefficients listed in Tables 2 and 3 were derived from a one-error least-squares regression. The increased errors of some stars (as indicated in the third column of Tables A1 and A2) were taken into account, and those stars were weighted as $1/\sigma$. The last lines of Tables 2 and 3 list the root-mean-square deviations in units of the standard deviations listed in Table 1. Explicitly,

$$\mathrm{rms}^2 = \frac{1}{N^2} \sum \left(\frac{I_{\mathrm{measured}} - I_{\mathrm{function}}}{\sigma} \right)^2 , \qquad (4)$$

where σ is the standard deviation listed in Table 1 except for stars having larger errors due to photon statistics (Tables A1 and A2). Errors were also decreased accordingly for stars with multiple observations. That these variable errors were explicitly taken into account is an improvement over the method of G93. We have revised a few of the gravities and [Fe/H] for G93 stars. These changes are summarized in the Appendix (Table A5).

In deriving the values of polynomial coefficients listed in Tables 2 and 3 a balance between a pointlessly large number of terms in the polynomial and accuracy of fit was attempted. For some indices with small measurement errors (notably Mg_2), it is errors in input atmospheric parameters that actually determine the scatter around the fit, not errors in the index measurement. The final rms scatter is therefore not known at the outset, but as one adds more terms to the fitted polynomial, the ultimate rms scatter is asymptotically approached. The F-test of variances was used to test whether any two different combination of fitted coefficients yielded a fit which was statistically different. When a new term was added, it was retained if the probability of the new distribution being the same was less than 0.5. This criterion translates into about a 5% difference between two rms values upon the addition of a new term. A set of coefficients was found for each index which is self-consistent in the sense that all terms present are needed for an adequate fit, but any other term one might add would not yield a statistically different fit. In a few cases, we saw particular problems with the fits, and one more term was added beyond the 0.5 guideline. Up to two measurements were thrown out of a few fits because of spurious residuals.

The final polynomials adopted should be an accurate smoothing of the input data. They should be extremely insensitive to random star-by-star index errors and errors in input atmospheric parameters. However, they are at the mercy of any systematic errors which exist in the temperature scale, the gravity scale, or the [Fe/H] scale, and this should be kept in mind. Because the atmospheric parameters are *input* to the polynomials, future scale changes do not require a rederivation of the fitting functions.

3.2. *V − K Fitting Functions*

In order to extend the work of G93 to the new indices, to provide a more empirical calibration that does not depend on deriving T_e, and to provide a useful check of the Θ_e functions, another set of functions was derived using $V-K$ as the temperature variable. Only the 10 new indices not considered in G93 were fit. The stars selected for the $V-K$ fitting functions were (1) all those stars considered in G93, (2) the new Coma and Hyades dwarfs, (3) an M0 giant (HR 2905) that meets the G93 $V-K<4$ cutoff criterion, (4) new FGK dwarfs with $V-K$ values (from Table A2E), and (5) HD 111721 (from Table A2G), a metal-poor dwarf with $V-K=2.15$ from Gratton & Sneden (1991).

As in G93, the fitting functions are polynomials in $V-K$, $\log g$, and [Fe/H]. Certain cross-terms (e.g., $(V-K)(\log g)$, $(V-K)$ (Fe/H)) are included but cross-terms between $\log g$ and [Fe/H] are *not* allowed, to retain separability in the resultant equations. Experimental inclusion of ($\log g$) [Fe/H] cross-terms never resulted in a significantly improved fit. Evidently, gravity does not couple strongly with abundance in determining index strengths in real stars. In G93, several of the indices (CN_1, Mg, TiO) were fit with an exponential form. For the new indices we find that straight polynomials fit better for all indices considered, including CN_2.

Plots of indices and residuals versus $V-K$ are shown in Figures 4–13 for the 10 new index fits (for the old 11 indices, we refer the reader to G93). The figures emulate those in G93 to make comparisons of index behavior easy. At the top of each figure, an effective temperature scale is given. The scale is

TABLE 2

Θ_e FITTING FUNCTION COEFFICIENTS FOR COOL STARS (3570 < T_e < 5160K)

Term	1. CN_1[2]	2. CN_2[2]	3. Ca4227[3]	4. G4300	5. Fe4383	6. Ca4455	7. Fe4531
Additive Constant	0.1723	0.1901	-0.2997	6.1924	2.9642	1.5326	3.0244
(log Θ)	3.7660	5.2625	15.3780	33.0914	95.3470	11.8034	21.3021
(log Θ)^2	-33.1882	-39.4219	211.6043	-220.4816	-377.3676	...	...
[Fe/H]	0.2709	0.2873	...	...	3.2305	0.7298	0.6231
[Fe/H]^2	0.1888	0.2060	...	-0.6158	...	...	...
[Fe/H]^3	0.0467	0.0535	...	...	-0.1731	...	0.0506
(log g)	...	...	...	...	0.9175	...	...
(log g)^2	-0.0066	-0.0062	0.0974	...	...	...	...
(log g)^3	...	...	...	...	...	0.0026	0.0056
(log Θ) (log g)	...	-0.4206	...	-5.5839	-12.4649	...	...
(log Θ) (log g)^2	-0.0622	...	...	...	...	...	...
[Fe/H] (log g)	...	...	...	...	...	...	0.1341
[Fe/H] (log Θ)^2	...	...	135.9686	...	...	...	...
(log g) [Fe/H]^2	...	...	...	...	...	...	...
Residual RMS	2.58	2.50	1.59	1.53	1.41	1.09	1.12
Term	**8. Fe4668**	**9. Hβ**	**10. Fe5015**	**11. Mg_1**	**12. Mg_2**	**13. Mg b**	**14. Fe5270**
Additive Constant	...	2.1471	6.3877	0.0345	0.0762	-1.1228	3.4111
(log Θ)	154.7570	...	21.1152	-2.8343	...	46.2019	17.2923
(log Θ)^2	-1508.7241	-307.5695	...	75.3661	47.2005	...	...
(log Θ)^3	7517.5278	2075.3740	...	-327.9276	-146.1148	681.4774	-596.5421
[Fe/H]	7.2810	0.2079	2.1785	0.0415	0.0836	0.7789	1.2899
[Fe/H]^2	2.9184	...	...	...	...	...	...
[Fe/H]^3	0.4048	...	...	-0.0050	-0.0077	-0.0607	...
(log g)	3.3396	-0.1680	-0.3128	...	...	1.3514	-0.5078
(log g)^2	-0.4802	...	...	0.0027	0.0102	...	0.1066
(log Θ) [Fe/H]	...	...	...	0.5013	0.8210	10.1217	...
(log Θ) (log g)	-25.0169	...	...	1.1371	1.0168	...	...
(log Θ) (log g)^2	...	-0.5883	...	...	...	...	...
(log g) (log Θ)^2	...	...	-43.8834	-8.1113	-12.0608	-115.2988	...
Residual RMS	1.46	1.30	1.39	2.55	2.81	2.05	1.13
Term	**15. Fe5335[3]**	**16. Fe5406[3]**	**17. Fe5709**	**18. Fe5782**	**19. Na D**	**20. TiO_1**	**21. TiO_2**
Additive Constant	1.9450	1.3752	1.1386	0.7642	1.6582	-0.5314	-0.5837
Constant in Exp.[1]	...	...	...	...	...	-0.5995	-0.5296
(log Θ)	19.2065	14.5727	...	10.1171	60.3902	...	...
(log Θ)^2	...	...	190.6756	...	...	-13.7325	...
(log Θ)^3	...	...	-1578.3523	-345.4548	-752.5432	262.7066	286.8986
[Fe/H]	1.6282	1.0494	0.4929	0.5284	2.2059	...	...
[Fe/H]^2	0.2817	...	...	...	0.7747	...	...
[Fe/H]^3	...	-0.0584	...	...	...	...	...
(log g)^2	0.0476	0.0211	...	...	...	...	...
(log g)^3	...	...	...	...	0.0171	...	...
(log Θ) [Fe/H]	...	...	...	...	15.8952	...	...
(log Θ) (log g)	...	...	...	...	-28.7499	0.2980	0.3643
(log Θ) (log g)^2	...	...	-0.2035	-0.1744	6.2953	...	...
[Fe/H] (log Θ)^2	...	...	...	...	...	4.9253	10.6302
(log g) (log Θ)^2	...	...	...	...	...	-5.0997	-7.5956
Residual RMS	1.31	1.32	1.13	1.06	2.19	1.45	3.19

[1] When this term appears, the polynomial is in its exponential form. This term is *inside* the exponential, and the term labeled "Additive Constant" is added *outside* the exponential.

[2] Functions for CN_1 and CN_2 are not valid below [Fe/H] = −1.

[3] Three indices show discontinuous behavior at about log Θ_e = 0.12 (T_e = 3823), so Ca 4427, Fe 5335, and Fe 5406 were fit only to stars hotter than this limit (instead of log Θ_e = 0.15). Use Tables 5 and 6 for cooler temperatures.

TABLE 3

Θ_e FITTING FUNCTION COEFFICIENTS FOR WARM STARS ($5040 < T_e < 13260$K)

Term	1. CN$_1$[2]	2. CN$_2$[2]	3. Ca4227	4. G4300	5. Fe4383[1]	6. Ca4455	7. Fe4531
Additive Constant	1.3308	0.8763	-0.4220	40.8740	-15.2137	-0.7362	-2.9636
(log Θ)	-7.2601	-4.6267	...	-210.2997	21.2603	...	6.2107
(log Θ)^2	10.5143	6.5272	...	311.2509	...	2.3650	...
(log Θ)^3	-4.6009	-2.7719	...	-135.3966	...	...	...
[Fe/H]	0.0204	...	0.2015	...	...	...	...
[Fe/H]^2	...	...	...	...	0.7105	0.1721	...
(log Θ) [Fe/H]	...	...	...	1.7400	2.9105	0.8484	0.9795
[Fe/H] (log Θ)^2	...	0.0222	...	...	...	...	...
(log g) (log Θ)^2	...	...	0.3906	...	...	...	...
Residual RMS	1.32	1.27	1.17	1.84	1.64	0.99	1.36
Supergiants in?	no	no	yes	no	yes	no	yes

Term	8. Fe4668	9. Hβ[1]	10. Fe5015	11. Mg$_1$	12. Mg$_2$[1]	13. Mg b[1]	14. Fe5270
Additive Constant	3.2430	29.0304	-4.0938	0.0536	1.2804	8.7334	-0.8921
(log Θ)	-19.6869	-47.1204	9.1303	...	-1.1895	...	...
(log Θ)^2	21.6173	19.8378	...	-0.4697	...	...	3.6501
(log Θ)^3	...	...	...	0.4868	...	...	...
[Fe/H]	...	...	...	...	0.0468	0.8537	0.8108
[Fe/H]^2	1.1699	...	0.4208	...	...	...	...
(log g)	...	...	...	...	-0.2596	-4.3748	...
(log g)^3	...	-0.0038	...	...	0.0017	...	...
(log Θ) [Fe/H]	...	...	2.4945	-0.0815	...	...	...
(log Θ) (log g)^2	...	...	...	...	...	0.7815	...
[Fe/H] (log Θ)^2	4.9505	...	...	0.1122	...	...	...
(log g) (log Θ)^2	...	...	...	...	0.2622	...	...
Residual RMS	1.61	1.35	1.39	1.70	2.41	1.95	1.70
Supergiants in?	yes	no	no	yes	no	no	yes

Term	15. Fe5335	16. Fe5406	17. Fe5709	18. Fe5782	19. Na D	20. TiO$_1$	21. TiO$_2$
Additive Constant	-1.0386	-0.4650	...	...	...	0.0134	-0.0115
(log Θ)^2	3.4925	...	...	...	...	...	0.0144
(log Θ)^3	...	1.9841	1.0573	0.6296	2.3060	...	...
[Fe/H]	...	...	...	0.2159	-0.6700	...	...
[Fe/H]^2	0.3224	...	0.0843	...	...	...	...
(log Θ) [Fe/H]	1.3286	...	0.5000	...	...	...	...
(log Θ) [Fe/H]^2	...	0.2312	...	...	...	...	...
[Fe/H] (log Θ)^2	...	0.9676	...	...	1.5383	...	...
Residual RMS	1.67	1.47	1.24	1.03	1.92	1.18	1.30
Supergiants in?	yes	yes	yes	yes	no	yes	yes

[1] Four indices could not be fit over the entire temperature range ($0.38 \le \Theta \le 1.0$), so for these the region of validity of the tabulated function is $0.75 \le \Theta \le 1.0$. For $0.38 \le \Theta \le 0.80$, use $\mathrm{Fe\,4383} = 11.4367 - 37.4777\Theta + 36.3357\Theta^2 + 0.9215[\mathrm{Fe/H}] - 0.8214 \log g$; $\mathrm{H}\beta = -48.3032 + 260.1385\Theta - 373.5425\Theta^2 + 161.9056\Theta^3$; $\mathrm{Mg}_2 = 0.1212\Theta^3 + 0.0105[\mathrm{Fe/H}]$; $\mathrm{Mg}\,b = -0.3996 + 3.3480\Theta^3$.

[2] CN_1 and CN_2 functions are not valid below [Fe/H] = −1.

that of RJWW for giants. Only the five coolest dwarfs (*open circles*) are affected by the mismatch between giant and dwarf temperature scales; see Figure 4*b* for the Johnson (1966) scale for dwarfs. The symbol key for different types of stars is the same as G93. Note the peculiar positive residuals for NGC 188 stars for indices Fe5709 and Fe5782. We find no evidence for flawed spectra, but further observations of NGC 188 stars are needed. Negative residuals for M71 in metallicity-sensitive iron indices (Fe4383, Fe4668) may mean that our adopted [Fe/H] of −0.56 is too high by about 0.1 dex.

The Θ_e fitting functions are to be preferred to the $V-K$ fitting functions whenever populations include M0–M3 giants, have hot horizontal branches, or have ages less than 2 Gyr. Comparison between the two sets of functions is valuable as a measure of the errors in the fitting process. The Θ_e fitting functions also have an advantage over the $V-K$ functions in that, for cool stars, the dwarf $V-K$s diverge from the giant $V-K$s (see Fig. 2). This is not a large effect, but for some indices (notably Fe4668) this divergence causes difficulty for the $V-K$ functions, which are unable to simultaneously track dwarfs and giants of *different temperatures.* Thus, Θ_e is a more "natural" variable, and enables easier fits. Also, this is why the $V-K$ functions are relatively restricted in temperature.

3.3. *Notes on Individual Indices*

CN_2.—CN_2 employs an alternate definition of the blue CN continuum that avoids Hδ. It was designed for stellar popula-

TABLE 4

$V-K$ FITTING FUNCTION COEFFICIENTS FOR THE 10 NEW INDICES

Term	CN_2 dwarfs	CN_2 giants	3. Ca4227	5. Fe4383	6. Ca4455
Constant	-0.2840	-0.7123	-1.7693	-9.5854	-0.1886
$(V-K)$	0.2438	0.5400	...	8.4567	0.8791
$(V-K)^2$	-0.0513	...	0.4054	-0.8171	...
$(V-K)^3$	...	-0.0205	...	...	...
[Fe/H]	...	0.2823	...	...	...
$[Fe/H]^3$	...	...	...	-0.1624	...
$(\log g)^2$	...	-0.0081	0.0929	...	...
$(V-K)$ [Fe/H]	...	...	0.1799	1.2260	0.2804
$(V-K)$ $(\log g)$	...	...	...	0.8683	...
$(\log g)$ $(V-K)^2$	...	...	...	-0.3126	...
Residual RMS	1.26	2.36	1.48	1.44	1.09

	7. Fe4531	8. Fe4668	10. Fe5015	16. Fe5406	17. Fe5709	18. Fe5782
Constant	5.2356	5.9634	...	-0.6732	-0.7988	-0.5211
$(V-K)$	...	...	4.1725	1.0733	1.5658	0.9620
$(V-K)^2$	...	...	-0.5863	...	-0.2505	-0.0969
$(V-K)^3$	0.0207	...	...	...	...	...
[Fe/H]	1.1277	-8.5058	1.8361	...	...	...
$[Fe/H]^3$	...	...	...	-0.0531	...	...
$(\log g)$	-1.9205	-2.4282	...	...	...	...
$(\log g)^2$	0.1996	...	...	...	...	...
$(V-K)$ [Fe/H]	...	11.5372	...	0.3925	0.1908	0.2098
$(V-K)$ $[Fe/H]^2$	...	0.7355	...	...	...	...
$(V-K)$ $(\log g)$	0.2862	1.1455	...	...	-0.0392	-0.0359
$(V-K)$ $(\log g)^2$	...	...	-0.0321	...	...	...
$(V-K)^2$ [Fe/H]	...	-2.0937	...	...	...	...
Residual RMS	1.05	1.55	1.45	1.41	1.23	0.98

NOTE.—For all indices but CN_2 the region of validity is all stars with $0.95 < V-K < 4.0$. For CN_2, the overall region is the same except that all giants with $[Fe/H] < -1.0$ were dropped. The separation between "dwarfs" and "giants" occurs at $V-K = 1.90$.

tions containing hot stars. We can test if CN_2 is a better definition than CN_1 by looking at (1) "throw" of the index in galaxies, (2) measurement accuracy, and (3) goodness of fit for the polynomial fitting functions. (1) The range of CN_1 and CN_2 from bright to dim elliptical galaxies is very nearly the same (Faber et al. 1994). (2) From Table 1, we see that CN_2 can be measured very slightly less accurately than CN_1. (3) From Table 2, we see that CN_2 can be fitted slightly better than CN_1. We conclude that the two indices are basically equivalent for normal ellipticals. The use of CN_2 for starburst galaxies may be beneficial but this is yet to be explored.

We also note that the present $V-K$ fit to CN_2 (Fig. 4*c*) seems to suffer from the same problem that affected CN_1 in G93: the residuals for the cluster stars vary systematically with $V-K$, partly because the allowed polynomial does not have high enough powers to match the rapid rise in CN with $V-K$ on the giant branch. This is not the whole story, however, as field giants do not generally share this behavior.

Ca4227.—This new index seems moderately Z-sensitive, especially in dwarfs. It is strongly dominated by Ca as opposed to Fe-peak elements and adds an important new element that can be quantitatively measured in our spectra.

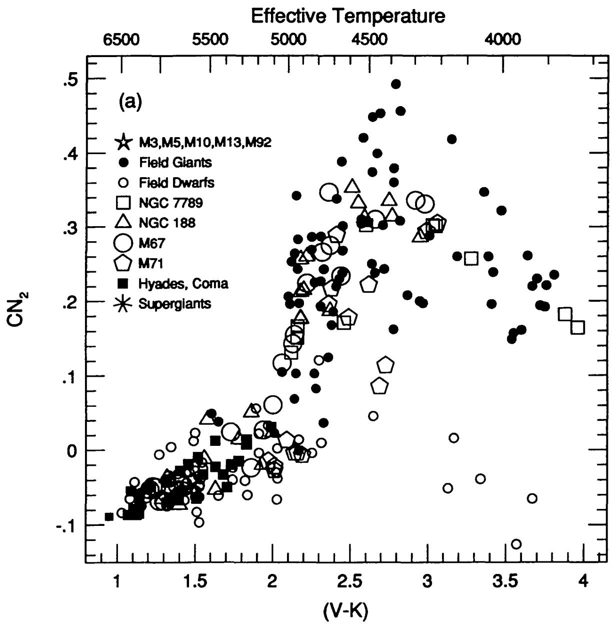
G4300.—The G band was considered in G93 in two pieces, like the treatment of CN_1, and two separate functions were fitted to giants and dwarfs. In our Θ_e fits, we elected to smooth over all stars. Although exact comparison is impossible because we include variations in measurement error, if we assume the Table 1 value as typical, our goodness of fit is the same. The inclusion of cool stars ($3570 < T_e < 3900$) and the steep temperature dependence makes the fit worse, but the addition of more polynomial terms and the truncation of the warmer stars offsets the former effects.

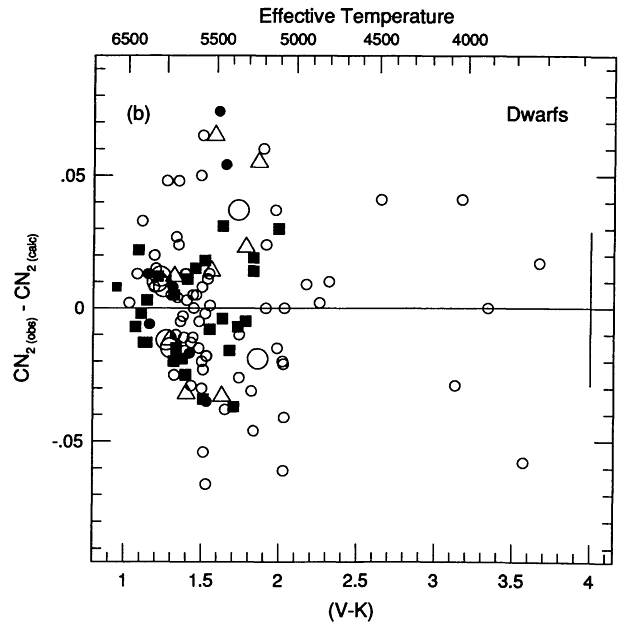
Ca4455.—This index is actually a blend with major contributions from Ca, Mn, Ti, Zr, V, Ni, and Fe, based on the spectrum of Arcturus.

Fe4668.—Iron may dominate this index, but it has major contributions from Mg, C_2, Cr, and Ti. This index is easy to measure and appears to be highly sensitive to metallicity, making it an important new index for the study of galaxies.

Na D.—Na D suffers from interstellar absorption because it is a resonance line. For the Θ_e fit here, an excess was subtracted off the equivalent width for some clusters, as described in G93. In angstroms of equivalent width, 0.35 was subtracted from M13, M67, and NGC 188, and 0.45 was subtracted from M71, M92, and NGC 7789. Cluster stars from M10, M5, and NGC 6171 were not included in the Na D fits. Supergiants were also not included due to their high reddenings.

Fe5709 and Fe5782.—Several NGC 188 stars have systematically high values in these indices (Figs. 12 and 13). Inspection of the spectra reveals no clues or problems. NGC 188 is also deviant in several indices studied by G93. This is not presently understood and merits more observations. Our NGC 188 observations are among the noisiest and were not weighted heavily in the fits a priori.





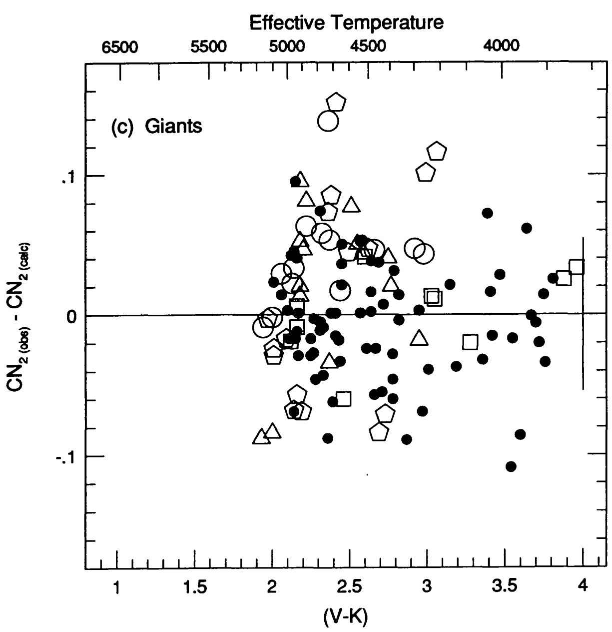


FIG. 4.—(*a*) CN_2 as a function of $V-K$. The effective temperature scale of RJWW is shown at the top. The key to the symbol types is shown. (*b*) Residuals from model fit as a function of $V-K$. This is the function for dwarfs, and only the dwarfs used for the fit are shown. The effective temperature scale of Johnson (1966) is shown at the top. The difference in giant vs. dwarf temperature scales is significant only for the five coolest dwarfs. The solid circles represent stars of luminosity class IV that are hotter than $V-K=1.90$. An approximate 1 σ error in the fit is shown as the bar at $V-K=4.0$. (*c*) Residuals from model fit for as a function of $V-K$. This is the function for giants, and only the stars used for the fit are shown. Note that the scale of the plot is different than in (*b*) because the scatter for giants is much larger. The 1 σ error in the fit is shown as the bar at $V-K=4.0$.

Altogether, eight new Fe-peak indices have been added to the index list (including Ca4455). Collectively, the new indices resemble Fe5270 and Fe5335 of G93; that is, they show strong sensitivity to Z but little to $\log g$, but there are some interesting variations. Of great importance to analyzing integrated spectra is the "throw" of an index (that is, range/error). Among the new indices, Fe4383 and Fe4668 have large throws. They are strong indices little affected by velocity broadening and should provide two valuable new ways to estimate abundances in integrated spectra.

3.4. *The Coolest Stars*

Stars cooler than 3570 K were not included in the above fits, but a handful of such M dwarfs and M giants exist in the stellar library. The abundances of these stars are poorly known, and we detected no systematic differences between disk and halo objects, so we opt to give simple quadratic fits for the indices as a function of temperature only. For the M giants, many do not have measured $V-K$, for many because they are variable. We therefore give quadratic coefficients as function of temperature (not $V-K$) in Table 5. All of the M dwarfs have measured $V-K$, so we give the quadratic coefficients as a function of $V-K$ (not T_e) in Table 6. A convenient linear transformation from T_e to $V-K$ is given at the end of Table 6 for readers preferring T_e. The bluer indices of the M dwarfs HD 131976 and L 789-6 are somewhat unreliable owing to poor S/N or emission and indices 1–7 for HD 131976 and indices 1–2, 7–9 for L 789-6 have been omitted from the fits.

4. SUMMARY AND DISCUSSION

We have defined and automatically measured 21 absorption features in the optical region for a sample of 460 stars. Eleven of these indices have been used in the past for studies of stars and stellar populations; 10 of them are new. Many of the stars have appeared in previous papers in this series while some appear here for the first time. For most of the new stars we also present atmospheric parameters T_e, $\log g$, and [Fe/H]. These

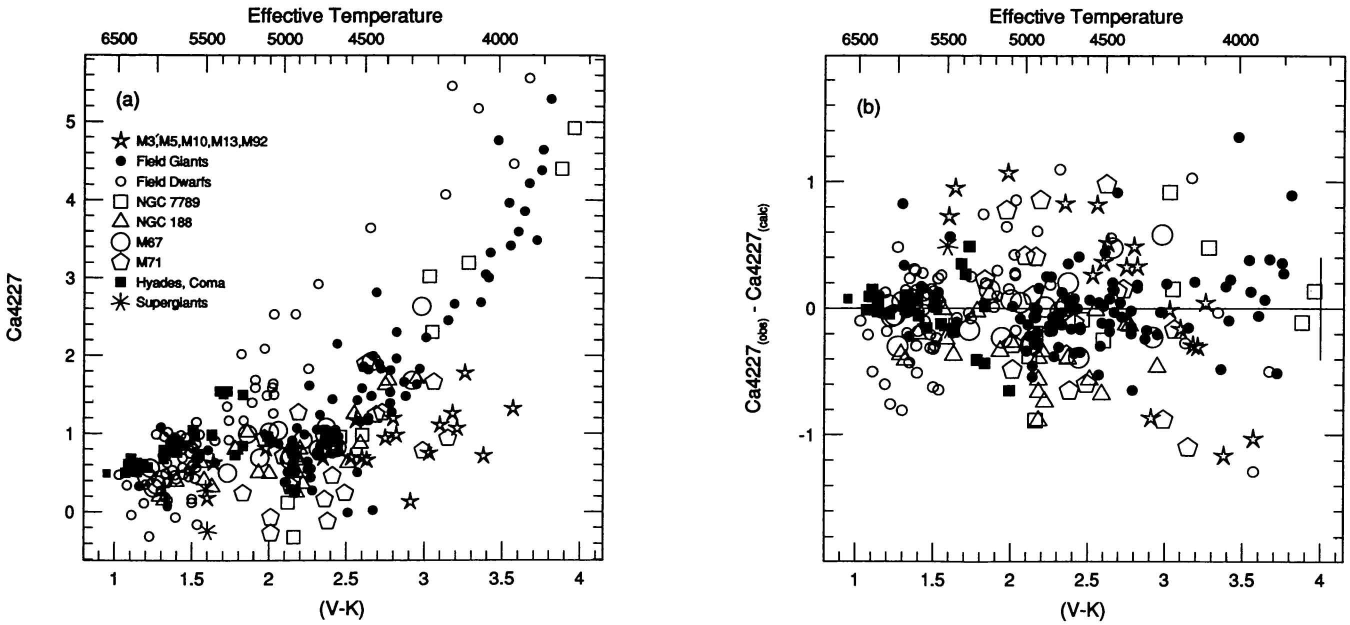


FIG. 5.—(a) Ca4227 as a function of $V-K$ and T_e. The key to symbol types is shown. (b) Residuals from model fit as a function of $V-K$. The 1 σ error in the fit is shown as the bar at $V-K = 4.0$.

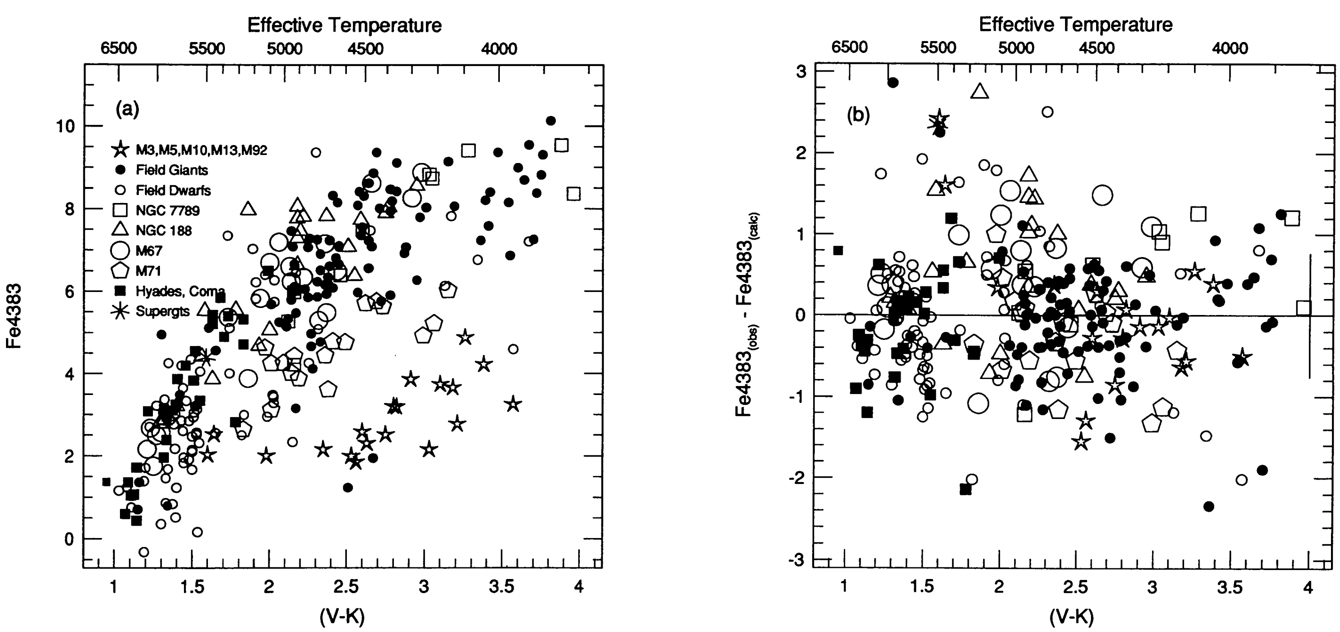


FIG. 6.—(a) Fe4383 as a function of $V-K$ and T_e. The key to symbol types is shown. Note the excellent sensitivity to metallicity by comparing the loci of globular cluster giants and field giants. (b) Residuals from model fit as a function of $V-K$. The 1 σ error in the fit is shown as the bar at $V-K = 4.0$.

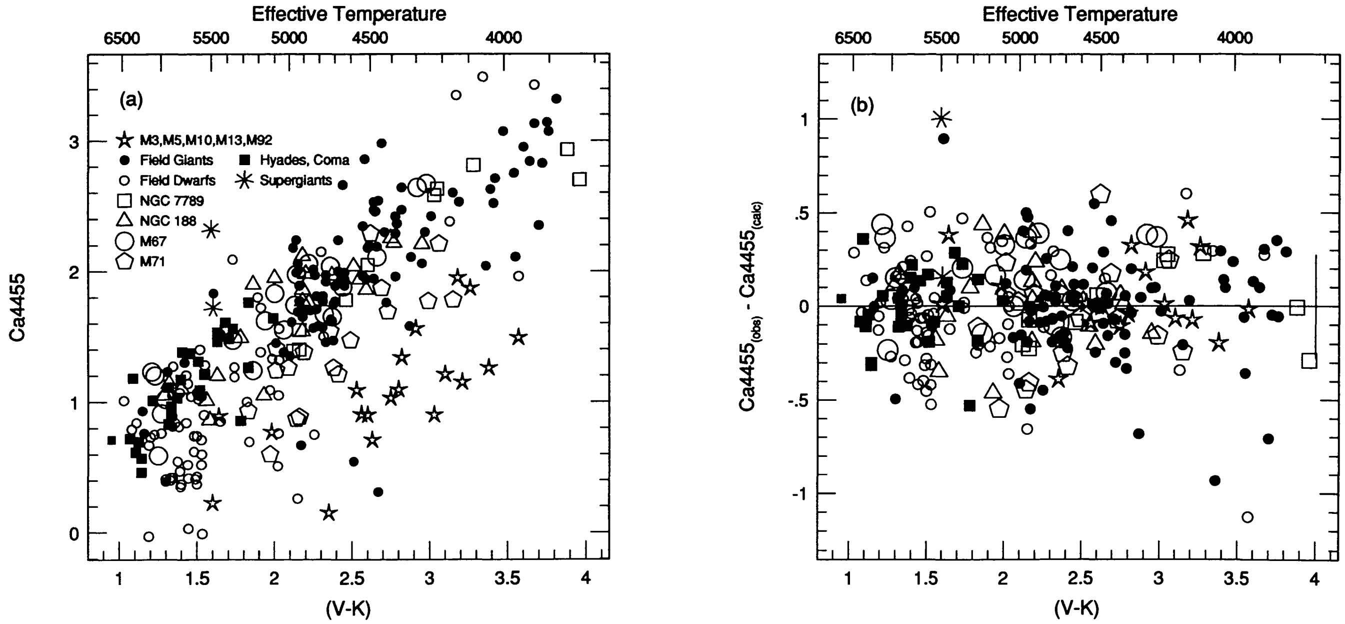


FIG. 7.—(a) Ca4455 as a function of $V-K$ and T_e. The key to symbol types is shown. (b) Residuals from model fit as a function of $V-K$. The 1 σ error in the fit is shown as the bar at $V-K=4.0$.

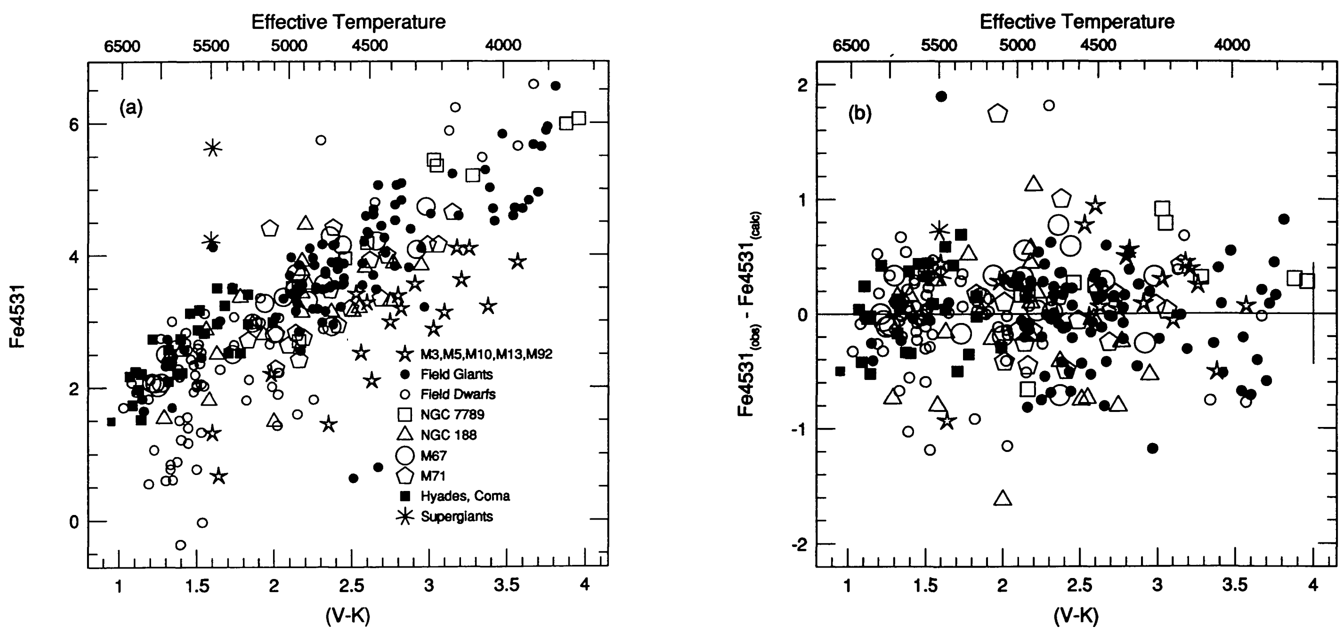


FIG. 8.—(a) Fe4531 as a function of $V-K$ and T_e. The key to symbol types is shown. (b) Residuals from model fit as a function of $V-K$. The 1 σ error in the fit is shown as the bar at $V-K=4.0$.

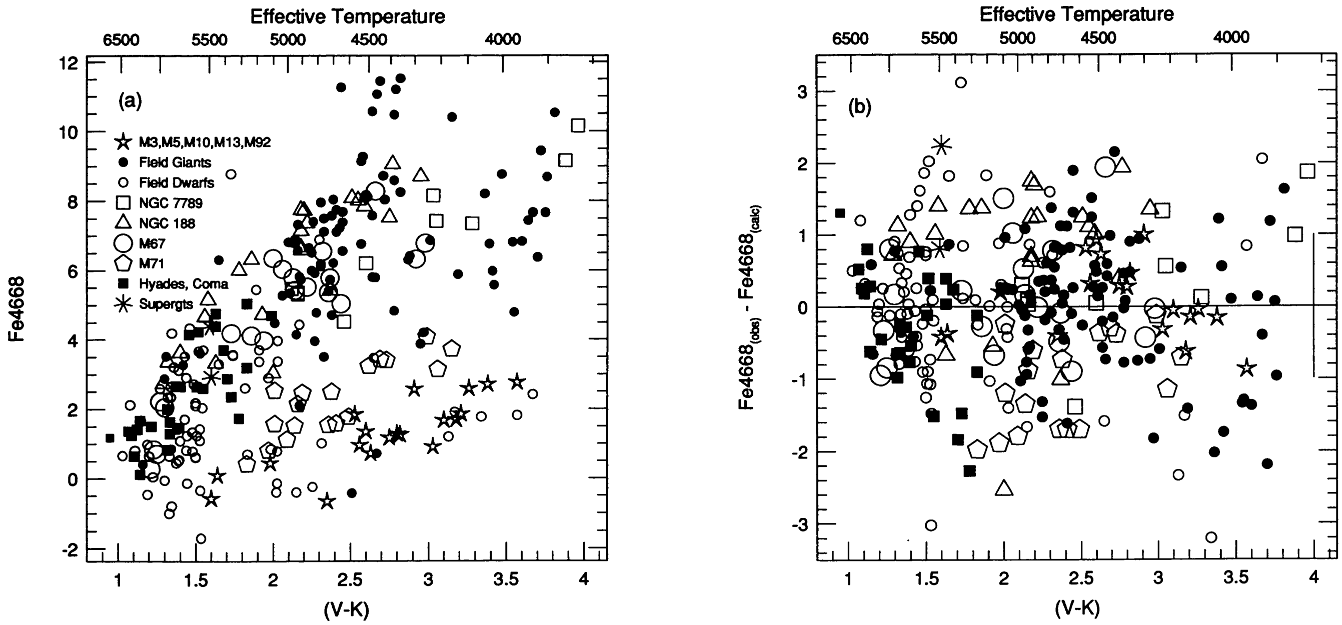


FIG. 9.—(a) Fe4668 as a function of $V-K$ and T_e. The key to symbol types is shown. Note the metallicity sensitivity. (b) Residuals from model fit as a function of $V-K$. The 1 σ error in the fit is shown as the bar at $V-K=4.0$. The negative residuals for M71 stars argue for a slightly (0.1 dex) lower metallicity for this cluster. This is in harmony with the other Fe indices, but the effect shows most clearly for this index because of its extraordinary metallicity sensitivity.

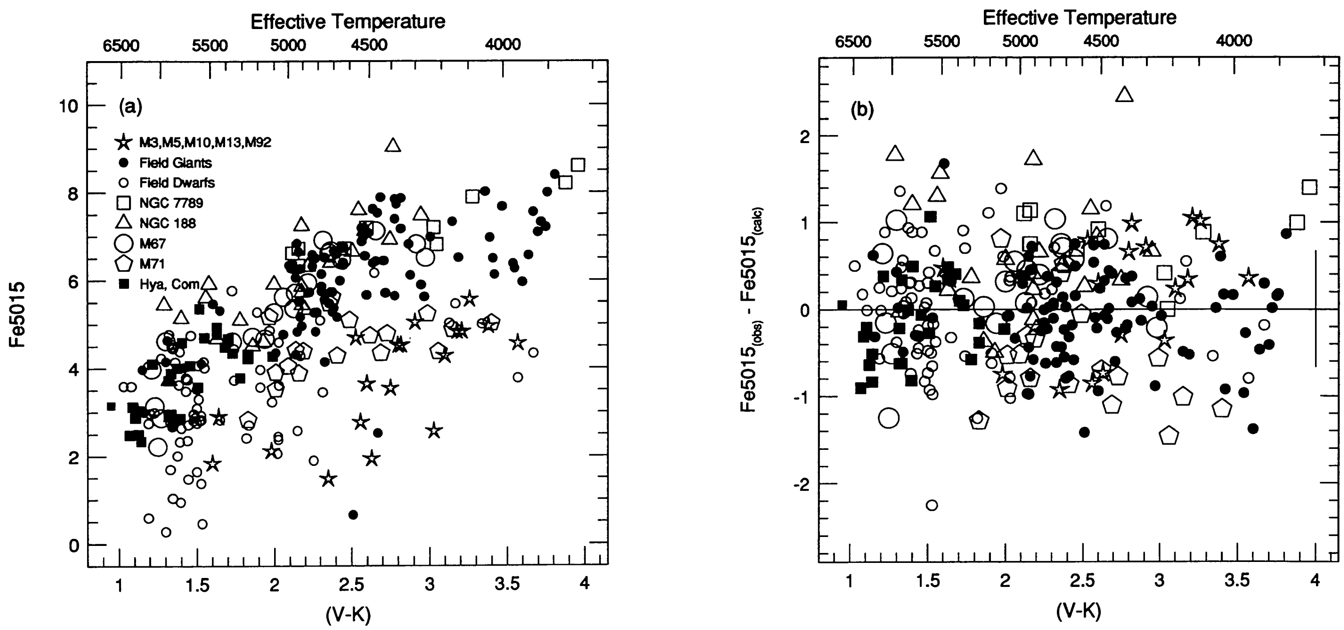


FIG. 10.—(a) Fe5015 as a function of $V-K$ and T_e. The key to symbol types is shown. Supergiants were excluded from this fit. (b) Residuals from model fit as a function of $V-K$. The 1 σ error in the fit is shown as the bar at $V-K=4.0$.

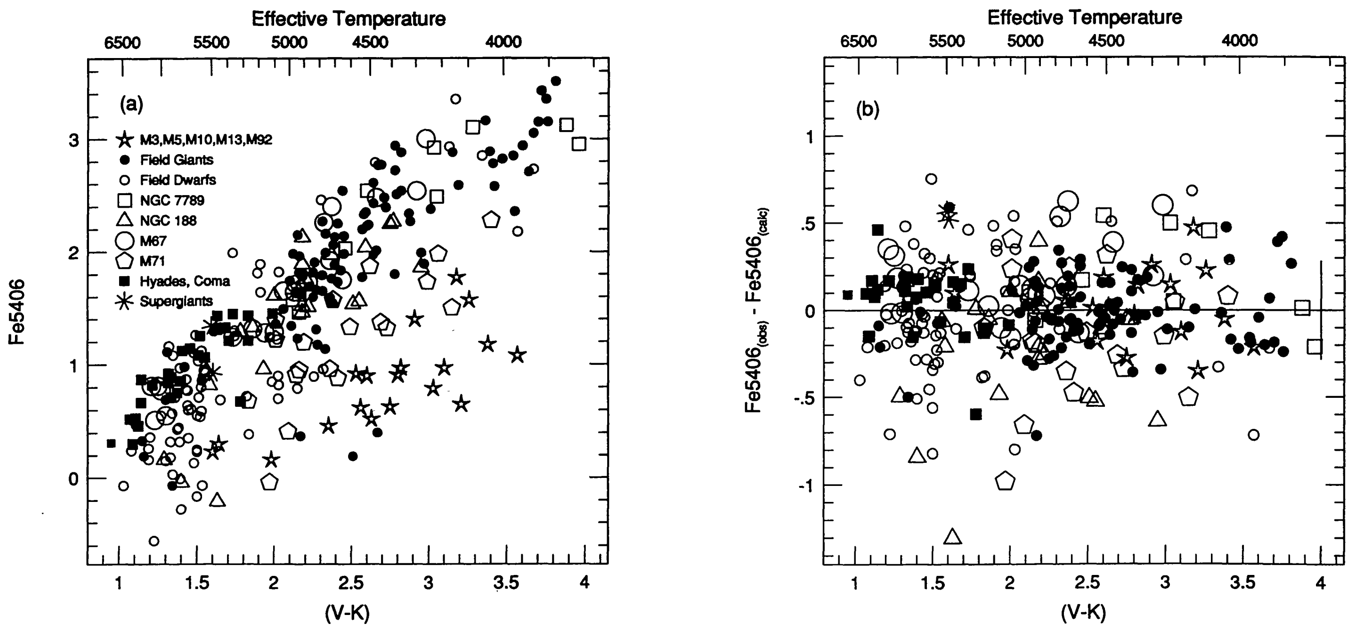


FIG. 11.—(a) Fe5406 as a function of $V-K$ and T_e. The key to symbol types is shown. (b) Residuals from model fit as a function of $V-K$. The 1 σ error in the fit is shown as the bar at $V-K=4.0$.

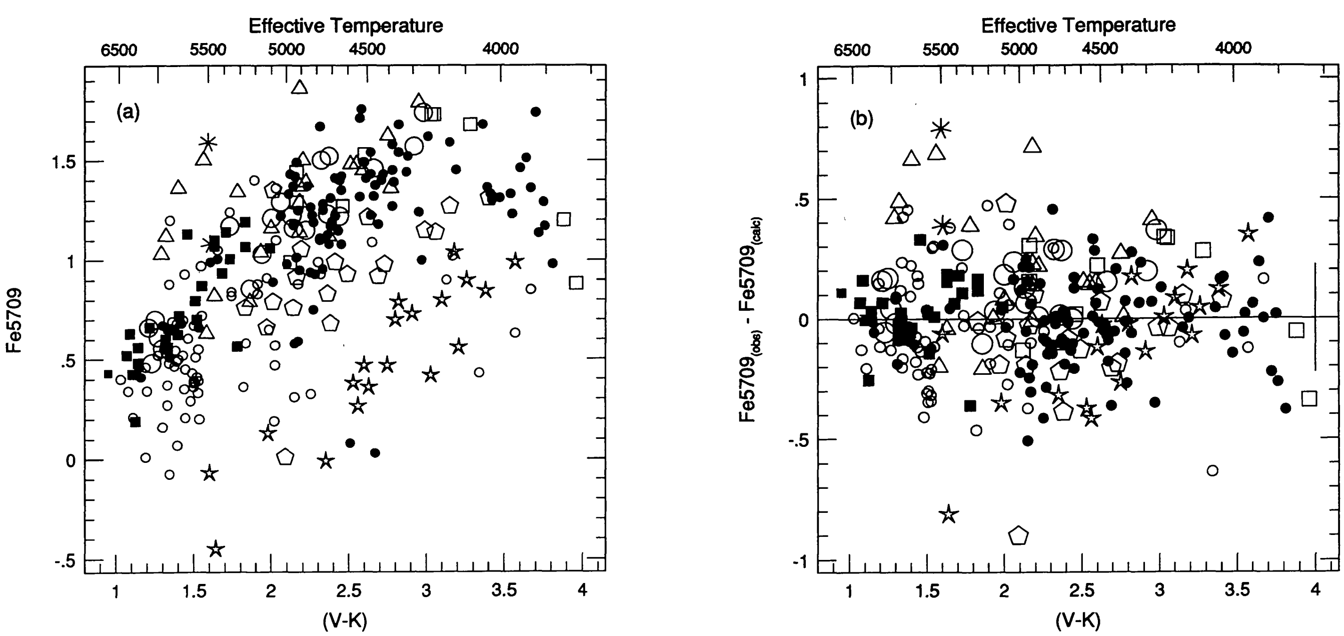


FIG. 12.—(a) Fe5709 as a function of $V-K$ and T_e. Note the good metallicity sensitivity of this weak index. (b) Residuals from model fit as a function of $V-K$. The 1 σ error in the fit is shown as the bar at $V-K=4.0$. Note systematic residuals for NGC 188 stars.

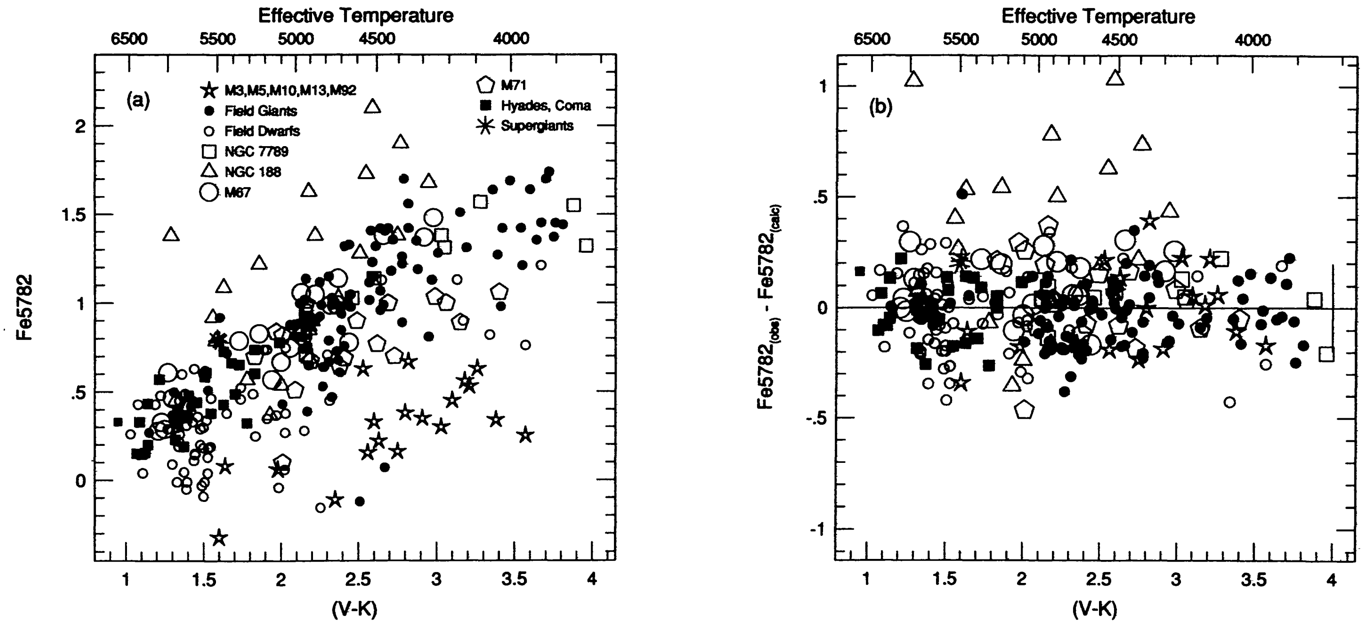


FIG. 13.—(*a*) Fe5782 as a function of $V-K$ and T_e. The key to symbol types is shown. (*b*) Residuals from model fit as a function of $V-K$. The 1 σ error in the fit is shown as the bar at $V-K=4.0$. Note the startling systematic residuals from NGC 188 stars.

parameters were either found in the literature or were derived from photometric data found in the literature.

To summarize the index data and to provide an aid for the construction of population models, we have presented (1) fitting functions as a function of $V-K$, log g, and [Fe/H] for the 10 new indices, (2) fitting functions as a function of Θ_e, log g, and [Fe/H] for all indices and for a greater temperature range than for the $V-K$ fitting functions, (3) quadratic approximations for all 21 M giant indices as a function of T_e, and (4) quadratic approximations for all 21 M dwarf indices as a function of $V-K$ or T_e. The preferred conversions between $V-K$ and T_e are those of RJWW for giants and Johnson (1966) for dwarfs, with the caveat for giants that $V-K$ colors appear to vary fairly strongly with metallicity below 3570 K, based on the models of Bessell et al. (1989).

Table 7 lists a sample of partial derivatives in T_e, log g, and [Fe/H] for each index. These were computed with the Θ_e fitting functions for two stars: a K giant with (T_e, log g, [Fe/H]) = (4500, 3, 0), and a G dwarf with parameters (6000, 4, 0). Entries in the table are listed as the change in index over

TABLE 5

QUADRATIC COEFFICIENTS IN T_e FOR M GIANTS

	Index	C_0	C_1	C_2
1	CN_1	2.0379	-1.6262×10^{-3}	2.9310×10^{-7}
2	CN_2	1.3614	-1.2333×10^{-3}	2.4043×10^{-7}
3	Ca4227	14.484	-3.2527×10^{-3}	1.6772×10^{-7}
4	G4300	-11.030	2.9856×10^{-3}	4.1073×10^{-7}
5	Fe4383	216.13	-1.4386×10^{-1}	2.3497×10^{-5}
6	Ca4455	-3.3037	5.4191×10^{-3}	-9.8489×10^{-7}
7	Fe4531	-11.560	4.9033×10^{-3}	-8.3331×10^{-8}
8	Fe4668	-84.851	8.1794×10^{-2}	-1.4932×10^{-5}
9	Hβ	-36.196	2.9880×10^{-2}	-5.2742×10^{-6}
10	Fe5015	-136.58	1.2586×10^{-1}	-2.3065×10^{-5}
11	Mg_1	4.3350	-3.0777×10^{-3}	5.2561×10^{-7}
12	Mg_2	1.0425	-4.4418×10^{-4}	7.7682×10^{-8}
13	Mg *b*	-60.119	5.9098×10^{-2}	-1.1004×10^{-5}
14	Fe5270	-24.153	1.6448×10^{-2}	-2.3709×10^{-6}
15	Fe5335	-6.9412	5.2087×10^{-3}	-6.1016×10^{-7}
16	Fe5406	16.020	-1.3358×10^{-2}	2.6283×10^{-6}
17	Fe5709	10.263	-9.5638×10^{-3}	1.8682×10^{-6}
18	Fe5782	17.717	-1.3024×10^{-2}	2.2894×10^{-6}
19	Na D	57.265	-3.0626×10^{-2}	4.4396×10^{-6}
20	TiO_1	-1.7528	1.7886×10^{-3}	-3.3611×10^{-7}
21	TiO_2	-3.3671	3.2580×10^{-3}	-5.9700×10^{-7}

NOTE.—Region of validity is between 2300 and 3900 K for M giants of mostly solar metallicity.

TABLE 6

QUADRATIC COEFFICIENTS IN $V-K$ FOR M DWARFS

	Index	C_0	C_1	C_2
1	CN_1	0.1234	-0.0899	0.00689
2	CN_2	0.5443	-0.2566	0.02273
3	Ca4227	0.3143	1.9564	-0.17402
4	G4300	12.202	-3.3556	0.27811
5	Fe4383	27.190	-9.0343	0.82927
6	Ca4455	3.4906	-0.1027	-0.03137
7	Fe4531	9.9836	-1.3061	0.02782
8	Fe4668	2.8569	-1.9164	0.47471
9	Hβ	15.411	-7.7717	0.88109
10	Fe5015	15.270	-5.0518	0.58055
11	Mg_1	0.5806	-0.0863	0.00524
12	Mg_2	0.9232	-0.2130	0.02454
13	Mg *b*	14.228	-5.0136	0.62793
14	Fe5270	13.998	-4.1814	0.38014
15	Fe5335	13.303	-3.8264	0.32262
16	Fe5406	7.8350	-1.9903	0.13898
17	Fe5709	5.5375	-1.7571	0.10068
18	Fe5782	4.1657	-1.2528	0.09038
19	Na D	3.6794	1.9365	-0.07710
20	TiO_1	-0.6741	0.2792	-0.01769
21	TiO_2	-1.0903	0.4355	-0.02141

NOTE.—Region of validity is between $V-K=2.7$ and 7.0 mag. Readers preferring T_e may note the best-fit line to the Johnson 1966 dwarf temperature calibration good to within 0.3 mag in $V-K$ between $T_e=2800$ and 4400: $V-K=11.16-0.00197T_e$.

100 K in temperature, 0.50 dex in log *g*, and 0.25 dex in [Fe/H]. The last three columns repeat these derivatives, but in units of the measured standard deviations listed in Table 1 to give an idea of how accurately a particular atmospheric parameter can be determined using IDS data. The Mg indices stand out because of their small error of measurement. Fe4668 also shines as a new metallicity indicator that is relatively insensitive to temperature.

For some indices the error of fit is significantly larger than the measurement error. These indices are CN_1, CN_2, Mg_1, Mg_2, Mg *b*, Na D, and TiO_2. The CN indices have a sudden rise among the giants that is probably due to interior-to-surface mixing (G93). To a lesser extent, the Mg features may also have real scatter among stars, possibly due to variations in Mg abundance in these stars. However, with the molecular features, and especially Mg, it is largely errors in temperature,

TABLE 7A

INDEX PARTIAL DERIVATIVES AT (T_e, log *g*, [Fe/H]) = (4500, 3, 0)

(1) Name	(2) I_0	(3) $\frac{dI}{dT/100K}$	(4) $\frac{dI}{d(\log g)/0.5}$	(5) $\frac{dI}{d[Fe/H]/0.25}$	(6) $\frac{dI'}{dT/100K}$	(7) $\frac{dI'}{d(\log g)/0.5}$	(8) $\frac{dI'}{d[Fe/H]/0.25}$
01 CN_1	0.190	-0.001	-0.030	0.070	-0.07	-2.08	4.86
02 CN_2	0.236	-0.003	-0.030	0.074	-0.19	-1.89	4.75
03 Ca4227	1.846	-0.338	0.302	0.082	-1.80	1.61	0.44
04 G4300	6.463	0.041	-0.137	-0.008	0.15	-0.51	-0.03
05 Fe4383	7.655	-0.217	0.152	0.808	-0.59	0.41	2.20
06 Ca4455	2.184	-0.113	0.037	0.182	-0.65	0.21	1.04
07 Fe4531	4.224	-0.204	0.081	0.256	-0.69	0.27	0.87
08 Fe4668	6.862	0.116	-0.434	1.857	0.26	-0.98	4.20
09 Hβ	0.885	0.196	-0.174	0.052	1.28	-1.13	0.34
10 Fe5015	6.170	-0.084	-0.210	0.545	-0.26	-0.65	1.69
11 Mg_1	0.172	-0.031	0.027	0.017	-5.93	5.13	3.20
12 Mg_2	0.327	-0.030	0.042	0.031	-5.13	7.20	5.31
13 Mg *b*	4.449	-0.176	0.536	0.319	-1.09	3.33	1.98
14 Fe5270	3.627	-0.128	0.077	0.322	-0.65	0.39	1.64
15 Fe5335	3.319	-0.184	0.148	0.411	-1.04	0.83	2.31
16 Fe5406	2.282	-0.140	0.065	0.262	-0.99	0.46	1.86
17 Fe5709	1.322	-0.054	-0.031	0.123	-0.44	-0.25	1.00
18 Fe5782	1.144	-0.060	-0.027	0.132	-0.44	-0.19	0.97
19 Na D	3.546	-0.248	0.500	0.757	-1.48	2.98	4.52
20 TiO_1	0.020	0.001	0.001	0.002	0.10	0.13	0.33
21 TiO_2	0.025	-0.005	0.000	0.004	-1.14	-0.03	0.90

TABLE 7B

INDEX PARTIAL DERIVATIVES AT (T_e, log g, [Fe/H]) = (6000, 4, 0)

(1) Name	(2) I_0	(3) $\frac{dI}{dT/100K}$	(4) $\frac{dI}{d(\log g)/0.5}$	(5) $\frac{dI}{d[Fe/H]/0.25}$	(6) $\frac{dI^1}{dT/100K}$	(7) $\frac{dI^1}{d(\log g)/0.5}$	(8) $\frac{dI^1}{d[Fe/H]/0.25}$
01 CN_1	-0.076	-0.009	0.000	0.005	-0.65	0.00	0.35
02 CN_2	-0.047	-0.007	0.000	0.004	-0.42	0.00	0.25
03 Ca4227	0.680	-0.036	0.138	0.050	-0.19	0.73	0.27
04 G4300	3.591	-0.364	0.000	0.365	-1.34	0.00	1.35
05 Fe4383	2.645	-0.295	0.000	0.620	-0.81	0.00	1.69
06 Ca4455	0.933	-0.055	0.000	0.180	-0.31	0.00	1.03
07 Fe4531	2.253	-0.086	0.000	0.206	-0.29	0.00	0.70
08 Fe4668	1.959	-0.229	0.000	0.888	-0.52	0.00	2.01
09 Hβ	3.204	0.193	-0.096	0.000	1.26	-0.63	0.00
10 Fe5015	3.576	-0.127	0.000	0.529	-0.39	0.00	1.64
11 Mg_1	0.011	-0.003	0.000	0.003	-0.63	0.00	0.52
12 Mg_2	0.092	-0.008	0.006	0.012	-1.34	0.95	2.00
13 Mg b	1.738	-0.174	0.504	0.213	-1.08	3.13	1.33
14 Fe5270	1.683	-0.085	0.000	0.203	-0.43	0.00	1.03
15 Fe5335	1.426	-0.081	0.000	0.283	-0.46	0.00	1.59
16 Fe5406	0.711	-0.058	0.000	0.173	-0.41	0.00	1.23
17 Fe5709	0.627	-0.031	0.000	0.106	-0.25	0.00	0.86
18 Fe5782	0.373	-0.018	0.000	0.054	-0.13	0.00	0.39
19 Na D	1.367	-0.067	0.000	0.104	-0.40	0.00	0.62
20 TiO_1	0.013	0.000	0.000	0.000	0.00	0.00	0.00
21 TiO_2	0.000	0.000	0.000	0.000	0.00	0.00	0.00

[1] The last three columns are the same as cols. (3), (4), and (5), except that the quantities listed have been divided by the IDS error listed in Table 1 for each index. Thus, the last three columns are in units of *standard deviations* per 100 K, per 0.5 dex, or per 0.25 dex for cols. (6), (7), and (8), respectively. Larger absolute values mean the index is more sensitive.

[Fe/H], and gravity that cause the rms index residuals to appear high because the measurement error is smaller than the error introduced by uncertain stellar parameters. The large scatter in Na D may be due mostly to variable absorption by interstellar clouds, which affects all stars outside the solar vicinity to some degree. TiO_2 has large scatter because several M giants are considered in which TiO is very large. Small errors in wavelength during measurement or small errors in input temperature cause very large deviations in TiO band strength for these stars, and this drives the larger average scatter.

With the addition of the new stars, the fitting formulae are now adequate to provide absorption feature strengths for populations between 0.5 and 20 Gyr in age and [Fe/H] between −1 and +0.5 dex. Such models are of course accurate only to the extent that *the abundance ratios of the Galactic calibrating stars reflect abundance ratios in external populations.* Strong evidence has been uncovered that this is not so for giant elliptical galaxies (Worthey, Faber, & González 1992). Despite this limitation, the present functions are an important jumping-off place for studying external populations, and the most inclusive calibrations of this type that have been attempted.

A listing of all 21 indices for all 460 stars and all derived atmospheric parameters is available in computer-readable form from the NSS-DCA Astronomical Data Center (adcrequest@nssdca.gsfc.nasa.gov), from G. W. (worthey@astro.lsa.umich.edu), and on the AAS CD-ROM (vol. 3). The distribution includes a bibliography and a short description of how the indices are measured.

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APPENDIX
INDEX MEASUREMENTS AND ATMOSPHERIC PARAMETERS

Tables A1 and A2 that follow are the heart of the project, but they are placed here in the Appendix because they are large, and the supporting verbiage is dense.

Table A1 lists all previously published stars. The first column gives the "HD" number for the star (Henry Draper Catalog). The second column gives other names: the "HR" number if the star is in the Bright Star Catalog (Hoffleit 1982), a cluster designation, a common name, or a "BD" (Bonner Durchmusterung) number. Columns (3)–(13) give the 21 index values. In column (3) on the

TABLE A1

COLLECTED INDICES FOR PUBLISHED STARS

HD	name 1 name 2	CN_1 qual[1]	CN_2 Mg_2	Ca4227 Mg *b*	G4300 Fe5270	Fe4383 Fe5335	Ca4455 Fe5406	Fe4531 Fe5709	Fe4668 Fe5782	Hβ4681 Na5895	Fe5015 TiO_1	Mg_1 TiO_2	source other
	M3 398	...	...	0.690	5.870	2.580	0.900	3.280	1.350	1.120	3.640	0.026	1,3
		2	0.074	0.760	1.570	1.230	0.900	0.470	0.330	1.140	0.017	0.005	
	M3 III-28	...	...	1.070	5.410	2.770	1.150	3.620	1.850	1.140	4.830	0.044	1,3
		2	0.095	1.030	2.570	1.370	0.650	0.560	0.530	0.610	0.018	0.012	
	M3 IV-25	...	...	0.980	6.170	3.190	1.340	3.190	1.260	1.250	4.520	0.031	1,3
		2	0.072	0.700	1.770	1.560	0.970	0.790	0.670	1.080	0.012	0.011	
	M5 II-51	...	...	0.690	4.390	1.990	1.090	3.410	1.840	1.110	4.690	0.028	1,3
		3	0.091	1.200	1.750	0.720	0.920	0.380	0.630	1.070	0.016	-0.001	
	M5 III-03	...	...	1.775	6.330	4.880	1.870	4.095	2.585	0.960	5.560	0.073	1,3
		1	0.162	2.160	2.940	2.300	1.570	0.900	0.630	1.160	0.019	0.029	
	M5 IV-19	...	...	1.260	5.830	3.660	1.950	4.100	1.690	0.960	4.830	0.069	1,3
		2	0.131	2.240	2.230	2.350	1.770	1.040	0.560	1.380	0.016	0.020	
	M5 IV-59	...	...	0.130	6.710	3.860	1.560	3.560	2.570	1.520	5.040	0.056	1,3
		2	0.120	1.440	2.690	1.830	1.400	0.730	0.350	1.340	0.013	0.015	
	M5 IV-86	...	...	0.630	1.330	2.520	0.890	0.670	0.090	2.450	2.900	0.008	1,3
		2	0.030	0.610	0.290	0.750	0.300	-0.450	0.080	1.060	-0.004	-0.005	
	M10 1015	...	...	0.715	4.490	4.225	1.260	3.220	2.705	0.670	4.955	0.057	1,3
		1	0.139	1.660	2.320	2.060	1.175	0.845	0.340	1.770	0.039	0.090	
	M10 1018	...	...	1.110	5.620	3.740	1.210	3.130	1.670	0.530	4.280	0.029	1,3
		1	0.064	0.460	1.850	1.690	0.970	0.800	0.450	2.030	0.021	0.025	
	M10 II-76	...	...	1.170	4.620	1.850	0.905	2.520	0.960	1.410	2.770	0.017	1,3
		1	0.046	0.950	1.370	0.830	0.620	0.265	0.155	1.260	0.012	0.005	
	M10 III-85	...	...	1.195	5.350	3.200	1.095	3.385	1.280	1.230	4.515	0.023	1,3
		1	0.075	0.930	2.180	1.580	0.910	0.700	0.380	1.710	0.008	0.018	
	M13 A 171	...	...	0.940	5.070	2.510	1.030	2.990	1.170	1.480	3.540	0.017	1,3
		1	0.052	0.930	1.560	1.080	0.630	0.470	0.160	1.500	0.008	0.017	
	M13 B 786	...	...	1.320	4.460	3.250	1.490	3.890	2.760	1.230	4.560	0.047	1,3
		1	0.094	0.700	2.090	2.180	1.080	0.990	0.250	1.900	0.015	0.046	
	M13 B 818	...	...	0.810	2.150	2.000	0.770	2.200	0.440	1.760	2.120	0.010	1,3
		2	0.046	1.270	1.180	0.410	0.160	0.130	0.060	1.380	0.014	0.017	
	M67 F 084	0.228	0.266	0.800	6.250	5.290	1.670	3.560	6.550	1.060	6.910	0.070	3
		1	0.177	2.810	3.420	2.460	2.260	1.500	0.990	2.370	0.018	-0.005	
	M67 F 094	-0.075	-0.053	0.450	3.420	2.160	1.230	2.070	0.280	3.460	3.980	...	3
		1	0.079	1.570	1.770	1.310	0.810	0.660	0.280	1.790	...	-0.008	
	M67 F 105	0.261	0.310	1.920	6.570	8.620	2.110	4.210	8.280	1.050	7.120	0.133	3
		1	0.287	3.740	3.690	3.380	2.480	1.460	1.380	3.680	0.012	0.034	
	M67 F 108	0.248	0.331	2.630	6.320	8.880	2.670	4.730	6.780	0.980	6.510	0.186	3
		1	0.330	3.740	3.770	3.730	3.000	1.740	1.480	3.900	0.030	0.059	
	M67 F 115	-0.083	-0.068	0.415	4.290	2.560	1.020	2.505	2.050	3.245	4.620	0.014	3
		1	0.076	1.250	1.690	1.075	0.550	0.555	0.465	1.215	0.008	-0.009	
	M67 F 117	-0.048	-0.024	0.995	4.175	3.885	1.240	2.975	4.120	2.250	4.715	0.050	3
		1	0.160	2.195	2.095	2.045	1.315	0.855	0.830	1.835	0.018	0.013	
	M67 F 119	-0.072	-0.050	0.310	3.190	1.750	0.590	2.000	0.710	3.380	2.220	0.016	3
		1	0.086	1.420	1.740	1.650	0.810	0.700	0.290	0.440	0.020	0.017	
	M67 F 125	-0.081	-0.049	0.560	3.360	2.670	1.200	2.060	0.840	3.250	3.140	0.008	3
		1	0.082	1.890	1.010	0.920	0.510	0.480	0.330	0.330	0.020	0.011	
	M67 F 164	0.231	0.275	1.080	5.760	5.480	1.650	2.920	5.780	0.940	6.670	0.071	3
		1	0.190	2.590	3.420	2.430	2.400	1.520	1.140	2.930	0.018	-0.002	
	M67 F 170	0.260	0.336	1.680	6.190	8.260	2.640	4.080	6.320	0.820	6.820	0.167	3
		1	0.302	3.700	3.890	3.370	2.540	1.570	1.370	4.180	0.018	0.050	
	M67 F 175	-0.088	-0.068	0.350	3.630	2.490	0.910	2.070	2.220	3.780	2.870	0.009	3
		1	0.081	1.070	1.690	0.720	0.770	0.610	0.610	0.850	0.025	0.006	
	M67 F 193	0.114	0.143	0.670	6.100	6.600	1.740	3.470	5.790	1.740	5.360	0.055	3
		1	0.199	3.520	2.780	2.490	1.640	1.220	1.060	2.830	0.017	0.011	
	M67 F 224	0.283	0.347	0.990	5.850	7.150	2.040	4.290	5.360	1.130	6.620	0.061	3
		1	0.215	3.250	3.450	2.930	1.920	1.230	0.990	3.620	0.007	0.025	
	M67 F 231	0.176	0.224	0.920	6.550	6.340	2.060	3.310	5.520	1.420	5.940	0.072	3
		1	0.205	3.190	2.870	3.030	1.730	1.150	1.050	3.160	0.007	0.009	
	M67 I-17	0.117	0.155	0.715	6.375	6.235	1.975	3.715	5.425	1.625	5.715	0.069	3
		1	0.206	3.780	2.915	2.570	1.710	1.160	0.815	2.465	0.013	-0.001	
	M67 II-22	0.047	0.061	1.020	6.800	6.700	1.830	2.810	6.350	1.480	5.270	0.071	3
		1	0.197	3.320	2.900	2.470	1.290	1.210	0.670	2.390	0.019	-0.007	
	M67 IV-20	0.197	0.234	0.820	6.500	6.490	1.880	4.150	5.040	1.130	6.460	0.066	3
		1	0.204	3.170	3.080	2.580	1.750	1.220	0.780	2.820	...	0.014	
	M67 IV-68	-0.009	0.027	0.690	5.630	5.830	1.620	3.270	3.980	1.620	4.670	0.048	3
		1	0.164	2.430	2.210	1.860	1.280	1.030	0.570	1.790	0.007	...	
	M67 IV-77	0.068	0.117	1.040	6.210	7.190	1.550	3.360	6.040	1.690	5.620	0.070	3
		1	0.204	3.420	2.660	2.780	1.650	1.290	0.750	2.680	0.010	...	
	M67 IV-81	0.005	0.024	0.500	5.550	5.370	1.470	2.500	4.190	2.390	4.610	0.032	3
		1	0.156	2.470	2.340	2.270	1.240	1.170	0.790	2.230	0.017	0.001	
	M71 1-09	0.174	0.217	-0.120	7.200	3.610	1.260	4.410	2.490	1.340	5.620	0.049	3
		1	0.141	2.630	2.410	2.250	1.570	0.680	0.640	2.040	0.019	0.024	
	M71 1-21	0.084	0.114	1.270	6.460	5.630	1.690	3.990	3.400	1.140	4.780	0.085	3
		1	0.193	3.100	2.490	2.410	1.320	0.980	0.700	1.940	0.018	0.026	
	M71 1-31	-0.008	0.007	0.950	5.050	5.310	1.410	2.720	4.380	1.920	5.400	0.022	3
		2	0.135	3.210	3.990	2.020	0.440	-0.220	1.630	2.260	0.041	0.009	

TABLE A1—*Continued*

HD	name 1	CN_1	CN_2	Ca4227	G4300	Fe4383	Ca4455	Fe4531	Fe4668	Hβ4681	Fe5015	Mg_1	source
	name 2	qual	Mg_2	Mg *b*	Fe5270	Fe5335	Fe5406	Fe5709	Fe5782	Na5895	TiO_1	TiO_2	other
	M71 1-34	-0.057	-0.022	-0.270	3.550	3.120	1.410	2.800	1.570	1.150	3.900	0.028	3
		2	0.042	1.970	2.450	1.670	1.390	1.350	0.100	2.350	0.041	...	
	M71 1-36	0.008	0.051	1.450	6.290	4.600	1.915	3.600	3.185	0.920	4.780	0.112	3
		1	0.221	3.095	2.460	2.035	1.655	1.080	0.865	2.305	0.024	0.046	
	M71 1-37	0.137	0.178	0.240	6.370	4.760	1.470	3.190	1.770	0.820	5.090	0.065	3
		2	0.158	2.530	2.240	1.680	1.330	0.930	0.900	2.050	0.025	...	
	M71 1-39	-0.028	0.013	0.710	7.560	4.260	1.260	2.630	1.120	0.620	4.040	0.013	3
		2	0.090	2.010	2.880	0.200	0.410	0.010	0.510	2.080	0.038	-0.005	
	M71 1-41	-0.058	-0.015	0.940	5.670	4.630	0.600	4.400	0.810	1.680	5.170	0.011	3
		2	0.081	2.660	2.320	1.350	-0.040	0.660	0.840	1.140	0.036	0.011	
	M71 1-53	0.225	0.305	1.660	6.000	5.220	2.210	4.150	3.140	0.770	4.370	0.132	3
		2	0.254	3.460	3.180	2.270	1.980	1.140	1.000	2.390	0.026	...	
	M71 1-59	...	0.039	1.080	7.120	5.720	1.290	2.380	2.830	1.170	5.290	0.066	3
		2	0.162	2.240	2.620	1.440	1.030	0.330	0.520	2.320	0.048	...	
	M71 1-63	0.157	0.196	0.160	6.680	4.440	1.540	3.460	1.540	1.330	5.470	0.038	3
		1	0.116	1.280	2.430	1.350	0.960	0.830	6.540	1.790	0.007	...	
	M71 1-64	0.084	0.150	1.980	6.910	5.320	1.950	3.820	4.560	0.450	5.390	0.141	3
		1	0.263	3.480	3.040	2.130	1.830	1.120	0.730	3.020	0.039	...	
	M71 1-65	0.186	0.243	0.500	6.110	4.760	1.410	2.600	2.350	1.030	4.630	0.071	3
		2	0.155	2.620	2.670	1.640	1.360	0.250	0.560	2.550	0.035	...	
	M71 1-66	0.144	0.222	1.890	6.975	5.705	2.290	3.920	3.235	0.630	4.735	0.132	3
		1	0.248	3.050	2.700	2.595	1.870	1.215	0.770	2.460	0.020	0.032	
	M71 1-71	0.039	0.086	1.240	6.880	5.750	1.870	3.340	3.430	0.430	4.340	0.102	3
		1	0.207	2.780	2.530	1.980	1.370	0.920	1.000	1.230	0.016	...	
	M71 1-73	0.182	0.236	-0.020	6.870	3.370	0.790	2.060	3.260	1.200	4.690	0.056	3
		2	0.140	2.240	2.190	0.930	0.790	1.180	0.710	2.370	0.014	...	
	M71 1-75	0.146	0.171	-0.410	6.190	4.540	0.730	2.810	3.540	1.380	3.710	0.049	3
		2	0.154	2.580	2.140	0.950	0.630	0.720	0.540	2.590	0.014	...	
	M71 1-87	-0.029	-0.027	-0.070	6.550	4.250	1.240	2.280	2.530	1.980	3.520	0.029	3
		1	0.098	1.790	1.840	1.080	1.220	0.790	0.820	2.030	0.016	0.012	
	M71 1-95	0.248	0.289	0.460	7.050	4.780	1.210	2.940	1.580	1.440	4.280	0.047	3
		1	0.135	1.990	2.560	1.970	0.880	0.990	0.690	1.980	0.015	0.017	
	M71 1-107	-0.021	-0.004	0.330	6.020	4.020	0.870	2.820	1.520	1.250	4.410	0.028	3
		1	0.112	1.270	2.270	1.530	0.910	0.760	0.840	1.290	0.018	...	
	M71 1-109	0.033	0.058	0.340	6.190	3.970	0.680	1.780	2.750	0.580	5.620	0.056	3
		2	0.135	1.760	1.110	2.040	0.100	1.080	1.140	1.350	0.018	...	
	M71 2-255	-0.223	-0.108	0.580	0.080	3.440	-0.590	-0.070	0.960	6.580	0.780	-0.014	3
		2	0.048	0.960	0.730	-1.730	0.010	-0.630	-0.430	2.630	0.048	0.040	
	M71 A2	-0.024	-0.007	1.270	6.995	3.880	1.380	2.745	2.465	1.495	4.385	0.060	3
		1	0.150	2.615	2.030	1.560	1.195	1.055	0.675	2.065	0.018	0.016	
	M71 A4	...	...	...	6.150	...	...	...	...	0.670	5.020	0.205	3
		1	0.344	3.850	3.040	3.150	2.280	1.310	1.060	2.650	0.046	0.116	
	M71 A6	...	...	2.470	5.970	7.660	2.590	5.870	4.930	0.780	6.240	0.222	1,3
		2	0.370	3.790	3.960	3.940	2.650	1.370	1.420	4.290	0.049	0.147	
	M71 A7	0.189	0.233	1.360	6.445	7.790	2.280	4.510	7.040	1.370	7.215	0.114	1,3
		1	0.256	3.345	3.705	3.150	2.465	1.500	1.315	3.245	0.014	0.037	2
	M71 A9	...	...	0.940	6.470	6.020	1.780	4.640	3.720	0.890	4.880	0.144	3
		2	0.267	3.120	2.920	2.280	1.500	1.270	0.890	2.640	0.017	0.058	
	M71 C	-0.022	-0.004	0.785	6.700	4.425	0.885	2.410	2.140	0.875	3.880	0.056	3
		1	0.140	2.470	1.585	1.520	0.950	0.915	0.995	1.810	0.016	0.017	
	M71 Q	-0.069	-0.119	2.140	2.720	0.420	-0.570	5.300	4.080	2.470	5.450	0.001	3
		3	0.063	1.420	1.230	1.730	-0.880	0.060	0.130	1.200	0.005	0.003	
	M71 S	0.226	0.294	0.780	6.625	4.920	1.770	4.150	4.080	1.015	5.230	0.102	3
		1	0.220	2.765	3.125	2.410	1.730	1.150	1.035	2.235	0.019	0.032	
	M71 X	0.012	0.032	0.240	5.350	2.640	0.930	2.710	0.420	1.710	2.830	0.006	3
		1	0.074	1.180	1.910	1.040	0.680	0.760	0.700	1.670	0.006	0.005	
	M71 Z	-0.106	-0.035	-0.240	-0.510	1.380	0.430	1.120	4.500	5.330	3.000	-0.012	3
		3	0.034	2.160	2.710	0.920	0.780	-0.060	-0.240	1.080	0.029	0.039	
	M71 KC 22	0.177	0.223	1.270	6.870	7.510	2.020	4.570	6.400	1.110	5.860	0.119	3
		2	0.269	4.080	3.240	2.650	1.880	1.230	1.420	2.830	-0.008	...	
	M71 KC 147	-0.064	-0.034	0.950	6.870	4.530	0.900	2.340	1.600	1.540	3.780	0.044	3
		2	0.138	2.310	2.360	1.880	0.960	1.110	1.100	1.130	0.009	...	
	M71 KC 169	0.035	0.075	0.270	4.960	2.470	0.600	2.750	1.920	1.680	3.760	0.012	3
		2	0.072	1.470	1.600	1.080	1.000	0.360	0.100	1.590	0.009	...	
	M71 KC 263	-0.064	-0.035	0.570	6.570	4.580	0.580	3.780	1.830	1.200	2.140	0.028	3
		2	0.144	3.340	2.330	1.780	1.070	0.600	-0.510	0.900	0.012	...	
	M92 III-13	...	...	0.750	3.810	2.150	0.900	2.880	0.910	0.950	2.570	0.009	1,3
		1	0.043	0.620	1.430	1.260	0.790	0.420	0.300	1.180	0.009	-0.016	
	M92 IV-114	...	...	0.690	2.130	2.150	0.150	1.440	-0.660	1.060	1.480	0.006	1,3
		2	0.023	0.520	0.100	0.730	0.460	-0.010	-0.110	1.040	0.010	-0.001	
	M92 IX-12	-0.131	-0.115	0.180	0.340	2.030	0.225	1.310	-0.580	2.210	1.840	-0.003	1,3
		1	0.014	0.700	-0.700	0.330	0.230	-0.070	-0.320	0.450	-0.006	-0.011	
	M92 XII-8	...	...	0.660	1.980	2.300	0.710	2.100	0.720	1.210	1.940	-0.006	1,3
		1	0.024	0.710	0.310	0.670	0.520	0.360	0.220	1.250	0.003	-0.011	
	NGC 188 I-20	-0.073	-0.028	2.350	5.520	6.780	1.600	3.680	3.250	1.240	4.530	0.062	3
		2	0.279	5.320	3.190	2.470	1.820	1.460	1.100	2.950	0.002	...	

TABLE A1—*Continued*

HD	name 1	CN_1	CN_2	Ca4227	G4300	Fe4383	Ca4455	Fe4531	Fe4668	Hβ4681	Fe5015	Mg_1	source
	name 2	qual	Mg_2	Mg *b*	Fe5270	Fe5335	Fe5406	Fe5709	Fe5782	Na5895	TiO_1	TiO_2	other
	NGC 188 I-55	-0.069	-0.053	0.320	5.430	3.870	1.200	2.500	3.330	2.520	4.670	0.049	3
		2	0.129	1.900	0.970	1.940	-0.210	0.820	1.090	1.590	0.051	...	
	NGC 188 I-57	0.166	0.187	0.890	7.270	7.820	1.970	3.140	5.420	0.680	6.400	0.105	3
		1	0.271	4.380	3.880	3.530	1.970	1.120	1.030	3.220	0.022	0.018	
	NGC 188 I-61	0.180	0.215	0.800	6.070	7.460	1.980	4.460	7.730	1.670	5.340	0.098	3
		2	0.241	3.610	4.010	2.820	1.760	1.500	0.900	3.330	0.011	...	
	NGC 188 I-69	0.286	0.335	1.620	7.115	7.895	2.255	3.300	7.525	0.730	6.920	0.164	3
		1	0.314	3.915	4.010	3.635	2.250	1.625	1.380	3.960	0.022	0.046	
	NGC 188 I-75	0.215	0.260	0.360	6.710	7.810	1.760	3.550	7.370	1.300	6.310	0.107	3
		2	0.242	2.960	2.730	2.860	1.510	1.390	1.380	3.180	0.016	...	
	NGC 188 I-85	0.138	0.176	0.660	6.100	8.060	1.770	3.900	7.150	1.310	5.860	0.104	3
		2	0.253	4.130	3.350	2.760	1.460	1.370	0.870	2.800	0.023	...	
	NGC 188 I-88	-0.010	0.014	0.800	6.080	5.550	1.490	3.360	6.010	1.490	5.100	0.071	3
		2	0.169	2.970	2.590	2.580	1.290	1.340	0.570	2.800	0.035	...	
	NGC 188 I-97	0.035	0.051	1.020	6.170	7.970	1.900	2.960	6.320	1.810	4.510	0.073	3
		2	0.225	3.990	2.960	2.140	1.330	0.790	1.220	3.030	0.026	...	
	NGC 188 I-105	0.320	0.353	0.625	7.550	7.075	2.040	3.140	8.085	1.130	6.650	0.114	3
		1	0.235	3.295	3.135	3.105	1.535	1.480	1.280	3.135	0.012	0.026	
	NGC 188 I-116	-0.024	0.024	0.490	5.430	5.060	1.950	1.480	3.040	1.900	5.910	0.089	3
		1	0.211	2.740	2.500	2.630	1.610	1.160	0.540	3.070	0.016	0.010	
	NGC 188 II-52	-0.044	-0.012	0.630	5.040	4.420	1.010	2.870	4.670	2.720	5.610	0.040	3
		2	0.145	2.370	1.890	1.810	0.940	1.500	0.920	1.620	0.009	...	
	NGC 188 II-64	-0.115	-0.073	0.390	4.960	3.210	1.100	2.550	3.630	2.820	5.140	0.022	3
		2	0.108	1.850	1.020	1.540	-0.040	1.360	0.420	2.560	0.016	...	
	NGC 188 II-67	-0.070	-0.037	0.150	5.300	2.860	1.140	2.450	3.360	2.790	3.730	0.029	3
		2	0.104	2.080	2.350	1.670	0.860	1.120	0.450	1.740	0.043	...	
	NGC 188 II-69	-0.109	-0.065	0.200	4.740	2.780	1.050	1.530	2.740	3.160	5.450	0.031	3
		2	0.082	0.540	0.650	1.590	0.160	1.030	1.380	1.740	0.018	...	
	NGC 188 II-72	0.246	0.314	1.680	5.960	8.040	2.220	3.870	9.060	1.140	9.030	0.174	3
		1	0.292	3.320	3.220	4.160	2.270	1.360	1.900	3.770	0.013	...	
	NGC 188 II-76	0.280	0.332	1.250	6.930	6.380	1.940	3.200	8.020	0.930	7.590	0.104	3
		1	0.220	2.840	3.300	3.200	1.560	1.480	1.730	3.340	0.019	...	
	NGC 188 II-79	-0.041	-0.020	0.500	6.320	4.680	1.050	2.790	4.730	0.970	4.610	0.066	3
		2	0.178	3.530	2.320	1.520	0.960	1.040	0.370	2.800	0.034	...	
	NGC 188 II-88	0.262	0.312	0.870	6.790	7.730	1.860	3.810	7.850	1.140	7.120	0.143	3
		2	0.262	3.250	2.910	3.280	2.040	1.450	2.100	3.460	0.018	...	
	NGC 188 II-93	0.001	0.041	0.410	6.700	5.530	0.860	1.800	5.160	1.960	5.920	0.083	3
		3	0.126	1.410	1.940	3.060	0.820	0.630	0.790	0.520	0.029	...	
	NGC 188 II-122	0.201	0.256	0.250	6.420	6.640	1.540	3.420	6.670	1.530	7.240	0.087	3
		2	0.214	2.960	2.130	3.460	1.520	1.140	1.630	2.460	0.025	...	
	NGC 188 II-126	0.177	0.212	0.500	7.170	7.770	1.860	3.130	6.590	1.410	5.730	0.114	3
		2	0.254	3.860	3.890	2.820	2.130	1.860	0.850	2.980	0.035	...	
	NGC 188 II-181	0.227	0.286	1.700	6.460	8.560	2.210	3.840	8.700	1.140	7.470	0.167	3
		1	0.292	3.370	3.160	3.610	1.860	1.790	1.680	3.520	0.020	...	
	NGC 188 II-187	0.152	0.177	0.700	6.270	7.290	2.120	3.760	7.750	1.640	5.440	0.113	3
		1	0.246	3.900	4.030	2.890	1.890	1.290	0.690	4.180	0.030	...	
	NGC 7789 338	0.074	0.137	-0.020	6.150	5.630	1.650	2.890	4.460	1.650	6.360	0.022	3
		1	0.136	1.700	2.980	2.190	1.380	1.210	0.710	3.060	0.009	0.008	
	NGC 7789 415	0.117	0.182	4.400	7.030	9.530	2.930	5.980	9.150	0.370	8.200	0.222	3
		1	0.429	4.550	4.070	4.040	3.120	1.200	1.550	5.200	0.137	0.313	
	NGC 7789 468	0.244	0.302	3.020	7.140	8.830	2.580	5.440	8.150	0.490	7.200	0.163	3
		1	0.327	3.560	4.420	3.700	2.920	1.730	1.380	4.500	0.031	0.074	
	NGC 7789 489	0.170	0.222	1.900	5.960	7.380	2.350	4.640	6.390	1.190	6.780	0.145	3
		1	0.295	3.410	4.190	3.440	2.560	1.480	1.360	4.140	0.018	0.057	
	NGC 7789 501	0.187	0.257	3.190	7.420	9.410	2.810	5.200	7.350	0.360	7.890	0.211	3
		1	0.379	3.960	4.420	3.990	3.100	1.680	1.570	5.170	0.042	0.119	
	NGC 7789 575	0.251	0.302	0.980	6.760	7.470	2.050	4.180	6.200	1.250	7.190	0.092	3
		1	0.228	3.080	3.050	2.890	2.540	1.530	1.140	3.320	0.018	0.035	
	NGC 7789 669	0.270	0.301	2.300	7.810	8.730	2.630	5.350	7.420	0.370	6.810	0.167	3
		1	0.326	3.680	4.450	3.370	2.490	1.730	1.310	4.410	0.030	0.064	
	NGC 7789 676	0.099	0.131	0.120	6.890	5.270	1.390	3.500	5.470	1.060	6.620	0.050	3
		1	0.148	2.150	3.320	2.450	1.570	0.990	0.870	2.560	0.013	0.010	
	NGC 7789 859	0.121	0.171	0.960	6.360	6.390	1.780	3.950	4.520	1.300	6.720	0.086	3
		1	0.213	2.820	3.380	3.300	2.030	1.270	1.030	3.290	0.025	0.031	
	NGC 7789 875	0.128	0.166	0.370	7.490	4.220	1.550	3.530	5.310	1.490	6.330	0.048	3
		1	0.151	2.490	3.400	1.870	1.460	1.290	0.940	2.650	0.014	0.012	
	NGC 7789 897	0.123	0.151	-0.320	6.080	5.970	1.400	2.700	5.360	1.830	6.720	0.049	3
		1	0.153	2.000	2.770	2.390	1.620	1.440	0.710	2.530	0.020	0.019	
	NGC 7789 971	0.099	0.164	4.920	6.700	8.360	2.700	6.060	10.150	1.020	8.600	0.213	3
		1	0.450	4.970	3.890	3.900	2.950	0.880	1.320	5.440	0.184	0.398	
1461	HR 0072	-0.018	0.004	1.020	5.760	4.260	1.270	2.470	4.190	2.480	4.450	0.009	2
		1	0.132	3.270	2.190	2.020	1.080	1.200	0.450	2.440	0.003	0.006	
3546	HR 0163	0.009	-0.001	0.240	6.820	3.150	0.670	2.550	2.100	1.560	5.170	0.035	1
		1	0.119	1.890	2.040	1.090	0.370	0.590	0.390	1.100	0.008	0.005	
3567		-0.057	-0.034	0.190	0.430	0.860	0.400	0.770	-1.000	3.170	1.700	-0.011	2
		1	0.013	0.720	0.200	0.440	0.320	0.270	-0.010	0.990	-0.004	0.007	

TABLE A1—*Continued*

HD	name 1	CN_1	CN_2	Ca4227	G4300	Fe4383	Ca4455	Fe4531	Fe4668	Hβ4681	Fe5015	Mg_1	source
	name 2	qual	Mg_2	Mg *b*	Fe5270	Fe5335	Fe5406	Fe5709	Fe5782	Na5895	TiO_1	TiO_2	other
3651	HR 0166	0.023	0.056	1.400	6.100	7.030	1.800	2.990	5.450	1.530	5.280	0.078	2
		1	0.277	5.350	3.240	3.090	1.810	1.400	0.740	3.490	0.007	0.006	
4307	HR 0203	-0.071	-0.028	0.120	4.550	2.470	1.070	2.020	2.180	2.540	3.530	-0.006	2
		1	0.088	2.020	1.860	1.260	0.230	0.360	0.600	1.270	-0.003	0.022	
4614	HR 0219	-0.073	-0.039	0.450	3.980	2.840	0.620	2.340	1.340	3.050	2.810	-0.003	2
		1	0.078	1.870	0.720	1.210	1.100	0.290	0.200	1.230	0.018	-0.017	
4628	HR 0222	-0.017	0.017	2.340	5.810	6.560	1.800	3.440	2.460	1.030	4.420	0.115	2
		1	0.323	5.780	2.960	2.970	1.630	1.070	0.670	3.850	0.007	0.010	
4656	HR 0224	0.103	0.161	3.590	6.310	8.990	2.950	4.700	6.830	0.790	5.950	0.232	1
		1	0.407	5.200	4.080	4.710	2.940	1.460	1.640	4.190	0.077	0.171	
5395	HR 0265	0.066	0.083	0.275	6.730	4.115	1.580	3.185	4.780	1.640	5.270	0.053	1
		1	0.152	1.950	2.770	1.550	1.175	0.930	0.640	1.070	0.007	0.015	
6203	HR 0296	0.150	...	...	6.450	...	...	...	...	1.450	...	0.071	1
		1	0.200	3.070	2.650	2.390	...	...	...	1.830	0.021	0.011	3
7010		0.104	0.120	0.470	6.300	5.130	1.210	3.560	4.930	1.090	5.070	0.057	1
		1	0.180	3.000	2.890	2.030	1.350	1.340	1.140	2.070	0.029	-0.006	
10307	HR 0483	-0.061	-0.057	0.470	4.520	3.020	1.070	1.500	3.120	2.930	4.380	0.031	2
		1	0.127	2.610	1.650	1.260	0.970	0.680	0.310	1.770	0.017	-0.011	
10380	HR 0489	0.208	0.260	2.660	6.590	8.060	2.530	4.590	5.880	0.870	6.510	0.172	2
		1	0.315	3.730	3.880	3.530	2.590	1.450	1.310	3.820	0.027	0.055	4
10476	HR 0493	-0.018	0.002	1.500	6.290	6.270	1.560	3.050	3.970	1.250	4.590	0.083	2
		1	0.271	5.500	3.300	3.300	1.820	1.360	0.750	3.240	0.001	0.020	
10700	HR 0509	-0.059	-0.041	2.020	6.620	2.500	1.000	1.800	2.610	1.630	2.420	0.056	2
		1	0.210	4.240	2.130	0.740	0.720	0.360	0.490	1.560	0.011	-0.012	
10780	HR 0511	-0.050	-0.024	1.770	5.720	6.210	1.590	2.780	4.350	1.670	4.730	0.038	2
		1	0.208	4.600	2.860	2.650	1.520	1.090	0.420	2.690	0.005	-0.011	
11004		-0.039	-0.020	0.120	3.650	2.510	0.640	2.270	1.920	2.370	4.110	0.012	1
		1	0.085	1.300	1.800	1.440	0.920	0.960	0.430	1.320	0.028	-0.003	
12929	HR 0617	0.192	0.250	1.165	7.730	7.225	1.945	3.695	5.800	1.310	6.385	0.122	1
		1	0.229	3.190	2.970	2.880	1.970	1.225	0.960	1.940	0.013	0.019	
13043		-0.073	-0.031	0.690	4.800	3.650	1.140	2.570	2.910	2.730	3.740	0.007	2
		1	0.104	2.500	1.750	1.490	0.770	0.930	0.630	1.680	0.001	0.011	
13783		-0.091	-0.061	0.910	5.360	2.550	0.850	2.270	3.300	2.370	2.830	0.031	2
		1	0.138	3.780	1.150	1.620	0.690	1.050	0.380	1.870	-0.012	0.001	
14802	HR 0695	-0.072	-0.053	0.710	5.000	2.350	0.910	1.520	3.520	2.630	2.970	0.015	2
		1	0.097	1.810	1.940	1.410	0.480	0.390	0.340	1.220	0.008	0.009	
17709	HR 0843	0.114	0.192	4.380	6.020	8.815	3.140	5.885	7.655	0.600	7.205	0.237	1
		1	0.436	4.050	4.140	4.110	3.350	1.290	1.370	4.290	0.104	0.250	
19373	HR 0937	-0.060	-0.042	0.625	4.265	2.950	1.050	2.400	2.650	3.125	4.545	0.017	2
		1	0.115	2.165	1.605	1.345	0.850	0.480	0.220	1.370	0.015	-0.002	
19445		-0.092	-0.047	-0.070	0.070	0.510	0.350	-0.360	0.540	2.690	0.950	0.010	2
		1	0.032	0.400	0.090	0.490	-0.010	0.070	-0.010	0.160	...	-0.002	
19476	HR 0941	0.217	0.243	0.730	6.700	6.660	1.890	3.850	7.330	1.960	5.520	0.063	1
		1	0.188	3.110	3.770	2.790	1.810	1.490	0.930	2.200	0.026	0.010	
20630	HR 0996	-0.034	-0.018	1.050	4.950	3.320	1.550	2.440	3.720	2.500	3.380	0.017	2
		1	0.135	3.570	2.490	2.300	1.010	0.790	0.330	1.530	0.015	-0.004	
20893	HR 1015	0.275	0.308	1.960	6.420	8.420	2.470	4.830	8.250	1.330	7.170	0.147	1
		1	0.293	3.800	3.830	3.350	2.540	1.680	1.420	3.840	0.019	...	
22484	HR 1101	-0.086	-0.043	0.370	4.030	3.040	0.890	3.000	2.340	3.020	4.490	0.030	2
		1	0.090	1.730	1.610	1.680	0.570	0.880	0.190	0.900	0.027	-0.001	
22879		-0.069	-0.044	0.477	3.270	1.827	0.417	1.387	-0.133	2.100	2.717	0.002	2
		1	0.082	1.663	1.128	0.988	0.353	0.207	0.143	1.118	0.005	0.002	
23439 A		-0.053	-0.023	1.490	5.150	2.950	1.330	2.010	0.850	0.660	3.230	0.050	2
		1	0.215	5.110	1.110	1.290	0.850	0.650	-0.040	1.950	0.005	0.008	
23439 B		-0.022	0.010	2.920	4.990	5.080	1.500	2.880	1.020	0.340	3.450	0.154	2
		1	0.376	6.430	2.550	1.910	0.960	0.930	0.450	3.050	-0.010	0.007	
24451		-0.056	-0.008	4.595	5.280	8.775	3.115	5.190	2.145	-0.009	5.365	0.296	2
		1	0.504	6.440	4.770	4.260	2.565	0.830	0.975	7.160	0.014	0.029	
25329		-0.046	-0.004	1.830	5.570	4.260	0.750	1.810	-0.245	0.550	1.900	0.080	2
		1	0.247	4.625	2.200	1.685	0.895	0.325	-0.155	2.255	0.012	-0.009	
26462	HR 1292	-0.119	-0.090	0.490	-0.080	0.140	0.440	2.000	0.830	5.470	2.890	0.001	2
	Hya vB 14	1	0.054	0.900	1.290	0.760	0.380	0.300	0.360	0.810	0.020	...	
26690	HR 1309	-0.082	0.034	1.410	0.365	0.520	0.430	1.700	-0.160	4.995	3.180	0.001	2
		1	0.056	0.645	1.445	0.925	0.610	0.240	0.150	1.085	...	-0.029	
26965	HR 1325	-0.044	-0.038	2.530	6.840	5.740	1.320	2.220	3.380	1.290	3.610	0.102	2
		1	0.307	5.960	2.490	2.090	0.820	1.100	0.380	2.820	0.025	-0.003	
27371	HR 1346	0.237	0.264	0.290	6.260	5.790	1.990	3.405	6.790	1.820	6.060	0.058	1,3
	Hya vB 28	1	0.164	2.570	3.070	3.140	1.645	1.175	0.745	2.550	0.017	0.010	
27561		-0.118	-0.089	0.490	1.080	1.370	0.710	1.490	1.180	4.720	3.150	-0.002	2
	Hya vB 37	1	0.046	0.790	0.820	0.580	0.310	0.430	0.330	0.830	0.025	-0.015	
27697	HR 1373	0.234	0.253	0.510	5.920	5.330	2.180	3.420	6.810	1.880	6.380	0.064	1,3
	Hya vB 41	1	0.173	3.000	3.280	3.210	1.980	1.430	1.000	2.490	...	0.008	
28068		-0.053	-0.033	0.740	3.900	3.340	1.210	2.820	2.600	2.670	4.700	0.019	2
	Hya vB 63	1	0.139	2.490	1.650	1.990	1.060	0.870	0.380	1.810	0.019	0.005	
28307	HR 1411	0.188	0.206	0.380	5.710	5.190	1.350	3.690	6.820	1.750	6.340	0.046	1,3
	Hya vB 71	1	0.163	2.580	3.150	2.460	1.740	0.980	0.810	2.290	0.015	0.010	

TABLE A1—*Continued*

HD	name 1 name 2	CN_1 qual	CN_2 Mg_2	Ca4227 Mg *b*	G4300 Fe5270	Fe4383 Fe5335	Ca4455 Fe5406	Fe4531 Fe5709	Fe4668 Fe5782	Hβ4681 Na5895	Fe5015 TiO_1	Mg_1 TiO_2	source other
28344		-0.056	-0.028	0.760	3.770	3.870	1.380	2.220	2.650	2.810	4.590	0.020	2
	Hya vB 73	1	0.122	2.260	1.940	1.580	1.120	0.720	0.480	1.810	0.009	-0.003	
30455		-0.075	-0.055	0.610	4.790	2.940	1.020	2.590	1.240	2.380	4.060	0.009	2
		1	0.122	2.480	1.190	1.380	1.030	0.380	-0.010	1.040	0.009	0.004	
30649		-0.066	-0.049	0.870	4.490	2.560	0.710	2.050	1.100	2.470	2.930	0.010	2
		1	0.110	2.350	1.420	1.070	0.590	0.390	0.130	1.080	0.020	-0.005	
30652	HR 1543	-0.096	-0.065	0.340	2.130	1.240	0.790	2.070	2.120	4.260	3.590	0.005	2
		1	0.062	1.140	1.590	1.460	0.240	0.340	0.430	0.900	0.014	-0.007	
34334	HR 1726	0.163	...	...	6.060	...	...	...	...	0.770	...	0.181	1
		1	0.340	4.580	3.740	2.970	...	...	...	2.700	0.027	0.049	3
34411	HR 1729	-0.078	-0.054	0.910	4.490	3.485	1.300	2.575	3.275	2.855	4.020	0.012	2
		1	0.117	2.395	1.945	1.690	0.980	0.680	0.420	1.355	0.018	0.001	
35620	HR 1805	0.358	0.418	2.450	7.000	9.140	2.600	5.230	10.400	0.850	7.330	0.214	1
		1	0.361	3.880	4.340	3.910	2.880	1.590	1.510	4.650	0.034	0.072	4
36003		-0.014	0.007	4.540	5.410	7.580	2.470	5.250	2.400	-0.082	5.320	0.338	2
		1	0.556	6.850	4.350	4.520	2.890	1.230	0.990	7.340	0.018	0.038	
37160	HR 1907	0.027	0.037	0.720	6.690	4.770	1.455	3.150	3.505	1.000	4.140	0.072	1
		1	0.174	2.810	2.300	1.740	1.135	0.955	0.470	1.430	0.020	0.005	
38393	HR 1983	-0.094	-0.058	0.610	2.550	1.390	0.670	1.820	0.990	3.720	2.750	0.007	2
		1	0.068	1.260	1.210	1.070	0.260	0.460	0.430	0.690	0.018	0.005	
38751	HR 2002	0.204	0.243	0.840	5.760	6.510	1.920	3.750	7.500	1.860	6.520	0.089	1
		1	0.216	3.030	3.380	2.920	1.990	1.280	1.030	2.820	0.020	0.016	4
39587	HR 2047	-0.053	...	...	4.070	...	...	...	...	3.200	...	0.019	2
		1	0.122	2.510	1.810	1.270	...	...	...	1.320	0.021	-0.025	3
47205	HR 2429	0.255	0.287	1.050	6.390	7.250	1.810	4.160	7.960	1.550	5.860	0.118	1
		1	0.279	4.390	3.600	3.020	2.270	1.670	1.150	3.840	0.023	0.023	
47914	HR 2459	0.224	0.322	4.760	7.070	9.360	3.070	5.830	8.760	0.640	7.670	0.264	1
		1	0.436	4.420	4.060	4.380	2.820	1.310	1.690	5.560	0.075	0.223	
48433	HR 2478	0.196	0.238	1.480	6.630	7.080	2.190	3.480	5.790	1.300	6.430	0.083	1
		1	0.212	2.860	3.510	2.790	2.010	1.320	0.990	2.660	0.022	0.030	
48682	HR 2483	-0.053	0.028	1.830	4.310	2.630	0.970	2.170	2.140	2.940	3.750	0.017	2
		1	0.102	2.210	2.370	1.900	0.360	0.680	0.420	1.630	0.007	0.067	
49161	HR 2503	0.206	...	...	5.370	...	...	...	...	0.850	...	0.178	1
		1	0.361	3.920	4.060	4.020	...	...	...	4.930	0.038	0.052	3
49293	HR 2506	0.287	...	...	6.610	...	...	...	...	1.540	...	0.071	1
		1	0.187	2.800	3.180	2.750	...	...	...	2.620	0.026	-0.009	3
50778	HR 2574	0.174	0.239	3.320	7.030	8.400	2.710	4.510	5.570	0.380	6.120	0.233	1
		1	0.378	3.910	3.840	3.750	2.580	1.300	1.420	3.200	0.051	0.116	
51440	HR 2600	0.120	0.162	1.390	6.750	5.900	1.960	3.830	4.830	0.970	5.640	0.124	1
		1	0.250	3.340	3.090	2.570	1.800	1.270	0.890	1.830	0.020	0.028	4
54719	HR 2697	0.324	0.379	1.530	6.450	7.940	2.290	4.760	8.590	1.280	7.840	0.121	1
		1	0.274	3.400	4.190	3.340	2.720	1.580	1.220	3.930	0.028	0.044	
54810	HR 2701	0.134	0.168	0.850	6.870	6.170	1.470	2.950	4.710	1.350	5.280	0.064	1
		1	0.176	2.870	3.060	2.250	1.540	1.170	0.610	2.060	0.021	0.018	
55575	HR 2721	-0.107	-0.097	0.570	3.900	2.510	0.520	2.530	1.430	2.280	1.380	-0.002	2
		1	0.088	1.780	1.330	0.880	0.800	0.330	0.040	1.380	0.009	-0.001	
58207	HR 2821	0.164	0.193	0.720	6.850	5.860	1.570	3.480	6.120	1.430	5.750	0.065	1
		1	0.180	2.860	3.190	2.330	1.650	1.100	0.790	1.910	0.019	0.013	
58972	HR 2854	0.134	0.196	3.000	5.980	7.580	2.520	4.700	5.970	0.810	6.490	0.187	1
		1	0.344	3.980	4.110	3.260	2.780	1.330	0.980	3.380	0.053	0.119	
61935	HR 2970	0.203	0.227	0.760	6.320	6.230	1.770	2.980	6.190	1.640	6.140	0.059	1
		1	0.179	2.770	3.310	2.510	1.790	1.110	0.670	2.070	0.018	0.017	
62721	HR 3003	0.081	0.149	3.960	6.550	8.150	2.750	4.590	6.810	0.350	6.370	0.264	1
		1	0.443	4.770	3.830	3.600	2.850	1.330	1.420	3.960	0.070	0.169	
64606		-0.075	-0.066	1.260	5.300	3.280	1.050	2.220	0.790	1.560	2.380	0.049	2
		1	0.192	4.190	1.510	1.330	0.700	0.570	0.270	1.880	0.020	0.006	
66141	HR 3145	0.140	0.197	1.830	6.560	7.790	2.300	3.210	4.200	1.020	5.620	0.132	1
		1	0.265	3.500	3.280	2.840	1.890	1.000	1.130	2.160	0.023	0.038	
69267	HR 3249	0.202	0.260	3.043	6.590	8.203	2.627	5.020	6.760	0.860	6.967	0.198	1
		1	0.343	3.430	3.880	3.870	2.887	1.363	1.270	3.480	0.050	0.091	
70272	HR 3275	0.165	0.220	4.210	6.350	9.540	3.130	5.670	7.660	0.870	7.550	0.235	1
		1	0.409	4.180	4.600	4.220	3.050	1.360	1.450	4.620	0.083	0.208	
72184	HR 3360	0.275	0.338	1.440	6.030	8.320	2.000	3.900	7.750	1.110	6.600	0.124	1
		1	0.279	4.240	3.890	3.490	2.250	1.410	1.320	3.800	0.025	0.022	
72324	HR 3369	0.259	0.269	0.545	6.180	5.850	1.565	3.955	5.990	1.570	6.320	0.054	1
		1	0.149	2.250	2.980	2.450	1.595	1.265	0.925	2.120	0.012	0.008	
73471	HR 3418	0.337	0.374	1.200	7.250	6.560	2.530	4.610	7.580	1.400	7.620	0.106	1
		1	0.239	3.360	4.270	3.150	2.430	1.430	1.070	3.640	0.014	0.036	
73593	HR 3422	0.112	0.125	0.935	6.120	6.160	1.630	3.505	5.400	1.380	5.470	0.072	1
		1	0.183	3.080	2.960	2.160	1.590	1.125	0.730	2.080	0.014	...	
73665	HR 3427	0.256	0.283	0.645	6.700	6.112	1.772	2.840	6.584	1.770	6.650	0.041	1
		1	0.168	2.550	3.190	2.730	1.962	1.014	1.138	2.620	0.009	0.007	
73710	HR 3428	0.268	0.286	0.641	6.390	7.064	2.014	3.184	6.512	1.760	6.580	0.065	1
		1	0.184	2.530	3.340	2.570	1.816	0.939	1.118	2.580	0.013	0.014	
74377		-0.010	0.022	2.570	5.450	5.450	1.810	3.650	2.610	0.480	5.080	0.212	2
		1	0.454	7.080	3.480	3.180	2.280	1.190	0.750	4.480	0.023	0.006	

TABLE A1—*Continued*

HD	name 1	CN_1	CN_2	Ca4227	G4300	Fe4383	Ca4455	Fe4531	Fe4668	Hβ4681	Fe5015	Mg_1	source
	name 2	qual	Mg_2	Mg *b*	Fe5270	Fe5335	Fe5406	Fe5709	Fe5782	Na5895	TiO_1	TiO_2	other
74442	HR 3461	0.209	0.230	1.046	7.020	6.806	1.948	3.218	7.220	1.330	5.986	0.088	1
		1	0.211	3.160	3.380	2.610	1.834	1.148	1.008	2.180	0.014	0.019	
75732	HR 3522	0.112	0.121	1.350	5.465	6.650	1.530	3.930	8.590	1.760	5.450	0.103	2
		1	0.305	5.770	3.595	3.095	1.990	1.210	0.810	3.815	0.025	-0.001	
79211	BD+ 53 1321	-0.158	-0.126	4.460	3.580	4.590	1.960	5.650	1.810	-1.410	3.770	0.335	2
	Gl 338 B	1	0.447	3.630	3.850	3.540	2.180	0.630	0.760	9.400	0.085	0.145	
83618	HR 3845	0.252	0.288	2.230	6.960	8.030	2.420	4.620	6.860	0.680	6.980	0.142	1
		1	0.278	3.230	4.050	3.720	2.380	1.620	1.280	2.890	0.021	0.047	
84937		-0.118	-0.064	0.110	-1.620	-0.320	-0.030	0.550	-0.460	3.490	0.590	0.009	2
		1	0.024	0.500	0.080	-0.020	0.160	0.010	...	0.370	0.016	-0.001	
85503	HR 3905	0.388	0.448	1.820	6.870	8.620	2.470	4.690	10.560	1.250	7.610	0.172	1
		1	0.327	4.290	4.130	3.750	2.610	1.540	1.420	4.610	0.023	0.038	4
86728	HR 3951	-0.041	-0.030	0.950	5.210	3.335	1.040	2.425	4.340	2.840	4.750	0.012	2
		1	0.144	3.125	2.215	1.950	0.610	0.605	0.360	1.860	0.025	-0.007	
88230		-0.078	-0.039	5.170	4.020	6.760	3.490	5.480	1.770	-0.580	5.000	0.394	2
		1	0.518	4.730	4.760	4.670	2.850	0.430	0.820	10.530	0.062	0.097	
88284	HR 3994	0.291	0.342	0.570	6.400	7.080	1.690	3.500	6.860	1.750	6.840	0.062	1
		1	0.195	2.950	3.170	3.130	2.150	1.420	1.020	3.390	0.024	0.018	
90508	HR 4098	-0.079	-0.063	0.840	4.600	2.140	0.740	2.040	2.100	2.380	3.090	-0.001	2
		1	0.105	2.470	1.370	1.340	0.250	0.390	0.300	1.430	0.018	0.001	
95272	HR 4287	0.286	0.301	0.860	7.280	6.660	1.940	3.570	6.560	1.370	6.340	0.088	1
		1	0.203	3.060	3.540	2.900	1.980	1.080	1.050	2.230	0.000	0.024	
97907	HR 4365	0.083	0.208	1.660	4.940	6.920	1.580	3.810	6.300	1.190	6.820	0.137	1
		1	0.276	3.580	3.360	2.840	2.340	1.440	1.350	3.100	0.028	0.044	
98230/1	HR 4374/5	-0.036	-0.047	1.150	5.240	3.130	0.600	1.320	-0.340	2.870	2.830	0.025	2
		1	0.121	2.180	1.440	1.500	1.120	0.550	0.180	1.040	0.019	...	
101501	HR 4496	-0.007	-0.024	1.170	5.245	5.110	1.265	3.065	3.545	1.890	4.440	0.037	2
		1	0.174	3.405	2.305	1.695	1.300	0.840	0.525	2.025	0.011	...	
102328	HR 4521	0.347	0.399	1.990	6.360	8.860	2.540	5.060	11.060	1.240	7.530	0.195	1
		1	0.351	4.320	4.470	4.210	2.765	1.375	1.405	4.780	0.023	0.046	
102870	HR 4540	-0.040	-0.006	0.990	3.910	3.220	0.760	2.740	2.590	3.340	4.230	0.008	2
		1	0.090	1.710	1.730	1.420	0.550	0.520	0.290	1.360	0.018	...	
103095	HR 4550	-0.047	-0.030	1.640	4.950	3.430	0.760	1.890	-0.140	1.140	2.450	0.038	2
		1	0.183	3.960	1.580	1.150	0.900	0.470	0.060	1.220	0.012	-0.009	
106516	HR 4657	...	...	-0.310	1.080	2.700	0.750	1.060	0.050	2.950	2.990	-0.004	2
		2	0.067	2.430	1.070	0.220	-0.560	...	0.480	0.690	-0.005	0.010	
108177		-0.086	-0.062	0.270	0.130	0.350	0.410	0.600	-0.050	3.160	0.280	0.004	2
		1	0.039	0.950	0.490	0.230	0.150	0.160	0.090	0.440	0.013	...	
110897	HR 4845	-0.054	-0.032	0.950	3.500	2.170	0.470	2.160	0.510	2.500	2.330	0.021	2
		1	0.099	1.970	1.210	0.580	0.320	0.490	-0.050	0.990	0.017	-0.003	
113226	HR 4932	0.194	0.196	0.385	5.930	5.140	1.610	3.965	5.345	1.970	6.270	0.035	1
		1	0.140	2.120	3.400	2.230	1.340	1.330	0.885	2.050	0.006	0.005	
114710	HR 4983	-0.070	-0.049	0.890	3.640	2.870	0.840	2.640	3.210	2.980	4.140	0.018	2
		1	0.105	2.150	1.740	1.610	0.710	0.690	0.600	1.350	0.016	-0.006	
114762		-0.082	-0.054	0.570	3.400	2.600	0.520	1.550	0.820	2.730	2.360	0.012	2
		1	0.085	1.650	0.540	0.920	0.640	0.350	0.110	0.670	0.010	0.002	
115043		-0.074	-0.075	0.960	3.980	3.370	0.840	2.400	2.340	2.250	4.770	0.001	2
		1	0.113	2.390	2.150	1.670	1.160	0.530	0.320	1.200	...	0.008	
115617	HR 5019	-0.054	-0.045	1.160	4.970	4.520	1.260	2.790	2.670	2.390	3.730	0.027	2
		1	0.162	3.420	2.340	2.300	1.260	0.800	0.580	1.490	0.020	0.006	
117176	HR 5072	-0.044	-0.040	0.920	5.610	4.010	1.190	2.640	3.570	2.050	3.730	0.031	2
		1	0.137	2.850	2.290	1.810	1.250	0.820	0.460	1.370	0.018	0.002	
120136	HR 5185	-0.104	-0.067	0.990	3.660	1.590	0.640	2.160	1.530	3.740	5.240	0.008	2
		1	0.079	1.530	1.720	1.480	0.820	1.210	0.330	0.400	0.026	-0.006	
121146	HR 5227	0.197	0.243	1.830	6.360	5.755	1.760	4.030	8.035	0.600	5.705	0.168	1
		1	0.336	4.860	3.600	2.930	2.395	1.430	1.355	3.290	0.022	0.038	
122563	HR 5270	-0.031	-0.040	-0.010	2.500	1.230	0.545	0.635	-0.430	1.160	0.650	0.003	1
		1	0.028	0.550	0.570	0.300	0.190	0.080	-0.120	0.510	0.007	-0.004	
124897	HR 5340	0.142	0.200	1.630	6.890	6.270	2.060	4.100	3.870	0.830	5.890	0.133	1
	alpha Boo	1	0.273	3.660	3.360	2.750	1.990	1.240	0.810	2.070	-0.005	0.045	
125560	HR 5370	0.294	0.360	1.810	6.950	8.470	2.420	4.520	10.470	0.900	7.390	0.165	1
		1	0.305	3.930	4.090	3.920	2.940	1.450	1.260	3.880	0.016	0.035	
129312	HR 5480	0.203	0.225	0.440	6.570	4.970	1.810	3.480	5.920	2.020	6.500	0.056	1
		1	0.138	1.830	3.020	2.420	1.660	1.190	0.640	2.270	0.005	0.014	
131976		-0.009	-0.018	3.180	0.520	0.760	0.510	2.320	4.150	-0.140	3.420	0.303	2
	Gl 570 B	1	0.437	4.130	3.000	2.890	1.680	-0.190	0.650	9.640	0.189	0.337	
131977	HR 5568	0.011	0.046	3.640	5.830	7.470	2.460	4.800	3.470	0.230	6.160	0.269	2
		1	0.495	6.240	4.450	4.450	2.790	1.090	1.130	6.990	0.027	0.007	
132142		0.027	0.033	2.090	6.820	6.400	1.090	2.650	2.900	1.940	4.860	0.057	2
		1	0.267	5.400	2.430	3.270	1.240	0.910	0.370	1.850	0.022	0.012	
132345	HR 5582	0.459	0.492	1.275	7.330	8.185	2.365	5.060	11.200	1.300	7.730	0.150	1
		1	0.317	4.470	4.260	4.060	2.510	1.390	1.700	5.000	0.035	0.030	
134083	HR 5634	-0.119	-0.084	0.473	1.497	1.160	1.010	1.693	0.660	4.047	3.593	-0.006	2
		1	0.058	1.500	0.777	0.917	-0.070	0.400	0.260	0.917	0.008	0.012	
134439		-0.068	-0.030	1.590	4.570	3.480	0.510	1.420	-0.400	0.980	2.060	0.026	2
		1	0.141	3.350	1.680	1.280	1.220	0.190	...	0.740	0.009	-0.007	

TABLE A1—*Continued*

HD	name 1 / name 2	CN₁ / qual	CN₂ / Mg₂	Ca4227 / Mg *b*	G4300 / Fe5270	Fe4383 / Fe5335	Ca4455 / Fe5406	Fe4531 / Fe5709	Fe4668 / Fe5782	Hβ4681 / Na5895	Fe5015 / TiO₁	Mg₁ / TiO₂	source / other
135722	HR 5681	0.086	0.103	0.550	6.810	4.660	1.710	3.510	3.960	1.220	4.830	0.051	1
		1	0.147	2.250	2.470	2.030	1.310	0.750	0.530	1.750	0.015	0.011	
136028	HR 5690	0.193	0.230	2.150	6.760	7.250	2.350	4.950	6.370	0.880	7.090	0.177	1
		1	0.345	3.590	4.170	4.450	3.150	1.740	1.700	4.120	0.053	0.053	
137759	HR 5744	0.247	0.306	1.860	7.050	8.310	2.200	4.320	8.110	1.190	7.070	0.139	1
		1	0.261	3.690	3.600	3.500	2.240	1.410	1.320	3.080	0.010	0.021	
139669	HR 5826	0.136	0.194	3.480	6.820	8.375	2.825	5.640	9.435	1.450	7.320	0.218	1
		1	0.410	4.240	3.890	4.550	3.425	1.135	1.740	6.240	0.094	0.222	
140283		-0.073	-0.039	-0.160	0.240	0.160	-0.010	-0.030	-1.700	2.730	0.460	-0.003	2
		1	0.015	0.220	0.440	0.600	-0.070	0.200	...	0.490	0.007	-0.003	
140573	HR 5854	0.352	0.420	1.160	7.040	8.413	2.857	4.200	9.277	0.880	7.000	0.124	1
		1	0.272	3.910	3.780	3.140	2.333	1.757	1.407	3.760	0.026	0.040	
141144		0.173	0.204	1.410	6.500	6.930	2.230	3.260	4.490	1.430	6.070	0.068	1
	BD+01 3131	1	0.193	2.850	3.160	2.610	1.580	1.140	1.000	2.290	0.009	0.021	5
141680	HR 5888	...	...	1.050	6.330	5.930	1.620	3.890	5.730	1.470	5.730	0.064	1
		1	0.154	2.320	2.670	2.390	1.760	1.080	0.680	1.870	0.008	0.021	
142091	HR 5901	...	...	1.240	6.220	6.900	1.970	3.710	7.120	1.610	5.560	0.088	1
		1	0.235	3.660	3.410	2.420	2.160	1.250	0.990	2.690	0.014	0.021	
142373	HR 5914	-0.087	-0.054	0.587	4.223	2.097	0.430	2.010	0.627	2.260	2.753	0.007	2
		1	0.078	2.013	0.713	0.960	-0.167	0.670	0.183	1.303	0.014	0.003	
142860	HR 5933	-0.117	-0.051	0.350	2.200	1.710	0.730	2.110	0.650	3.830	2.970	0.004	2
		1	0.061	1.170	1.400	0.840	0.360	0.340	...	0.700	0.009	-0.008	
142980	HR 5940	...	...	1.580	6.110	7.550	2.180	4.350	8.170	1.230	5.660	0.138	1
		1	0.300	3.970	3.310	2.710	2.230	1.490	1.150	3.280	0.016	0.034	
143107	HR 5947	...	...	1.480	6.600	7.070	2.110	4.390	6.410	1.240	6.110	0.118	1
		1	0.248	3.220	3.500	2.510	2.270	1.520	1.190	2.510	0.018	0.038	
143761	HR 5968	-0.049	-0.040	0.520	5.040	3.350	0.830	2.210	0.770	2.680	3.990	0.029	2
		1	0.116	2.030	1.580	1.580	0.520	0.610	0.300	1.490	...	-0.002	
144872		-0.025	0.018	3.230	5.540	7.290	2.200	4.140	2.020	0.330	4.290	0.168	2
		1	0.393	6.370	3.470	3.200	1.730	1.100	0.540	4.590	0.004	0.005	
145148	HR 6014	...	...	1.615	5.920	7.275	1.970	3.845	7.410	1.190	5.265	0.122	1
		1	0.290	4.620	3.500	2.840	1.905	1.225	0.990	3.100	0.016	0.016	
145328	HR 6018	0.138	0.186	0.910	6.390	6.610	1.770	3.550	6.210	1.300	5.370	0.087	1
		1	0.222	3.490	3.170	2.650	1.880	1.180	0.850	2.360	0.015	0.014	4
145675		0.088	0.138	1.350	5.860	7.350	2.090	3.510	8.780	2.130	5.770	0.099	2
		1	0.298	5.340	3.310	2.940	1.990	1.240	...	3.400	0.017	0.004	
147379 A		-0.138	-0.065	5.560	3.080	7.200	3.430	6.580	2.410	-0.095	4.330	0.357	2
	Gl 617 A	1	0.470	4.260	4.110	4.220	2.730	0.850	1.210	10.800	0.077	0.182	
147379 B		-0.195	-0.171	6.200	2.280	2.310	2.020	4.310	6.700	1.290	4.870	0.222	2
	Gl 617 B	1	0.444	5.700	2.460	2.090	1.430	-0.100	0.170	9.920	0.272	0.565	
147677	HR 6103	...	...	0.990	6.090	6.050	1.700	4.100	6.650	1.810	5.730	0.058	1
		1	0.172	2.490	3.020	2.040	1.690	1.370	0.910	2.410	0.014	0.020	
148513	HR 6136	0.284	0.347	2.680	5.210	7.230	2.040	5.290	8.200	0.960	8.010	0.215	1
		2	0.388	4.020	4.440	4.430	3.160	1.680	1.640	6.370	0.058	0.071	
149161	HR 6159	0.180	0.261	3.852	6.580	8.692	2.840	4.828	7.432	0.170	6.562	0.256	1
		1	0.436	4.550	3.850	3.740	2.708	1.510	1.352	3.790	0.084	0.214	
149661	HR 6171	0.001	0.022	1.590	5.410	6.220	1.380	3.350	3.710	1.710	3.970	0.066	2
		1	0.255	5.030	3.460	2.860	1.890	0.830	0.740	3.220	0.021	-0.003	
152792		-0.036	-0.017	0.690	4.820	2.310	0.900	2.020	2.040	2.020	4.150	...	2
		1	0.084	1.820	0.920	1.100	0.950	0.970	0.190	1.080	0.019	0.002	
153210	HR 6299	0.249	0.310	1.428	7.270	8.082	2.345	3.872	9.142	1.330	7.188	0.128	1
		1	0.263	3.430	3.640	3.480	2.200	1.712	1.018	2.520	0.015	0.039	
153597	HR 6315	-0.095	-0.055	0.690	2.730	1.460	0.480	1.740	0.490	3.460	2.210	...	2
		1	0.079	1.760	0.790	0.600	0.160	0.510	0.210	1.000	0.009	...	
157089		-0.069	-0.053	0.530	4.420	1.910	0.740	1.930	0.790	2.220	2.960	0.005	2
		1	0.095	1.890	1.260	1.190	0.130	...	0.290	1.340	0.010	0.003	
157214	HR 6458	-0.058	-0.035	0.430	5.450	3.210	1.400	2.360	3.670	2.530	2.810	0.031	2
		2	0.106	2.360	1.630	2.050	0.540	0.410	0.340	1.240	0.032	0.012	
160693		-0.005	0.012	0.750	5.300	4.350	0.410	2.190	2.720	2.150	2.880	-0.005	2
		3	0.108	2.470	1.660	1.470	1.260	0.430	-0.030	0.520	0.031	-0.006	
164259	HR 6710	-0.108	-0.069	0.340	0.650	0.140	0.240	1.890	0.950	4.980	2.570	-0.010	2
		1	0.041	0.320	1.420	1.160	0.660	-0.010	0.020	0.230	0.011	-0.001	
165195		0.024	0.035	0.020	4.290	1.940	0.310	0.800	0.720	0.700	2.520	0.008	1
		1	0.060	0.460	0.720	0.860	0.400	0.030	0.070	1.060	0.014	0.003	
165760	HR 6770	0.170	0.197	0.510	6.430	5.470	1.690	3.530	5.820	1.810	6.260	0.037	1
		1	0.139	2.310	3.030	2.410	1.620	1.250	0.760	2.060	0.013	0.011	4
166620	HR 6806	-0.019	0.014	2.530	4.740	6.450	1.990	3.500	4.440	1.100	4.280	0.121	2
		1	0.343	5.850	3.060	3.040	1.710	0.880	0.970	3.680	0.009	-0.010	
167042	HR 6817	...	...	1.070	6.180	6.010	1.650	3.550	5.740	1.500	4.960	0.071	1
		1	0.200	3.300	2.970	2.240	1.780	0.950	0.650	2.090	0.008	0.016	
168755	HR 6872	...	...	1.150	6.560	7.350	1.940	4.590	8.090	1.350	6.550	0.096	1
		1	0.224	2.930	3.630	2.850	2.350	1.490	1.230	3.110	0.019	0.035	
170153	HR 6927	-0.081	-0.040	0.590	2.370	1.830	0.620	1.490	0.430	2.840	2.520	0.009	2
		1	0.074	1.890	0.310	1.110	0.780	0.290	0.060	1.660	0.011	0.010	
175743	HR 7148	0.226	0.268	0.960	6.760	7.070	1.990	3.870	7.390	1.510	6.780	0.087	1
		1	0.220	3.310	3.580	2.950	2.140	1.420	0.980	2.420	0.012	0.019	

TABLE A1—*Continued*

HD 	name 1 name 2	CN_1 qual	CN_2 Mg_2	Ca4227 Mg *b*	G4300 Fe5270	Fe4383 Fe5335	Ca4455 Fe5406	Fe4531 Fe5709	Fe4668 Fe5782	Hβ4681 Na5895	Fe5015 TiO_1	Mg_1 TiO_2	source other
175751	HR 7149	...	...	0.990	6.330	6.340	1.750	4.150	7.580	1.500	5.730	0.079	1
		1	0.199	2.840	3.170	2.670	2.060	1.310	0.980	2.450	0.020	0.025	
176411	HR 7176	...	...	1.030	6.330	7.230	1.890	4.160	8.040	1.540	6.670	0.076	1
		1	0.210	3.070	3.200	2.960	2.130	1.190	0.940	2.760	0.013	0.031	
180928	HR 7317	0.083	0.157	3.410	6.470	6.860	2.110	4.710	4.780	0.940	6.260	0.208	1
		1	0.353	4.460	3.310	3.170	2.360	1.230	1.210	3.040	0.041	0.093	
181984	HR 7352	0.376	0.453	2.810	7.060	9.360	2.980	4.440	11.440	1.500	7.880	0.200	1
		1	0.360	4.640	4.840	3.840	2.770	1.180	1.420	4.440	0.027	0.048	
184406	HR 7429	0.244	0.302	1.890	6.550	8.010	2.300	4.260	8.720	1.020	6.440	0.184	1
		1	0.346	4.800	3.810	3.500	2.480	1.400	1.180	3.610	0.018	0.032	4
184492	HR 7430	0.251	0.304	0.503	6.160	5.967	1.963	3.543	6.763	1.900	6.883	0.062	1
		1	0.151	2.190	3.320	2.510	1.773	1.317	1.117	2.850	0.019	0.019	
185144	HR 7462	-0.031	-0.004	1.690	5.640	5.820	1.720	2.980	3.375	1.720	3.570	0.042	2
		1	0.213	4.350	2.680	2.340	1.640	0.880	0.350	2.310	0.008	-0.007	
186408	HR 7503	-0.044	-0.049	0.790	5.087	4.203	1.203	2.830	3.520	2.777	3.780	0.025	2
		1	0.133	2.447	2.180	1.530	0.870	0.697	0.330	1.577	0.012	-0.005	
186427	HR 7504	-0.024	-0.025	0.990	5.005	4.055	1.280	3.115	3.705	2.590	4.010	0.025	2
		1	0.136	2.570	2.190	1.710	0.930	0.720	0.465	1.565	0.016	0.001	
187691	HR 7560	-0.080	-0.052	0.410	3.170	3.420	1.180	1.900	2.980	3.480	3.880	0.011	2
		1	0.093	1.840	1.430	1.660	0.570	0.620	0.130	1.340	-0.001	-0.002	
187923	HR 7569	-0.030	-0.083	0.810	5.430	3.050	1.050	2.650	2.660	2.955	3.300	0.024	2
		1	0.121	2.355	2.540	1.435	0.710	0.510	0.620	1.475	0.021	-0.001	
188056	HR 7576	0.387	0.456	2.300	6.700	9.110	2.640	5.090	11.520	1.170	7.860	0.215	1
		1	0.382	4.620	4.350	4.100	2.880	1.540	1.560	5.500	0.028	0.052	4
188512	HR 7602	0.006	0.023	0.913	6.410	5.680	1.450	3.060	4.487	1.460	4.353	0.055	1
		1	0.179	3.170	2.450	2.090	1.360	0.890	0.433	1.780	0.009	0.001	
190406	HR 7672	-0.097	-0.067	0.740	3.920	3.290	1.110	3.220	2.530	3.230	3.650	0.003	2
		1	0.090	1.990	1.780	1.360	0.940	0.470	0.540	1.830	0.008	0.001	
193901		-0.018	0.023	0.170	2.520	1.670	0.370	0.770	0.610	2.460	1.650	-0.011	2
		1	0.044	1.650	0.650	0.930	0.550	0.380	-0.090	1.270	0.017	-0.003	
195633		-0.101	-0.070	0.240	2.240	1.000	0.330	2.180	0.410	3.120	2.620	-0.010	2
		1	0.046	0.990	0.980	1.010	0.410	0.040	0.280	1.330	0.005	-0.008	
197076	HR 7914	-0.095	-0.067	0.980	3.870	2.850	0.840	2.670	1.710	2.610	3.480	-0.004	2
		1	0.106	2.500	1.740	1.550	0.780	0.520	0.450	1.610	0.002	-0.007	
198149	HR 7957	0.079	0.103	0.910	6.800	5.970	2.060	3.270	4.150	1.450	4.830	0.063	1
		1	0.198	3.140	2.860	2.320	1.230	0.580	0.890	1.500	0.003	0.010	
199580		0.085	0.105	0.870	6.090	5.250	1.380	3.340	5.280	1.280	4.770	0.063	1
		1	0.201	3.380	3.070	2.310	1.490	1.220	0.880	1.970	0.028	0.003	
200779		-0.014	0.045	5.270	5.910	8.470	3.720	6.130	2.790	-0.160	6.190	0.374	2
	Gl 818	1	0.549	5.540	4.990	4.770	3.250	1.320	1.140	8.570	0.023	0.045	
201626		0.083	0.080	-1.690	6.840	2.530	0.310	1.210	16.620	1.020	0.570	0.239	1
		1	0.140	0.480	0.750	0.500	0.190	0.140	-0.050	1.510	0.016	-0.022	
201891		-0.080	-0.049	0.420	2.910	1.230	0.370	1.210	1.090	2.660	2.640	0.012	2
		1	0.066	1.470	0.620	0.710	-0.280	0.500	0.370	0.930	0.001	-0.013	
203344	HR 8165	0.173	0.220	0.740	7.000	6.080	2.240	3.790	7.110	1.340	5.160	0.108	1
		1	0.221	3.190	2.890	2.370	1.730	1.220	0.760	2.190	0.005	0.010	
204587		-0.054	0.016	5.460	5.170	7.820	3.350	6.230	1.910	-0.990	5.460	0.400	2
		1	0.557	5.280	4.250	4.240	3.350	1.020	0.900	8.450	0.038	0.089	
205153		...	...	1.080	4.960	4.950	0.390	2.320	2.880	3.480	4.150	0.001	2
		1	0.066	1.790	1.560	1.520	0.690	0.670	0.370	2.150	0.022	0.008	
205650		...	...	-1.750	3.670	1.960	0.030	1.160	1.240	2.880	1.480	-0.003	2
		1	0.056	1.830	1.020	0.490	0.600	0.450	0.150	1.530	0.027	0.001	
208906		-0.106	-0.066	0.490	2.690	1.460	0.420	0.840	0.650	3.230	2.770	0.010	2
		1	0.066	1.580	1.050	1.060	0.180	0.370	0.300	1.110	-0.002	-0.006	
210027	HR 8430	-0.078	-0.043	-0.040	1.410	0.750	0.840	1.930	0.810	4.550	3.060	0.002	2
		1	0.073	1.100	1.020	0.840	0.470	0.210	0.040	0.610	-0.001	-0.005	
215648	HR 8665	-0.083	-0.038	0.070	2.450	0.790	0.810	1.690	0.860	3.290	2.670	0.003	2
		1	0.058	1.070	1.240	1.250	-0.070	0.510	0.380	0.810	-0.006	0.003	
217877	HR 8772	-0.091	-0.056	0.795	3.765	2.760	0.810	2.280	1.425	3.050	3.625	-0.006	2
		1	0.087	2.025	1.715	1.535	0.445	0.545	0.490	1.530	0.007	0.010	
219134	HR 8832	0.062	0.121	3.860	6.250	9.360	2.150	5.740	6.890	0.540	5.090	0.196	2
		1	0.452	6.670	3.950	4.060	2.460	0.990	0.710	5.760	0.010	0.005	
219449	HR 8841	0.203	0.238	0.780	6.850	7.100	1.890	3.650	7.690	1.390	6.400	0.098	1
		1	0.225	3.210	3.540	2.880	2.140	1.350	0.980	2.240	0.021	0.022	
219617		-0.061	-0.038	0.150	0.995	1.680	0.420	0.610	-0.790	2.820	1.040	-0.014	2
		1	0.030	1.010	0.530	0.770	0.030	-0.075	0.260	1.090	0.009	0.007	
221148	HR 8924	0.319	0.388	2.150	7.290	8.150	2.660	3.550	11.260	1.530	6.730	0.169	1
		1	0.370	5.060	4.290	3.950	2.540	1.400	1.330	5.080	0.032	0.030	
222368	HR 8969	-0.080	-0.048	0.220	3.035	2.040	0.830	2.065	1.595	3.515	3.505	0.001	2
		1	0.063	1.055	1.090	1.265	0.690	0.485	0.335	1.055	0.010	0.007	
224930	HR 9088	-0.085	-0.060	1.170	4.695	2.995	0.695	2.115	0.705	1.865	2.710	0.027	2
		1	0.149	3.355	1.400	1.275	0.385	0.580	0.250	2.045	0.004	0.004	
232979		-0.115	-0.109	5.200	4.060	5.810	2.750	5.930	0.340	-1.210	4.550	0.340	2
	Gl 172	1	0.452	3.990	3.940	4.400	2.710	0.280	0.830	9.510	0.062	0.153	
	BD+ 17 4708	-0.097	-0.063	0.535	0.190	0.835	0.545	0.885	0.450	3.370	2.010	0.001	2
		1	0.023	0.520	0.840	0.920	0.430	0.465	0.045	0.790	0.006	0.001	

TABLE A1—*Continued*

HD	name 1 name 2	CN_1 qual	CN_2 Mg_2	Ca4227 Mg *b*	G4300 Fe5270	Fe4383 Fe5335	Ca4455 Fe5406	Fe4531 Fe5709	Fe4668 Fe5782	Hβ4681 Na5895	Fe5015 TiO_1	Mg_1 TiO_2	source other
	BD+ 19 5116 A	-0.066	-0.143	5.970	3.620	2.770	2.760	3.980	7.800	-5.330	4.650	0.274	2
	Gl 896 A	1	0.496	4.390	2.710	2.610	1.490	-0.870	0.010	10.870	0.310	0.614	
	BD+ 19 5116 B	-0.083	-0.169	5.700	2.660	1.690	2.150	3.310	9.140	-3.700	5.020	0.231	2
	Gl 896 B	2	0.533	6.380	2.300	1.710	0.660	-1.590	-0.120	11.490	0.404	0.822	
	BD+ 43 0044 B	-0.191	-0.158	6.220	2.200	4.380	2.670	3.820	1.840	0.310	4.690	0.327	2
	Gl 15	1	0.483	4.740	2.790	2.450	1.600	-0.650	0.320	12.570	0.216	0.465	
	BD+ 44 2051 A	-0.179	-0.155	4.810	2.590	2.990	1.640	4.920	0.060	-0.850	5.170	0.354	2
	Gl 412 A	1	0.455	4.040	3.360	2.390	2.140	0.070	0.430	11.320	0.142	0.297	
	BD+ 56 1458	-0.088	-0.051	4.070	3.600	6.130	2.380	5.880	1.200	-1.550	5.020	0.353	2
	Gl 394	1	0.505	4.620	4.610	4.350	2.930	0.900	1.130	8.690	0.044	0.073	
	Gl 699	-0.152	-0.129	4.480	1.080	3.690	1.510	3.920	5.110	1.180	6.430	0.337	2
	Barnard's star	1	0.552	6.160	3.200	2.440	1.560	-1.010	-0.090	14.190	0.353	0.430	6
	Luyten 789-6	0.062	0.243	...	2.440	3.600	0.840	4.200	9.420	-1.970	7.380	0.220	2
	Gl 866	2	0.645	9.210	2.270	1.890	0.180	-1.900	-0.200	12.720	0.442	1.047	
	Ross 248	-2.080	-0.196	6.340	1.170	3.710	1.690	1.810	14.400	4.340	7.530	0.169	2
	Gl 905	1	0.564	8.770	2.060	1.540	0.700	-1.880	-0.140	12.890	0.381	0.952	

[1] Column 3, second line contains an approximate indication of larger-than-average error. If a "1" is listed, the error is about that of the Table 1 value. If a "2" is listed, the error is about twice the Table 1 value, and if a "3" is listed, the error is about 3 times the Table 1 value.
[2] The original 11 indices for M71 A7 were revised after Faber et al. 1985: a second observation was averaged with the first. The modified indices appear in G93 unannounced.
[3] These spectra were lost subsequent to the original publication.
[4] This is one of the nine standard stars, several of which were observed every run.
[5] HD 141144 is mislabeled HD 141644 in the body of Table 2a of Faber et al. 1985. The name is correct in the notes to that table.
[6] Barnard's star (Gl 699) was mislabeled BD +04 3561 in Table 2 of G93.
SOURCES.—(1) Faber et al. 1985, Table 2. (2) G93, Table 2. (3) G93 Table 3.

second line of each entry is listed a crude indication of the quality of the spectrum, based on the *G* parameter (see § 2.2). If "1" is listed, the error is typical (as listed in Table 1), if a "2" is listed, the errors are roughly twice those listed in Table 1, and if a "3" is listed, the errors are roughly 3 times those listed in Table 1. In column (14) on the first line is given an indication of where the star was published in earlier papers in this series. In column (14) on the second line, other notes appear. The key for column (14) is given at the end of the table.

In Table A1 the stars are listed with cluster stars first (except for Hyades stars, which are listed with the field stars), then field stars listed by HD number, then a few field stars that have only BD numbers, then three M dwarfs, listed by their common designations.

Table A1 cluster numberings are from the following sources. M3—Johnson & Sandage (1956) or Osborne (1973); M5—Arp (1955); M10—Osborne (1973) or Arp (1955); M13—Savedoff (1956) as tabulated in Osborne (1973); M67—Fagerholm (1906) or Eggen & Sandage (1964); M71—Cudworth (1985) or Arp & Hartwick (1971); M92—Sandage & Walker (1966) as tabulated in Osborne (1973); NGC 188—Sandage (1962); NGC 7789—Küstner (1923) as tabulated by Janes (1977); Hyades = Melotte 25—van Bueren (1952).

Table A2 lists new stars in several groups. Table A2A lists main-sequence stars in the Coma Berenices cluster (Melotte 111; numbering of Trumpler 1938) and in the Hyades (Melotte 25; numbering of Bueren 1952). Table A2B lists globular cluster stars that were not included in G93 because they are horizontal-branch stars and hence hotter than $V-K=0.95$. The numbering sources for M5 and M92 are the same as in Table A1. For NGC 6171 = M 101, the numbering is that of Sandage & Katem (1963). Table A2C lists field M giants, and Table A2D lists hot field stars that are either BA main-sequence stars or field horizontal-branch stars. Table A2E lists FGK dwarfs and subgiants that were not useful to G93 because they were either too hot or had unknown atmospheric parameters. Table A2F lists BAFG supergiants, and Table A2G lists six GK giants not published in Faber et al. (1985). Finally, in Table A2H, all remaining stars are listed. These are stars whose atmospheric parameters are uncertain or unknown, and only the spectral type is listed. These include (1) eight GK dwarfs and giants, (2) a few faint Landolt (1983) *UBVRI* equatorial standard stars (these are labeled DSA, for Durchmusterung of Selected Areas), and (3) selected faint stars from the SAO catalog that were used for aperture tests in conjunction with galaxies. Most stars in the library were observed only once, but many of the faint stars in Table A2H were observed multiple times. They are therefore useful as secondary line strength standards, supplementing the original nine bright standard stars, which have *V* magnitudes between 4 and 6.

PHYSICAL PARAMETERS FOR NEW STARS

Also listed in Table A2 for the new stars are effective temperatures, gravities, and values of [Fe/H] where available. The [Fe/H] values were taken from various literature sources, listed in the notes. Temperatures and gravities were either taken from the literature or derived by us from photometry. In either case, we give notes within the table to indicate where the values come from. Some general comments are given below, listed by table subsection.

In Table A2A, masses for Coma and Hyades stars are adopted based on cluster ages and the isochrones of VandenBerg (1985).

TABLE A2A

NEW STARS: HYADES AND COMA DWARFS

HD N_{obs}	Name BD	CN_1 qual	CN_2 Mg_2	Ca4227 Mg *b*	G4300 Fe5270	Fe4383 Fe5335	Ca4455 Fe5406	Fe4531 Fe5709	Fe4668 Fe5782	Hβ4681 Na5895	Fe5015 TiO_1	Mg_1 TiO_2	T_e	log *g*	Sp. Type
	Coma A 3	-0.001	0.031	0.960	5.570	6.500	1.640	2.980	4.700	1.780	4.270	0.058	5100	4.534	G9 V
1		1	0.185	3.470	2.860	2.390	1.450	1.060	0.780	1.830	0.005	0.003			
	Coma A 13	-0.054	-0.033	1.545	5.515	5.845	1.605	3.235	3.705	1.720	4.485	0.043	5357	4.544	K0 V
2		1	0.205	4.270	2.890	2.500	1.325	0.935	0.665	2.140	0.018	0.008			
	Coma A 14	-0.038	-0.015	0.730	6.460	2.815	0.855	2.520	1.730	1.575	3.780	0.021	5196	4.318	G4 V
2		1	0.083	1.330	1.285	0.950	0.675	0.565	0.325	0.780	0.015	-0.003			
	Coma A 21	-0.016	0.007	0.845	6.030	4.715	1.260	2.955	3.195	1.535	4.215	0.040	5147	4.410	G7 V
2		1	0.157	2.810	2.420	1.800	1.210	1.065	0.605	1.620	0.016	-0.003			
107214	Coma T 65	-0.092	-0.063	0.775	3.180	2.955	0.895	2.365	1.295	2.905	2.960	0.017	5960	4.301	G0 V
2		1	0.100	2.070	1.825	1.505	0.710	0.655	0.400	1.175	0.016	0.001			
107276	Coma T 68	-0.261	-0.184	0.192	-2.442	-1.758	-0.052	1.042	-0.450	7.745	1.568	-0.023	8030	4.086	A6 IV-V
4		1	0.027	0.655	0.858	0.392	-0.135	0.148	0.058	0.858	0.008	-0.005			
107513	Coma T 82	-0.166	-0.101	0.670	-1.050	-0.680	0.390	1.000	0.090	6.160	2.250	-0.017	7080	4.128	A9 V
1		1	0.028	0.490	0.770	0.640	0.100	-0.110	0.140	0.820	0.002	-0.005			
107583	Coma T 85	-0.094	-0.065	0.750	3.960	2.380	0.965	2.335	1.630	2.700	3.885	0.009	5960	4.383	G1 V
2		1	0.106	2.385	1.965	1.425	0.890	0.560	0.320	1.180	0.012	-0.006			
107611	Coma T 86	-0.120	-0.087	0.620	2.090	1.065	0.695	1.970	1.415	3.735	2.495	0.000	6395	4.274	F6 V
2		1	0.065	1.695	1.265	1.030	0.460	0.190	0.155	0.995	0.016	-0.002			
107685	Coma T 90	-0.103	-0.085	0.510	1.690	0.430	0.460	1.510	0.120	3.040	2.340	-0.008	6359	4.276	F5 V
1		1	0.045	1.330	1.240	0.570	0.870	0.480	0.200	0.740	0.015	-0.002			
107793	Coma T 97	-0.102	-0.070	0.680	3.610	1.960	0.830	2.090	0.830	3.100	2.910	0.002	5940	4.338	F9 V
1		1	0.086	2.030	1.670	1.290	0.840	0.590	0.340	1.160	0.018	0.003			
	Coma T 102	-0.096	-0.067	0.825	4.215	3.245	1.170	2.735	1.470	2.890	2.860	0.015	5851	4.361	G1 V
2	BD+27 2121	1	0.111	2.510	1.925	1.595	0.855	0.625	0.355	1.430	0.014	0.004			
108154	Coma T 114	-0.116	-0.079	0.680	2.055	1.040	0.615	2.235	0.645	3.870	2.875	0.003	6431	4.299	F8 V
2		1	0.063	1.425	1.395	1.110	0.530	0.425	0.145	0.755	0.010	-0.009			
	Coma T 132	-0.090	-0.065	1.045	5.205	3.835	1.310	2.870	2.640	2.310	3.570	0.020	5659	4.467	G5 V
2		1	0.141	3.255	2.185	2.140	1.080	0.795	0.585	1.490	0.008	-0.005			
	Coma T 150	-0.048	-0.020	1.545	5.070	5.395	1.560	3.490	2.355	1.510	4.345	0.054	5291	4.299	G9 V
2	BD+25 2511	1	0.212	3.815	2.755	2.360	1.445	1.005	0.655	2.120	0.016	-0.002			
25825	Hya vB 10	-0.088	-0.061	0.920	4.170	3.100	1.030	2.200	2.660	3.040	4.000	0.008	5980	4.414	G0 V
1		1	0.101	2.300	1.930	1.460	0.750	0.650	0.190	1.610	0.016	-0.006			
26736	Hya vB 15	-0.058	-0.031	0.970	4.480	3.820	1.130	2.790	3.870	2.730	4.480	0.017	5800	4.343	G3 V
1		1	0.136	2.920	2.450	1.830	0.990	0.970	0.490	1.690	0.018	-0.008			
26756	Hya vB 17	-0.045	-0.019	0.850	5.160	4.200	1.370	3.120	4.150	2.530	4.060	0.025	5745	4.526	G5 V
1		1	0.157	3.120	2.580	2.150	1.140	1.130	0.440	1.980	0.016	-0.013			
26784	Hya vB 19	-0.084	-0.049	0.570	3.220	3.080	1.010	2.730	1.500	3.860	4.100	0.009	6293	4.271	F8 V
1		1	0.095	1.840	1.950	1.240	0.820	0.660	0.570	1.270	0.017	-0.001			
284253	Hya vB 21	-0.008	0.014	1.500	5.830	5.320	1.760	3.400	5.050	2.100	4.320	0.051	5273	4.565	K0 V
1		1	0.231	4.310	2.790	2.780	1.430	1.190	0.740	2.620	0.013	-0.003			
27250	Hya vB 26	-0.044	-0.023	0.980	5.570	5.210	1.460	2.960	4.390	2.300	4.780	0.035	5550	4.496	G9 V
1		1	0.189	3.850	2.810	2.520	1.430	1.070	0.430	2.150	0.016	-0.009			
27406	Hya vB 31	-0.078	-0.043	0.790	3.680	3.140	1.110	2.570	2.000	3.150	3.720	0.012	6084	4.309	G0 V
1		1	0.100	2.290	1.890	1.490	0.920	0.600	0.230	1.370	0.026	-0.001			
27524	Hya vB 35	-0.117	-0.087	0.500	1.740	0.590	0.720	2.170	1.360	4.310	2.480	0.004	6571	4.249	F5 V
1		1	0.063	1.160	1.180	0.860	0.520	0.520	0.150	1.090	0.016	-0.009			
27534	Hya vB 36	-0.101	-0.055	0.610	2.230	1.360	1.180	1.730	1.250	4.670	3.120	0.010	6536	4.241	F6 V
1		1	0.058	0.800	1.420	1.370	0.300	0.630	0.330	0.850	0.019	-0.009			
28099	Hya vB 64	-0.044	-0.010	0.970	4.540	4.550	1.090	3.170	4.230	2.880	5.360	0.027	5667	4.391	G2 V
1		1	0.147	3.070	2.350	2.040	1.250	0.700	0.610	2.060	0.010	-0.011			
28483	Hya vB 81	-0.115	-0.067	0.625	2.215	1.720	0.570	2.205	1.665	4.095	3.030	0.002	6432	4.301	F6 V
2		1	0.067	1.345	1.260	1.080	0.665	0.560	0.435	1.385	0.018	0.002			
28593	Hya vB 87	-0.016	0.012	0.990	5.220	5.420	1.530	3.500	4.760	2.350	4.930	0.036	5489	4.477	G8 V
1		1	0.182	3.660	2.780	2.270	1.310	1.100	0.730	2.110	0.017	0.002			
28910	Hya vB 95	-0.192	-0.113	0.260	-0.610	-0.780	-0.010	1.300	0.090	6.960	2.990	-0.015	7395	3.787	A8 V n
1		1	0.019	0.480	0.820	0.360	0.670	0.320	0.340	1.050	0.018	-0.005			
29375	Hya vB 103	-0.146	-0.066	0.690	-0.210	0.380	0.350	1.840	1.570	6.580	2.170	0.014	6988	4.050	F0 V
1		2	0.030	0.390	1.280	0.630	0.040	0.170	0.400	0.640	0.020	-0.006			
29388	Hya vB 104	-0.265	-0.163	0.550	-2.270	-1.620	0.210	0.330	0.050	8.490	1.160	-0.021	8380	3.873	A6 V n
1		2	0.016	0.620	0.860	0.570	0.560	0.490	0.280	0.240	0.005	-0.018			
30034	Hya vB 111	-0.188	-0.110	0.660	-0.580	-1.100	0.270	1.630	-0.260	6.670	2.990	-0.006	7395	4.028	F0 V
1		1	0.029	0.680	1.260	0.850	0.450	0.400	0.120	0.950	0.017	-0.012			
30210	Hya vB 112	-0.225	-0.142	0.380	-1.810	-1.430	0.280	1.220	0.080	7.890	2.600	-0.001	7970	4.152	Am
1		1	0.037	0.540	1.270	0.300	0.580	0.530	0.380	0.830	0.013	-0.006			
31236	Hya vB 126	-0.164	-0.100	0.310	-0.250	0.340	0.210	1.720	0.010	6.080	2.540	0.000	7069	4.252	F3 IV
1		1	0.046	0.660	1.210	0.830	0.320	0.310	0.350	1.060	0.008	-0.012			
27935	Hya vB 140	-0.070	-0.050	1.510	5.080	4.900	1.480	2.520	2.880	2.090	4.670	0.059	5261	4.478	G5 V
1		1	0.200	3.750	2.690	2.210	1.210	1.140	0.490	2.870	0.019	0.003			

NOTES.—Temperatures are from interpolation in the color table of Johnson 1966. $B-V$ and $R-I$ values were averaged. Hyades [Fe/H] = 0.13 is from Boesgaard & Friel 1990. Coma cluster [Fe/H] = −0.07 from Boesgaard 1987. Gravity estimated from L, M, and T_e. Distance modulus to Coma estimated by scaling that given by Janes & Adler 1982 (based on main-sequence fitting) to the adopted Hyades distance modulus of 3.45. This gives a modulus of $(m-M)_0 = (m-M)_V = 4.95$ for Coma. Bolometric corrections were also taken from Johnson 1966, but the zero point was adjusted to agree with a solar BC of −0.12. Stellar masses estimated from the VandenBerg 1985 isochrones with ages 0.4 and 0.7 Gyr for the Coma and Hyades clusters, respectively (Friel & Boesgaard 1992).

TABLE A2B

New Stars: Cluster Horizontal-Branch Stars

Name N_{obs}	CN_1 qual	CN_2 Mg_2	Ca4227 Mg *b*	G4300 Fe5270	Fe4383 Fe5335	Ca4455 Fe5406	Fe4531 Fe5709	Fe4668 Fe5782	Hβ4681 Na5895	Fe5015 TiO_1	Mg_1 TiO_2	$(M_V)_0$ T_e	$(B-V)_0$ log *g*	BC_V
M5 I-45	-0.053	0.009	-0.790	1.990	3.070	0.660	-1.740	0.080	3.190	0.940	-0.029	0.82	0.53	-0.24
1	2	0.032	1.330	1.090	-0.440	0.770	0.170	0.560	0.910	0.016	0.004	5850	2.61	
M5 II-53	-0.217	-0.133	-0.170	-6.700	-1.480	-0.710	-1.580	-0.070	8.240	-0.820	0.008	1.20	-0.08	-0.52
1	3	0.014	1.530	-0.740	-3.360	0.770	-0.760	0.090	0.230	0.116	-0.008	10460	3.66	
M5 II-76	-0.070	-0.040	-0.080	0.580	0.320	0.430	1.490	-0.440	2.970	1.680	0.002	0.78	0.47	-0.17
1	2	0.045	1.110	0.970	0.950	0.250	0.410	0.180	1.080	0.020	-0.006	6060	2.70	
M5 IV-87	-0.057	-0.012	0.570	-0.600	-0.140	0.200	2.520	0.180	3.220	1.410	-0.037	0.72	0.50	-0.17
1	2	0.014	1.050	0.420	0.050	0.170	0.060	-0.570	1.340	0.010	0.019	5950	2.63	
M92 I-10	-0.282	-0.228	0.060	-2.740	-0.950	-0.270	1.270	-1.090	9.380	1.740	-0.005	0.89	-0.04	-0.28
1	3	-0.009	0.200	1.300	0.130	-0.170	0.600	-0.310	0.860	0.024	-0.019	9290	3.44	
M92 I-13	-0.103	-0.081	0.320	2.560	1.860	-0.170	1.070	-0.340	2.540	0.990	-0.023	-0.02	0.53	-0.26
1	2	0.070	1.480	1.190	1.490	0.160	-0.200	0.260	0.450	0.047	-0.008	5680	2.22	
M92 II-23	-0.281	-0.216	-0.350	-1.480	-2.320	-0.250	-0.200	1.150	7.950	0.560	-0.027	0.65	0.07	-0.08
1	3	0.025	0.680	1.880	0.700	0.580	0.170	-0.590	0.750	0.038	-0.013	7510	3.05	
M92 VI-74	-0.137	-0.099	0.120	3.760	2.390	0.420	2.530	2.610	3.390	4.170	-0.006	-0.32	0.50	-0.19
1	1	0.061	0.970	1.300	1.440	0.520	0.380	-0.350	1.150	0.025	-0.002	5950	2.21	
M92 XII-24	-0.288	-0.212	-0.160	-3.640	2.190	-0.080	0.530	-3.630	7.840	0.230	0.017	1.30	-0.09	-0.68
1	3	0.023	0.030	1.740	1.360	-0.440	-0.060	-0.760	0.970	-0.011	-0.007	11100	3.75	
NGC 6171 04	-0.025	0.039	0.330	-0.700	3.340	-0.730	1.240	-0.390	2.660	0.890	-0.030	0.90	0.46	-0.17
1	2	0.047	0.940	1.400	0.700	0.060	0.080	-0.100	2.500	0.042	-0.006	6100	2.75	
NGC 6171 45	-0.157	-0.168	0.850	1.420	-1.710	1.550	2.050	3.470	4.040	1.940	-0.009	1.28	0.51	-0.19
1	3	0.121	2.940	1.370	0.980	0.990	-0.240	-0.350	2.550	0.048	0.007	5920	2.85	

Notes.—Bolometric corrections and T_e from the K92 theoretical grid as a function of $(B-V)_0$ assuming log $g = 2$ for stars redder than $B-V = 0.05$, and log $g = 3$ for stars bluer than that. Expected error in T_e from the photometric uncertainty is roughly 15% for the hottest stars but less than 4% for the stars near 6000 K. Mass at the horizontal branch for all clusters assumed 0.65 $M_{\odot}$. General cluster parameters and sources for photometry are given in Table A3.

TABLE A2C

New Stars: Field M Giants

HD N_{obs}	HR Variable	CN_1 qual	CN_2 Mg_2	Ca4227 Mg *b*	G4300 Fe5270	Fe4383 Fe5335	Ca4455 Fe5406	Fe4531 Fe5709	Fe4668 Fe5782	Hβ4681 Na5895	Fe5015 TiO_1	Mg_1 TiO_2	Sp. Type	T_e Note	[Fe/H] Note	log *g* Note
17491	HR 0832	-0.127	-0.077	5.450	3.540	0.220	3.700	3.710	22.580	4.850	26.520	-0.078	M4 III	3560	...	...
1	Z Eri	2	0.444	14.400	4.990	3.320	1.090	-0.760	...	4.250	0.483	...		1		
18191	HR 0867	-0.134	-0.108	6.030	3.590	-0.105	4.175	4.065	24.705	5.375	28.775	-0.108	M6 III	3250	...	...
2	RZ Ari	1	0.408	15.235	4.740	1.630	0.680	-0.750	-1.360	4.970	0.480	0.883		1		
60522	HR 2905	0.152	0.221	4.640	6.210	9.300	3.070	5.940	8.680	0.770	7.990	0.258	M0 III-IIIb	3902	0.12	1.2
1		1	0.455	4.670	4.180	4.490	3.150	1.170	1.450	5.130	0.123	0.275		5	3	3
94705	HR 4267	-0.096	-0.058	4.220	4.560	-0.140	3.380	3.450	20.560	4.550	26.110	-0.097	M5.5 III	3335	...	...
1	VY Leo	2	0.403	14.130	4.340	3.820	1.330	-0.350	-0.650	4.210	0.415	0.802		1		
113285		-0.191	-0.283	7.550	-2.800	10.010	3.720	-0.770	25.870	5.520	30.790	0.036	M8 III	2300	...	...
1	RT Vir	1	0.437	17.840	0.810	1.520	-0.530	-1.970	-0.300	10.700	0.604	1.022		1		
114961		-0.167	-0.188	7.380	-0.460	10.500	4.320	0.210	24.090	4.950	32.110	-0.076	M7 III	3014	-0.81	0.0
1	SW Vir	2	0.419	18.520	1.770	2.780	-1.260	-1.660	-0.050	8.760	0.619	0.981		2	2	2
126327		-0.140	-0.158	8.200	-1.640	11.940	4.390	-0.860	24.240	4.240	31.500	0.031	M7.5 III	3000	-0.58	0.0
1	RX Boo	1	0.444	18.060	1.390	1.360	-0.990	-1.730	-0.330	10.230	0.583	0.969		2	2	2
137471	HR 5739	0.086	0.130	3.650	6.930	7.420	2.800	5.910	8.810	1.070	8.490	0.198	M1 III	3810	...	...
1		1	0.433	4.640	4.100	4.340	3.560	1.120	1.470	4.880	0.158	0.332		1		
148783	HR 6146	-0.164	-0.105	6.630	1.360	-4.420	4.300	3.440	23.870	5.860	32.340	-0.132	M6 III	3250	-0.06	0.2
1	G Her	1	0.432	17.230	3.870	4.520	-0.760	-1.390	0.010	6.010	0.550	1.054		4	4	4
151203	HR 6227	-0.018	0.029	3.710	6.400	5.570	2.910	6.280	13.190	2.200	10.370	0.183	M3 IIIab	3640	...	...
1		1	0.508	7.180	3.740	3.680	3.100	0.340	0.830	4.790	0.317	0.619		1		
167006	HR 6815	0.022	0.100	4.900	4.560	6.620	3.010	5.140	12.160	1.810	10.140	0.200	M3 III	3640	...	...
1	V669 Her	1	0.504	7.460	3.650	3.260	2.550	0.490	0.710	3.890	0.297	0.616		1		
168720	HR 6868	0.130	0.184	4.870	7.210	8.370	2.970	5.910	9.440	0.520	7.460	0.262	M1 III	3810	...	...
1		1	0.493	5.020	4.010	4.020	3.130	1.210	1.400	5.000	0.154	0.340		1		
175865	HR 7157	-0.113	-0.064	5.670	3.290	-0.730	4.430	3.830	22.980	4.950	25.570	-0.088	M5 III	3420	...	...
1	R Lyr	1	0.425	14.640	4.340	3.760	1.070	-0.880	-0.410	4.180	0.435	0.831		1		
207076		-0.163	-0.138	6.720	1.460	-8.580	3.540	1.700	23.190	4.750	32.830	-0.129	M7 III	2750	...	...
1	EP Aqr	1	0.376	17.270	3.270	4.550	-0.890	-1.960	0.230	5.630	0.583	0.941		1		
218329	HR 8795	0.178	0.235	5.290	6.140	10.130	3.320	6.550	10.520	1.000	8.390	0.256	M1 IIIab	3810	...	...
1		1	0.474	4.840	4.320	4.660	3.510	0.980	1.440	5.740	0.148	0.341		1		
219734	HR 8860	-0.012	0.043	4.630	5.930	7.500	3.130	5.430	10.520	1.400	8.950	0.205	M2 III	3730	...	...
1		1	0.479	6.560	4.310	3.890	2.750	0.310	1.280	4.770	0.256	0.518		1		

Notes.—(1) T_e from spectral type vs. T_e relation of RJWW. (2) Parameters from Tsuji 1986. Effective temperatures are based on angular diameters from Ridgway et al. 1982. The abundances shown are actually [C/H] values. (3) Gravity and [Fe/H] from Brown et al. 1989. (4) Parameters from Smith & Lambert 1985. (5) T_e from $V-K$ via RJWW.

TABLE A2D

NEW STARS: HOT FIELD STARS

HD N_{obs}	HR	CN_1 qual	CN_2 Mg_2	Ca4227 Mg *b*	G4300 Fe5270	Fe4383 Fe5335	Ca4455 Fe5406	Fe4531 Fe5709	Fe4668 Fe5782	Hβ4681 Na5895	Fe5015 TiO_1	Mg_1 TiO_2	T_e Note	log *g* Note	[Fe/H] Note	Sp. Type
2857		-0.219	-0.151	-0.030	-2.140	-1.510	0.200	-0.260	-0.710	6.910	0.020	-0.004	7450	2.60	-1.3	A2
1		1	0.003	0.340	-0.190	0.540	0.260	0.380	0.060	1.110	0.021	-0.005	1	1	1	6
6695	HR 0328	-0.283	-0.196	-0.440	-2.840	-2.950	0.040	0.490	-0.560	8.475	0.350	-0.020	8390	4.3	...	A3 V
2		1	0.013	0.275	0.060	0.390	0.025	-0.040	-0.200	0.570	0.010	-0.011	3	3		
8424	HR 0398	-0.231	-0.142	-0.090	-2.583	-0.998	-0.201	0.337	-0.786	8.118	0.179	-0.008	8455	4.1	...	A0 Vnn
9		1	0.008	0.258	0.190	0.181	0.123	-0.016	-0.031	0.816	0.010	-0.003	3	3		
36162	HR 1832	-0.223	-0.058	1.620	-2.790	-0.430	0.220	1.100	-0.080	7.730	1.660	0.005	8260	4.28	...	A3 Vn
1		2	0.047	0.480	0.610	0.930	0.230	-0.190	0.280	1.090	-0.003	0.022	4	5		
109995		-0.272	-0.168	0.210	-3.657	-2.243	-0.123	0.137	-1.320	8.420	-0.100	-0.002	8300	3.50	-1.99	A0 V
3		1	0.005	0.450	-0.980	-0.420	-0.497	0.173	0.110	0.637	0.011	-0.002	2	2	2	6
161817		-0.228	-0.155	0.020	-2.150	-1.220	-0.060	-0.170	-0.680	6.820	0.470	0.006	7450	2.93	-1.71	A2 VI
1		1	0.032	0.930	0.240	0.000	-0.080	-0.020	0.300	1.050	0.018	-0.011	2	2	2	6
172958	HR 7030	-0.213	-0.120	-0.130	-2.560	-0.940	0.140	-0.450	-0.270	7.610	-0.410	0.007	11300	3.75	...	B8 V
1		1	0.010	-0.060	-0.160	0.100	0.230	-0.040	0.010	0.670	0.011	-0.015	3	3		
175638	HR 7141	-0.211	-0.129	0.190	-2.510	-1.830	0.530	0.840	-0.310	7.940	0.820	-0.019	8150	3.9	...	A5 V
1		1	0.015	0.110	0.350	1.010	0.310	-0.110	-0.200	0.300	-0.002	-0.016	3	3		
176301	HR 7171	-0.161	-0.085	-0.230	-2.150	0.120	0.050	-0.220	-1.040	5.810	-0.110	0.010	13100	3.5	...	B7 III-IV
1		1	0.010	-0.090	0.010	0.050	0.110	-0.010	0.090	0.550	0.014	-0.009	3	3		

NOTES.—(1) T_e, log *g*, and [Fe/H] from Danford & Lea 1981. (2) T_e, log *g*, and [Fe/H] from Adelman & Hill 1987. (3) T_e, log *g* estimated from Strömgren c_1 and β using the grids of Moon & Dworetsky 1985. (4) T_e from linear interpolation in the lower $B-V$ scale of Table 3 of Böhm-Vitense 1981. (5) Log *g* taken as the average for the spectral type (Landolt-Börnstein 1982). (6) A horizontal-branch star.

We adopt an age for the Coma cluster of 0.4 Gyr (Friel & Boesgaard 1992). We adopt an age of 0.7 Gyr for the Hyades (Friel & Boesgaard 1992). This is a change from G93, who adopted 0.2 Gyr, and it reduces the masses of the giants by 0.15 dex, to 2.3 $M_\odot$. Parenthetically, if the Hyades giants are really horizontal-branch stars, their masses need to be reduced even further due to mass loss along the first-ascent red giant branch, but this effect is minor, perhaps 0.04 dex in log *g*. We aim for gravities accurate to 0.25 dex on a star-by-star basis. Masses for dwarfs were interpolated via M_V in the VandenBerg (1985) isochrones.

The rest of the gravity calculation uses the fundamental parameters T_e, L, and M. Effective temperature was derived from broadband photometry assuming zero reddening for both clusters, and L comes from M_V. We adopt distance moduli of 3.45 and 4.95 for Hyades and Coma clusters, respectively. Bolometric corrections were taken from Johnson (1966), with the caveat that his solar BC (0.0) was adjusted to agree with that of VandenBerg (−0.12; e.g., VandenBerg 1985. Also note that $M_{V,\odot} = 4.84$, and that we adopt a solar luminosity of 3.826×10^{33} ergs s^{-1}; Allen 1973).

In Table A2B, gravities are found from the same fundamental relation, and 0.65 $M_\odot$ was adopted for all horizontal-branch stars.

For Table A2C, the M giants sometimes lack K measurements and several are also variable in V, so $V-K$ was not used to find temperatures. Instead, the effective temperature–spectral type calibration of RJWW was used.

In Table A2D, the *uvbyβ* calibration used to derive atmospheric parameters is that of Moon & Dworetsky (1985), which we adopted because it is preferred by Figueras, Torra, & Jordi (1991) and Torra et al. (1990). The grid is based on the model atmospheres of Bell & Gustafsson (e.g., Bell & Gustafsson 1989). For these stars, no effects of reddening were found in the Strömgren colors (see Crawford 1978, Table 1). The *uvbyβ* colors were taken from the homogenized catalog of Hauck & Mermilliod (1990) as it appeared on the Selected Astronomical Catalogs, Volume 1, CD-ROM distributed by the Astronomical Data Center. The rest of Table A2 needs no comment here.

In deriving effective temperatures from Johnson-Cousins broadband colors, empirical color-temperature calibrations were adopted, except for the hot horizontal-branch stars of Table A2B, for which theoretical colors from the Kurucz (1992, hereafter K92) grid were used. The empirical calibrations adopted are (1) Johnson (1966) for cool dwarfs, (2) RJWW for cool giants of all metallicities with $V-K$ values, (3) Carney (1983) for metal-poor dwarfs, (4) Saxner & Hammarbäck (1985) when only $B-V$ or $b-y$ was available for medium-temperature stars, and (5) Böhm-Vitense (1981) for stars hotter than Saxner & Hammarbäck, using the lower branch in her Figure 3, which agrees better with the hotter end of the Saxner & Hammarbäck calibration. Exceptions to these guidelines are noted in Table A2. Temperature references cited in Table A2 all use colors to determine temperature, often in a more sophisticated way than we do. Accuracy of temperatures depends strongly on the type of star considered, the accuracy of the photometry, and the adopted reddening, but an order-of-magnitude estimate for the accuracy is ~150 K. See the above references for better estimates. Systematic temperature errors should be much smaller than this, based on the agreement among calibrations in Figures 2 and 3, except for M giants, where uncertainties are large.

In Table A2, no references are given for spectral types. Spectral types come from different sources and are not meant to be homogeneous or particularly accurate, except in cases where they are used to estimate an effective temperature. The sources are the (1) the Bright Star Catalog (Hoffleit 1982), (2) J. González, private communication, (3) the Simbad database, and (4) Laird (1985). The listed spectral type of HD 111721 (G6 V, Table A2G) does not agree with its spectroscopic gravity (giant), but no other large discrepancies of this nature have been noticed.

TABLE A2E

NEW STARS: FIELD FGK DWARFS

HD N_{obs}	HR	CN_1 qual	CN_2 Mg_2	Ca4227 Mg *b*	G4300 Fe5270	Fe4383 Fe5335	Ca4455 Fe5406	Fe4531 Fe5709	Fe4668 Fe5782	Hβ4681 Na5895	Fe5015 TiO_1	Mg_1 TiO_2	T_e Note	log *g* Note	[Fe/H] Note	Sp. Type
13974	HR 0660	-0.082	-0.052	0.760	3.750	2.690	0.840	1.890	0.930	2.410	2.930	0.031	5694	4.601	-0.33	G0 V
1		1	0.132	2.590	1.980	1.530	0.840	0.530	0.390	1.680	0.017	-0.001	8	5	6	
23249	HR 1136	0.043	0.069	0.830	6.550	7.460	2.240	3.150	6.890	1.610	4.310	0.100	4820	3.86	0.02	K0+ IV
1		1	0.253	4.320	3.330	2.670	1.630	1.370	0.810	2.870	0.016	0.009	2	2	2	
43318	HR 2233	-0.079	0.004	1.395	2.985	1.855	0.905	2.155	-0.875	3.545	3.385	0.010	6069	3.777	-0.30	F6 V
2		1	0.073	1.275	1.265	0.910	0.385	0.575	0.285	0.940	0.001	-0.019	8	5	10	
69897	HR 3262	-0.110	-0.077	0.400	2.340	1.370	0.640	1.850	0.560	3.550	2.240	0.008	6156	4.152	-0.52	F6 V
1		1	0.066	1.290	1.180	0.740	0.250	0.550	0.220	0.770	0.012	-0.008	8	5	6	
82328	HR 3775	-0.116	-0.075	0.330	2.300	1.360	0.760	1.640	0.410	3.910	3.000	0.015	6314	4.014	-0.06	F6 IV
1		1	0.066	1.140	1.190	0.930	0.190	0.410	...	0.250	0.011	0.002	7	5	6	
89010	HR 4030	-0.083	-0.063	0.700	5.040	3.240	1.040	2.450	3.610	2.580	4.110	0.028	5670	3.905	-0.03	G2 IV
1		1	0.118	2.360	1.890	1.480	0.860	0.660	0.510	1.360	0.009	-0.002	7	5	12	
89449	HR 4054	-0.095	-0.057	0.500	1.880	0.700	0.930	1.820	1.680	4.310	3.970	0.007	6334	4.059	-0.02	F6 IV
1		1	0.075	1.300	2.090	1.520	0.330	0.460	0.270	1.010	0.008	-0.003	7	5	13	
114946	HR 4995	0.013	0.040	0.680	5.940	4.870	1.190	2.580	2.630	1.320	4.040	0.043	4930	3.61	-0.44	G6 V
1		1	0.149	2.660	2.640	2.030	1.430	0.980	0.760	1.340	0.013	0.010	2	2	2	
121370	HR 5235	-0.072	-0.039	0.720	4.550	3.050	1.230	2.730	3.520	3.340	4.640	0.018	6036	3.716	0.38	G0 IV
1		1	0.095	1.820	2.140	1.620	1.110	0.550	0.500	1.530	0.013	-0.005	7	5	6	
136202	HR 5694	-0.100	-0.071	0.560	3.290	2.120	0.800	2.440	1.610	3.180	3.420	0.006	6030	3.89	-0.07	F8 III-IV
1		1	0.072	1.340	1.670	1.380	0.780	0.490	0.260	1.020	0.014	-0.004	2	2	2	
137391	HR 5733	-0.169	-0.117	0.267	...	0.887	0.570	1.637	-0.353	5.777	3.650	-0.012	7190	4.14	0.28	F0 V
3		1	0.050	0.817	0.787	0.597	-0.067	0.517	0.057	1.077	0.011	-0.004	11	11	1	
148816		-0.077	-0.045	0.620	3.410	2.220	0.440	1.370	-0.010	2.380	2.200	0.003	5815	4.00	-0.72	F9 V
1		1	0.075	1.560	1.190	1.100	0.230	0.160	0.180	1.100	0.003	-0.006	3	4	4	
161797	HR 6623	0.009	0.038	0.630	5.660	4.565	1.520	3.005	6.310	2.350	5.320	0.051	5390	3.83	0.23	G5 IV
2		1	0.165	2.970	2.600	2.125	1.330	1.005	0.720	2.010	0.012	-0.001	2	2	2	
165908	HR 6775	-0.071	-0.030	0.425	2.570	0.230	0.630	2.170	1.040	2.745	3.230	0.017	5883	4.225	-0.46	F7 V
2		1	0.064	1.145	1.295	0.530	0.305	0.550	0.245	1.180	0.008	-0.005	3	5	6	
182572	HR 7373	0.011	0.049	0.790	5.970	5.110	1.830	4.120	8.650	2.870	5.470	0.053	5555	3.380	-0.41	G8 IV Hδ1
1		1	0.184	3.500	3.400	2.100	1.290	0.990	0.920	2.530	0.006	0.011	7	5	6	
190360	HR 7670	...	...	1.120	5.580	5.150	1.340	3.570	6.720	2.360	4.750	0.061	5248	3.889	0.26	G6 IV + M6 V
1		1	0.199	3.800	2.650	2.390	1.450	0.890	0.480	2.050	0.013	0.003	8	5	9	
192310	HR 7722	0.079	0.126	1.180	6.310	8.110	1.930	3.680	5.070	1.600	5.010	0.101	4966	4.50	-0.08	K0 V var
1		1	0.302	5.970	3.640	3.160	1.900	1.220	0.750	4.330	0.029	0.021	6	6	6	
200580		-0.063	-0.021	0.350	3.320	2.010	0.970	1.650	1.200	2.810	2.150	0.007	5685	4.182	-0.75	F8-9 V
1		1	0.089	1.580	1.080	0.890	0.720	0.500	0.090	1.160	0.016	0.004	7	5	6	
207978	HR 8354	-0.116	-0.075	0.160	1.640	-1.440	-0.200	1.340	-1.420	3.710	2.470	0.002	6263	4.067	-0.57	F6 IV-V
1		1	0.051	0.460	-0.050	0.000	-0.270	-0.090	0.280	0.460	0.019	0.014	8	5	6	
216385	HR 8697	-0.126	-0.089	0.210	2.010	1.190	1.160	2.520	1.570	3.590	2.880	0.000	6130	3.86	-0.33	F7 IV
1		1	0.065	1.070	1.440	0.900	-0.020	0.350	0.720	0.680	-0.009	0.010	2	2	2	

NOTES.—(1) [Fe/H] from Gustafsson & Nissen 1972. (2) Parameters from Laird 1985. (3) T_e from $(R - I)_J$ via the Appendix I fitting function of Carney 1983. (4) Peterson 1981. (5) Log *g* from Strömgren c_1 via the calibration of Laird 1985. (6) Straight mean from Cayrel de Strobel et al. 1992. (7) T_e from $V - K$ via the Appendix I fitting function of Carney 1983. (8) T_e and $b - y$ via the Appendix I fitting function of Carney 1983. (9) Hearnshaw 1974a, b; 1976a, b. (10) [Fe/H] estimated from Strömgren m_1 via calibration of Laird 1985. (11) T_e and log *g* from Malagnini & Morossi 1990. (12) [Fe/H] from Cayrel de Strobel et al. 1981. (13) [Fe/H] from Herbig & Wolff 1966.

TABLE A2F

NEW STARS: SUPERGIANTS

HD N_{obs}	HR	CN_1 qual	CN_2 Mg_2	Ca4227 Mg *b*	G4300 Fe5270	Fe4383 Fe5335	Ca4455 Fe5406	Fe4531 Fe5709	Fe4668 Fe5782	Hβ4681 Na5895	Fe5015 TiO_1	Mg_1 TiO_2	T_e Note	log *g* Note	[Fe/H] Note	Sp. Type
7927	HR 0382	-0.055	-0.010	-0.370	2.370	4.370	-0.660	0.740	-0.880	4.300	2.870	-0.024	7300	0.40	...	F0 Ia
1		1	0.053	0.960	1.640	-0.440	-0.230	0.370	0.550	2.100	0.023	0.003	4	4		
17378	HR 0825	-0.075	-0.024	-0.220	1.030	2.490	-0.460	0.650	-1.310	3.270	0.870	-0.001	8530	1.35	...	A5 Ia
1		1	0.040	0.940	0.080	0.270	-0.240	0.390	0.710	2.240	0.031	-0.005	5	5		
18391		0.033	0.049	-0.240	6.700	6.060	1.720	5.630	2.940	3.070	11.590	0.047	5500	0.00	-0.25	G0 Ia
1		1	0.144	-0.100	3.860	3.340	0.930	1.080	0.790	2.810	0.027	0.029	1	1	1	
20041	HR 0964	-0.058	-0.022	-0.330	-0.390	-0.170	-0.650	-0.010	-0.630	2.220	-0.080	0.001	9560	2.13	...	A0 Ia
1		1	0.015	-0.090	-0.220	0.040	-0.310	0.450	0.510	1.350	0.026	-0.003	6	3		
39970	HR 2074	-0.073	-0.035	0.290	-0.560	0.710	-0.200	-0.400	-0.950	1.860	-0.340	-0.002	6410	1.43	...	A0 Ia
1		1	0.011	-0.100	0.110	-0.290	-0.130	0.210	0.610	1.260	0.014	-0.005	2	3		
41117	HR 2135	-0.036	-0.017	-0.333	-0.937	-0.110	-0.493	-0.860	0.067	0.307	1.407	-0.016	17460	2.70	...	B2 Iave
3		1	-0.004	0.140	-0.183	0.227	-0.330	-0.035	0.523	0.577	0.010	-0.009	7	7		
163506	HR 6685	-0.065	-0.013	0.210	0.910	2.870	0.290	1.250	-0.230	3.790	3.080	-0.015	6400	1.20	-0.41	F2 Ibe
1		1	0.040	0.660	0.880	0.490	0.080	0.020	0.010	2.080	0.009	-0.033	8	8	8	
185859	HR 7482	-0.078	-0.062	-0.050	-0.700	0.630	0.770	-0.060	1.800	1.820	0.490	-0.009	21860	2.80	...	B0.5 Iae
1		1	-0.002	-0.180	0.130	-0.160	0.010	0.250	0.270	...	0.014	-0.003	9	3		
188727	HR 7609	0.060	0.091	0.290	6.390	4.390	2.320	4.220	4.390	2.740	8.970	0.041	5690	1.67	0.0	G5 Ib var
1		1	0.088	0.020	2.700	2.430	1.340	1.590	0.800	1.350	0.020	0.007	10	10	11	
190603	HR 7678	-0.073	-0.079	-0.240	-1.130	0.590	0.200	0.090	-0.750	0.280	1.570	-0.008	18800	2.41	...	B1.5 Iae
1		1	0.004	-0.550	-0.030	0.220	0.050	0.110	0.390	0.800	0.012	...	5	5		
195593	HR 7847	-0.093	-0.056	0.220	1.670	2.600	0.700	2.410	-0.270	4.470	5.870	0.009	6600	1.95	0.12	F5 Iab
1		1	0.061	0.040	2.030	1.500	0.760	0.600	0.150	1.260	0.007	-0.007	12	12	12	
198478	HR 7977	-0.052	-0.036	-0.170	-0.880	0.110	-0.460	-0.650	-0.610	0.760	1.590	-0.005	14900	2.19	...	B3 Iae
1		1	0.005	-0.400	-0.160	0.020	-0.150	0.160	0.290	0.270	0.011	-0.007	5	5		
199478	HR 8020	-0.051	-0.036	0.010	-0.910	-0.890	-0.730	0.540	-0.540	0.530	0.460	0.005	11200	1.90	...	B8 Iae
1		1	0.005	0.040	-0.100	-0.090	-0.210	0.190	0.130	1.160	0.012	-0.006	13	13		
207260	HR 8334	-0.074	-0.033	-0.090	-0.410	0.240	-0.730	0.050	-1.720	2.800	0.620	-0.008	9450	2.09	...	A2 Ia
1		1	0.023	0.310	-0.240	0.340	-0.130	0.360	0.500	0.790	0.017	0.006	6	3		
213470		-0.081	-0.036	0.290	0.070	1.460	-0.500	0.240	-1.570	3.380	1.090	-0.009	5850	1.38	...	A3 Ia
1		1	0.018	-0.120	0.410	0.130	-0.020	0.370	0.530	1.690	0.034	0.008	2	3		
217476	HR 8752	0.090	0.116	-0.480	6.260	6.980	1.200	5.100	1.070	3.600	10.560	0.029	...	...	...	G4 Ia
1		1	0.129	0.470	3.400	2.620	0.060	0.570	0.360	3.670	0.031	0.014				

NOTE.—HR 8752 is well studied, but we list no parameters for this superluminous star because of its apparent long-term variability. HR 2135, 7482, 7678, and 7977 were not used in deriving fitting functions because they are too hot for the temperature range considered.

NOTES.—(1) Parameters from Luck & Bond 1982. (2) T_e from linear interpolation in table 4 of Böhm-Vitense 1981. (3) Average log *g* as a function of spectral type from Landolt-Börnstein 1982. (4) T_e and log *g* from Ferro et al. 1988. (5) T_e and log $L/L_\odot$ from de Jager, Nieuwenhuijzen, & van der Hucht 1988. Mass estimated from the evolutionary tracks of Schaller et al. 1992 to derive log *g*. (6) From spectral-type, $B-V$ relation of Landolt-Börnstein 1982 and the temperature scale of Böhm-Vitense 1981. (7) T_e and a distance estimate from Underhill et al. 1979. With a color excess of $E(B-V) = 0.51$ (Greenberg & Chlewicki 1983) we derive an absolute magnitude of -7.48. With a bolometric correction from Johnson 1966 adjusted to VandenBerg's scale, we derive an absolute luminosity. Surface gravity follows from an estimate of the evolutionary mass via Schaller et al. 1992 of 17 $M_\odot$. (8) Luck, Bond, & Lambert 1990. (9) T_e from Gulati, Malagnini, & Morossi 1989. (10) Average of parameters from Fernley, Skillen, & Jameson 1989. (11) Klochkova & Panchuk 1991. (12) Log *g* and [Fe/H] from Eggen 1991. T_e determined from c_1 and β. (13) T_e and log *g* from Leitherer & Wolf 1984.

TABLE A2G

NEW STARS: FIELD GK GIANTS

HD N_{obs}	HR	CN_1 qual	CN_2 Mg_2	Ca4227 Mg *b*	G4300 Fe5270	Fe4383 Fe5335	Ca4455 Fe5406	Fe4531 Fe5709	Fe4668 Fe5782	Hβ4681 Na5895	Fe5015 TiO_1	Mg_1 TiO_2	$(R-I)_J$ Note	T_e Note	log *g* Note	[Fe/H] Note	Sp. Type
2665		-0.072	-0.051	0.170	5.230	1.030	0.380	1.060	0.190	0.880	1.640	-0.010	...	5000	2.50	-2.00	G5 III
1		1	0.015	0.320	0.740	0.160	0.210	0.370	0.270	1.090	0.002	...		6	6	6	
41636	HR 2153	0.119	0.164	1.170	6.430	5.850	1.680	3.990	6.210	1.520	6.200	0.109	...	4690	2.50	-0.16	G9 III
1		1	0.227	3.010	3.130	2.920	1.990	1.240	1.200	1.750	0.013	...		2	2	2	
111721		-0.058	-0.050	0.290	5.830	2.330	0.260	1.590	-0.400	1.050	2.580	0.012	0.47	5103	2.87	-1.10	G6 V
1		1	0.061	1.140	1.470	1.030	0.790	0.310	0.280	0.620	0.012	0.001	5	5	5	5	
120452	HR 5196	0.273	0.339	0.625	5.845	7.500	2.325	3.535	7.150	1.740	6.315	0.093	0.50	4760	2.60	0.03	K0.5 III-IIIb
1		1	0.192	2.240	2.965	2.685	2.060	1.310	0.740	2.725	0.009	0.031	4	2	2	2	
125454	HR 5366	0.164	0.196	0.327	6.020	5.580	1.650	3.747	5.610	1.490	5.903	0.057	0.51	4775	2.50	-0.10	G9 III
3		1	0.164	2.427	2.983	2.580	1.683	1.243	0.695	2.313	0.011	0.020	4	2	2	2	
232078		0.079	0.129	1.177	6.317	3.723	1.540	3.877	1.840	0.660	4.940	0.103	0.82	4000	0.40	-1.60	K4-5 III-II
3		1	0.188	1.743	2.630	1.930	1.270	0.847	0.890	1.980	0.038	0.063	3	1	1	1	

NOTES.—(1) Leep & Wallerstein 1981. (2) Brown et al. 1989. (3) Lanz 1986. (4) Hoffleit 1982. (5) Gratton & Sneden 1991. (6) Gilroy et al. 1988.

TABLE A2H

NEW STARS: STARS WITHOUT ATMOSPHERIC PARAMETERS

HD	Name	CN_1	CN_2	Ca4227	G4300	Fe4383	Ca4455	Fe4531	Fe4668	Hβ4681	Fe5015	Mg_1	Sp. Type
N_{obs}	BD	qual	Mg_2	Mg *b*	Fe5270	Fe5335	Fe5406	Fe5709	Fe5782	Na5895	TiO_1	TiO_2	
4744		0.098	0.142	1.850	6.540	7.120	2.240	3.380	4.640	0.950	5.370	0.159	G8 IV
1		1	0.293	3.850	2.800	2.810	1.670	1.360	0.960	2.620	0.020	0.047	
30021	HR 1506	0.099	0.153	1.360	5.330	5.290	1.690	3.900	5.630	1.570	6.360	0.048	G8 III
1		1	0.174	2.930	2.870	2.740	1.460	1.370	0.630	2.600	0.004	...	
67767	HR 3191	0.035	0.070	0.790	5.650	4.790	1.210	3.180	3.950	1.750	4.350	0.037	G7 V
1		1	0.168	3.430	2.420	2.620	1.410	0.900	0.670	1.930	0.018	-0.003	
100030	HR 4435	0.039	0.052	0.960	5.955	4.595	1.315	3.270	3.950	1.475	4.710	0.045	G9 IV
1		1	0.146	2.470	2.260	1.900	1.195	0.860	0.555	1.475	0.008	-0.004	
172401		0.274	0.312	0.313	6.327	6.103	1.987	3.687	7.843	1.723	7.110	0.055	K0 III
3		1	0.163	2.430	3.380	2.730	1.817	1.373	1.170	2.640	0.015	0.015	
196755	HR 7896	...	...	0.920	5.030	4.260	1.310	3.200	4.200	2.350	4.390	0.033	G5 IV + K2 IV
1		1	0.114	2.110	1.950	1.790	1.020	0.770	0.380	1.300	0.011	0.008	
211038		0.043	0.086	1.340	5.530	6.040	1.460	2.880	5.700	1.090	4.470	0.090	G8 V
1		1	0.242	4.620	2.630	2.040	1.490	0.950	0.640	1.990	0.017	0.009	
218527	HR 8807	0.015	0.047	-0.050	6.240	4.080	0.950	2.830	3.670	1.710	5.350	0.035	G8 III-IV
1		1	0.124	2.050	1.920	2.200	1.110	1.060	0.910	1.950	0.015	0.021	
	DSA 94-168	0.057	0.077	1.035	6.545	6.430	1.755	2.980	4.570	1.185	4.775	0.076	K2
2		1	0.209	3.970	3.110	2.770	1.530	1.190	0.805	2.535	0.000	0.007	
	DSA 94-188	-0.011	0.039	4.025	5.740	8.340	2.575	4.355	2.775	0.525	5.320	0.236	G5
2		1	0.486	7.135	3.800	3.640	2.510	1.235	0.760	4.625	0.005	0.002	
	DSA 94-251	0.168	0.212	2.077	6.187	7.533	2.210	3.950	6.927	0.753	5.963	0.158	K2
3		1	0.324	4.513	3.757	3.150	2.077	1.300	1.183	3.250	0.008	0.031	
	DSA 94-300	0.242	0.286	1.190	6.060	7.740	1.970	3.450	8.080	1.645	5.890	0.116	K2
2		1	0.277	4.435	3.705	3.300	2.160	1.305	1.080	3.775	0.016	0.013	
	DSA 99-14	-0.028	...	0.630	6.035	4.625	0.975	3.320	2.610	1.280	4.145	0.031	G–K
2		1	0.137	2.780	2.505	1.410	0.995	1.135	0.400	1.320	0.022	-0.001	
	DSA 99-250	0.029	0.052	0.650	7.360	5.600	1.850	3.040	2.110	1.890	3.620	0.039	G3
1		1	0.113	1.600	2.180	1.650	0.810	0.600	...	0.980	0.026	0.011	
	DSA 99-288	0.140	0.186	1.000	6.830	7.770	2.090	3.240	5.410	1.540	6.210	0.083	K3
1		1	0.222	3.680	3.560	3.120	2.310	1.470	...	2.680	0.013	0.023	
	DSA 99-362	0.241	0.285	1.115	6.600	8.115	2.135	3.575	6.970	1.285	6.225	0.101	K2
2		1	0.242	3.665	3.470	3.180	2.195	1.290	0.830	2.830	0.021	0.024	
	DSA 103-95	0.238	0.277	1.850	6.050	8.280	2.040	3.390	8.690	1.230	5.440	0.125	gG8
1		1	0.282	4.030	4.040	4.070	2.450	1.280	1.320	2.750	0.004	0.033	
	DSA 103-194	-0.033	-0.005	1.130	5.080	4.730	1.150	2.870	4.170	2.980	3.480	0.003	G7
1		1	0.141	3.190	2.250	2.830	1.160	0.620	0.710	1.750	0.004	0.008	
	DSA 103-526	0.197	0.238	0.290	6.910	6.280	1.730	3.530	6.620	1.530	5.620	0.079	g:G8
1	BD+00 2862	1	0.183	2.760	3.140	3.170	1.820	1.160	0.960	2.010	0.011	0.014	
	DSA 103-646	-0.059	-0.026	0.980	5.190	4.480	1.180	2.350	3.550	2.560	3.960	0.009	G5
1		1	0.141	3.520	2.700	2.130	1.320	0.800	0.640	1.820	0.003	0.004	
	DSA 107-442	0.277	0.329	1.650	6.585	7.940	2.420	4.515	8.710	1.000	7.140	0.148	gG8
2		1	0.292	3.850	3.855	3.590	2.385	1.630	1.470	3.365	0.016	0.040	
	DSA 107-484	0.286	0.336	1.450	6.710	8.395	2.355	4.555	8.765	0.855	6.425	0.158	g:G8
2		1	0.310	4.280	3.725	3.515	2.400	1.515	1.200	3.595	0.010	0.033	
	DSA 107-609	0.107	0.148	0.750	6.420	5.955	1.735	3.480	4.650	1.130	5.350	0.075	g:G4
2	BD+00 3388	1	0.196	3.220	3.025	2.655	1.735	1.205	0.940	2.290	0.009	0.021	
	DSA 110-507	0.130	0.178	0.893	5.793	6.560	1.813	3.213	10.157	2.353	6.260	0.091	
3		1	0.219	3.693	3.363	2.703	1.210	1.433	1.027	3.753	0.016	0.007	
	DSA 113-259	0.287	0.334	1.056	6.798	7.748	2.114	4.076	8.918	1.140	6.810	0.142	K
5		1	0.276	3.880	3.490	3.090	2.208	1.538	1.212	3.118	0.022	0.032	
	DSA 113-475	0.104	0.145	0.720	7.018	5.815	1.762	3.768	4.995	1.192	5.428	0.075	G5
4		1	0.191	3.128	2.848	2.092	1.485	1.218	0.903	2.512	0.011	0.020	
	DSA 114-670	0.197	0.244	1.727	6.230	8.107	2.430	4.010	7.447	1.000	6.140	0.128	g::K5
3		1	0.284	4.000	3.790	2.963	2.333	1.570	1.230	3.057	0.012	0.036	
237809	SAO 027250	-0.091	-0.060	0.330	2.825	1.570	0.445	1.930	1.055	3.195	2.540	0.012	G5
2		1	0.078	1.280	0.805	1.060	0.525	0.450	0.125	0.625	0.009	0.014	
091739	SAO 099192	-0.112	-0.071	0.342	2.158	0.925	0.610	1.880	1.582	3.748	3.230	0.013	G0
4		1	0.070	1.090	1.352	1.252	0.650	0.455	0.285	0.830	0.003	0.002	
	SAO 099632	-0.099	-0.059	0.412	1.876	0.788	0.586	1.936	1.144	3.850	2.956	0.009	F8
5	BD+20 2610	1	0.071	1.272	1.312	1.138	0.522	0.414	0.406	0.778	0.015	...	
108549	SAO 100111	-0.078	-0.052	0.872	4.750	3.620	0.960	2.152	1.878	2.752	3.070	-0.001	G5
4		1	0.120	2.950	1.822	1.678	0.835	0.642	0.322	0.918	0.016	-0.002	
	SAO 100199	-0.099	-0.058	0.295	2.640	0.890	0.605	1.745	1.115	3.610	3.435	0.007	F7
2	BD+14 2530	1	0.071	1.385	1.245	0.790	0.840	0.475	0.125	0.690	0.012	0.001	
	SAO 119387	-0.021	0.014	1.810	5.150	5.955	1.585	3.640	3.910	1.375	4.475	0.034	K0
2	BD+06 2610	1	0.223	4.635	2.805	2.945	1.835	0.765	0.820	2.335	0.012	0.002	
	SAO 119458	-0.041	-0.012	0.380	4.725	3.890	1.335	3.005	5.170	3.240	5.275	0.030	G0
2	BD+08 2613	1	0.125	2.075	2.315	1.760	1.100	0.975	0.695	1.500	0.015	0.003	
	SAO 137138	0.269	0.304	0.945	6.815	7.395	2.040	3.750	7.910	1.140	6.645	0.097	G5
2	BD-03 2777	1	0.227	3.155	3.355	3.110	2.200	1.365	1.165	2.730	0.008	0.022	
	SAO 137330	0.017	0.049	1.445	5.975	7.195	1.735	2.875	5.835	1.395	4.700	0.086	G8
2	BD-03 2844	1	0.262	4.550	2.980	2.380	1.605	1.595	0.770	2.775	0.012	0.011	

TABLE A3

GENERAL GLOBULAR CLUSTER PARAMETERS AND BIBLIOGRAPHIC SOURCES

Cluster	$(m-M)_V$	$E(B-V)$	[Fe/H]	Age	Photometry
M5	14.40	0.03	-1.30	15 Gyr	8
	3	4	1	3	
M92	14.60	0.02	-2.20	18 Gyr	9
	3	4	5	3	
NGC 6171	14.60	0.31	-0.99	15 Gyr	10
	6	6	7	2	

NOTES.—(1) [Fe/H] for M5 is the mean of those values listed in Burstein et al. 1986. (2) The age for NGC 6171 = M107 is typical among halo globulars (Ferraro et al. 1991). (3) VandenBerg 1983. (4) Burstein & McDonald 1975. (5) Kraft 1979. (6) Zinn 1985. (7) Zinn & West 1984. (8) Photometry from Buonanno, Corsi, & Fusi Pecci 1981. (9) Photometry from Buonanno et al. 1983. (10) Photometry from Dickens & Rolland 1972.

TABLE A4

SUPPLEMENTAL MEASUREMENTS FOR PUBLISHED STARS

Star Name	CN_1	Mg_1	Mg_2	Mg b	TiO_1	TiO_2
M92 IX-12	-0.131	...	...	...	...	...
HD 144872	...	...	...	...	...	0.005
HD 193901	-0.018	...	...	...	...	...
HD 201626[1]	...	0.239	0.140	0.480	...	-0.022
HR 4287	...	...	...	...	0.000	...
HR 5270	...	...	...	...	...	-0.004

[1] Some indices for this CH star (Ca4455, Mg_2, Mg b) have uncertainties about twice their Table 1 value owing to sharp spectral discontinuities (C_2 bandheads, also found in the TiO index) within index bands, which is why these indices were not included in Faber et al. 1985. This star was not used in deriving fitting functions.

TABLE A5

ATMOSPHERIC PARAMETERS: MODIFICATIONS TO G93 PARAMETERS

Star Name	Star Name	Star Name	[Fe/H]	log g
HR 1292	HD 26462	Hya vB 14	0.13	4.122
			2	1
HR 1346	HD 27371	Hya vB 28	0.13	2.600
			2	5
HR 1373	HD 27697	Hya vB 41	0.13	2.645
			2	5
HR 1411	HD 28307	Hya vB 71	0.13	2.690
			2	5
HR 5634	HD 134083		0.05	4.376
			3	1
HR 6315	HD 153597		-0.16	4.420
			4	1

NOTES.—(1) Log g from c_1 photometry via the calibration of Laird 1985. (2) [Fe/H] for the Hyades from Boesgaard & Friel 1990. This is 0.02 dex less than was adopted by G93. (3) [Fe/H] a straight mean from Cayrel de Strobel et al. 1992. (4) [Fe/H] estimated from Strömgren m_1 as in Laird 1985. (5) Log g estimated with a better estimate for the mass of these Hyades giants (see Appendix text).

Table A3 lists the globular cluster parameters adopted for the horizontal branch stars in Table A2B. We refer the reader to Table 4 of G93 for information about other clusters.

We remeasured the 11 old indices in the published stars for this paper. When we compared old versus new indices, we discovered a few measurements that are perfectly valid, but were missed in the original papers. The indices and some reasons for noninclusion are listed in Table A4. The other reason seems to be bookkeeping errors.

Table A5 contains additions or modifications to the atmospheric parameters of G93. Other changes of note are: (1) The Hyades metallicity was revised from +0.15 to +0.13 (Boesgaard & Friel 1990). (2) The Hyades age was changed from 0.2 to 0.7 Gyr (Friel & Boesgaard 1992). (3) Because the metallicity of the Hyades was revised, the metallicity of NGC 7789 was dropped 0.02 dex, since its metallicity was given in terms of that of the Hyades (Twarog & Tyson 1985).

The entire collection of 21 indices for 460 stars and all derived atmospheric parameters is available in computer-readable form from the NSS-DCA Astronomical Data Center (adcrequest@nssdca.gsfc.nasa.gov), from G. W. (worthey@astro.lsa.umich.edu), and on the AAS CD-ROM (vol. 3).

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