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YOUNG, HIGH-VELOCITY A STARS. I. ROTATIONAL VELOCITIES AND A CATALOG OF EARLY-TYPE STARS AT THE SOUTH GALACTIC POLE

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ABSTRACT

A number of high-velocity A stars at the South Galactic Pole (SGP), at distances of 1 to more than 4 kpc from the plane, were shown by Rodgers, Harding, and Sadler to be Population I stars, with calcium abundances of one-third solar to solar metallicity and a velocity dispersion perpendicular to the plane of 66 km s^{-1}. This combination of properties is unique among Galactic stellar populations.

To further explore theories of their origin, the stars were reobserved at higher resolution. The sample was augmented from a catalog, compiled from many sources, of all known early-type stars (305 to 15th magnitude) in 218 deg^2 at the SGP. Strömgren photometry, Hδ line widths, radial velocities and calcium abundances are tabulated for about 200 of the early-type stars. Rotational velocities ($v \sin i$) for eight distant stars were obtained. Their $v \sin i$ values are typical of normal young A stars.

Subject headings: radial velocities — stars: abundances — stars: early-type — stars: high-velocity — stars: rotation

I. INTRODUCTION

a) *Observations of* A *Stars*

In 1971 Rodgers published a study of 54 A stars between 12th and 15th magnitude in the region of the South Galactic Pole (SGP). He found that 21 of these stars appeared to be of near-solar calcium composition, yet they were at distances of more than 1 kpc from the disk, with a radial velocity dispersion (perpendicular to the plane) of 66 km s^{-1}. This was quite unexpected, because stars observed at large distances from the disk were usually considered to be members of an old metal-poor population formed during the early stages of Galactic evolution (Eggen, Lynden-Bell, and Sandage 1962). Some previous studies had indicated the presence of a few apparently young A stars up to a kiloparsec from the plane, with an exponential scale height many times that of normal disk A stars (Sargent and Searle 1968; Perry 1969), but Eggen (1969) had suggested that these stars were actually old disk blue stragglers. Philip (1974) observed A stars with the Strömgren *uvby* system in part of the SGP area surveyed by Rodgers (1971) and found that the surface gravities of some of the stars, derived from the Strömgren c_1 index, were entirely normal for main-sequence (MS) A stars. (See also Relyea, Matlock, and Philip 1975).

Greenstein and Sargent (1974), in a study of 189 faint blue halo stars within 30° of the Galactic poles, found that 26% of the sample had the high rotational velocities of metal-line strengths typical of normal, young, MS B stars. This group had a radial velocity dispersion of 63 km s^{-1} (for 45 stars, excluding several that they indicated might actually be Population II stars), similar to Rodgers's result of 66 km s^{-1}. Other workers have reported apparently MS OB stars far from the Galactic plane (Tobin and Kilkenny 1981; Tobin and Kaufmann 1984). Tobin (1986) and Keenan, Brown, and Lennon (1986) used high-dispersion and *IUE* spectra to show that the stars have Population I metal abundances and are indistinguishable from young disk stars.

Rodgers, Harding, and Sadler (1981, hereafter RHS) acquired flux-calibrated spectra and medium- and high-resolution spectra of some of the SGP A stars. Three of the later-type A stars were photometrically monitored to explore the possibility that metal-rich RR Lyrae stars had been included in the sample, but periodic light variations were not observed. Surface gravities and temperatures were derived from comparisons with Kurucz (1979) models and were found to be normal Population I values.

The distances of 19 Population I stars were found to range from 1 to over 4 kpc from the plane. The MS lifetimes listed by RHS were overestimated by a factor of 2 due to an error in the calibration, but even on that scale their ages are still not long enough for normal disk dispersive mechanisms to scatter the stars so far from the plane. Young A stars have a W velocity dispersion (perpendicular to the plane) of 9 km s^{-1} and MS lifetimes of less than 1.2 Gyr, yet it would take at least a 5 Gyr period for their W dispersion to grow to even 21 km s^{-1} (Mihalas and Binney 1981). This is still significantly smaller than Rodgers's W value of 66 km s^{-1}, which is similar to that found for thick disk stars (40 km s^{-1}) or halo stars (60–120 km s^{-1}).

The RHS calcium abundances are also unusual, ranging from one-third of the Population I metallicity to normal Population I values (−0.5–0.0 dex). Young A stars usually have abundances from −0.1–0.2 dex. The age-metallicity distribution for disk stars formed over the last 15 Gyr (Twarog 1980) shows that abundances as low as −0.5 are usually observed only in late-type disk dwarfs formed more than 9 Gyr ago. No Population I MS A star could possibly be that old. Although the kinematics of the A stars are similar to those of thick disk or halo stars, the lower than normal abundances of the A stars are still greater than those of thick disk stars (-0.9 to -0.3 dex) or halo stars (less than -0.9 dex). In sum, within the framework of the standard picture of galactic evolution, not one of the three descriptive parameters of age, abundance, or kinematics is consistent with any other. According to RHS, the velocities of the distant A stars are characteristic of the oldest stellar populations; their abundances are intermediate; yet they are young, possibly coeval, stars.

Stetson (1981*a*, *b*, 1983) found high-velocity A and F stars in the Solar neighborhood and concluded that the "evidence strongly favors the existence of main-sequence A stars with abnormally large space motions." His stars had a radial velocity dispersion of 57 km s^{-1}. Pier (1983) studied halo AB stars. Some of Rodgers's SGP A stars were included in his analysis. He found generally good agreement with Rodgers's abundances are gravities, but disagreed with some of the radial velocities (see § II*b* for discussion of radial velocity results). Hartkopf and Yoss (1982) reported a kinematic and abundance survey of G and K giants at the Galactic poles. Out of 83 giants at distances of from 1 to 5 kpc from the plane, 26 were found to be metal rich, using a criterion equivalent to RHS's abundance range of -0.5–0.0 dex. Hartkopf and Yoss suggested that their metal-rich giants may be recent descendants of the high-velocity A stars.

Note that although primarily A stars are discussed in this work, this does not imply that *only* A stars are involved—Stetson (1981*a*) found high-velocity F as well as A stars (although some low-abundance, high-velocity F stars may be explicable as simply old or thick disk stars). However, the usual result of a star-forming event is a range of stellar masses. MS stars of lower mass than A stars presumably also exist at large distances from the plane, but are simply too faint to have been observed in the above studies.

b) *Possible Origins of the* A *Stars*

There have been several hypotheses proposed to account for the distant A stars. Generally they fall into three categories:

1. *They are misidentified evolved or abnormal stars*, such as blue horizontal-branch (HB) stars or blue stragglers.
2. *They are randomly accelerated young disk stars*, the result of normal energetic Galactic processes such as supernova bubbles, galactic fountains, cloudlet-cloudlet collisions in the halo, black hole encounters, supernova explosions in close binary systems, or ejections from young associations by binary interactions.
3. *They are the results of an unusual and recent event*: they were formed from a mixture of Galactic gas and lower abundance, high-velocity gas accreted during the merger of a small satellite galaxy with the Milky Way.

Hypotheses of the first type are possible because in the same spectral range as MS A stars also occur stars of quite different evolutionary histories, such as blue HB stars and blue stragglers. HB stars are often high-velocity stars, with greater luminosities and lower gravities (2.9–3.6 dex) than most MS A stars. At higher temperatures HB gravities increase until the HB overlaps the late B main sequence. For very early A stars, the distinctive abundance indicator of the Ca II K line at 3933 Å falls to a fraction of an angstrom in equivalent width, so for some early (intermediate gravity) A spectra it may be difficult to distinguish between young and evolved stars. Figure 1 is a plot in the gravity-temperature plane of the HB and MS loci and some representative evolutionary mass tracks. HB stars rotate at very low velocities, usually less than 30 km s^{-1}. The mean $v \sin i$ for a sample of 33 blue HB stars from five globular clusters is only 13 km s^{-1} (Peterson 1985).

Blue HB stars usually show abundances ≤ -1.0, but among redder stars in the HB instability strip (from $b-y$ around 0.15–0.30) are found old disk RR Lyrae stars of type *c*. They are thought to be post–red-giant–branch descendants of relatively metal-rich old disk stars. Theoretically, a very restricted mass range of these stars could evolve to the HB blueward of the instability strip (Taam, Kraft, and Suntzeff 1976), where normally only metal-poor stars would be seen. Blue HB analogs of the metal-rich RR Lyraes might explain the A star abundances, but a companion population of metal-rich RR Lyraes would then be expected to occur in the same field, and RHS showed that there are no photometric variables among the later-type metal-rich A stars at the SGP. Another difficulty with this suggestion is that even if all the high-velocity A stars were to be derived from such a population, they would still only have a radial velocity dispersion appropriate to the old disk, which is less than half of the A star dispersion of over 60 km s^{-1}.

To segregate members of a group of A stars into MS and HB stars is not a trivial operation. Statistically, given a large sample of A stars, the majority of lower gravity stars will be HB, and higher gravity ones will be MS. However, the luminosity of a star on the HB is very sensitive to variations in helium abundance and core mass (Sweigart and Gross 1976), so the HB for field stars may be broad, and low–core-mass stars may appear in the intermediate gravity range. More importantly, it must be recognized that the normal evolutionary path of a young A star between the MS and the base of the red giant branch (RGB) passes through the gravity-temperature range occupied by the HB (Fig. 1). For early A stars, around 10% of this total dwarf-to-subgiant evolutionary stage can occur at gravities as low as 3.4–3.8 dex (Iben 1967). For this reason, studies that utilize photometric gravity indices alone (e.g., Philip 1974) as their MS/HB criteria will lead to misclassifications for specific stars. For accuracy it is *essential* that an additional criterion, like abundance, be utilized. Such an indicator is the Ca II K line equivalent width W(K), which correlates well with overall metallicity, except in the case of Am stars. These show low calcium abundances typical of stars several spectral types earlier than that indicated by their other metal lines, but they are easily recognized from m_1 indices, gravities, and spectral appearance.

The other group of A stars, the blue stragglers, are observed near the upper MS of galactic (and some globular) clusters and "straggle" relative to the other cluster stars (presumed coeval), which have evolved to the red giant branch. Blue stragglers appear to have extended main-sequence lifetimes, perhaps from mass transfer from a companion or from some mixing mechanism that could supply hydrogen for a longer period of core burning. Longer MS lifetimes mean that

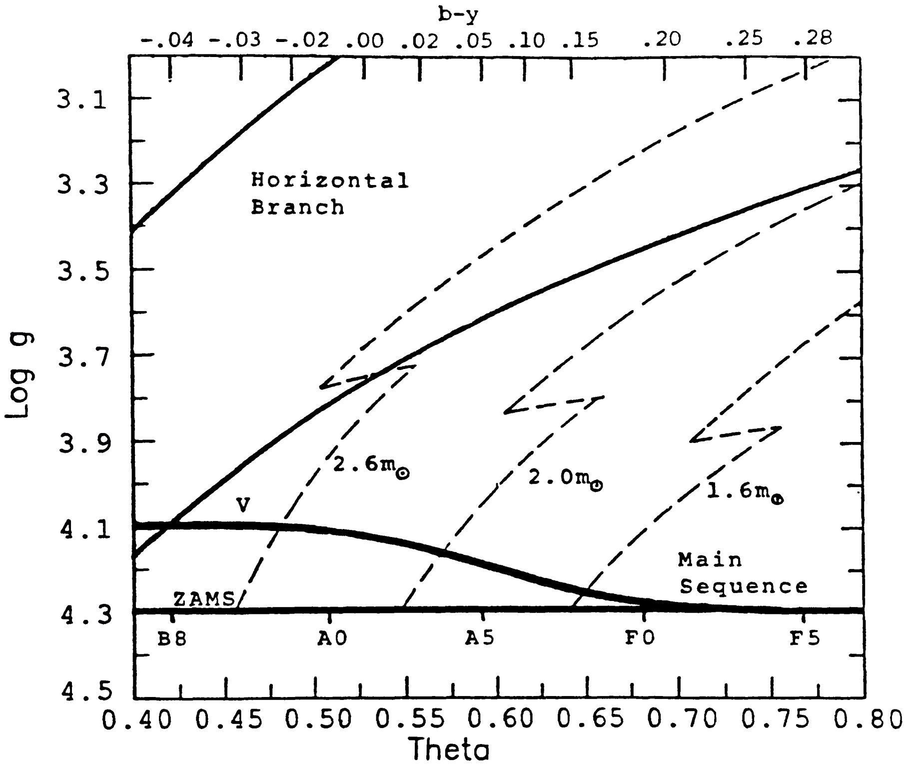

FIG. 1.—Log gravity against $\Theta_{\rm eff}$ (5040/effective temperature) for A stars. The main sequence (Allen 1973) is shown for the ZAMS and class V. The extent of the horizontal branch is from Greenstein and Sargent (1974) and Newell, Rodgers, and Searle (1969). Three evolutionary mass tracks are shown, for 2.6, 2.0, and 1.6 solar masses (Green, Demarque, and King 1987). The $b - y$ colours for gravity of 4.0 dex, along top axis, are from Kurucz (1979).

blue stragglers may gain a larger *W* velocity dispersion from disk dispersive mechanisms (Wielen 1977). Any blue stragglers that might occur in the field would appear to be normal young A stars. Compared to the SGP A stars, blue stragglers from the old disk have a similar range of metallicities, but their *W* velocity dispersion (20–30 km s^{-1}) is significantly lower. Thick disk blue stragglers have similar kinematics to the A stars, but their abundances are lower. However, these restraints might disappear if either or both of the RHS abundances or kinematics were to be in error.

There is some evidence that blue stragglers may rotate at lower velocities than normal stars of the same spectral type. Main-sequence A stars have a large range of rotational velocities, generally between 50 and 250 km s^{-1}. To examine the distribution of $v \sin i$ with spectral class, all the values of A stars with luminosity class V, Am, or Ap classifications from the Uesugi and Fukuda (1970) $v \sin i$ catalog were tabulated (904 stars).

Slettebak *et al.* (1975), in a major calibration of standard stars for $v \sin i$ determinations, found that previous values had been measured at round 5% too high. García and Levato (1984) quantified the derivation of new $v \sin i$ from old measurements and found for A and F stars

$$v \sin i_{(\rm new)} = 0.92\left[v \sin i_{(\rm old)}\right] - 2.0 \text{ km s}^{-1}. \qquad (1)$$

The Uesugi and Fukuda results were converted to the new system with equation (1). Table 1 shows the total number, mean, and standard deviation of the $v \sin i$ values in each group. The relative percentage of stars, in bins of rotational velocity as a function of spectral type, is shown in Figure 2. It appears that most class V A stars rotate faster than 70 km s^{-1}, but that the majority of Am and Ap stars rotate at less than 70 km s^{-1}.

Mermilliod (1982) shows that most young clusters contain blue stragglers, of which over 60% in the spectral range B3 to A2 (Abt 1985) are magnetic (Bp and Ap) stars. Out of 13 blue stragglers, Abt finds rotational velocities of less than 50 km s^{-1} for all but one star. Among later A stars, the only available data is on blue stragglers in the open cluster M67. Peterson, Carney, and Latham (1984) find values of 120, 70, 65, and less than 10 km s^{-1} for four mid-to-late A blue stragglers. Deutch (1966, 1968) also found values of 50–100 km s^{-1} for seven of the brightest M67 blue stragglers. Peterson, Carney, and Latham (1984) conclude that the M67 blue stragglers appear to be rotating more slowly than average. However, since the M67 values are not significantly different from the lower range of MS A stars for their spectral types (the star at 10 km s^{-1} is an Am type), it cannot be concluded that slow rotation will be as distinctive a feature for blue stragglers in the later A spectral range as it is for the early A blue stragglers (Twarog 1987).

The suggestion that Ap characteristics may be common among blue stragglers may also not hold among later A types, because Twarog and Tyson (1985) indicate that, on the basis of photometric classifications, fewer than expected Am and

TABLE 1

SUMMARY OF v sin i VALUES FROM THE UESUGI AND FUKUDA CATALOG

Spectral Type	n	$\langle v \sin i \rangle$ (km s^{-1})	$\sigma_{v \sin i}$ (km s^{-1})
A0V	128	129	74
A1V	92	116	72
A2V	134	115	62
A3V	94	111	50
A4V	41	131	45
A5V	50	115	48
A6V	13	131	51
A7V	69	110	43
A8V	9	120	31
A9V	10	83	41
Am	165	48	30
Ap	99	50	51

Ap stars appear among the NGC 7789 blue stragglers. However, as they point out, photometric classification of A star peculiarities is not definitive, and spectral classification of these stars would be necessary to establish this finding.

Theories that fall in the first of the three categories listed at the beginning of this section demand that the parameters derived by RHS have been misinterpreted or are simply wrong. Measurements of v sin i for a sample of the SGP A stars may be useful to explore the proposition that they are a population of blue stragglers and will certainly indicate whether or not they are misidentified HB stars. Accurate surface gravities, radial velocities, and abundance measurements (Lance 1988, hereafter Paper II) will aid further examination of these possibilities.

Hypotheses in the second category suggest that the A stars are the consequences of rare, but continuous, mechanisms operating on disk A stars. All of these theories may be tested by two requirements: that the stars be formed randomly over time and that they be composed of normally enriched disk matter. Further discussion of these theories, and the data necessary to examine them, is reported in Paper II.

The hypothesis in the third category was proposed by RHS, who suggested that the A stars were recently formed from a mixture of Galactic gas and high-velocity gas accreted from a satellite galaxy merging with the Milky Way. Again, this theory is examined in Paper II. Table 2 summarizes the parameters of the A stars from RHS, and the predicted values from other hypotheses.

The remainder of § I describes the compilation of a catalog of all the known early-type stars to spectral type F0, to 15th magnitude, over a large area at the SGP. Selection effects that may have influenced the conclusions of previous studies have been discussed. In § II, spectral and photometric observations for many of the catalog stars are described. Rotational velocity measurements have also been obtained for some stars. Section III describes the results of the rotational velocity data.

c) The SGP Catalog

The list of previously uncataloged blue stars at the SGP (list II of Philip and Sanduleak (1968, hereafter PS) was the basis of the A star observations by Rodgers (1971).

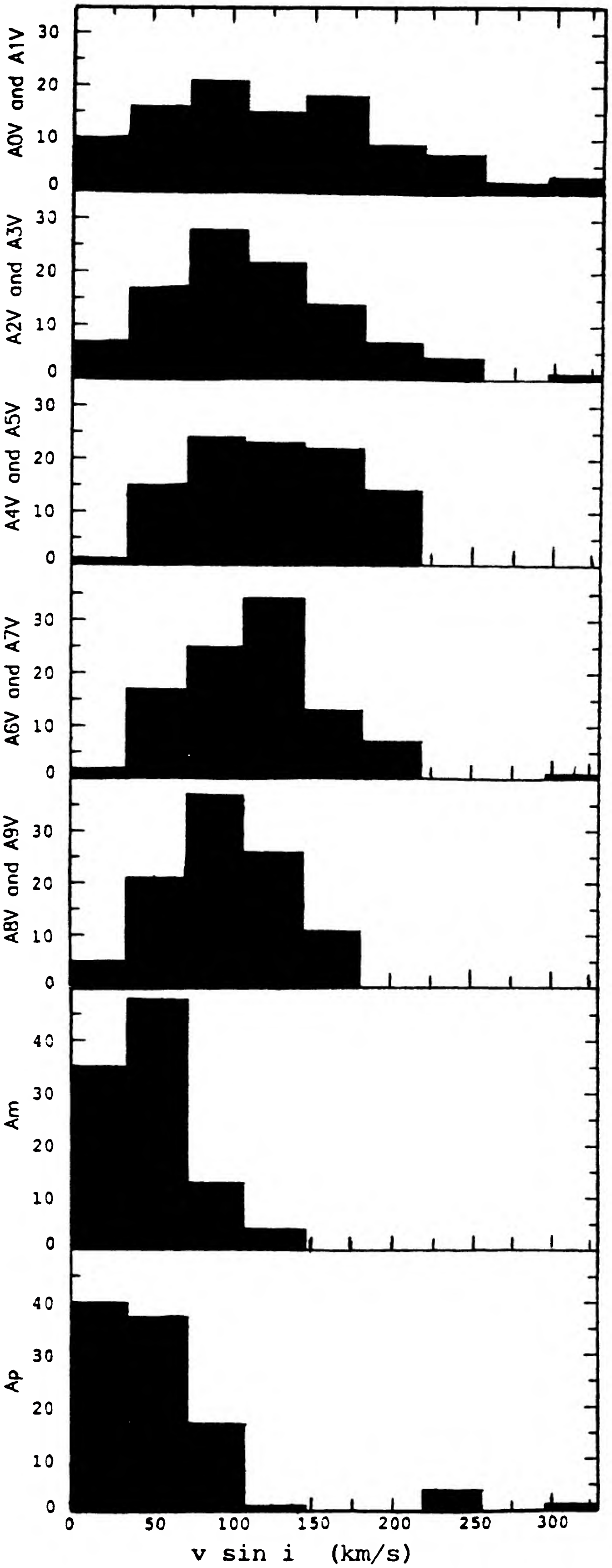

FIG. 2.—The relative percentages of A stars (class V, Am, and Ap), in bins of rotational velocity, from the Uesugi and Fukuda (1970) catalog.

TABLE 2

OBSERVED AND PREDICTED PROPERTIES OF HIGH-VELOCITY A STARS

	RHS (Observed)	Disk (Any Accelerating Source)	Old Disk Blue Stragglers	Thick Disk Blue Stragglers	Metal-rich RR Lyrae-Type Stars	Horizontal Branch
Mean gravity (dex)	−4.1	4.1	3.6–4.1	3.6–4.1	< 3.6	< 3.6
Age distribution	Coeval	Stochastic	Stochastic	Stochastic	Stochastic	Stochastic
Age (yr)	$\leq 10^9$	$\leq 10^9$	...	...	...	$\sim 10^{10}$
Abundance (dex)	−0.5–0.0	−0.1–0.2	−0.5–0.0	−0.9 to −0.3	−0.5–0.0	≤ -1.0
W dispersion (km s^{-1})	66	...	20–30	40	20–30	60–120
Mean $v \sin i$ (km s^{-1})	...	~120	~80	~80	< 30	< 30
Scale height (pc)	700	...	350	1000	350	2000–3000
Status	Population I	Population I	Evolved Population I	Intermediate	Evolved Population I	Population II

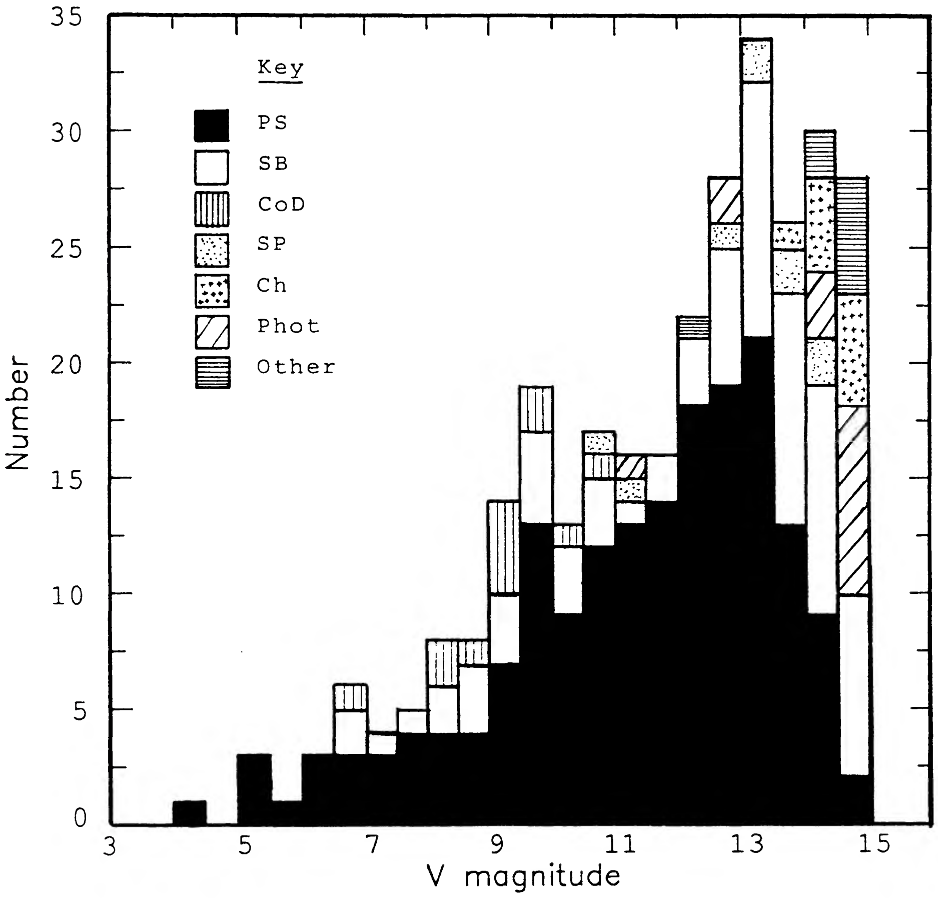

FIG. 3.—The sources of stars in the SGP blue star catalog: PS, Philip and Sanduleak (1968); SB, additional stars found by Slettebak and Brundage (1971) in the same area; CoD, Cordoba Durchmusterung, mainly late A and F0 stars; SP, Philip and Stock (1972), additional stars in one-third of the area, not found by either PS or SB; Ch, Chavira (1958); Phot, Photometric studies, mostly late A and F0, from Bok and Basinski (1964), Eriksson (1978), and Ratnatunga (1983); other, Pier (1983), Drilling (1977), CSI list (Ochsenbein, Bischoff, and Egret 1981).

It is, however, incomplete at all magnitudes. Slettebak and Brundage (1971, hereafter SB) surveyed objective prism plates around the SGP to spectral type F0 (with a limiting magnitude of about 14.5) and found many stars that were overlooked in the PS survey. PS stated that they had searched for spectral types to A7, but in a comparison with other classifications, SB showed that PS had in fact systematically classified F0 stars as A7, so spectral-type limits were actually the same for both studies. In the area covered by both surveys, from 6th to 14th magnitude, PS overlooked 25% of all the stars that were identified by SB and 32% of the total number of stars that have now been collected from several sources. SB missed 8% of the stars listed by PS and 15% of the total (Fig. 3).

The area of 218 deg^2 at the SGP, covered by both PS and SB, was used as the basis of a blue-star catalog. It runs from 0^h16^m to 1^h22^m in right ascension and from $-20°$ to $-35°$ in declination (1950 coordinates). The total number of stars presently in the catalog is 305, to 15th visual magnitude and to $B-V$ of 0.35. Stars were collated from the lists of PS, SB, Chavira (1958), and Philip and Stock (1972, hereafter SP), who surveyed a 5° wide strip centered on the SGP, which covered one-third of the catalog area. SP found a further nine stars in the strip that were not found by either PS or SB, suggesting that up to 18 more stars might exist to the SB limit of 14.5 mag over the whole area. The SGP catalog should be complete from the brightest nearby early-type stars to almost 14th magnitude stars in the central (SP) strip and about 90% complete to that limit outside the strip. Between 14th and 15th magnitude the catalog is probably only around 75% complete. A few other faint stars were found from photometric sources, principally Bok and Basinski (1964), Eriksson (1978), and Ratnatunga (1983).

More metal-rich A stars are likely to be present at the SGP than have so far been observed, not only because PS's list II is incomplete, but because PS's list I, of stars with BD and CD numbers, actually contains stars of 12th and even 13th magnitude from the CD survey. It became clear during the course of this work that it would not be presently possible to carry out observations on all the stars in the catalog, so an area within it of 100 deg^2 near SA 141 was selected for intensive study, hereafter termed the "box." The box had been covered not only by the three objective prism surveys mentioned above, but many of its stars had also been photometrically observed, so it was very nearly complete to 14th magnitude and to spectral type F0. Its coordinates are from 0^h36^m to 1^h22^m in right ascension and from $-23°40'$ to $-33°40'$ in declination (Fig. 4).

Table 5 (below) lists all the stars in the catalog, their varied nomenclature, 1950 coordinates, spectral types from other sources (some very approximate), their apparent visual magnitudes and any broad-band (*UBV*) photometry from the literature. Some of the coordinates are less accurate than others. This reflects their source. Most of these fainter stars have finding charts in PS, SB, and Chavira (1958).

d) *Selection Effects*

In previous studies of the A stars, some fairly serious selection effects have arisen, as a result of absolute magnitude differences; selection effects between early and late-type A stars, and between MS stars and stars of higher luminosity, both Population I and II. The absolute visual magnitude range for MS A0 to F0 stars is from +0.7 to +2.9. (Straižys and Kuriliene 1981). The maximum distance that an F0V star can be seen at 14th magnitude is only 1660 pc. It is possible to observe mid A stars to around 2000 pc, while only stars earlier than A3V can be seen to 3000 pc. An A0V can be observed to about 4500 pc. Hence, the A star sample contains relatively more late A stars to about 1500 pc and relatively more early A stars at greater distances.

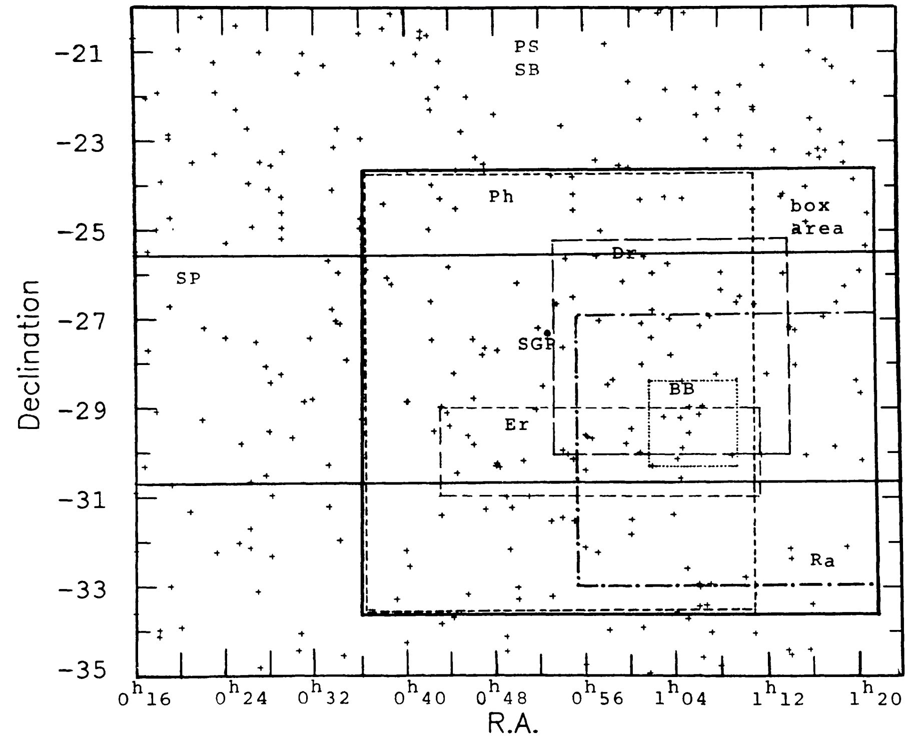

FIG. 4.—Positions (1950 coordinates) of stars in the total SGP catalog area (218 deg^2) and box area (100 deg^2). PS, SB, and SP areas surveyed by objective prism. Philip (1974) (Ph) used Strömgren photometry, Drilling (1977) (Dr), Eriksson (1978) (Er), Bok and Basinski (1964) (BB), and Ratnatunga (1983) (Ra) used *UBV* or *BV* photometry.

A consequence of this is that the most distant observed A stars are the bright early-type ones, which are those that are most vulnerable to errors in MS/HB classification. This results both from the proximity of the HB to spectral type A0, and from possible overestimation of the size of the Ca II K line in very early A stars due to the presence of interstellar calcium along the line of sight. This latter possibility is not a serious problem for the SGP A stars, because the effect is very small at high latitudes. Pier (1983) measured the equivalent widths of interstellar calcium lines, and from his data for stars in the SGP area, the mean amount (when large enough to be apparent) was only 0.17 Å [compared to normal A star W(K) values between 0.40 and 5.50 Å].

However, because the earliest A stars are those that are at the greatest distances and also those that are most open to disagreement about their evolutionary status, a spurious argument has arisen (Pier 1983) that since *reliably* MS stars (mid-to-late A) are seen only to 2 or 3 kpc, then they simply do not exist beyond 3 kpc. In fact, this apparent cutoff is no more than a simple consequence of the magnitude limit for A stars observed to the present—only stars earlier than A3V will be seen beyond 3 kpc at 14th magnitude. Compared to the few disputed distant earlier-type stars, it is the larger number of MS mid-to-late A stars (at 1–3 kpc from the plane) that are actually of greater kinematic significance because their high velocity dispersion clearly shows that some of these stars are capable of traveling further than 3 kpc from the Galactic plane.

A second selection effect is that previous estimates of the A star scale height may be inconsistent with the observed velocity dispersion. The theoretical relationship of scale height to velocity dispersion is model dependent. For stars in the solar neighborhood, each *UVW* component of velocity for a single generation of stars may be well described by a Gaussian distribution, while overlapping populations of different ages and spectral types may be described by a series of Gaussians forming velocity distributions that have higher peaks and larger wings than a Gaussian of the same dispersion (Wielen and Fuchs 1982).

However, at distances greater than around 1 kpc from the plane, the run of density for a specific stellar population has been observed to fall off approximately exponentially or as a sech^2 distribution (van der Kruit and Searle 1981; Norris 1987). The direct extrapolation of these models to the plane may lead to an overestimation of the disk stellar density, but at large Z the models are a most useful approximation. The scale height for a specific population may be derived by plotting the log of the density of stars (at particular Z heights) against the run of Z. For an exponential distribution, the points will fall on a straight line. Thus, if the density at a particular Z height is

$$D_z = D_0 e^{-Z/\beta}, \tag{2}$$

where D_0 is the density at the plane, then the exponential scale height β may be found from

$$\beta = \frac{Z}{2.3(\log_{10} D_0 - \log_{10} D_z)} . \tag{3}$$

However, the scale height derived in this way from the magnitude-limited A star sample will be an underestimate, because too few stars in distant bins have been included, relative to nearby stars, and a line through the plotted points will have too steep a slope.

The velocity dispersion for a minority group of stars with negligible mass relative to the disk, for distances greater than about 1 kpc from the plane, may be estimated from Poisson's equation and the equation of hydrostatic equilibrium, so that

$$\sigma_m^2 = 4\pi G D_0 \beta_D \beta_m , \tag{4}$$

where G is the gravitational constant, D_0 is the disk mass density at the plane, β_D is the disk exponential scale height, and β_m is the exponential scale height of the minority population. Setting $\beta_D = 350$ pc, this simplifies to

$$\sigma_m^2 = 2.46\beta_m , \tag{5}$$

where σ is in km s^{-1} and β_m is in parsecs. (For $\beta_D = 300$ pc, the factor is 2.11.)

RHS found an exponential scale height of 700 pc, which would indicate a velocity dispersion of about 38–41 km s^{-1}, based on the above discussion. This is somewhat inconsistent with their measure velocity dispersion of 66 km s^{-1}, which would indicate instead a scale height of around 1800 pc. Since this apparent discrepancy may be a result of model assumptions, it may be more useful to compare *in situ* observations. The only stars with kinematic and density data similar to the SGP stars, responding to the same Galactic potential at the same Z, are those of the thick disk. Freeman (1987) discusses results for several groups of thick disk stars and finds that their measured exponential scale height of 950 pc is consistent with both an observed and theoretically derived W velocity dispersion of around 40 km s^{-1}. Hence it would appear that the SGP A star scale height of 700 pc is low relative to that expected from stars with 66 km s^{-1} dispersion. The effect discussed above of incomplete sampling may explain the lower scale height found by RHS. Alternatively, if the A stars are young and not well mixed, their velocity dispersion and density distribution may not follow a simple exponential model.

A further selection effect is that the proportion of HB stars relative to MS stars has been overestimated. For instance, Philip (1974) discusses the relative numbers of both types of stars at the SGP and the North Galactic Pole (NGP) without taking into consideration that the HB stars will be drawn from a larger volume than the intrinsically less luminous MS stars.

All of these difficulties suggest that it would be most useful to acquire a distance-limited sample of early-type stars. Due to the incompleteness of the surveys previously discussed, many A stars at the SGP have never been observed. To derive accurate gravities and temperatures, both Strömgren *uvby* photometry and spectral indices are needed. Further photometry was obtained for a large proportion of the stars without previous data from 9th to 14th magnitude in the box. Spectra were obtained for all but two of the stars between the same limits, apart from some such as sdO, sdB, white dwarf, and sdF stars, whose classifications were straightforward from *uvby* photometry. In addition, many of the RHS A stars outside the box were reobserved at medium resolution, while high-resolution spectra were obtained for eight of the stars to measure their $v \sin i$ values.

II. OBSERVATIONS

a) *Photometry*

The Strömgren c_1 index is most useful as a surface gravity indicator for all A stars, and the y band magnitude is almost identical to V in broad-band photometry. Major calibrations of the *uvby* system were reported by Strömgren (1966) and Crawford (1975, 1977, 1979). Philip, Miller, and Relyea (1976) describe methods of analysis of the indices.

Observations were obtained for 25 SGP stars using the two channel chopper (TCC) on the 40 inch (1.0 m) telescope at Siding Spring. The TCC simultaneously uses two gallium arsenide detectors and two sets of filters. (One set was kindly supplied by R. Shobbrook, and both sets had been manufactured in the same batch.) Standard stars from the list of Grønbech and Olsen (1976) were observed throughout each night. Acquisition and reduction programs used were written by M. S. Bessell and S. Russell. Results from both detectors were found to be consistent.

Recently, data from Philip (1986) became available for 12 of the observed stars (very kindly supplied prior to publication). The differences between measurements, in the sense of this data minus Philip's data are $\Delta V = -0.014 \pm 0.054$, $\Delta(b-y) = 0.008 \pm 0.011$, $\Delta m_1 = -0.015 \pm 0.025$, and $\Delta c_1 = -0.001 \pm 0.047$. Due to weather problems it was only possible to do one series of observations per star on the 40 inch telescope, so Philip's values were used where possible, as they were from a large number of observations. The accuracy of the indices for subsequent derivations (Paper II) needs to be high, but not perfect, so no attempt was made to transform results from different studies to a common system. The few overlapping observations were in good agreement. The V magnitudes are listed in Table 5, and the $b-y$, m_1 and c_1 indices in Table 6, both in the Appendix, together with results from other sources.

b) *Medium-Resolution Spectra*

These were obtained on the Mount Stromlo 74 inch (1.9 m) telescope. One series of observations was at coudé focus, with a reciprocal dispersion of 40 Å mm^{-1} and 1.2 Å resolution. The spectral range covered from 3820 to 4170 Å. The detector was the Mount Stromlo two-dimensional blue photon counting array (BPCA), an intensified CCD of great sensitivity at blue wavelengths. An iron-argon lamp was observed before and after each exposure. The other series of observations was also done on the Mount Stromlo 74 inch telescope with the BPCA detector at Cassegrain focus, with 1.4 Å resolution. Arc spectra were cross-correlated to check if any channel shift had occurred while the spectra were being recorded. Any shift was usually negligible for coudé spectra and equivalent to less than 4 km s^{-1} for Cassegrain spectra. The spectra were reduced with Mount Stromlo software to wavelength and log wavelength (linear velocity) scales.

i) *Radial Velocities*

Several radial velocity standard template stars had been acquired separately for each observing run and were cross-correlated with program stars to derive the radial velocity shifts, using programs by G. Wilson and D. Carter. While the cross-correlation method is successful for late-type stars with distinctive metal lines, it has difficulties with A stars at the resolution obtained (1.2 Å). This is because measurable metal lines are almost absent in early A stars and are weak in later ones. A further complication is that the strong hydrogen lines give very broad cross-correlation peaks, of 20–30 km s^{-1}, which also lead to random inaccuracies. A range of Fourier wavenumber filters were experimented with (cross-correlating templates of known radial velocity against each other), but it was not possible to increase accuracy to better than 10–15 km s^{-1} by this method.

An alternative technique was simply to measure the wavelength shifts of plots of the (medium-resolution) Ca II K lines by hand, corrected for heliocentric velocities, for around 30 solar neighborhood A stars. By comparison with Ca II K line shifts from high-resolution spectra of the same stars, it was possible to check the accuracy of the former. It was found that neither of the two techniques (cross-correlation or hand measurement) used separately was as accurate as the mean of both methods. The residuals of the mean values relative to the high-resolution measurements had a dispersion of 8 km s^{-1}. A plot of radial velocity values of all stars in common with either Pier (1983) or Rodgers (1971) is shown in Figure 5. Eight Population I stars common to both those studies and this one are listed in Table 3 together with the means and velocity dispersions. Note that while there is disagreement between individual values, *the dispersion is almost identical from three studies*, which suggests that the dispersion for the more complete sample (Paper II) is well defined. The radial velocities from these spectra and from any other available sources are listed in Table 6 in the Appendix.

ii) *Hydrogen Line Widths*

The equivalent widths of the Balmer series of hydrogen lines in A stars are a function of temperature for the whole A star range, and are also particularly sensitive to surface gravity effects for the early and mid A star spectral types. The Balmer jump, a measurement of the difference between the continuum opacity above and below the Balmer limit at 3650 Å, is also gravity sensitive for almost all A stars, becoming larger for lower gravities. When Balmer line width and the Balmer jump (measured by c_1) are calibrated with stellar atmospheric models, they can be most useful indicators of gravity and temperature for A stars (see Paper II for technique).

The linear width (in angstroms) of a Balmer line at a specific proportion of the continuum height is used as an estimate of the equivalent width, which is difficult to measure. The line widths are measured at either 80% or 70% of the height of the continuum, termed $D(0.80)$ or $D(0.2)$ and $D(0.70)$, respectively. $D(0.80)$ falls where the wings of the hydrogen lines broaden rapidly in MS stars, and is more sensitive to the effects of uncertainties in the continuum level. At $D(0.70)$, the slopes of the wings are at about 45°, and it is

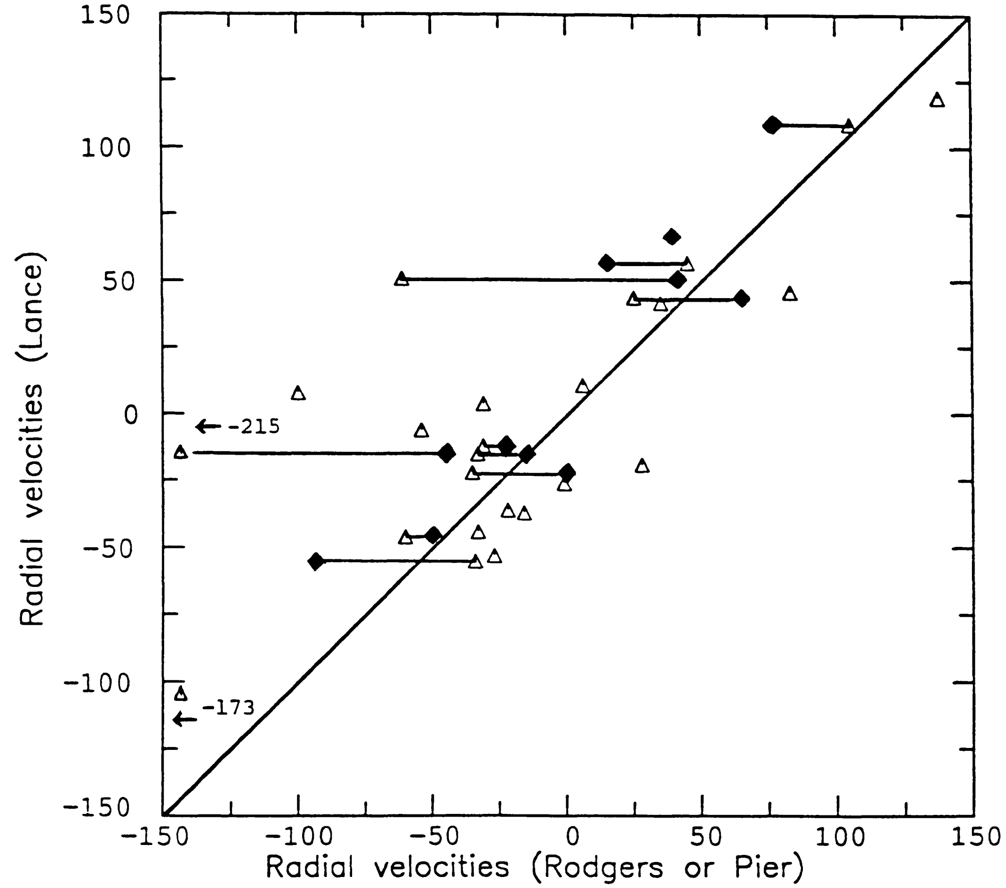

FIG. 5.—Radial velocities (this paper) against those found by Pier (*diamonds*) and Rodgers (*triangles*). Values for the same stars are joined by lines. Note that three of Rodgers's values are highly discrepant, presumably due to errors from lower resolution spectra. Otherwise, of 10 stars (either Population I or II) common to all three studies, this study finds better agreement with five of Rodgers' values than with Pier's; and, for the other five, the reverse holds (although Pier's results have clearly less scatter than those of Rodgers).

TABLE 3

RADIAL VELOCITIES OF POPULATION I STARS COMMON TO THREE STUDIES

Number	Star	Rodgers (1971) (km s^{-1})	Pier (1983) (km s^{-1})	Lance (1988) (km s^{-1})
36........	PS 4II	−34	−94	−55
46........	PS 7II	−31	−23	−12
53........	PS 10II	105	76	109
88........	PS 20II	45	15	57
128........	PS 30II	25	65	44
150........	PS 32II	−60	−50	−46
161........	PS 37II	−35	0	−22
164........	PS 39II	−33	−15	−15
Mean ...		−2.3	−3.3	7.5
σ_W.......		55.6	56.4	56.8

consequently a more accurate index. [$D(0.80)$ can be derived from $D(0.70)$ via Kurucz (1979) models if the gravity and temperature are known.] $D(0.70)$ values for Hδ were measured for the digitized spectra. Errors from extremes of continuum level estimates are no more than ±1.5 Å. These results, and a few from other sources, are listed in Table 6 in the Appendix.

iii) *Calcium* K *Lines*

The equivalent widths of the Ca II K line at 3933.7 Å were measured with an interactive program which fits and plots a Gaussian to the line. The accuracy of this method was checked by comparison with values obtained from a planimeter, which were found to be in good agreement. Lines were measured three times over a period of several months to minimize random errors in judgment of the continuum level. The scatter between different measurements for the same line was small, usually around 8% of the total equivalent width. The results, with a few from other sources, are listed in Table 6 in the Appendix.

c) High-Resolution Spectra and Rotational Velocities

Five of the SGP A stars which RHS classified as Population I, and three $v \sin i$ templates, were observed on the 3.9 m Anglo-Australian Telescope (AAT) at Siding Spring, with 11 Å mm^{-1} at the image photon counting system detector, equivalent to 0.30 Å resolution. The spectra were reduced as described for medium-resolution spectra. It is relatively easy to measure $v \sin i$ values of less than about 140 km s^{-1} by hand, from the FWHM of lines in a digitized spectrum, and with a calibration such as in Gray (1976, p. 401) simply read off a mean $v \sin i$. (Note that Gray's ordinate is ambiguously entitled "half width," but the original data from which the graph was drawn used FWHI [Slettebak *et al.* 1975].) In practice, it becomes very difficult to measure $v \sin i$ from plots of A stars whose lines have been broadened by more than about 140 km s^{-1}, so an automated Fourier technique then becomes useful.

Programs written by D. Carter were used to obtain the rotational velocities, utilizing the technique described by Sargent *et al.* (1977, hereafter SSBS). This method normally finds the velocity dispersions of galaxies by minimizing the difference between the Fourier-transformed spectrum of a broadened template and a program galaxy. The broadening function used is Gaussian. A stellar line profile is the convolution of a flux profile of a nonrotating star with a "rotation profile," *elliptical* in form (Gray 1976), which was systematically underestimated by the fitted SSBS Gaussian. To correct for this underestimation, a calibration curve (Fig. 6) was derived from the SSBS velocities set against $v \sin i$ values measured by hand with Gray's calibration, for a large number of solar neighborhood A star high-resolution spectra.

The program star SSBS results (the mean of the rotational velocities relative to three template stars) were read into Figure 6 to find the actual value of $v \sin i$. Since the minimum that could be found by the templates (due to their own $v \sin i$ broadening) was 38 km s^{-1}, the narrow lines of stars below that value were simply measured by hand, again using Gray's calibration. Three other SGP A stars were observed at coudé focus on the Mount Stromlo 74 inch (1.9 m) telescope, with a reciprocal dispersion of 11.4 Å mm^{-1}, and resolution almost identical to that obtained from the AAT. The AAT template stars were used for these spectra as well, because for two of the program stars with narrow lines, rotational velocities found from hand measurement agreed very well with the calibrated SSBS output.

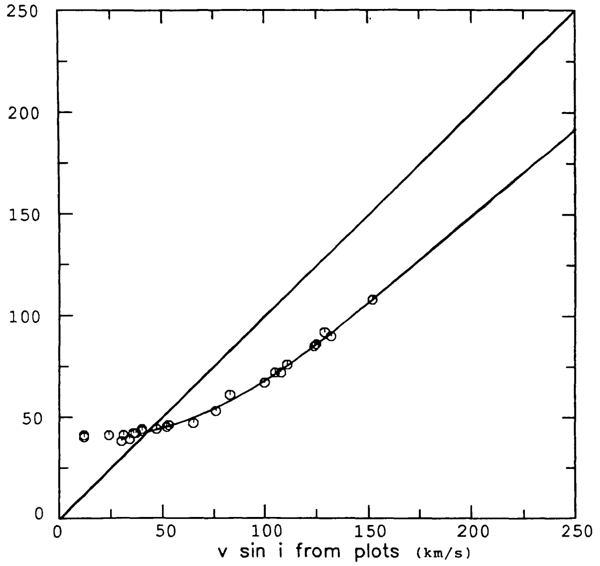

FIG. 6.—The calibration curve used for derivation of $v \sin i$ values from SSBS output.

Seven of the nearby A stars with $v \sin i$ results were also studied by Stetson (1983). Figure 7 shows a comparison between our respective $v \sin i$ measurements. It can be seen that the agreement is very good, apart from the star with the highest rotation velocity, for which Stetson measured a value 30 km s^{-1} greater than that found here. This is probably because the calibration curve (Fig. 6) was extrapolated as conservatively as possible, leading to a slight underestimation of the highest rotational velocities. There is clearly no indication that the $v \sin i$ values derived from this technique have been *over*estimated in any way for the SGP stars.

III. RESULTS

Table 4 shows the name, the approximate spectral type (from the color), the mean and dispersion of the SSBS output, the rotational velocities from spectral plots, and the final calibrated $v \sin i$ values for the AAT and 74 inch program stars and details of the template stars. Five out of the eight stars, with values of 131, 188, 111, 172, and 123 km s^{-1}, have rotational velocities which are clearly too high for HB stars, but which are typical of young MS A stars (see Fig. 2).

Three others have lower rotational velocities. They appear to be normal Am or Ap stars, although these classifications cannot be definitive, as they are usually derived from objective prism spectra. PS 2II (48 km s^{-1}) shows the strong Sr II line at 4077 Å indicative of an Ap star in the mid A range (Morgan, Keenan, and Kellman 1942). The equivalent width of the line at 4077 Å was 0.33 Å, while that of the template Ap star (HR 8949) was 0.36 Å. In comparison, PS 30II (a normal A star of around one spectral class later than PS 2II, so it would be expected to actually have stronger metal lines) had an equivalent width at 4077 Å of only 0.14 Å.

PS 29II ($v \sin i$ of 36 km s^{-1}) is almost certainly an Am star, as its spectrum is very similar to that of the template star HR 178 (A7m). To quantify this, the mean equivalent width of the iron triplet lines at 4045, 4063, and 4071 Å was calculated. The template has a mean equivalent width of 0.52 Å; that of PS 29II is 0.42 Å, in comparison to PS 62II (slightly later type than PS 29II) which is only 0.13 Å. PS 29II had an m_1 index of 0.193. Am stars are often indicated by m_1 indices greater than 0.200, but the normal range for Am stars at PS 29II's $b - y$ of 0.139 is from 0.170 to 0.240 (Kilkenny and Hill 1975), so its m_1 index is not inconsistent with an Am classification.

The spectrum of PS 57II ($v \sin i$ 30 km s^{-1}) also shows enhanced metal lines and appears to be a marginal Am star. Its iron triplet mean equivalent width is 0.29 Å, while that of PS 37II, a normal A star of around the same temperature, is only 0.15 Å.

IV. DISCUSSION

Around 25% of MS A stars are Am, and about 10% are Ap stars (Wolff 1983). To find one Ap and two Am stars out of eight MS stars is very nearly the expected proportion. Their

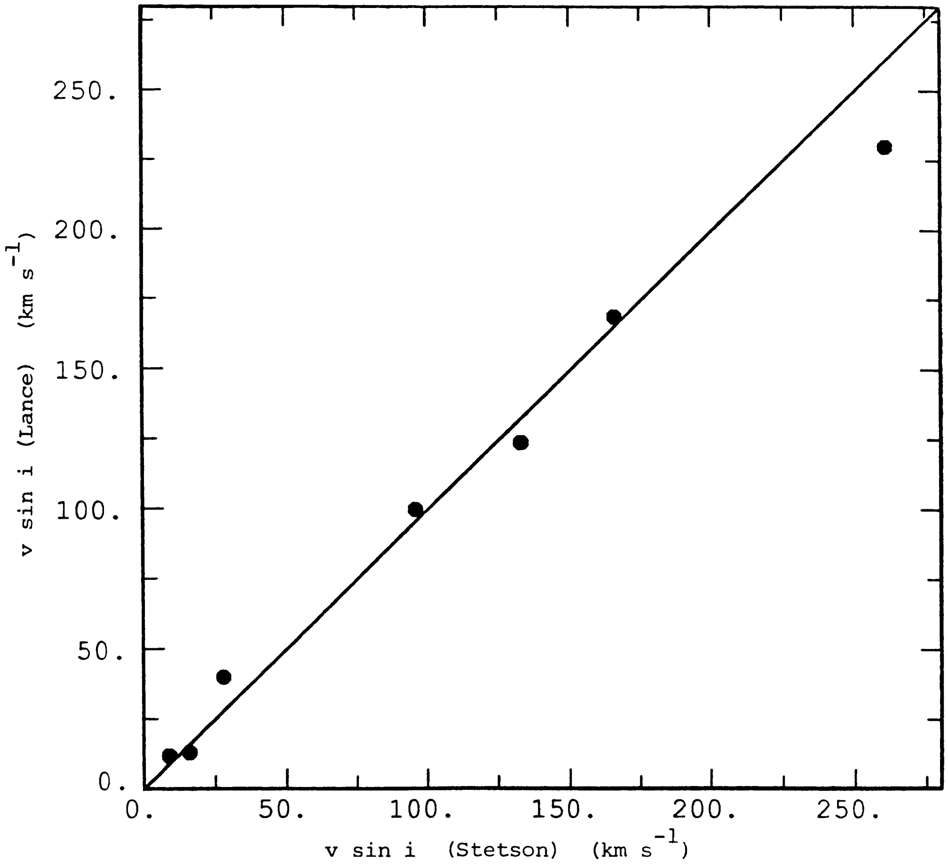

FIG. 7.—The derived $v \sin i$ values for seven stars measured both by the technique described in this paper and by Stetson (1983).

TABLE 4

SGP PROGRAM STARS AND $v \sin i$ TEMPLATES

Number[a]	Star	Spectral Type[b]	$\langle v \sin i \rangle$ SSBS[c]	Dispersion	$v \sin i$ (Plots)[d]	$v \sin i$ (Adopted)[e]
12.............	PS 2II	A3Vp	44	5	47	47
161.............	PS 37II	A4/5V	85	8	124	123
265.............	PS 57II	A5Vm:	38	7	30	30
18.............	PS 3II	A9V	92	10	129	131
49.............	PS 8II	A7V	138	7	...	188
125.............	PS 29II	A8Vm	42	3	36	36
128.............	PS 30II	A4V	76	7	111	111
287.............	PS 62II	A8V	125	16	...	172
Template.......	HR 8949	A2Vp	...	...	23	23
Template.......	HR 7990	A3m	...	...	44	44
Template.......	HR 178	A7m	...	...	38	38

[a] First three stars are 74 inch observations; all others are from AAT.

[b] Spectral types for program stars only are estimates from color and spectra.

[c] Rotational velocities from SSBS output.

[d] Rotational velocities from spectral plots.

[e] The adopted calibrated values of $v \sin i$.

presence in the sample complicates comparison between blue stragglers and the SGP stars, as it is not yet clear (see § I*b*) whether any relationship between spectral peculiarity and blue straggler formation exists over the whole temperature range for A stars. If only the nonpeculiar A stars are considered, Abt (1985) shows that many of the non–Ap hotter blue stragglers are also slowly rotating stars, while of Peterson, Carney, and Latham's (1984) few later A blue stragglers (apart from the Am star), one has an average rotation for its spectral type, and two are less than the mean. Excluding

TABLE 5

NOMENCLATURE, COORDINATES, SPECTRAL TYPES, UBV PHOTOMETRY AND SOURCES, FOR SGP CATALOG STARS

No^{a}	SB^{b}	PS^{c}	ID^{d}	CD, others^{e}	B^{f}	R.A. (1950)	Dec. (1950)	Spectral type^{g}	m_V^{h}	B-V	U-B	S^{i}
1	122			CD -31 99		0 16 04	-30 53 48	A0	12.75	0.14	0.18	P
2	123					0 16 12	-20 42 00	A0	12.9			
3	124		1492			0 16 24	-33 36 00	A5	8.82			
4			CH148			0 16 24	-32 12 00	B	14.47	-0.17	-1.07	BI
5	125		CH149	CD -25 92		0 16 42	-25 29 00	A	12.72	-0.01	0.13	AT
6	126		CH150	CS22882-03		0 16 45.4	-30 18 27	A0	14.53	0.01	0.08	P
7			SP222			0 17 02.4	-27 42 04	A0	13.5			
8	131			BD -22 46		0 17 24	-22 03 00	F0	10.6			
9	133	1II		CS22882-07		0 17 46.9	-29 04 14	A0	14.46	0.04	0.10	P
10	134	1I	1619	CD -25 99		0 17 48.6	-24 58 47	A0	8.64	0.35	0.14	BW
11	135	2I		CD -25 101		0 17 54	-25 29 00	A7	11.8			
12	136	2II				0 18 04.9	-21 54 52	A3	12.27	0.15	0.15	EG
13			1667	CD -24 104		0 18 17.2	-23 54 26	F0	6.77			
14	137	3I		CD -34 99		0 18 18	-34 07 00	F0	11.9			
15	143			GD603		0 18 42	-33 58 00	A	14.62			
16			SP224			0 18 59.9	-26 42 53	DA	13.8			
17			CH153			0 19 06	-22 51 00	A	14.7			
18		3II				0 19 23	-32 59 12	A7	13.01	0.32	0.12	EG
19	146	4I		CD -23 112		0 19 24	-22 57 00	A5	11.0			
20	147		CH154	GD605		0 19 30	-24 43 00	B	14.48	-0.33	-1.23	BI
21	149					0 19 48	-30 43 00	F0	13.0			
22	151	5I		CD -34 111		0 20 00	-33 55 00	A5	13.2			
23	152	6I	1869	BD -21 41		0 20 24	-20 56 00	A7	10.5			
24	153	7I	1909	CD -31 138		0 20 42.5	-31 18 46	B9IVMN	6.55	0.00	-0.31	BW
25			CH155			0 21 30	-23 28 00	A	14.9			
26	161	8I	2026	CD -29 106		0 21 48.5	-29 15 26	A1V	8.14	0.14	0.16	BW
27	162	9I	2037	CD -27 110		0 21 59.3	-27 11 37	A5IV	8.36	0.29	-0.02	BW
28	163		2080			0 22 24	-20 13 00	F0	8.82			
29	167	10I	2178	BD -22 65		0 23 11.3	-21 54 29	A1Vn	7.63	0.06	0.05	BW
30	169			LB7736		0 23 30	-21 14 00	B	13.98			
31	171		CH157			0 23 48	-23 17 00	B6	14.60			
32	172	11I		CD -32 128		0 23 52	-32 13 54	A0	12.40	-0.02	0.00	P
33	173			GD612		0 23 52.8	-27 25 13	A	14.47			
34		12I		CD -25 145		0 24 12	-25 17 00	A7	12.1			
35	178					0 25 00	-22 17 00	F0	13.18			
36	179	4II				0 25 05.2	-32 01 26	A9	13.14	0.31	-0.02	EG
37	181	13I	2395	BD -20 67		0 25 06.3	-20 24 39	A7IV	6.80	0.22	0.13	BW
38	182	14I	2415	CD -30 127		0 25 17.7	-29 47 21	B9/A0V	11.15	0.05	-0.02	BW
39	188					0 26 12	-22 43 00	A7	12.8			
40		15I	2527	CD -25 155		0 26 20.6	-24 54 46	F0IIIn	7.13	0.13		CS
41	191	5II	CH158			0 26 36	-23 56 00	A0	14.02	0.06	0.19	EG
42			SP229			0 26 37.5	-27 30 50	OB	13.2			
43			CH159			0 26 42	-30 39 00	A	14.4			
44	193	16I		CD -32 152		0 26 42	-32 08 00	A7	11.3			
45	192	6II		CS22882-33		0 26 46	-31 42 18	A	14.23	0.06	0.13	P
46	194	7II				0 26 47.8	-33 06 26	A0	13.42	0.19	0.10	EG
47	197	17I	2613	CD -23 173		0 27 05.3	-23 27 39	A2	10.28	0.32	0.02	BW
48	195			CD -35 150		0 27 00	-34 49 00	A3	13.3			
49	198	8II				0 27 10.9	-21 00 12	A5	13.03	0.22	0.09	EG
50	199	18I	2641	CD -30 138		0 27 28.7	-30 30 25	A0V	9.52	0.15	0.10	BW
51			SP231			0 27 32.4	-28 03 49	Aw	11.3			
52		9II				0 27 47.2	-29 31 10	F	12.22	0.41	-0.19	EG
53	202	10II		CS22882-15		0 27 54.8	-28 25 32	A0	14.26	0.16	0.11	P
54	203	19I	2696	CD -24 179		0 27 52.7	-24 03 50	A3/5V	5.18	0.13		CS
55	207	20I		CD -32 160		0 28 18	-32 19 00	A7	12.3			
56	208	11II				0 28 36	-30 57 00	A	14.28	0.06	0.20	EG
57		12II				0 28 48	-23 32 00	A0	14.51	0.07	0.09	EG

TABLE 5—*Continued*

No[a]	SB[b]	PS[c]	ID[d]	CD, others[e]	B[f]	R.A. (1950)	Dec. (1950)	Spectral type[g]	m_V[h]	B-V	U-B	S[i]
58	210	13II		CS22882-14		0 28 53.9	-28 14 02	A0	12.99	0.02	0.06	P
59	211		CH162			0 29 00	-24 14 00	A	13.5			
60	212	14II				0 29 00	-25 11 00	A0	13.32	0.00	0.02	EG
61	213	21I	2846	CD -23 186		0 29 08.9	-23 13 19	A3	10.61			
62	214					0 29 12	-24 35 00	A	13.4			
63	215			CD -25 182		0 29 24	-24 56 00	F0	12.3			
64			SP235			0 29 50.2	-29 39 35	A5w	12.9			
65			2980	CD -34 180		0 30 25.0	-34 26 44	F2	8.94			
66	221	15II				0 30 34.5	-21 27 52	A0	13.99	0.12	0.13	EG
67	222	22I	3002	CD -34 181		0 30 36.2	-34 03 05	A5IV/V	9.57	0.24	0.10	BW
68	225	16II		CS22882-18		0 30 54.2	-28 50 58	A0	14.26	0.10	0.14	P
69			CH163	GD619		0 31 25.0	-27 24 56	A	14.2			
70	230					0 31 30	-21 01 00	A0	13.8			
71	231	17II		CS22882-19		0 31 36.2	-28 47 11	A0	13.18	-0.01	-0.03	P
72	235	18II				0 32 51.8	-21 17 13	A0	12.6			
73	236	23I	3244	CD -26 173		0 33 03.9	-25 40 27	A7III	8.20	0.28		CS
74	238	24I		CD -27 171		0 33 21.7	-26 46 17	F0	10.2			
75				CS22882-22		0 33 23	-30 16 42	AB	14.99	0.10	0.19	P
76			3300	CD -24 224		0 33 26.9	-24 04 35	A3	10.28			
77	242	25I	3326	CD -23 220		0 33 37.6	-23 06 58	A7p	6.05	0.30		CS
78			3338	CD -27 174		0 33 43.5	-27 02 07	F0	8.48			
79				CS22882-25		0 33 54	-31 12 30		14.91	0.03	0.12	P
80				CD -26 179		0 33 59.0	-25 56 54	A7	9.8			
81	246	19II				0 34 06	-22 42 00	A0	13.66	0.17	0.16	EG
82		26I	3417	CD -34 206		0 34 21.1	-34 33 26	A8V	10.76			
83		27I		CD -28 170		0 34 36.7	-27 54 38	A7	12.1			
84	248		3436			0 34 24	-31 58 00	F0	9.81			
85	250	28I		CD -27 179		0 34 54	-27 06 00	A3	13.0			
86	254	29I	3559	CD -25 233		0 35 55.9	-24 56 15	A5	8.53			
87	256	30I	3580	BD -21 84		0 36 01.9	-20 34 16	B8V	6.74	-0.11	-0.57	BW
88	257	20II		CS22882-20	f	0 36 10	-29 14 54	A0	14.01	0.14	0.16	P
89	259	21II			f	0 36 12	-24 43 00	A0	13.95	0.06	0.23	EG
90	264					0 36 24	-34 59 00	A5	13.23			
91	263	31I	3622	CD -26 196	f	0 36 24.6	-25 52 11	A5V	7.77	0.22		CS
92	265	32I		CD -23 239		0 36 30	-22 55 00	F0	10.8			
93	272	22II			f	0 38 14.9	-26 03 17	A5/7	13.04	0.25	0.07	EG
94	273	33I		CD -24 266	f	0 38 18	-24 23 00	B	12.69			
95	276	23II			f	0 38 40.3	-26 12 06	A0	13.82	0.13	0.16	EG
96	277	34I	3885	BD -20 118		0 38 48.6	-20 08 13	A0	9.79	-0.08	-0.24	BW
97	279	24II				0 38 54	-20 28 00	A7	12.05			
98	280					0 39 24	-21 14 00	A0	14.0			
99	283	25II			f	0 39 42	-33 17 00	A	14.54	0.08	0.21	EG
100	284	35I	3999	CD -32 254	f	0 39 53.7	-32 11 25	A2V	9.32	0.13	0.09	BW
101	285	26II			f	0 39 57.8	-28 50 48	A3	13.62	0.18	0.12	EG
102	286	37I	4011	CD -34 245		0 39 57.2	-34 15 50	A9V	9.57	0.34	0.12	BW
103	287	36I		CD -29 201	f	0 40 03.5	-28 51 01	A2	11.29	0.12	0.08	BW
104	288	38I	4052	CD -32 257	f	0 40 14.4	-32 32 29	A5	10.59			
105	292					0 41 18	-21 02 00	A0	12.9			
106	294	39I	4158	BD -21 99		0 41 24.9	-20 40 22	A9	9.56	0.27	0.02	BW
107	293	40I	4157	BD -21 100		0 41 27.4	-20 31 14	A2	9.59	0.02	-0.04	BW
108			SP249	CD -27 224	f	0 42 10.8	-26 35 24	A8	10.5			
109	298	27II			f	0 42 14.3	-27 27 21	A2	12.97	0.07	0.16	EG
110		41I	4247	BD -22 127		0 42 15.6	-22 16 39	F2V	5.23	0.33		CS
111	299	42I	4248	CD -24 297	f	0 42 19.7	-23 57 00	A3	10.35			
112	300		4259			0 42 24	-20 37 00	F0	8.93			

TABLE 5—*Continued*

No[a]	SB[b]	PS[c]	ID[d]	CD, others[e]	B[f]	R.A. (1950)	Dec. (1950)	Spectral type[g]	m_V[h]	B-V	U-B	S[i]
113	301				f	0 42 24	-24 58 00	A	13.5			
114	302	28II			f	0 42 26.6	-29 30 42	A0	14.16	0.13	0.10	EG
115	304	43I		CD -22 243		0 42 54	-22 02 00	A0	12.4			
116	306	45I	4329	CD -29 213	f	0 43 05.2	-28 57 28	A0	10.12	0.18	0.09	BW
117	307	44I	4327	BD -21 106		0 43 08.3	-21 10 54	A0V	9.51	0.14	0.11	EG
118	310	46I		BD -22 130		0 43 18	-21 46 00	A0	11.9			
119	312	47I	4399	CD -29 215	f	0 43 37.9	-29 05 59	A9V	9.64	0.28	0.03	BW
120	313	48I		CD -34 276		0 43 42	-33 50 00	F0	11.6			
121				CS22942-04	f	0 43 46	-24 15 42		14.61	0.17	0.06	P
122	314	49I	4414	CD -26 247	f	0 43 48.0	-25 48 36	F0V	9.05	0.29	0.01	PH
123	315			E 29.2.002	f	0 43 49.8	-29 23 27	A0	13.63	0.26		E
124	316	50I		CD -31 285	f	0 43 54	-31 24 00	F0	11.40			
125	317	29II			f	0 44 14.5	-28 12 38	A5	13.42	0.29	0.13	EG
126	318	51I	4485	CD -34 280		0 44 13.3	-33 41 32	A0IV	10.52	0.09	0.01	BW
127	320	52I	4507	CD -24 321	f	0 44 31.9	-24 29 20	A5	7.50			
128	322	30II		CS22942-06		0 44 34.2	-23 37 16	A5	12.90	0.18	0.08	P
129	323			CD -30 230	f	0 44 32.2	-30 27 14	F0	10.35	0.30	0.08	E
130	326	53I		CD -23 308		0 45 24	-22 46 00	F0	13.0			
131	327		4623	CD -30 240	f	0 45 30.3	-29 37 00	F0III	7.57	0.32	0.07	E
132	329	54I	4622	BD -22 134		0 45 32.6	-21 59 40	B9V	5.57	-0.05	-0.12	BW
133	330	31II			f	0 45 29.7	-33 10 04	A	12.99	0.40	-0.13	EG
134	332			E 54	f	0 46 08	-27 27 06	A	14.81	0.27	0.12	E
135	333		4691		f	0 46 15	-28 46 06	F0	6.76	0.35	-0.01	E
136			4689	CD -23 311		0 46 20.7	-23 20 20	A5	9.42			
137	335	55I		CD -30 248	f	0 46 35	-29 48 30	A7	10.69	0.33	0.07	PH
138	337	56I		CD -28 251	f	0 46 47.9	-27 48 05	A5	11.45	0.26	0.06	PH
139	338				f	0 47 00	-27 39 00	A3	13.42			
140	340	57I	4772	CD -24 347		0 47 05.7	-23 38 01	A2/3V	6.26	0.14	0.13	BW
141				CS22942-09		0 47 26	-23 29 30		14.76	0.29	-0.04	P
142	342	58I		CD -31 306	f	0 47 48	-31 16 00	A0	12.45			
143	344	59I		CD -30 253	f	0 48 08.7	-30 14 24	A2	11.46	0.18	0.09	PH
144	343		4876	CD -28 260	f	0 48 10.2	-27 42 24	A9III/IV	9.43	0.36	0.08	E
145	345					0 48 12	-22 23 00	A0	13.9			
146				E30.1.036	f	0 48 22.6	-30 19 24	E	12.99	0.35		E
147				E30.1.041	f	0 48 51	-30 17 36	E	11.45	0.35		E
148			4974	CD -35 285		0 49 02.2	-35 03 15	A5	9.48			
149				E30.5.048	f	0 49 13	-30 59 06	B	14.40	-0.30		E
150	350	32II		HL6772	f	0 49 22.0	-32 10 01	A0	13.65	0.09	0.15	EG
151	351	61I		CD -34 317		0 49 24	-34 27 00	A3	12.80			
152		62I	5024	CD -31 319	f	0 49 29.4	-31 13 48	A9V	9.22	0.34	0.07	E
153	353			CS22942-13	f	0 50 13	-26 10 42	A	14.61	0.19	0.17	P
154	354	33II			f	0 50 24	-33 01 00	A0	13.53	-0.06	-0.12	EG
155	355			E 30.1.053	f	0 50 32.0	-30 10 52	A	14.07	0.09		E
156	360	34II		GD659	f	0 50 54	-33 17 00	B	13.36	-0.22	-1.15	EG
157				E30.5.071	f	0 51 33	-30 58 18	E	14.12	0.32		E
158	361	63I		CD -29 259	f	0 51 41.4	-29 01 21	A5	11.06	0.21	0.11	PH
159	362	35II	HL685	CS22942-15	f	0 51 54.0	-27 11 54	A0	13.08	0.07	0.16	P
160	363	36II			f	0 52 16.0	-28 30 10	A3	13.78	0.19	0.17	EG
161	366	37II		CS22942-20	f	0 53 09.8	-23 44 44	A5	12.30	0.21	0.06	P
162	367	64I		CD -31 353	f	0 53 12	-31 32 00	A3	11.76			
163	371	38II			f	0 53 32.7	-26 39 12	A3	13.59	0.34	0.04	DR
164	373	39II			f	0 53 48	-33 13 00	A0	13.64	0.20	0.19	EG
165	375	65I	5496	CD -31 362	f	0 53 58.3	-31 27 14	B9/A0V	10.58	-0.07	-0.19	BW
166				E29.5.101	f	0 54 16	-29 56 24	A	14.96	0.18		E

TABLE 5—*Continued*

No[a]	SB[b]	PS[c]	ID[d]	CD, others[e]	B[f]	R.A. (1950)	Dec. (1950)	Spectral type[g]	m_V[h]	B-V	U-B	S[i]
167	377	66I	5524	CD -26 303	*f*	0 54 22.7	-25 37 59	A5V	7.22	0.15	0.04	DR
168	379	67I	5546	CD -30 283	*f*	0 54 30.0	-30 01 51	A5IV/V	10.23	0.22	0.09	BW
169			CH179		*f*	0 54 36	-27 38 00	A	14.8			
170			CH180			0 54 42	-22 38 00	A	14.2			
171				E30.0.073	*f*	0 54 56.2	-30 08 18	A	14.72	0.08	0.13	E
172	384	68I		CD -31 372	*f*	0 55 06	-31 32 00	F0	12.6			
173	386		5630		*f*	0 55 18	-26 30 00	F0	9.99			
174	387	70I		CD -24 415	*f*	0 55 48	-23 47 00	A7	12.12			
175	388	69I		CD -24 414	*f*	0 55 49	-24 10 12	A0	12.35	-0.03	-0.09	P
176	389			CS22942-26	*f*	0 55 57	-24 31 54	A0	14.38	0.18	0.06	P
177	390	71I	5737	CD -30 297	*f*	0 56 11.9	-29 37 37	B7III	4.31	-0.18	-0.52	BW
178				E29.3.097	*f*	0 56 18	-29 35 54	A	14.35	0.17		E
179	391			CD -35 332		0 56 30	-34 45 00	A3	11.70	0.10	0.21	P
180	393	73I	5769	CD -30 299	*f*	0 56 36.7	-29 40 17	A4V	9.31	0.19	0.07	DR
181	398		5824	CD -32 395	*f*	0 57 03.2	-32 14 04	A9V	9.64	0.32	0.00	E
182	399	74I		CD -27 317	*f*	0 57 16.0	-27 01 54	A3/5	11.12	0.17	0.10	DR
183				CD-25 390	*f*	0 57 28.9	-25 00 00	A7	10.61			
184	402					0 57 54	-23 24 00	A5	13.6			
185	404			CS22942-28	*f*	0 57 59	-25 33 54	A3	13.55	0.31	0.04	DR
186	403	41II				0 58 00	-20 48 00	A5	11.6			
187	405			CD -28 307	*f*	0 58 00	-28 28 00	A	13.15			
188	408	42II			*f*	0 58 27.7	-28 21 37	A2	14.23	0.21	0.04	DR
189	410	43II	CH183			0 58 54	-33 59 00	B	12.57	-0.16	-0.99	AT
190		44II				0 59 09.7	-23 31 47	A7	12.15	0.36	-0.07	EG
191			6088	CD -26 334	*f*	0 59 23.9	-26 09 20	A5	9.75			
192	411	75I		CD -30 314	*f*	0 59 37.4	-29 47 22	A5	12.83	0.29	-0.02	DR
193	414	77I	6178	CD -32 410	*f*	1 00 03.2	-31 49 14	A1/2IV	5.49	0.10	0.12	E
194	413	76I		CD -31 412	*f*	1 00 04.6	-31 29 28	A8	10.42	0.32	0.08	E
195				CS22942-37		1 00 38	-23 34 36	A	14.15	0.10	0.21	P
196	415					1 00 42	-21 39 00	A	13.8			
197	416	78I	GD673	CD -30 324	*f*	1 00 49.5	-29 59 42	B9/A0	11.19	-0.01	-0.33	PH
198	418			E 29.2.132	*f*	1 00 52	-29 27 36	A5	13.24	0.21	-0.03	DR
199	421				*f*	1 01 18	-28 01 00	B	13.08			
200			CH186		*f*	1 01 19.3	-25 35 04	A5	13.91	0.24	0.04	DR
201	420	79I		CD -24 469	*f*	1 01 24	-24 17 12	A0	12.77	0.09	0.14	P
202			CH185		*f*	1 01 18	-27 06 00	A	14.6			
203	423	45II				1 01 36	-33 55 00	A0	13.83	0.06	0.10	EG
204	426	80I	6340	CD -35 361		1 01 38.5	-34 56 40	A2V	8.99	0.08	0.03	BW
205	425			CD -22 371		1 01 42	-22 30 00	A7	11.2			
206	429			BD -20 189		1 01 54	-20 03 00	F0	10.4			
207	431	82I	6365	CD -30 330	*f*	1 01 53.5	-30 17 23	A3III/IV	9.81	0.26	0.05	E
208	430	81I	6364	CD -27 345	*f*	1 01 53.7	-27 25 21	A5/7III	9.62	0.28	0.03	BW
209	432		CH189	CS22942-31	*f*	1 02 11	-26 47 48	A	14.98	0.08	0.14	P
210			DR19	CS22942-32	*f*	1 02 36	-25 58 00	A2	14.63	0.22	0.01	DR
211	433	84I	6451	BD -20 191		1 02 45.9	-20 07 19	A7V	8.56	0.24	0.16	BW
212				BOK358F	*f*	1 02 57.9	-29 11 36	E	14.80	0.34		B
213	435	46II			*f*	1 03 13.7	-24 14 16	A0	13.38	-0.03	-0.11	EG
214	439			BD -20 193		1 03 24	-20 03 00	A2	10.7			
215			6515	BD -22 193		1 03 24.7	-21 50 01	A5	8.48	0.37		CS
216	440		6516		*f*	1 03 27.3	-25 44 57	A9V	9.22			
217	441	83I	6532	CD -27 355	*f*	1 03 31.4	-26 59 45	A2m	8.43	0.15	0.06	DR
218	442			CD -28 345	*f*	1 03 36.8	-27 48 11	A7	12.09			
219				KR3	*f*	1 03 44.3	-31 22 53		14.65	0.06		KR
220				BOK312F	*f*	1 04 07.6	-30 07 53	E	14.50	0.32		B

TABLE 5—*Continued*

No[a]	SB[b]	PS[c]	ID[d]	CD, others[e]	B[f]	R.A. (1950)	Dec. (1950)	Spectral type[g]	m_V[h]	B-V	U-B	S[i]
221	446	47II	CH191	GD679	f	1 04 24	-33 34 00	B	13.58	-0.30	-1.12	EG
222				BOK255F	f	1 04 26.7	-29 13 05	E	14.79	0.34		B
223			SP280		f	1 04 26.9	-30 34 16	A2w	13.08			
224	449	48II			f	1 04 34.6	-28 23 45	A0	13.15	0.22	0.01	DR
225	451	85I	6670	CD -30 348	f	1 04 38.1	-29 52 56	A9V	9.38	0.34	-0.04	DR
226	450	86I	6668	CD -24 496	f	1 04 47.3	-24 15 45	A5	6.36	0.17	0.09	BW
227	453	49II			f	1 05 00	-32 35 00	F0	12.88			
228			6724	CD -29 334	f	1 05 11.3	-29 33 13	F0V	9.29	0.35		E
229	455	87I	6723	CD -29 335	f	1 05 12.6	-28 58 16	A8V	9.08	0.28	0.01	DR
230	456					1 05 12	-33 43 00	A	14.1			
231	457					1 05 48	-20 07 00	A2	12.8			
232	458	89I		BD -22 206		1 06 04.7	-22 23 59	A5	11.90			
233	459	88I	CH192	CD -33 417	f	1 06 04.5	-32 59 31	B	12.23	-0.23	-0.98	CS
234			CH193	CI-331061	f	1 06 12	-32 56 00	A	14.5			
235	460	90I	CH194	CD -27 372	f	1 06 13.4	-27 09 06	B6	12.58	-0.15	-0.61	DR
236			6855	CD -34 439		1 06 20.5	-34 34 47	F0V	9.44	0.38		CS
237			KR7	BOK125F	f	1 06 23.3	-28 57 16	E	14.69	0.33		B
238				E29.0.197	f	1 06 25	-29 08 36	E	12.52	0.34		E
239	462	50II				1 06 30	-21 47 00	A0	13.36	0.07	0.20	EG
240				CI-331066	f	1 06 36	-33 26 00	B	12.05			
241	463	91I	CH195	CD -33 421	f	1 06 42.4	-33 23 58	B4	12.16	-0.15	-0.1	GW
242	464	92I		CD -33 423	f	1 07 00.4	-32 55 41	A2	12.5			
243	466	51II				1 07 06	-22 57 00	A3	12.88	0.28	0.04	EG
244	467				f	1 07 04.8	-26 55 43	F0	13.36	0.41	-0.21	DR
245	469				f	1 07 35.5	-28 14 29	A	13.10	0.36	-0.14	DR
246	471	93I		CD -34 450		1 07 48	-34 01 00	F0	10.7			
247			7038	CD -35 407		1 07 55.2	-34 46 08	F1	9.38			
248	474	52II		HL3361	f	1 08 07.0	-26 20 42	A0	13.18	-0.02	-0.05	DR
249	473			HL7200	f	1 08 07.4	-25 56 40	A0	14.28	0.01	0.03	DR
250	477	94I		BD -22 210		1 08 36	-22 16 00	F0	10.7			
251	480	53II		CS22946-01		1 08 51	-21 54 48	A0	13.04	0.00	0.06	EG
252				BOK 96F	f	1 08 56.1	-30 03 40		14.90	0.34		B
253	481	95I	7184	CD -27 389	f	1 09 26.7	-26 37 18	A2III/IV	9.88	0.21	0.07	DR
254	485	54II	CH201	GD691	f	1 09 48.0	-26 29 20	A0	13.15	-0.24	-1.04	DR
255	486	55II				1 09 59.4	-21 44 15	A0	12.96	0.08	0.11	EG
256	488	96I		CD -23 439		1 10 00	-23 06 00	A0	12.6			
257	493	97I		CD -23 448		1 10 36	-22 52 00	A3	11.8			
258	496			CD -34 465		1 10 52.7	-34 02 09	A5/F0	10.5			
259	495	56II			f	1 10 54	-32 47 00	A	12.78			
260	497			CD -22 422		1 11 07.1	-22 17 03	A7	12.3			
261	499		7400		f	1 11 24	-24 31 00	F0	9.73			
262	502	98I		CD -30 389	f	1 11 33.1	-30 02 15	A3	12.24			
263	503				f	1 11 36	-26 40 00	A5	14.25	0.24	-0.03	DR
264	504	99I		BD -22 217		1 11 48	-22 13 00	F0	11.1			
265	505	57II				1 11 59.8	-21 17 40	A5	12.16	0.21	0.12	EG
266			DR44		f	1 12 30	-28 14 00	A2	14.00	0.29	-0.04	DR
267	509	100I	7553	CD -23 462		1 12 56.3	-23 11 06	A5	9.57			
268	511		7629	CD -24 548	f	1 13 29.5	-24 14 11	F0III	7.13	0.30		CS
269	512	101I		CD -26 414	f	1 13 37.2	-25 58 22	A7	11.99	0.29	-0.01	DR
270	514	102I	7652	CD -24 549	f	1 13 42.3	-24 10 04	A1V	10.07	0.11	0.08	BW
271	515		7676	CD -34 483		1 13 47.5	-34 24 44	A3m	8.38			
272	516		CH202	KR12	f	1 14 09.2	-27 11 15	A1	14.81	0.08	0.19	DR
273	517	103I		CD -32 498	f	1 14 18	-32 08 00	A3	11.6			
274	519	58II		KR13	f	1 14 36.0	-27 14 48	A0	13.45	0.03	0.10	DR

TABLE 5—*Continued*

No[a]	SB[b]	PS[c]	ID[d]	CD, others[e]	B[f]	R.A. (1950)	Dec. (1950)	Spectral type[g]	m_V[h]	B-V	U-B	S[i]
275	520		CH203	KR14	f	1 14 36.0	-28 01 46	A0	14.54	0.05	0.09	DR
276	521					1 14 48	-34 31 00	A	14.3			
277	522	104I		CD -32 501	f	1 14 54	-32 22 00	A2	11.59			
278			SP295		f	1 15 28.4	-30 02 57	Aw	14.0			
279	528	105I	7875	CD -24 562	f	1 15 40.6	-24 0 16	A2	9.71	0.30	0.13	BW
280	529	107I	7876	CD -25 515	f	1 15 41.7	-24 48 07	A2	10.05	0.20	0.07	BW
281	530	106I	7898	CD -34 494		1 15 44.3	-34 24 00	A9IV	7.74	0.26		CS
282	531	108I	7908	CD -23 477		1 16 01.0	-23 16 31	A7III	7.29	0.28		CS
283	532	59II			f	1 16 00	-33 23 00	A0	13.65	0.08	0.21	EG
284		60II		GD696		1 16 48.4	-23 10 02	A0	14.38	0.00	0.02	EG
285	534					1 16 42	-20 59 00	F0	13.0			
286	535	109I	8033	CD -23 483		1 16 58.2	-23 22 10	F0V	9.19	0.31		CS
287	537	62II			f	1 17 07.2	-26 57 33	A7	12.96	0.28	0.10	EG
288	539			CD -23 488		1 17 26.9	-23 12 04	A5/F0	9.0			
289	543	110I	8091	BD -21 213		1 17 32.4	-21 10 44	A5	10.6			
290	544	111I		CD -23 492		1 17 36	-22 45 00	A2	12.5			
291			8145	CD -30 434	f	1 18 03.6	-29 51 41	F2V	8.45	0.32		CS
292		112I	8163	CD -27 443	f	1 18 19.6	-26 37 46	A9/F0V	10.18			
293	549	113I		BD -21 217		1 18 54	-21 20 00	A2	11.3			
294	551	114I		CD -26 442	f	1 19 05.4	-26 16 11	A0	10.79	0.21	0.07	PW
295	552	115I		CD -23 500		1 19 12	-23 02 00	A3	11.5			
296	554				f	1 19 36	-32 06 00	A0	13.92			
297	557	116I		CD -23 504		1 19 48	-23 28 00	A0	11.1			
298	559	117I		CD -24 590	f	1 20 00	-23 51 00	A0	12.3			
299			SP298		f	1 20 24.5	-28 40 10	A1w	14.25			
300		118I		CD -28 421	f	1 20 30	-28 23 00	A7	11.67			
301	561		8380			1 20 18	-21 41 00	F0	8.09			
302	562			CD -26 452	f	1 20 28.0	-25 54 59	A7	11.51			
303	563		CH211		f	1 20 29.2	-30 10 15	A	14.47			
304	567		8472	CD -25 554	f	1 21 01.9	-25 20 42	A0	10.31	-0.07	-0.38	BW
305	568		8487	CD -25 555	f	1 21 11.9	-24 36 47	A7Vn	6.65	0.24		CS

[a] Catalog number.

[b] Slettebak and Brundage 1971.

[c] Philip and Sanduleak 1968, lists I and II. Four stars from PS—60I, 72I, 40II, and 61II—were omitted from the catalog as they are all later spectral types than F stars.

[d] Identifications, HD number; CH, Chavira 1958; SP, Philip and Stock 1972; DR, Drilling 1977.

[e] CD number, BD number; CS, Pier 1983; E, Eriksson 1978; KR, Ratnatunga 1983; BOK, Bok and Basinski 1964; CI, CSI (Ochsenbein, Bischoff, and Egret 1981); LB, Luyten 1966; HL, Haro and Luyten 1962; GD, Giclas, Burnham, and Thomas 1972.

[f] Star is in box area.

[g] Spectral types with luminosity classification are from Michigan Spectral Catalog (Houk 1978); others are the estimates from original finding lists.

[h] Magnitudes to two decimal places are from *UBV* or *uvby* photometry. Those to one decimal place are the estimates from original finding lists.

[i] Sources for *UBV* photometry: AT, Andrews and Thackeray 1973; B, Bok and Basinski 1964; BI, Iriarte 1970; BW, Westerlund 1963; CS, Cousins and Stoy 1963; E, Eriksson 1978; EG, Eggen (in Rodgers 1971); DR, Drilling 1977; P, Pier 1983; PH, in Philip 1974; PW, Penston and Wing 1972.

TABLE 6

STRÖMGREN PHOTOMETRY, RADIAL VELOCITIES, $D(0.70)$ AND W(K) VALUES, FOR SGP STARS

No	ID[a]	$b-y$[b]	m_1	c_1	RV[c] (km s^{-1})	D(.70)[d] (Å)	W(K)[e,f] (Å)	S[g]	comments
1	122						1.0[e]		
3	124	0.190	0.184	0.704				HH	[h]
6	126				+32		0.3[e]		
9	133 1II	0.048	0.127	1.354	-115	[d]16.0	0.5[e]	Ph	
10	134 1I	0.202	0.235	0.734	[c]+29			Ph	[h]
12	136 2II	0.080	0.170	1.056	+42	26.9	2.39	Ph	
13	1667	0.172	0.197	0.857				HH	[h]
15	143	-0.090	0.270	-0.250				GS	[h]
18	3II	0.229	0.166	0.583	+67	12.3	5.53	Ph	
20	147	-0.175	0.054	-0.204				GS	
24	153 7I	-0.029	0.138	0.659	[c]-5			AM	[h]
26	161 8I	0.059	0.221	1.002	[c]-5			HH	[h]
27	162 9I	0.184	0.125	0.796	[c]+13			HH	[h]
28	163	0.221	0.166	0.580				HH	[h]
29	167 10I	0.024	0.168	1.097	[c]+1			HH	[h]
30	169	-0.121	0.067	-0.168				GS	[h]
31	171	-0.073	0.111	0.485				GS	[h]
32	172 11I	0.008			+11	20.8	0.57		
33	173	0.105	0.130	1.290				EB	[h]
35	178	0.301	0.086	0.339				HH	[h]
36	179 4II	0.166	0.194	0.645	-55	14.2	3.70	Ph	
37	181 13I	0.147	0.250	1.298	[c]+14			Ph	[h]
38	182 14I	-0.011	0.158	1.044	[c]+23			Ph	[h]
40	15I	0.188	0.170	0.936	[c]+19			HH	[h]
41	191 5II	0.251	0.239	0.950	-132		0.4[f]	Ph	[h]
45	192 6II	0.054	0.166	1.254	0		0.7[e]	Ph	[h]
46	194 7II	0.108	0.188	0.885	-12	22.7	2.81	Ph	
47	197 17I	0.235	0.129	0.553				HH	[h]
49	198 8II	0.156	0.182	0.849	+46	18.4	4.25	Ph	
50	199 18I	0.050	0.208	0.993	+34	25.1	1.47	HH	
52	9II	0.293	0.109	0.377	-36		2.1[f]	Ph	[h]
53	202 10II	0.097	0.177	0.930	+109	26.8	2.03	Ph	
54	203 19I	0.079	0.152	1.047	[c]+1			HH	[h]
56	208 11II	0.039	0.172	1.342			0.4[f]	Ph	[h]
57	12II						0.4[f]		
58	210 13II	0.016	0.136	1.255	+22		0.5[e]	Ph	[h]
60	212 14II	-0.005	0.141	1.043	-119	[d]16.0	0.4[f]	Ph	
61	213 21I	0.207	0.165	0.711				HH	[h]
65	2980	0.215	0.167	0.726				HH	[h]
66	221 15II	0.077	0.132	1.313	-105	23.2	1.33	Ph	[i]
67	222 22I	0.131	0.191	0.856				HH	[h]
68	225 16II	0.066	0.157	1.280	-15	25.8	0.82	Ph	[i]
71	231 17II	0.013	0.112	1.179	-50	[d]17.4	0.5[e]	Ph	
72	235 18II	0.008	0.137	1.242	-37	24.1	0.55	Ph	variable
73	236 23I	0.171	0.149	0.773	[c]+6			HH	[h]
75	C22882-22				+92		0.5[e]		
76	3300	0.288	0.162	0.428				HH	[h]
77	242 25I	0.165	0.230	0.723	[c]+14			HH	[h]
78	3338	0.223	0.156	0.645				HH	[h]
79	C22882-25				+19		0.5[e]		
81	246 19II	0.131	0.128	1.232	+6	[d]21.8	1.2[f]	Ph	
82	26I	0.185	0.178	0.710				HH	[h]
84	248	0.198	0.182	0.631				HH	[h]
86	254 29I	0.116	0.201	0.908				HH	[h]
87	256 30I	-0.070	0.125	0.490	[c]+9			HH	[h]
88	257 20II	0.090	0.131	1.242	+57	24.3	1.71	Ph	
89	259 21II	0.019	0.166	1.268	-9	[d]20.0	0.5[f]	Ph	
90	264	0.242	0.092	0.644				GS	[h]
91	263 31I	0.115	0.206	0.812	+22	5.7	5.37	HH	[i]
93	272 22II	0.161	0.161	0.809	-36	17.0	3.34	Ph	
94	273 33I	0.244	0.088	0.506				GS	[h]

TABLE 6—*Continued*

No	ID[a]	$b-y$[b]	m_1	c_1	RV[c] (km s^{-1})	D(.70)[d] (Å)	W(K)[e,f] (Å)	S[g]	comments
95	276 23II	0.075	0.170	1.202	+92	[d]17.0	1.2[f]	Ph	
96	277 34I	-0.060	0.182	0.685				HH	[h]
97	279 24II	0.228	0.136	0.658	-44	12.8	3.86	Ph	
99	283 25II	0.031	0.124	1.222	-32	[d]21.0	0.7[f]	Ph	
100	284 35I	0.040	0.219	0.987	-10	21.7	2.65	HH	
101	285 26II	0.097	0.218	0.925	+42	[d]25.0	1.7[f]	Ph	
102	286 37I	0.217	0.140	0.856				HH	[h]
103	287 36I	0.061	0.207	0.969	-24	24.1	1.14	Ph	
104	288 38I	0.155	0.214	0.779	-39	10.9	2.41	HH	
106	294 39I	0.210	0.109	0.752				GS	[h]
107	293 40I	0.001	0.154	1.070				HH	[h]
109	298 27II	0.034	0.178	1.208	+8	25.5	2.60	Ph	
110	41I	0.230	0.137	0.553	[c]+14			HH	[h]
111	299 42I	0.133	0.210	0.851	+54	17.4	3.53	HH	
112	300	0.223	0.151	0.632				HH	[h]
113	301				-84	12.3	2.39		
114	302 28II	0.055	0.201	1.006		[d]27.0	0.4[f]	Ph	
116	306 45I	0.074	0.209	1.033	-4	29.3	2.14	Ph	
117	307 44I	0.077	0.188	1.059	+24	29.3	2.96	HH	
119	312 47I	0.169	0.201	0.784	-15	15.6	3.38	Ph	
121	C22942-04				+95		1.0[e]		
122	314 49I	0.192	0.167	0.722	[c]-17			Ph	[h]
123	315				+82	20.8	3.12		
124	316 50I	0.251	0.145	0.669	-11	7.1	4.35	L	
125	317 29II	0.170	0.193	0.756	-76	17.0	3.65	Ph	
126	318 51I	0.051	0.179	0.952	-24	27.4	1.08	HH	
127	320 52I	0.121	0.219	0.907	+17	16.0	3.27	HH	
128	322 30II	0.079	0.205	0.953	+44	24.6	2.96	Ph	
129	323	0.193	0.192	0.739	-9	12.3	3.73	L	
131	327	0.196	0.169	0.736	[c]+10			HH	[h]
132	329 54I	-0.016	0.137	0.968	[c]+19			Ph	[h]
133	330 31II	0.222	0.105	0.489	+51	11.8	1.71	Ph	
135	333	0.224	0.155	0.580	+4	10.4	4.07	HH	
136	4689	0.255	0.165	0.489				HH	[h]
137	335 55I	0.198	0.190	0.769	+21	14.2	4.39	Ph	
138	337 56I	0.173	0.152	0.880	-16	11.8	3.41	Ph	
139	338	0.179	0.127	0.956				GS	[h] RR Lyrae
140	340 57I	0.084	0.165	1.206	[c]+6			Ph	[h]
141	C22942-09				-5		1.6[e]		
142	342 58I	0.230	0.118	0.512	+27	9.9	1.43	GS	
143	344 59I	0.111	0.195	0.936	-8	26.0	1.96	Ph	
144	343	0.212	0.226	0.618	-18	11.8	5.99	HH	
146	E30.1.036	0.211	0.130	0.595	+87	11.3	5.47	L	
147	E30.1.041	0.288	0.134	0.562	+37	9.0	5.84	L	
148	4974	0.219	0.160	0.684				HH	[h]
150	350 32II	0.134	0.160	1.045	-46	29.7	1.45	Ph	[i]
152	62I	0.219	0.162	0.700	[c]+4			HH	[h]
153	353				+31		0.6[e]		
154	354 33II	-0.001	0.109	0.932	+68	[d]9.5	0.1[e]	Ph	
156	360 34II	-0.114	0.129	-0.209	-4		0.4[f]	Ph	[h]
158	361 63I	0.150	0.193	0.886	+3	19.8	2.74	Ph	
159	362 35II	0.064	0.157	1.254	-32	[d]20.0	0.5[e]	Ph	
160	363 36II	0.129	0.117	1.200	+106	[d]18.0	1.7[f]	Ph	
161	366 37II	0.104	0.199	0.888	-22	23.6	3.02	Ph	
162	367 64I	0.204	0.173	0.774	+20	11.3	2.12	L	
163	371 38II	0.235	0.135	0.870	-19	9.4	3.85	Ph	UV Scl.
164	373 39II	0.078	0.193	0.971	-15	24.0	3.09	Ph	
165	375 65I	-0.028	0.144	0.878	[c]-26	16.5	0.33	Ph	
167	377 66I	0.057	0.201	1.028	+32	19.8	2.47	Ph	
168	379 67I	0.121	0.183	0.926	-24	23.1	2.72	Ph	
172	384 68I				-18	10.9	4.11		
173	386	0.202	0.200	0.704	-61	11.8	3.95	HH	

TABLE 6—*Continued*

No	ID^{a}	$b - y^{b}$	m_1	c_1	RV^{c} (km s^{-1})	D(.70)^{d} (Å)	W(K)^{e,f} (Å)	S^{g}	comments
174	387 70I	0.210	0.157	0.749	-90	10.8	2.91	L	
175	388 69I	-0.009			+78	18.9	0.42		
176	389				-28		1.1^{e}		
177	390 71I	-0.050	0.097	0.494	^{c}+10			Ph	^{h}
180	393 73I	0.111	0.194	0.926	^{c}+10			Ph	^{h}
181	398	0.189	0.159	0.716	-7	10.9	3.05	HH	
182	399 74I	0.095	0.222	1.005	-10	22.7	3.09	Ph	
183	CD-25 390	0.300	0.081	0.633	-16	7.1	3.46	L	
185	404				+34		3.2^{e}		
186	403 41II	0.228	0.150	0.722	-63	13.7	5.44	Ph	
187	405	0.237	0.075	0.972				GS	^{h}RR Lyrae
188	408 42II	0.142	0.171	0.913	-14	^{d}22.0	0.9^{f}	Ph	
189	410 43II	-0.114	0.066	-0.049	+59		0.4^{f}	Ph	^{h}
190	44II	0.252	0.139	0.499	+4	8.5	5.16	Ph	
191	6088	0.213	0.165	0.630	-12	11.3	4.25	HH	
192	411 75I	0.191	0.183	0.694	+132	15.1	3.55	Ph	
193	414 77I	0.041	0.187	1.069	^{c}+4			AM	^{h}
194	413 76I	0.194	0.193	0.680	-11	12.8	4.58	HH	
195	C22942-37				-98		1.4^{e}		
197	416 78I	-0.018	0.183	0.705	+23	15.1	0.34	Ph	
198	418	0.241	0.096	0.691	+91	13.2	3.80	L	
199	421	0.328	0.084	0.233				GS	^{h}
200	CH186				-82		3.20		
201	420 79I	0.051			+145	24.0	2.16		
203	423 45II				-41		0.3^{e}		
204	426 80I	0.041	0.212	1.004	^{c}-2			HH	^{h}
207	431 82I	0.150	0.164	0.822	-1	13.7	2.41	HH	
208	430 81I	0.157	0.220	0.707	+13	13.2	2.64	Ph	
209	432				+2		0.4^{e}		
210	DR19				+72		1.5^{e}		
211	433 84I	0.116	0.257	0.885	^{c}-5			HH	^{h}
213	435 46II	0.007	0.124	1.044	+119	22.2	0.63	Ph	
215	6515	0.223	0.167	0.583	^{c}+16			HH	^{h}
216	440	0.236	0.142	0.527	+25	9.0	3.93	HH	
217	441 83I	0.084	0.236	0.838	^{c}0			Ph	^{h}
218	442	0.329	0.061	0.303	-94	5.2	3.30	GS	
221	446 47II	-0.121	0.088	-0.150	+21		0.4^{f}	Ph	^{h}
223	SP280	0.325	0.086	0.290	-17	5.7	3.18	L	
224	449 48II	0.170	0.113	0.935	+82	^{d}15.0	1.0^{f}	Ph	
225	451 85I	0.213	0.150	0.652	+22	11.3	3.30	HH	
226	450 86I	0.140	0.209	0.829	^{c}+15			Ph	^{h}
227	453 49II	0.265	0.118	0.851	+28		0.4^{f}	Ph	^{h}RR Lyrae
228	6724	0.253	0.145	0.615	^{c}+1			HH	^{h}
229	455 87I	0.178	0.171	0.746	^{c}+2			HH	^{h}
233	459 88I	-0.112	0.109	-0.033	+1	15.6	0.10	Ph	
235	460 90I	-0.069	0.128	0.404	+182	15.1	0.30	Ph	
236	6855	0.231	0.164	0.572	^{c}+11			HH	^{h}
238	E29.0.197	0.283	0.197	0.417	+1	8.0	6.41	L	
239	462 50II	0.035	0.138	1.348	+147	^{d}17.6	0.5^{f}	Ph	
240	CI-331066	0.357	0.203	0.383	+13	4.7	6.61	L	
241	463 91I	-0.078	0.120	0.269	+259	11.8	0.33	Ph	
242	464 92I				-36	29.8	1.30		
243	466 51II	0.184	0.178	0.685	+26		2.2^{f}	Ph	^{h}
245	469	0.253	0.088	0.526				GS	^{h}
247	7038	0.252	0.179	0.565				HH	^{h}
248	474 52II	0.002	0.129	1.138	-34	^{d}17.0	0.4^{f}	Ph	
251	480 53II	0.004	0.134	1.209	+85	^{d}17.5	0.1^{f}	Ph	
253	481 95I	0.116	0.213	0.879	+18	20.8	2.36	Ph	
254	485 54II	-0.105	0.083	-0.055	-42		0.4^{f}	Ph	^{h}
255	486 55II	0.031	0.150	1.271	-6	21.7	1.46	Ph	
259	495 56II	0.187	0.124	0.790	-2	^{d}16.0	1.6^{f}	Ph	
260	497				+14	13.7	3.83		

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TABLE 6—*Continued*

No	ID[a]	$b-y$[b]	m_1	c_1	RV[c] (km s^{-1})	D(.70)[d] (Å)	W(K)[e,f] (Å)	S[g]	comments
261	499	0.209	0.175	0.711	+14	8.0	3.04	HH	
262	502 98I	0.059	0.198	0.924	+55	29.8	2.05	L	
264	504 99I	0.189	0.215	0.609				Ph	[h]
265	505 57II	0.102	0.183	0.875	+11	21.7	3.26	Ph	
267	509 100I	0.213	0.168	0.684				Ph	[h]
268	511	0.184	0.179	0.755	[c]-1			HH	[h]
269	512 101I	0.200			[c]-47	12.8	2.79		
270	514 102I	0.061	0.224	1.022	0	19.0	1.88	Ph	
271	515	0.085	0.280	0.715	[c]+11			HH	[h]
273	517 103I				+247	28.3	1.75		
274	519 58II	0.013	0.167	1.260	+200	[d]22.0	0.4[f]	Ph	
277	522 104I	0.043			+58	19.4	1.72		
279	528 105I	0.165	0.239	0.832	-72	15.6	2.59	HH	
280	529 107I	0.085	0.211	0.992	+31	26.9	1.56	HH	
281	530 106I	0.158	0.182	0.821	[c]+3			HH	[h]
282	531 108I	0.196	0.136	0.660	[c]+11			HH	[h]
283	532 59II	0.042	0.169	1.246	+26		0.4[f]	Ph	[h]
284	60II	-0.011	0.163	1.152	-26	17.0	0.36	Ph	
286	535 109I	0.179	0.205	0.645	[c]+15			HH	[h]
287	537 62II	0.166	0.191	0.775	-53	16.1	4.48	Ph	
291	8145	0.192	0.196	0.772	[c]-5			HH	[h]
292	112I				-18		2.81		
294	551 114I	0.110	0.165	0.914	-41	18.4	3.25	L	
295	552 115I				+5	27.4	2.75		
296	554	0.140	0.090	1.230				GS	[h]
297	557 116I				+2	25.5	1.89		
298	559 117I				-7	24.6	2.54		
299	SP298	0.221	0.144	0.397	-21	14.6	1.10	L	
300	118I	0.300	0.089	0.548	+16	8.0	4.42	L	
301	561	0.233	0.273	0.687				HH	[h]
302	562	0.218	0.094	0.689	+28	12.7	2.96	L	
303	563	0.069	0.108	1.146	+191	25.5	0.41	L	
304	567	-0.018	0.113	0.601	-26	10.9	0.13	HH	
305	568	0.138	0.209	0.815	[c]-1			HH	[h]

[a] Three-digit numbers are SB, numbers with "I" or "II" are PS, others are as in Table 5.

[b] Where $b-y$ alone is given, it has been derived from $B-V$ via Kurucz 1979 models.

[c] Radial velocity is from Abt and Biggs 1972.

[d] D 0.70 was derived from D 0.80 values (Rodgers 1971) via Kurucz 1979 models.

[e] W(K) is from Pier 1983. The radial velocity cited is also from that paper.

[f] W(K) is from Rodgers 1971 or Rodgers, Harding, and Sadler 1981, as is the radial velocity cited. Other than results marked with footnotes c–f radial velocity, D 0.70 and W(K) values are from the present paper.

[g] The sources of the *uvby* photometry: HH, McFadzean, Hildich, and Hill 1983; Ph, Philip 1974 and 1986; GS, Graham and Slettebak 1973; EB, Eggen and Bessel 1978; AM, Albrecht and Maitzen 1980; L, this paper.

[h] No spectrum was available, so that gravities and temperatures were found from *uvby* photometry only.

[i] The photometry was not consistent with spectral indices—PS 15II and PS 16II are discussed in III*d*. For PS 32II, $b-y$ was derived from Eggen's $B-V$, as it was consistent with other measures, rather than Philip's $b-y$. For PS 31I, the spectral type is around F2, in contrast to $b-y$ of 0.115.

peculiar A stars, the mean $v \sin i$ for three M67 blue stragglers is 85 ± 30 km s^{-1}, and for five SGP A stars, 145 ± 33 km s^{-1}, a 2 σ difference. If the slowly rotating peculiar stars are included, then the difference, not unexpectedly, becomes less apparent: 66 ± 45 km s^{-1} for the M67 stars and 105 ± 61 km s^{-1} for the SGP stars.

While there is a reasonable indication that the nonpeculiar SGP A stars have systematically higher rotational velocities than blue stragglers, the sample of blue stragglers presently available for comparison is too small to consider this result to be reliably established. It is clear that the SGP stars are not HB stars (whether metal-rich or metal-poor), with expected $v \sin i$ values of less than 30 km s^{-1}; so part of the first-category hypothesis, that the distant A stars might have been misidentified HB stars, is not supported. In the case of blue stragglers the rotational velocity criterion is less decisive, so their properties require further exploration.

In Paper II of this series, data on a large number of SGP A stars are derived, including surface gravities, temperatures, abundances, distances, kinematics, and ages. The sample is classified into Populations I and II. All the hypotheses concerning the origin of the distant Population I stars are critically examined in the light of these more accurate measurements.

V. SUMMARY

1. A catalog has been compiled of 305 early-type stars to F0 and 15th magnitude in 218 deg^2 at the SGP (see Tables 5 and 6).
2. Strömgren photometry and medium- and high-resolution spectra for many of the catalog stars have been obtained. Radial velocities, Hδ line widths [$D(0.70)$], Balmer jumps (Strömgren c_1 indices), and Ca II K line equivalent widths have been measured and tabulated.
3. Rotational velocities ($v \sin i$) were obtained for eight distant A stars and are typical of values for normal young MS stars.

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REFERENCES

Abt, H. A. 1985, *Ap. J.* (*Letters*), **294**, L103.
Abt, H. A., and Biggs, E. S. 1972, *Bibliography of Stellar Radial Velocities* (Tucson: KPNO).
Albrecht, R., and Maitzen, H. M. 1980, *Astr. Ap. Suppl.*, **42**, 29.
Allen, C. W. 1973, *Astrophysical Quantities* (London: Athlone).
Andrews, P. J., and Thackeray, A. D. 1973, *M.N.R.A.S.*, **165**, 1.
Bok, B. J., and Basinski, J. 1964, *Mem. Mount Stromlo Obs.*, **4**, 3.
Chavira, E. 1958, *Bols. Obs. Tonantzintla*, No. 17, p. 15.
Cousins, A. W. J., and Stoy, R. H. 1963, *Royal Obs. Bull.*, **64**.
Crawford, D. L. 1975, *A.J.*, **80**, 955.
______. 1977, *A.J.*, **83**, 48.
______. 1979, *A.J.*, **84**, 1858.
Deutch, A. J. 1966, *Carnegie Institute of Washington Year Book 65, 1965–1966*, (Baltimore: Garmond/Pridemark), p. 148.
______. 1968, *Carnegie Institute of Washington Year Book 67, 1967–1968*, (Baltimore: Garamond/Pridemark), p. 24.
Drilling, J. S. 1977, *A.J.*, **82**, 714.
Eggen, O. J. 1969, *Pub. A.S.P.*, **81**, 741.
Eggen, O. J., and Bessell, M. S. 1978, *Ap. J.*, **226**, 411.
Eggen, O. J., Lynden-Bell, D., and Sandage, A. R. 1962, *Ap. J.*, **136**, 748.
Eriksson, I. W. 1978, *Uppsala Astr. Obs. Report*, No. 11.
Freeman, K. C. 1987, *Ann. Rev. Astr. Ap.*, **25**, 603.
García, B. E., and Levato, H. 1984, *Rev. Mexicana Astr. Ap.*, **9**, 9.
Giclas, H. L., Burnham, R., and Thomas, N. G. 1972, *Lowell Obs. Bull.*, **7**, 217.
Graham, J. A., and Slettebak, A. 1973, *A.J.*, **78**, 295.
Gray, D. F. 1976, *The Observation and Analysis of Stellar Photospheres* (New York: John Wiley).
Green, E. M., Demarque, P., and King, C. 1987, *The Revised Yale Isochrones and Luminosity Functions* (New Haven: Yale University Press).
Greenstein, J. L., and Sargent, A. I. 1974, *Ap. J. Suppl.*, **28**, 157.
Grønbech, B., and Olsen, E. H. 1976, *Astr. Ap. Suppl.*, **25**, 213.
Haro, G., and Luyten, W. J. 1962, *Bol. Obs. Tonantzintla y Tacubaya*, **3**, 37.
Hartkopf, W. I., and Yoss, K. M. 1982, *A.J.*, **87**, 1679.
Houk, N. 1978, *Michigan Catalogue of Two-Dimensional Spectral Types for the HD Stars*, (Ann Arbor: University of Michigan Press).
Iben, I. 1967, *Ann. Rev. Astr. Ap.*, **5**, 571.
Iriarte, B. 1970, *Bol. Obs. Tonantzintla*, **5**, 213.
Keenan, F. P., Brown, P. J. F., and Lennon, D. J. 1986, *Astr. Ap.*, **155**, 333.
Kilkenny, D., and Hill, P. W. 1975, *M.N.R.A.S.*, **173**, 625.
Kurucz, R. J. 1979, *Ap. J. Suppl.*, **40**, 1.
Lance, C. M. 1988, submitted (Paper II).
Luyten, W. J. 1966, *A Search for Faint Blue Stars: XXXIX, The South Galactic Pole* (Minneapolis: University of Minnesota Press).
McFadzean, A. D., Hildich, R. W., and Hill, G. 1983, *M.N.R.A.S.*, **205**, 525.
Mermilliod, J.-C. 1982, *Astr. Ap.*, **109**, 37.
Mihalas, D., and Binney, J. 1981, *Galactic Astronomy* (2d ed.; San Francisco: Freeman).
Morgan, W. W., Keenan, P. C., and Kellman, E. 1942, *An Atlas of Stellar Spectra* (Chicago: University of Chicago Press).
Newell, E. B., Rodgers, A. W., and Searle, L. 1969, *Ap. J.*, **158**, 699.
Norris, J. 1987, *Ap. J.* (*Letters*), **314**, L39.
Ochsenbein, F., Bischoff, M., and Egret, D. 1981, A*Astr. Ap. Suppl.*, **43**, 259.
Penston, P. W., and Wing, R. F. 1972, *Observatory*, **93**, 149.
Perry, C. L. 1969, *A.J.*, **74**, 139.
Peterson, R. C. 1985, *Ap. J.* (*Letters*), **294**, L35.
Peterson, R. C., Carney, B. W., and Latham, D. W. 1984, *Ap. J.*, **279**, 237.
Philip, A. G. D. 1974, *Ap. J.*, **190**, 573.
______. 1986, private communication.
Philip, A. G. D., Miller, T. M., and Relyea, L. 1976, *Dudley Obs. Rept.*, No. 12.
Philip, A. G. D., and Sanduleak, N. 1968, *Bol. Obs. Tonantzintla y Tacubaya*, **4**, 253.
Philip, A. G. D., and Stock, J. 1972, *Bol. Obs. Tonantzintla y Tacubaya*, **6**, 201.
Pier, J. R. 1983, *Ap. J. Suppl.*, **53**, 791.
Ratnatunga, K. U. 1983, Ph.D. thesis, Australian National University.
Relyea, L., Matlock, L. T., and Philip, A. G. D. 1975, *Dudley Obs. Rept.*, No. 9.
Rodgers, A. W. 1971, *Ap. J.*, **165**, 581.
Rodgers, A. W., Harding, P., and Sadler, E. 1981, *Ap. J.*, **244**, 912.
Sargent, W. L. W., Schecter, P. L., Boksenberg, A., and Shortridge, K. 1977, *Ap. J.*, **212**, 326.
Sargent, W. L. W., and Searle, L. 1968, *Ap. J.*, **152**, 443.
Slettebak, A., and Brundage, R. K. 1971, *A.J.*, **76**, 338.
Slettebak, A., Collins, G. W., Boyce, P. B., White, N. M., Parkinson, I. D. 1975, *Ap. J.*, **29**, 137.
Stetson, P. B. 1981*a*, *A.J.*, **86**, 1337.
______. 1981*b*, *A.J.*, **86**, 1882.
______. 1983, *A.J.*, **88**, 1349.
Straižys, V., and Kuriliene, G. 1981, *Ap. Space Sci.*, **80**, 353.
Strömgren, B. 1966, *Ann. Rev. Astr. Ap.*, **4**, 433.
Sweigart, A. V., and Gross, P. G. 1976, *Ap. J. Suppl.*, **32**, 367.
Taam, R. E., Kraft, R. P., and Suntzeff, N. 1976, *Ap. J.*, **207**, 201.

Tobin, W. 1986, *Astr. Ap.*, **155**, 326.
Tobin, W., and Kaufmann, J. P. 1984, *M.N.R.A.S.*, **207**, 369.
Tobin, W., and Kilkenny, D. 1981, *M.N.R.A.S.*, **194**, 937.
Twarog, B. A. 1980, *Ap. J.*, **242**, 242.
______. 1987, private communication.
Twarog, B. A., and Tyson, N. 1985, *A.J.*, **90**, 1247.
Uesugi, A., and Fukuda, I. 1970, *Mem. Faculty of Science*, *Kyoto Univ.*, No. 33, Art. 5.
van der Kruit, P. C., and Searle, L. 1981, *Astr. Ap.*, **95**, 116.
Westerlund, B. W. 1963, *M.N.R.A.S.*, **127**, 83.
Wielen, R. 1977, *Astr. Ap.*, **60**, 263.
Wielen, R., and Fuchs, B. 1982, in *Kinematics, Dynamics, and Structure of the Milky Way*, ed. W. L. H. Shuter (Dordrecht: Reidel), p. 81.
Wolff, S. C. 1983, *The A Stars: Problems and Perspectives* (Washington, DC: NASA).

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