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STELLAR KINEMATIC GROUPS. II. A REEXAMINATION OF THE MEMBERSHIP, ACTIVITY, AND AGE OF THE URSA MAJOR GROUP

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ABSTRACT

Utilizing *Hipparcos* parallaxes, original radial velocities and recent literature values, new Ca II H and K emission measurements, literature-based abundance estimates, and updated photometry (including recent resolved measurements of close doubles), we revisit the Ursa Major moving group membership status of some 220 stars to produce a final clean list of nearly 60 assured members, based on kinematic and photometric criteria. Scatter in the velocity dispersions and H-R diagram is correlated with trial activity-based membership assignments, indicating the usefulness of criteria based on photometric and chromospheric emission to examine membership. Closer inspection, however, shows that activity is considerably more robust at *excluding* membership, failing to do so only for $\leq 15\%$ of objects, perhaps considerably less. Our UMa members demonstrate nonzero vertex deviation in the Bottlinger diagram, behavior seen in older and recent studies of nearby young disk stars and perhaps related to Galactic spiral structure. Comparison of isochrones and our final UMa group members indicates an age of 500 ± 100 Myr, some 200 Myr older than the canonically quoted UMa age. Our UMa kinematic/photometric members' mean chromospheric emission levels, rotational velocities, and scatter therein are indistinguishable from values in the Hyades and smaller than those evinced by members of the younger Pleiades and M34 clusters, suggesting these characteristics decline rapidly with age over 200–500 Myr. None of our UMa members demonstrate inordinately low absolute values of chromospheric emission, but several may show residual fluxes a factor of ≥ 2 below a Hyades-defined lower envelope. If one defines a Maunder-like minimum in a *relative* sense, then the UMa results may suggest that solar-type stars spend 10% of their entire main-sequence lives in periods of precipitously low activity, which is consistent with estimates from older field stars. As related asides, we note six evolved stars (among our UMa nonmembers) with distinctive kinematics that lie along a 2 Gyr isochrone and appear to be late-type counterparts to disk F stars defining intermediate-age star streams in previous studies, identify a small number of potentially very young but isolated field stars, note that active stars (whether UMa members or not) in our sample lie very close to the solar composition zero-age main sequence, unlike *Hipparcos*-based positions in the H-R diagram of Pleiades dwarfs, and argue that some extant transformations of activity indices are not adequate for cool dwarfs, for which Ca II infrared triplet emission seems to be a better proxy than Hα-based values for Ca II H and K indices.

Key words: Galaxy: kinematics and dynamics — open clusters and associations: individual (Ursa Major group) — stars: distances — stars: kinematics — stars: late-type

1. INTRODUCTION

Despite a bevy of work by the late Olin Eggen arguing for the existence of stellar moving groups, the idea of kinematically identifiable relic assemblages of otherwise unremarkable field stars sharing a common origin and earlier history remains a curiously controversial one. On the one hand, the very idea of the dissolution of clusters and associations seems a reasonable one on its face. Open clusters confidently dated as older than the solar age are rare, with an exhaustive list presently including Berkeley 17 (~12 Gyr; Phelps 1997), NGC 188 (~7 Gyr; Sarajedini et al. 1999), and NGC 6791 (~8 Gyr; Chaboyer, Green, & Liebert 1999). Indeed, it has been known for several decades that cluster lifetimes in the Galactic disk are typically a few hundred million years (Wielen 1971). Theoretical calculations considering the disruption of star clusters due to internal relaxation, tidal effects of the stationary Galactic field, and encounters with massive objects (e.g., giant molecular clouds) corroborate such empirical estimates (Wielen 1991). This body of

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evidence seems consistent with the view of typical Galactic disk stars forming in an association or cluster but eventually taking up residence in the general field (Pudritz 2002). In this picture, moving groups are viewed as a segue whose stellar denizens retain distinctive kinematic signatures expected from the slow diffusion of former clusters' stellar orbits (Wielen 1977).

On the other hand, however, much criticism has been leveled at the idea of stellar moving groups, particularly, though not exclusively, old ones; such entities have been questioned on various grounds: the true uniformity of individual stellar properties, the a priori nature of assumptions sometimes used to identify group members, and data and bookkeeping issues (e.g., Taylor 2000 and references therein). Recent work has placed stellar moving groups on considerably firmer footing. Several *Hipparcos*-based studies utilizing nonparametric analyses (requiring no a priori assumptions concerning the extent of groups' three-dimensional kinematic, age, and spatial phase space) have found numerous significant phase-space density enhancements above those of the general disk field population (Asiain et al. 1999; Chereul, Crézé, & Bienaymé 1999; Skuljan, Hearnshaw, & Cottrell 1999); many of these detected structures correspond to Eggen's previously proposed kinematic groups, streams, and superclusters. More importantly, some of these analyses "detect" (as they should) known real structures such as the Pleaides.

Ursa Major, residing in Eggen's proposed Sirius supercluster (Eggen 1992), has received considerable historical attention among putative moving groups. As noted by Soderblom & Mayor (1993, hereafter SM93), UMa is a "best case" moving group. Its kinematics are distinctive compared with the young and intermediate-age disk field. Moreover, its relatively young age (0.3 Gyr according to SM93) has likely led to the intriguing circumstance that it contains a verifiable nucleus, albeit sparse. Given the previous UMa-oriented studies of Soderblom & Clements (1987) and SM93 and the recent nonparametric *Hipparcos*-based studies noted above, we take the reality of the UMa moving group as established.

Our purpose here is to reinvestigate the membership of the UMa moving group. In doing so, we utilize new parallaxes, radial velocities, activity measures, and resolved photometry of close doubles not available to SM93 and consider a larger sample of candidate members than the recent study of Montes et al. (2001). We selected most candidate members from the previous UMa group studies of SM93 and Montes et al. (2001 and references therein); a few others were included based on suggested possible UMa membership mentioned in other non–UMa-dedicated literature studies (e.g., Gaidos, Henry, & Henry 2000). The analysis was carried out with three major goals in mind. First, we wished to identify very clean samples of UMa group members and nonmembers that could be employed in future spectroscopic studies (or for refining extant ones) addressing the chemical homogeneity of moving groups. In doing so, two compromises are made: many stars are deemed to have uncertain membership status, and the necessity of adopting a priori kinematic definitions of the UMa group (based on the sparse nucleus) biases the resulting kinematic statistics. Second, we wished to revisit the age determination of the UMa group by using our membership list and new stellar isochrones. Third, we wished to investigate questions about chromospheric activity in UMa group stars motivated by the previous studies of Soderblom & Clements (1987) and SM93—namely, is activity a robust membership indicator? How do the overall level and spread of chromospheric emission in the UMa group compare with those in older and younger clusters? An important secondary goal was to investigate the coherence of kinematic and photometric membership criteria and chromospheric activity; this has import for future use of combined criteria in investigating membership in other moving groups, as well as for the reality of moving groups themselves.

2. DATA

2.1. *New Radial Velocity Data*

Radial and rotational velocities of candidate UMa group B, A, F, and a few later spectral type stars north of $\delta = -15^\circ$ were measured from CCD spectrograms centered at 4520 Å having 2 pixel (15 μm) resolution of $R \sim 60{,}000$. These were obtained with the long camera of the 1.22 m telescope of the Dominion Astrophysical Observatory using the 1752 × 532 thinned, UV-coated SITe-2 CCD, which yielded spectra of 63 Å in extent. The observations were made either as one exposure with signal-to-noise ratio $S/N = 200$ or as several observations each of lower S/N. In addition to the program stars, nightly spectra of one or more of the early radial velocity standards from Fekel (1992) were also obtained.

Each reduced (bias-subtracted, flat-fielded, dispersion-corrected, and extracted) stellar spectrum was cross-correlated with the most appropriate template spectrum by using the program VCROSS (Hill & Fisher 1986). These template spectra, which covered the 4520 Å region, were calculated with the program SYNTHE (Kurucz & Avrett 1991) using Kurucz (1993) ATLAS9 solar composition models with $\log g = 4.0$ and a microturbulence of 2 km s^{-1}. For every 500 K between 14,000 and 5000 K, such spectra were calculated for rotational velocities from 10 to 40 km s^{-1} in steps of 10 km s^{-1}.

The effective temperature of each star was estimated from the mean $uvby\beta$ photometry of Hauck & Mermilliod (1980) by using the program of Napiwotzki, Schonberner, & Wenske (1993) or from the spectral type if accurate photometry was not available. For each star, a template spectrum at an effective temperature given above was chosen to match the estimated temperature. In choosing an appropriate broadening for a template, two opposing requirements were considered. First, the width of the cross-correlation function should not be unnecessarily broadened, and second, the noise in the cross-correlation function generated by the stellar spectrum should be reduced by increasing the template broadening. In practice, templates were broadened by increasing amounts from a minimum of 10 km s^{-1} up to a maximum of 40 km s^{-1} for stars with the greatest $v \sin i$.

The cross-correlation functions were fitted with the appropriate Gaussian or rotational profile in a consistent manner. The centroid and width were allowed to vary but the slope of the fit was fixed at zero, an important restriction. A similar procedure was followed for the velocity standards. The standard stars used, plus their mean velocities and errors, are shown in Table 1. Two of the stars from Fekel (1992), 22 Dra and τ Her, were not used because of asymmetric cross-correlation functions.

Based on the range in corrections and the errors noted in Table 1, the decision was made to not apply any zero-point shift to adjust the DAO velocity system. In part, this was

TABLE 1
RADIAL VELOCITY STANDARDS

Star Name	HR No.	Sp. Type	Std. Velocity (km s^{-1})	Mean Velocity (km s^{-1})	σ (mean) (km s^{-1})	Mean Correction (km s^{-1})
β UMa........	4295	A1 V	−13.4	−12.3	0.2	−1.1
σ Boo..........	5447	F2 V	+0.0	+0.5	0.2	−0.5
o Peg...........	8641	A1 IV	+8.5	+9.9	0.1	−1.4
θ Leo...........	4359	A2 V	+7.7	+7.1	0.2	+0.6

also based on the suspicion that the radial velocity of o Peg may be variable. Fekel (1992) gives 7.7 and 8.5 km s^{-1} for θ Leo and o Peg, respectively, while Adelman (1988) measured 7.5 and 9.1 km s^{-1}, respectively, from DAO 2.4 Å mm^{-1} photographic spectra. Grenier et al. (1999) find +3.6 km s^{-1} for o Peg based on seven measurements; the inferred $\sim$5 km s^{-1} dispersion in their measures seems large for this relatively sharp-lined A star. With an estimated error of 0.5–1.0 km s^{-1} in our measures, this indicates good agreement for θ Leo; however, we suspect o Peg may be a spectroscopic binary.

The individual radial velocities are given in Table 2 along with the HJD of the midpoint of each exposure. The mean velocities given have an internal error estimated from the fit to the cross-correlation function when only one spectrum is available or an external mean error (standard deviation of the mean) plus a mean internal error when more than one is available. While the external mean error is to be preferred when available, for those stars with limited measures or measures confined to a single night, we adopted the generally larger internal error to be conservative.

2.2. *Kinematics*

Space motions (U, V, W) and their uncertainties were derived with the version of the code used by Johnson & Soderblom (1987), but updated for J2000.0 coordinates and to include covariance terms in the error matrices. This was accomplished using *Hipparcos* parallaxes and uncertainties, proper motions and uncertainties from the PPM catalogs (e.g., Bastian & Röser 1998), and final radial velocities. These data and relevant notes are given for each star in Table 3. Sources of the tabulated radial velocities (in no particular order) are our new measurements, previous measures given in SM93, values from the more recent radial velocity catalogs of Barbier-Brossat & Figon (2000) and Duflot, Figon, & Meyssonnier (1995), and precision values from the literature. In most cases, catalog values replaced the SM93 values unless the latter were their precision CORAVEL results.

Uncertainties in the catalog velocity values are frequently qualitative. Reasonable adopted numerical values were arrived at by comparison of quality flags and numerical uncertainties for those stars having both, taking into account the number of observations. Comparison of different measurements for stars not identified as binaries indicates pleasing agreement, typically within 1.5 km s^{-1} or better. A few discrepant values (e.g., those for HD 27861, 111456, 148112AB, 205765AB, 206538A, and 209515AB and GJ 625) suggest continued benefit from additional measurements, monitoring, or both. Variance-weighted mean radial velocities from the differing sources were determined for each star; these were utilized to determine final UVW kinematics and their formally propagated uncertainties, which are listed in Table 4.

2.3. *Photometry*

Precision photometry (V magnitudes and $B-V$ and $V-I$ colors) and uncertainties were extracted from the *Hipparcos* and Tycho Catalogues and are listed in Table 5, along with the absolute magnitudes derived from the *Hipparcos* parallaxes. In cases in which these data were absent or unusually uncertain or possibly contaminated by close components, literature photometry was drawn upon. Of particular note is the new Tycho-based photometry of close doubles provided by Fabricius & Makarov (2000). Their V_T magnitudes and B_T-V_T colors were transformed to Johnson V and $B-V$ by using the relations from Bessell (2000). Reliable photometry for close components can provide additional photometric constraints on evolutionary status and represents a significant improvement over previous membership studies.

2.4. *Metallicities*

Iron abundances were taken from the catalogs of Cayrel de Strobel et al. (1997) and Cayrel de Strobel, Soubiran, & Ralite (2001) and are provided in Table 5, along with the formal dispersion (standard deviation) of multiple measurements. In cases of two measurements, the range is indicated; no uncertainty estimate is given for single measurements. Older measurements with (rightly or wrongly) perceived lesser reliability are flagged with question marks. We acknowledge that the tabulated values are probably inhomogeneous, and no attempt has been made to rectify this. Such an attempt is not practically accomplished either empirically (because of lack of overlap between different studies) or fundamentally (because of implicit differing assumptions in the analyses, such as choice of model atmospheres, temperature scales, atomic data, solar normalization, etc., which are impossible to calibrate).

2.5. *Activity Indicators*

Residual chromospheric flux ratios of Ca II H and K are also provided in Table 5. These are predominantly new Kitt Peak National Observatory coudé feed–based values from D. R. S. and J. R. K.'s ongoing study of chromospheric activity in nearby stars, though a few measures have been taken from the literature. The " additional candidates " lack Ca II–based measures. For all other objects, the lack of an entry signals that the activity measures from SM93 were utilized.

3. RESULTS

3.1. *Activity-based Classifications*

For consistency with the activity divisions of SM93, we divided the sample into different categories (probable spectroscopic members, possible spectroscopic members, probable spectroscopic nonmembers, and additional candidates)

TABLE 2
New Ursa Major Radial Velocity Data

Name	HR	HD	Sp. Type	Exp. No.	HJD (2,445,000+)	RV (km s^{-1})	σ(ext) (km s^{-1})	σ(int) (km s^{-1})	T_{eff} (K)	log g (cgs)
Cluster:										
37 UMa	1277	91480	F1 V	9700754	502.8886	−12.4	...	...	7018	4.30
				9700755	502.9095	−11.8	...	...	...	...
				9700757	502.9324	−12.9	...	...	...	...
				9700758	502.9539	−12.5	...	...	...	...
Mean						−12.4	0.2	0.6	...	...
γ UMa	4554	103287	A0 Ve	9611647	256.7518	−10.5	...	0.8	9355	3.79
δ UMa	4660	106591	A3 V	9611648	256.7603	−20.2	...	1.0	8707	3.88
ϵ UMa	4905	112185	A0pCr	9611649	256.7678	−10.4	...	0.2	9543	3.59
HR 4867	4867	111456	F5 V	9611721	259.7431	−18.2	...	1.1	6417	4.60
78 UMa	4931	113139	F2 V	9611650	256.7974	−4.1	...	1.0	6945	4.21
ζ UMa A	5054	116656	A1 VpSrSi	9611657	256.8551	−5.9	...	2.2	8966	4.55
ζ UMa B	5055	116657	A1m	9611658	256.8662	−7.0	...	1.2	8425	4.40
80 UMa	5062	116842	A5 V	9611659	256.8842	−9.1	...	0.4	8098	4.02
Stream:										
σ And	68	1404	A2 V	9616495	302.9768	−7.7	...	2.4	8929	4.02
19 Cet	235	4813	F7 IV–V	9621304	379.7634	10.2	...	...	6229	4.43
				9621305	379.7849	10.4	...	...	...	...
				9621306	379.8064	10.3	...	...	...	...
Mean						10.3	0.1	0.4	...	...
39 And	290	6116	A5m	9616587	303.9312	3.5	...	0.9	8073	3.93
80 Psc	330	6763	F0 III–IV	9616590	303.9730	11.9	...	0.8	6922	4.00
89 Psc	378	7804	A3 V	9621310	379.8320	2.1	...	0.5	8802	3.79
χ Cet	531	11171	F3 III	9621311	379.8546	−1.4	...	1.0	7153	4.18
HR 534 AB	534	11257	F2 Vw	9621315	379.8793	11.2	...	...	7005	4.05
				9621316	379.8967	11.2	...	...	...	...
Mean						11.2	0.0	0.4	...	...
ϵ Tri	599	12471	A2 V	9616591	303.9896	0.1	...	0.4	9294	3.76
HR 647	647	13594	F4 V	9621387	382.7390	−12.8	...	...	6422	4.12
				9621388	382.7598	−12.9	...	...	...	...
				9621390	382.7980	−13.0	...	...	...	...
Mean						−12.9	0.1	0.7	...	...
HR 710	710	15144	A6 VpSrCr	9621392	382.8238	−12.6	...	...	8500	4.37
				9621393	382.8509	−13.1	...	...	...	...
				9621397	382.9057	−14.0	...	...	...	...
Mean						−13.2	0.4	0.5	...	...
ν Cet	754	16161	G8 III	9622599	431.6873	8.4	...	...	...	...
				9622601	431.7179	8.4	...	...	...	...
				9622602	431.7456	8.2	...	...	...	...
				9622605	431.8040	8.7	...	...	...	...
				9622730	434.6121	8.3	...	...	...	...
				9622731	434.6399	8.2	...	...	...	...
				9622777	434.7045	7.4	...	...	...	...
Mean						8.2	0.2	0.4	...	...
HR 797	797	16861	A2 V	9621398	382.9293	6.6	...	...	9153	4.20
				9621399	382.9508	6.8	...	...	...	...
				9621401	382.9730	4.8	...	...	...	...
Mean						6.1	0.6	0.2	...	...
γ Cet A	804	16970	A3 V	9616498	302.9955	−4.4	...	...	9296	4.07
				9621320	379.9215	−4.4	...	...	...	...
Mean						−4.4	0.0	0.8	...	...
γ Cet B	804	16970	...	9616498	302.9955	−12.9	...	...	...	...
				9621320	379.9215	−7.8	...	...	...	...
Mean						−10.3	2.6	1.4	...	...
HR 875	875	18331	A1 Vn	9700390	497.6109	−16.6	...	...	8568	3.61
				9700391	497.6324	−16.2	...	...	...	...
				9700683	502.6167	−2.3	...	...	...	...
				9700684	502.6375	−8.8	...	...	...	...
Mean						−11.0	3.4	3.3	...	...
ϵ Ari A	887	18519	A2 Vs	9700570	501.6125	−21.4	...	...	8953	3.66
				9700571	501.6334	−23.2	...	...	...	...
Mean						−22.3	0.9	1.4	...	...

TABLE 2—*Continued*

Name	HR	HD	Sp. Type	Exp. No.	HJD (2,445,000+)	RV (km s^{-1})	σ(ext) (km s^{-1})	σ(int) (km s^{-1})	$T_{\rm eff}$ (K)	log g (cgs)
ϵ Ari B	888	18520	A2 Vs	9700570	501.6125	27.5	...	...	...	...
				9700571	501.6334	27.2	...	...	...	...
Mean						27.4	0.2	0.6	...	...
HR 906	906	18778	A7 III–IV	9702440	534.6926	−4.2	...	0.3	...	...
HR 1046	1046	21447	A1 V	9702438	534.6466	−1.7	...	1.8	9335	4.24
66 Tau	1381	27820	A3 V	9621402	382.9965	−8.2	...	1.1	8514	3.53
42 Eri	1383	27861	A2 V	9700573	501.6598	−0.8	...	...	8759	3.73
				9700574	501.6807	−3.9	...	...	...	...
				9700576	501.7050	−4.5	...	...	...	...
				9700577	501.7258	1.8	...	...	...	...
				9700686	502.6640	−5.2	...	...	...	...
				9700687	502.6847	−4.6	...	...	...	...
Mean						−2.9	1.1	2.9	...	...
7 Cam	1568	31278	A1 V	9622779	434.7375	26.6	...	...	...	...
				9622781	434.7701	27.1	...	...	...	...
				9622783	434.8007	27.1	...	...	...	...
				9622785	434.8319	25.6	...	...	...	...
Mean						26.6	0.4	0.4	...	...
β Eri	1666	33111	A3 III	9700579	501.7504	−3.6	...	2.7	8104	3.58
o Aur	1971	38104	A2 VpCr	9700701	502.7195	−7.8	...	...	9132	3.57
				9700702	502.7403	−6.9	...	...	...	...
				9700704	502.7632	−8.7	...	...	...	...
				9700705	502.7840	−6.3	...	...	...	...
				9700707	502.8070	−7.9	...	...	...	...
Mean						−7.5	0.4	0.4	...	...
τ Aur	1995	38656	G8 III	9700417	497.7444	−18.7	...	...	...	...
				9700418	497.7652	−18.7	...	...	...	...
				9700420	497.7881	−19.8	...	...	...	...
				9700421	497.8090	−19.8	...	...	...	...
				9700593	501.8253	−18.4	...	...	...	...
				9700594	501.8461	−18.4	...	...	...	...
				9700596	501.8697	−18.3	...	...	...	...
				9700597	501.8906	−19.7	...	...	...	...
Mean						−19.0	0.2	0.4	...	...
χ^1 Ori	2047	39587	G0 V	9622656	433.8786	−11.4	...	...	5938	4.65
				9622658	433.9314	−9.8	...	...	...	...
Mean						−10.6	0.8	0.4	...	...
β Aur A	2088	40183	A2 IV	9700467	497.8875	−123.7	...	...	9095	3.84
				9700468	497.8944	−123.3	...	...	...	...
Mean						−123.5	0.2	0.7	...	...
β Aur B	2088	40183	...	9700467	497.8875	91.1	...	...	...	...
				9700468	497.8944	91.0	...	...	...	...
Mean						91.0	0.0	0.7	...	...
42 Aur	2228	43244	F0 V	9702151	529.7166	−11.9	...	1.8	7206	3.75
RR Lyn A	2291	...	A3 Vm	9702149	529.6712	−79.1	...	0.3	7939	4.12
RR Lyn B	2291	44691	...	9702149	529.6712	77.8	...	1.0	...	...
Sirius	2491	48915	A1 Vm	9700416	497.7250	−3.6	...	0.2	10043	4.31
16 Lyn	2585	50973	A2 Vn	9702147	529.6469	−11.6	...	3.0	9242	3.76
λ Gem	2763	56537	A3 V	9700470	497.9183	−10.1	...	...	8475	3.91
				9700471	497.9398	−3.2	...	...	...	...
				9700580	501.7763	−5.6	...	...	...	...
Mean						−6.3	2.0	2.8	...	...
π^1 UMa	3391	72905	G1.5 Vb	9702062	528.7940	−11.8	...	0.3	5533	5.14
ν Cnc	3595	77350	A0pHgMn	9702060	528.7774	−14.8	...	0.2	10358	3.61
18 UMa	3662	79439	A5 V	9700630	501.9422	−19.3	...	...	7946	4.01
				9700644	501.9756	−20.7	...	...	...	...
				9700645	501.9964	−10.5	...	...	...	...
Mean						−16.8	3.2	1.6	...	...
21 LMi	3974	87696	A7 V	9622661	433.9828	−10.6	...	...	8036	4.15
				9622662	434.0044	−9.7	...	...	...	...
Mean						−10.1	0.4	1.0	...	...
34 Leo	3998	88355	F7 V	9702444	534.7776	−14.4	...	0.4	6558	4.29
ζ Leo	4031	89025	F0 III	9622664	434.0304	−21.6	...	1.1	6905	2.87
δ Leo	4357	97603	A4 V	9622665	434.0520	−21.1	...	1.2	8309	3.90

TABLE 2—*Continued*

Name	HR	HD	Sp. Type	Exp. No.	HJD (2,445,000+)	RV (km s^{-1})	σ(ext) (km s^{-1})	σ(int) (km s^{-1})	$T_{\rm eff}$ (K)	log g (cgs)
ι Leo............	4399	99028	F4 IV	9622667	434.0761	−10.2	...	...	6769	3.93
				9622668	434.1015	−10.3	...	...	...	...
Mean........						−10.3	0.1	0.4	...	...
29 Com.........	4865	111397	A1 V	9702066	528.8669	−5.1	...	1.3	9117	3.78
41 Vir A........	4900	112097	A7 III	9702069	528.9131	9.4	...	1.1	7250	3.96
41 Vir B........	4900	112097	...	9702069	528.9131	−28.4	...	1.1	...	...
78 Vir...........	5105	118022	A1pSrCrEu	9611863	261.7302	−10.4	...	0.4	9710	4.20
HR 5214.......	5214	120818	A5 IV	9702449	534.8924	−7.2	...	0.9	8500	4.26
τ Vir.............	5264	122408	A3 V	9611869	261.7455	−6.9	...	1.1	8049	3.35
κ^2 Boo A......	5329	124675	A8 IV	9611727	259.7751	−14.9	...	0.8	7748	3.74
18 Boo..........	5365	125451	F5 IV	9700649	502.0418	2.0	...	...	6737	4.35
				9700651	502.0661	0.7	...	...	...	...
Mean........						1.4	0.8	0.7	...	...
HR 5373.......	5373	125642	A2 V	9702071	528.9662	−15.9	...	0.8	9222	3.96
ζ Boo AB......	5477/8	129246/7	A2 III	9611733	259.7873	−0.1	...	1.2	...	...
HR 5492.......	5492	129798	F2 V	9702246	533.0413	−3.7	...	1.2	6687	4.31
ϵ Boo A........	5506	129989	K0 II–III	9611739	259.7935	−15.1	...	0.4	...	...
45 Boo..........	5634	134083	F5 V	9611745	259.8041	−7.6	...	...	6661	4.43
				9611746	259.8207	−7.5	...	...	...	...
Mean........						−7.5	0.1	1.0	...	...
8 Ser.............	5721	137006	F0 V	9702451	534.9738	−9.4	...	1.1	7594	4.11
ν^1 Boo..........	5763	138481	K5 III	9611752	259.8533	−11.8	...	1.7	...	...
α CrB...........	5793	139006	A0 V	9611875	261.7535	19.8	...	0.9	9832	3.85
HR 5830.......	5830	139798	F2 V	9700760	502.9799	2.6	...	...	6828	4.12
				9700761	503.0008	2.2	...	...	...	...
				9700763	503.0237	3.6	...	...	...	...
				9700764	503.0455	3.0	...	...	...	...
				9700766	503.0674	4.4	...	...	...	...
				9700767	503.0883	2.2	...	...	...	...
Mean........						3.0	0.4	1.3	...	...
HR 5859.......	5859	140775	A0 V	9702244	533.0020	−7.3	...	0.5	9323	3.78
β Ser............	5867	141003	A2 IV	9611876	261.7585	−6.4	...	1.5	8715	3.60
υ CrB...........	6074	146738	A3 V	9616463	302.6905	1.0	...	0.7	8537	3.21
ω Her...........	6117	148112	B9pCr	9611758	259.8873	17.2	...	1.4	9871	3.72
HD 151044...	...	151044	F8 V	9616569	303.7067	−12.3	...	0.3	6180	4.47
52 Her..........	6254	152107	A2 VpSrCrEu	9611882	261.7674	−3.1	...	1.0	8856	4.15
α Oph...........	6556	159561	A5 III	9611888	261.7796	12.1	...	1.6	7938	3.61
HR 6917.......	6917	169981	A2 IV	9616465	302.7167	−8.3	...	0.2	8769	3.66
5 Aql A.........	7059	173654	A2 Vm	9616466	302.7381	−0.3	...	0.2	8500	4.28
5 Aql B.........	7059	173654	...	9616466	302.7381	36.6	...	0.3	...	...
11 Aql..........	7172	176303	F8 V	9611889	261.7998	15.9	...	0.7	6116	3.80
16 Lyr...........	7215	177196	A7 V	9611660	256.9161	5.0	...	1.1	8122	4.13
59 Dra..........	7312	180777	A9 V	9611905	261.8261	−5.3	...	0.7	7252	4.34
HR 7451.......	7451	184960	F7 V	9616472	302.7860	1.9	...	0.3	6370	4.28
HR 7781A....	7781	193592	A2 Vs	9616475	302.8188	−2.0	...	0.2	8947	4.11
HR 8170.......	8170	203454	F8 V	9621383	382.6619	12.9	...	...	6200	4.64
				9621384	382.6848	10.7	...	...	...	...
				9621385	382.7084	8.0	...	...	...	...
Mean........						10.5	1.4	0.4	...	...
ρ Cyg............	8252	205435	G8 IIICN	9611765	259.9081	7.4	...	1.0	5184	...
HR 8263.......	8263	205765	A2 V	9616478	302.8556	9.4	...	1.1	8960	3.83
76 Cyg..........	8291	206538	A2 V	0616575	303.7872	−8.2	...	0.9	8763	3.63
HR 8407.......	8407	209515	A0 IV	9616480	302.8760	−11.0	...	0.9	9997	3.74
32 Aqr..........	8410	209625	A5m	9611771	259.9331	13.9	...	0.2	7851	3.88
π^2 Peg...........	8454	210459	F5 III	9616481	302.8870	6.0	...	1.7	...	...
HR 8473.......	8473	210873	B9pHgMn	9616578	303.8262	−4.1	...	0.9	10895	3.89
δ Aqr............	8709	216627	A3 V	9616488	302.9276	17.8	...	0.6	8699	3.56
15 And.........	8947	221756	A1 III	9616489	302.9373	15.6	...	0.9	8741	3.82
λ Psc.............	8984	222603	A7 V	9616491	302.9551	9.3	...	0.8	7946	4.01

TABLE 3
Parallaxes, Proper Motions, and Radial Velocities

HD/Name	π (mas)	$\sigma(\pi)$ (mas)	μ_α (km s^{-1})	$\sigma(\mu_\alpha)$ (km s^{-1})	μ_δ (km s^{-1})	$\sigma(\mu_\delta)$ (km s^{-1})	V_r (km s^{-1})	$\sigma(V_r)$ (km s^{-1})	Notes
745	7.81	0.96	−25.2	3.1	−26	3.4	−1.8	0.3	1
1404	23.11	0.68	−62.5	0.7	−41	0.7	−7.7	2.4	2
							−8.0	2.0	3
2410	6.12	0.79	−17.0	2.6	−21	3.0	+8.3	1.5	3
4813	64.69	1.03	−225.6	0.6	−229	0.8	+10.3	0.4	2
							+8.5	0.1	4
							+9.7	0.6	5
6116	9.49	0.86	−24.8	4.3	−12	4.6	+3.5	0.9	2
							+4.4	2.0	3
6763	27.84	0.88	−264.2	1.1	−185	1.3	+11.9	0.8	2
							+6.7	1.3	4
							+7.1	2.0	3
6920	18.98	0.71	−132.5	2.3	−40	2.5	−13.9	0.1	4
							−12.6	0.9	5
7804	14.83	0.86	−46.4	0.5	−25	0.5	+2.1	0.5	2
							+5.3	2.0	3
11131	43.47	4.48	−145.9	2.4	−87	2.5	−4.2	0.2	4
							−2.5	2.0	3
11171	42.35	0.87	−145.9	0.6	−93	0.7	−1.4	1.0	2
							−0.9	1.5	4
11257	23.46	1.02	−72.1	4.7	−32	4.4	+11.2	0.4	2
							+11.1	1.5	4
							+11.1	1.4	5
12471	8.81	0.82	−31.3	4.4	+2	4.3	+0.1	0.4	2
							+3.3	1.5	3
13594AB	24.07	0.96	−80.1	4.6	−57	4.6	−12.9	0.7	2, 6 (0″.2)
							−8.1	1.5	4, 6 (0″.2)
13959AB	26.37	3.69	−104.3	4.6	−53	4.3	+0.2	0.1	4, 6 (0″.3)
							−1.7	1.2	5, 6 (0″.3)
							−0.6	0.2	6 (0″.3), 7
15144AB	15.24	0.95	−50.6	2.4	−52	2.4	−13.2	0.5	2, 6 (12″)
							+2.0	1.0	5, 6 (12″), 8
16161	8.77	1.11	−26.9	0.5	−25	0.6	+8.2	0.2	2, 9 (9″)
							+6.4	0.7	5, 9 (9″)
16861AB	7.66	0.94	−28.0	3.0	−31	2.8	+6.1	0.8	2
							+6.1	2.0	3
16970A	39.78	0.95	−134.8	9.9	−150	9.9	−4.4	0.8	2, 6 (0″.9), primary
							−5.1	1.5	3, 6 (0″.9), primary
16970B	...	...	...	...	...	...	−10.3	2.6	2, 6 (0″.9), secondary
							−12.5	1.5	3, 6 (0″.9), secondary
16970	...	...	...	...	...	...	−6.5	2.5	2, 3, 6 (0″.9), 8
18331	17.28	0.93	−34.4	1.1	−44	1.3	−11.0	3.9	2
							−15.0	3.0	3
18519	11.15	1.48	−21.0	3.9	0	3.7	−22.3	0.9	2, 6 (1″.4), 10, secondary
							−6.0	2.5	3, 6 (1″.4), 10, secondary
18520	11.15	1.48	−21.0	3.9	0	3.7	+27.4	0.6	2, 6 (1″.4), primary
							−7.9	2.0	3, 6 (1″.4), primary
18645	8.71	1.18	−6.0	2.0	−26	2.0	−9.0	7.2	3, 11
							−3.6	1.3	11, 12
							−2.3	0.7	1, 11
18778	16.13	0.53	−43.2	4.9	+10	5.1	−4.2	0.3	2, 9, 11
							−7.4	4.0?	3, 8, 9, 11
21447	17.07	0.69	−53.6	4.8	−12	4.6	−1.7	1.8	2
							+0.3	1.5	3
24160	15.54	0.58	−46.0	0.9	−51	1.0	+2.0	1.0	4
24916AB	63.41	2.00	−195.0	1.9	−151	1.9	+6.2	1.0	3, 6 (11″)
							+4.3	0.9	1, 6 (11″)
26913	47.86	1.15	−98.4	2.2	−109	2.1	−7.0	0.3	4, BY Dra var.
							−7.6	1.0	5, BY Dra var.
26923	47.20	1.08	−108.9	2.5	−104	2.3	−7.1	0.1	4
							−8.1	2.5	3
27820	8.23	0.94	−22.2	4.9	−10	4.9	−8.2	1.1	2, 9 (0″.1)
							−3.5	2.0	3, 9 (0″.1)

TABLE 3—*Continued*

HD/Name	π (mas)	$\sigma(\pi)$ (mas)	μ_α (km s^{-1})	$\sigma(\mu_\alpha)$ (km s^{-1})	μ_δ (km s^{-1})	$\sigma(\mu_\delta)$ (km s^{-1})	V_r (km s^{-1})	$\sigma(V_r)$ (km s^{-1})	Notes
27861	15.66	0.80	−49.4	0.7	−57	0.7	−2.9	1.2	2
							−5.3	1.0	13
							−11.0	2.5	3
28495	36.32	1.07	−86.8	2.6	+37.0	2.5	−11.0	0.3	1
29697	74.13	1.24	−242.4	1.9	−251	1.9	+5.0	3.6	5, BY Dra var.
							+0.3	0.1	1, BY Dra var.
29875AB	49.67	0.53	−140.8	0.9	−77	0.9	−0.3	0.7	5, 9 (3″.6), 14
							−0.1	0.8	9 (3″.6), 13, 14
							−0.6	0.9	1, 9 (3″.6), 14
30834	5.81	0.82	−25.3	3.4	−3	3.1	−16.5	0.5	4
							−16.5	1.0	3
31000	35.14	1.12	+6.0	2.8	+13.0	2.7	−6.2	0.4	1
31278	8.68	0.81	−39.9	5.0	+14	5.0	+26.6	0.4	2, 6 (0″.2), 11
							−9.5	2.5	3, 6 (0″.2), 8, 11
33111	36.71	0.76	−94.1	0.4	−81	0.5	−3.6	2.7	2
							−9.0	1.5	4
							−9.2	1.5	3
							−11.2	2.1	13
33564A	47.66	0.52	−81.6	0.5	+161	0.6	−10.3	0.4	5, 9 (26″)
38104	6.76	0.86	−9.7	0.5	+1	0.6	−7.5	0.4	2
							−6.4	1.5	3
38393	111.49	0.60	−292.5	0.6	−370	0.7	−9.1	0.1	4
							−9.7	1.0	3
38656A	15.34	0.80	−33.7	4.8	−31	4.8	−19.0	0.3	2, 9 (14″)
							−19.0	0.4	5, 9 (14″)
39587	115.43	1.08	−188.5	2.3	−92	2.2	−10.6	0.8	2
							−13.5	0.4	4
							−13.0	0.2	5
40183	39.72	0.78	−57.3	0.4	0	0.5	−123.5	0.7	2, Algol var., 9 (185″), primary
							+91.0	0.7	2, 6 (185″), secondary
							−18.2	1.5	4, Algol var., 9 (185″)
							−17.1	1.5	3, 8, Algol var., 9 (185″)
41593	64.71	0.91	−125.7	2.9	−107	3.0	−9.8	0.1	4
							−11.7	2.0	3
42581	173.19	1.12	−135.0	2.6	−706	2.7	+4.3	0.5	5, 11
43244	13.86	0.78	−31.0	4.6	+7	4.5	−11.9	1.8	2
							−8.0	2.5	3
43318	28.02	0.76	−160.5	2.2	−222	2.3	−39.6	0.2	4
							−36.6	1.5	3
44691	12.01	0.97	−29.1	5.1	+31	4.7	−79.1	0.3	2, 9, primary
							+77.8	1.0	2, 9, secondary
							−11.9	2.5	3, 8, 9
44762A	13.75	0.60	−22.5	6.4	−54	6.3	−2.6	1.5	4, 8, 9, 11
45088AC	68.20	1.10	−123.6	2.0	−166	2.1	−8.4	0.2	4, 9 (11″), 11, BY Dra var.
							−8.4	1.5	3, 8, 9 (11″), 11, BY Dra var.
48682A	60.56	0.73	−2.2	0.5	+165	0.6	−23.6	0.1	4, 9 (31″)
48915	379.21	1.58	−553.1	0.4	−1205	0.4	−3.6	0.2	2, 9, 11
							−6.0	2.2	8? , 9, 11, 13
							−9.4	1.9	4, 9, 11
							−7.3	1.0	3, 8, 9, 11
50692	57.89	0.90	−46.1	3.1	+27	2.7	−14.7	0.1	4
							−14.7	0.3	5
50973	14.49	0.69	−21.2	1.3	−4	1.7	−11.6	3.0	2
							−8.0	3.0	3
GJ 268.3	81.05	2.42	−37.7	2.2	−196	1.7	−7.5	0.1	1, 11, 15
56168	39.10	1.15	−69.0	2.1	+72	2.1	−8.8	2.0	5
							−9.1	0.5	1
56537	34.59	0.93	−47.5	0.4	−37	0.4	−6.3	2.5	2, 9 (10″)
							−9.3	1.7	5, 9 (10″)
56537AB	...	...	...	...	...	...	−8.8	0.5	7, 9 (10″), 16
59747	50.80	1.29	−51.5	2.9	+18	2.7	−16.2	0.4	1
							−20.7	3.4	5
60491	40.32	1.26	−84.9	2.3	−46	2.4	−9.7	0.7	1
61245A	8.98	0.55	+36.1	3.4	−21	3.4	+1.6	0.3	1, 5, 9, 11
61606A	70.44	0.94	+67.4	2.1	−281	2.3	−19.3	0.7	5, 9 (58″)

TABLE 3—*Continued*

HD/Name	π (mas)	$\sigma(\pi)$ (mas)	μ_α (km s^{-1})	$\sigma(\mu_\alpha)$ (km s^{-1})	μ_δ (km s^{-1})	$\sigma(\mu_\delta)$ (km s^{-1})	V_r (km s^{-1})	$\sigma(V_r)$ (km s^{-1})	Notes
61606B	70.44	0.94	+64.4	2.0	−287	2.2	−16.2	1.9	5, 6 (58″), 17
62668A	4.97	1.23	−5.1	3.1	−9	3.3	−23.1	5.2?	9, 11, 12
							−28.3	0.4	1, 9, 11
63433	45.84	0.89	−6.7	2.3	−12	2.2	−18.7	1.0	5
64096A	59.98	0.95	−58.2	2.5	−337	2.6	−21.1	0.1	4, 6 (0″.2), 11
							−21.5	?	5, 6 (0″.2), 8, 11
64942	20.69	1.15	+25.1	2.1	−20	2.2	−8.1	0.8	1
71974AB	34.83	1.37	−13.5	3.0	+11	2.8	−13.3	?	5, 6 (0″.6)
							−15.4	0.6	1, 6 (0″.6)
							−16.8	0.2	6 (0″.6), 7
GJ 2069Aab/BC	78.05	5.69	−229.5	6.4	−87.4	3.5	+4.4	0.1	9 (13″, 0″.4), 11, 13, 15, 18
72905	70.07	0.71	−23.4	2.8	+87	2.9	−11.8	0.3	2
							−12.3	0.2	4
							−13.4	0.7	5
75605	14.26	1.25	+3.8	3.9	−48	3.8	−7.8	1.5	4, 9, 11
							−6.7	1.1	9, 11, 19
75935	24.66	1.34	+17.4	4.6	−10	4.3	−19.0	0.6	1
76218	38.21	1.00	−25.4	2.8	−13	2.7	−12.8	0.5	1
77350	7.14	0.96	−4.1	4.1	−12	3.9	−14.8	0.2	2, 9, 11
							−14.3	2.5	3, 8, 9, 11
79028	51.12	0.72	−17.2	3.6	−26	3.2	−14.2	0.5	4, 9, 11
							−14.6	1.5	3, 8, 9, 11
79439	27.55	0.80	+48.5	1.1	+61	1.4	−16.8	3.9	2
							−18.7	2.5	3
80388	19.20	0.88	+29.2	2.2	+25	2.2	−12.0	2.5	3, 6 (19″)
80389	17.40	1.07	+33.7	2.1	+23	2.1	−12.0	2.5	3, 6 (19″), 20
81659	25.07	1.00	+36.3	2.0	−128	2.0	−16.8	0.5	1
81858AB	29.05	1.29	+53.3	3.0	−8.0	2.9	−6.9	0.6	4, 6 (2″.7)
							−8.0	0.3	6 (2″.7), 7
							−6.0	2.5	3, 6 (2″.7), 8
85364	16.31	0.80	+13.5	0.5	−28	0.6	−10.0	1.5	4
85444	11.92	0.81	−18.8	3.2	−33	3.1	−13.5	1.5	4
							−14.3	0.6	5
85512	89.67	0.82	+470.0	3.0	−474	3.1	−9.6	2.0	5
87696	35.78	0.84	+52.7	6.3	−4	5.8	−10.1	1.0	2
							−17.6	1.0	5
GJ 378.2	44.77	1.96	−64.8	2.0	−99.5	1.4	−15.1	0.2	5, 15
88355A	14.49	0.84	+27.7	2.6	−41	2.5	−14.4	0.4	2, 6 (0″.1)
							−15.2	0.2	4, 6 (0″.1)
88654	10.80	0.96	+22.2	1.7	−35	1.9	−7.0	0.4	1
89025	12.56	0.78	+17.9	0.4	−7	0.5	−21.6	1.1	2
							−15.0	1.5	4
							−20.4	1.1	5
91480	37.80	0.61	+67.7	0.5	+39	0.6	−12.4	0.2	2
							−10.4	0.5	4, 21
							−10.5	0.8	5, 21
91752	21.60	0.75	+36.3	3.0	−35	2.9	−23.7	1.5	3
94686A	16.01	1.01	+51.6	2.6	+40	2.5	...	...	6 (2″.7)
95418	41.07	0.60	+82.2	0.4	+34	0.4	−12.0	0.5	4, 21
							−12.0	0.8	5, 21
95650	85.76	1.36	+140.5	4.2	−53	4.2	−14.9	0.9	5, BY Dra var.
97305	3.39	1.08	+2.8	2.4	−12	2.8	+3.0	1.3	11, 12
97603	56.52	0.83	+141.9	0.3	−130	0.4	−21.1	1.2	2
							−20.2	0.8	5
98712AB	76.00	1.70	+178.5	2.9	−112	2.9	+4.9	2.5	5, 6 (4″.5), BY Dra var.
99028	41.26	1.16	+162.2	9.9	−70	9.9	−10.3	0.4	2, 6 (1″.4), 11
							−10.3	2.0	4, 6 (1″.4), 11
							−11.0	5?	5, 6 (1″.4), 8, 11
							−11.5	0.2	6 (1″.4), 8, 11, 19
99648/9?	5.25	0.84	+18.0	0.4	−12	0.5	−9.1	1.5	4, 9 (89″)
							−9.3	0.2	9 (89″), 19
100043	15.56	0.82	+33.6	2.4	−47	2.4	−1.8	1.0	22
100310	22.33	1.22	+61.1	2.1	−15	2.1	−9.6	0.4	1
102070AB	9.31	0.81	+31.3	0.5	−30	0.6	−2.6	1.5	4, 6 (0″.1)
							−4.0	0.7	5, 6 (0″.1)

TABLE 3—*Continued*

HD/Name	π (mas)	$\sigma(\pi)$ (mas)	μ_α (km s^{-1})	$\sigma(\mu_\alpha)$ (km s^{-1})	μ_δ (km s^{-1})	$\sigma(\mu_\delta)$ (km s^{-1})	V_r (km s^{-1})	$\sigma(V_r)$ (km s^{-1})	Notes
GJ 447	299.58	2.20	+605.6	2.1	−1219	1.9	−29.0	1.2	5, 15
							−13.0	5.0	1, 15
103287	38.99	0.68	+95.0	0.3	+12	0.3	−10.5	0.8	2, 21
							−12.6	0.5	4, 21
							−12.6	0.8	5, 21
BD +19°2531	25.27	1.40	+103.6	3.5	−74	3.6	−5.5	0.4	1
238087	35.24	1.24	+93.7	5.7	+14	5.4	−15.0	3.0	3
106591	40.05	0.60	+103.7	0.4	+9	0.4	−20.2	1.0	2, 21
							−13.4	0.5	4, 21
109011	42.13	3.11	+111.5	3.6	+7	3.8	−11.0	0.8	21, 23
							−13.1	0.6	4, 21
							−5.0	?	3
238090	65.29	1.47	+224.8	4.7	+96	4.5	−14.9	2.8	5
109647	38.08	1.11	+117.4	3.8	−3	3.9	−9.0	0.3	4, 21
109799	28.91	0.75	+88.1	2.7	−99	2.5	−0.9	1.5	4, 9
110463	43.06	0.82	+124.2	4.7	+6	4.5	−10.2	0.2	21, 23
							−9.7	0.3	4, 21
							−6.3	1.0	5, 21
111397	8.10	0.77	+29.1	4.1	−13	4.1	−5.1	1.3	2
							−8.1	1.5	5
111456	41.39	3.20	+109.9	3.8	−3	3.6	−18.2	1.1	2, 21
							−12.0	1.5	4, 21
112097A	16.40	0.78	+58.6	4.8	−31	4.3	+9.4	1.1	2, primary
112097B	...	...	...	...	...	...	−28.4	1.1	2, secondary
112097AB	...	...	...	...	...	...	−3.9	3.3	5, 11
112185	40.30	0.62	+111.7	0.4	−6	0.4	−10.4	0.2	2, α CVn var.
							−9.3	0.5	4, 21, α CVn var.
112196	29.19	1.60	+45.9	2.3	−40	2.3	−7.2	1.6	1
113139AB	40.06	0.60	+123.0	5.3	−2	4.9	−4.1	1.0	2, 6 (0″.3), 21
							−9.8	0.5	4, 6 (0″.3), 21
							−7.5	1.0	5, 6 (0″.3), 8, 21
113139	...	...	...	...	...	...	−9.8	1.0	3, 6 (0″.3), 21
238179	10.50	1.24	+103.2	5.5	−14	5.0	−45.2	0.2	23
							−44.4	0.3	4
114260	36.82	0.85	+159.7	3.3	−334	3.3	−12.0	0.1	4
							−6.8	1.5	3
114723AB	12.82	1.48	+22.9	3.9	−8.0	3.7	−12.0	1.8	5, 6 (2″.5)
115043	38.92	0.67	+112.8	2.7	−11	2.6	−8.5	0.1	4, 21
							−9.1	0.7	5, 21
238208	17.87	1.19	+75.9	4.8	−34	4.5	−49.2	0.2	23
							−48.6	0.3	4
116656	41.73	0.61	+121.5	0.4	−20	0.4	−5.9	2.2	2, 6 (13″), 11, 21
							−5.6	0.5	4, 5, 6 (13″), 11, 21
116657	...	...	...	...	...	...	−7.0	1.2	2, 6 (13″), 11, 21, 24
							−5.6	0.5	4, 6 (13″), 11, 21, 24
							−9.3	2.0	5, 6 (13″), 11, 21, 24
116842	40.19	0.57	+116.2	5.8	−9	5.3	−9.1	0.4	2, 21
							−8.9	0.5	4, 21
							−8.8	0.8	5, 21
238224	39.84	1.44	+128.4	4.8	−22	4.7	−8.2	0.5	6 (0″.1), 23
							−6.6	3.5	3, 6 (0″.1)
GJ 516AB	72.66	40.63	+253.0	37.5	−221.8	28.4	+4.0	4.0	3, 9 (3″)
GJ 516A	...	...	...	...	...	...	−1.8	?	1, 9 (3″)
GJ 519	91.72	1.23	+311.8	7.8	−53	6.6	−10.4	3.0	5, 9, 11
118022	17.79	0.80	+44.9	0.8	−24	0.8	−10.4	0.4	2, α CVn var.
							−11.7	1.6	5, α CVn var.
120528	13.60	0.93	+101.4	4.0	−36	4.1	−23.2	0.2	23
							−22.5	0.3	4
120818	11.24	0.68	+23.4	3.2	−4	3.0	−7.2	0.9	2
							−14.6	3.4	5
122408A	14.94	0.88	+18.0	0.4	−21	0.5	−6.9	1.1	2, 9 (82″)
							−2.0	1.1	5, 9 (82″)
122408B	...	...	−3.0	4.0	−13	4.0	...	...	6 (82″)
124752A	25.89	1.04	+147.0	1.9	−11	2.0	−5.6	2.0	4, 6 (5″.5)
							−8.1	2.0	5, 6 (5″.5)

TABLE 3—*Continued*

HD/Name	π (mas)	$\sigma(\pi)$ (mas)	μ_α (km s^{-1})	$\sigma(\mu_\alpha)$ (km s^{-1})	μ_δ (km s^{-1})	$\sigma(\mu_\delta)$ (km s^{-1})	V_r (km s^{-1})	$\sigma(V_r)$ (km s^{-1})	Notes
124674	16.66	4.78	+72.4	5.7	−9	5.8	−20.4	1.5	4, 6 (12″)
							−21.5	1.5	5, 6 (12″)
124675	21.03	0.83	+49.2	3.2	−2	3.1	−14.9	0.8	2, 6 (12″)
							−17.5	2.5	5, 6 (12″)
125451A................	38.33	0.81	+105.2	0.7	−30	0.8	+1.4	0.8	2, 9 (59″)
							−3.0	1.5	4, 9 (59″)
							−1.4	1.3	5, 9 (59″)
125642	7.30	0.60	+21.0	4.8	−15	4.8	−15.9	0.8	2
							−10.5	2.0	3
128311	60.35	0.99	+196.6	2.3	−245	2.2	−9.6	0.4	1
129246/7...............	18.07	1.24	+58.3	9.9	−20	9.9	−0.1	1.2	2, 6 (0″.8)
							−5.4	0.8	5, 6 (0″.8), 8?
129674	14.69	0.64	+7.4	2.6	+9.0	2.7	−11.0	4.8	5, 9, 11
							−9.2	4.0	9, 11, 12
							−3.0	3.2	9, 11, 12
129798AB	23.47	0.57	+73.6	4.7	−32	4.5	−3.7	1.2	2, 6 (4″)
							−6.3	2.0	3, 6 (4″)
							−6.8	1.0	1, 6 (4″)
129989AB	15.55	0.78	−44.1	4.9	+13	4.6	−15.1	0.4	2, 6 (3″)
							−16.8	0.7	5, 6 (3″)
							−17.5	0.5	6 (3″), 19
131156AB	149.26	0.76	+164.4	3.9	−125	4.0	+1.3	0.1	4, 6 (6″.9)
							+1.5	0.2	5, 6 (6″.9)
GJ 569ABab	101.91	1.67	+276.0	2.0	−122.1	1.3	−8.6	1.0	5, 9 (5″, 0″.09), 15
							−7.2	0.3	9 (5″, 0″.09), 15, 25
134083	50.70	0.76	+185.1	0.6	−165	0.6	−7.5	1.0	2, 9 (13″)
							−9.9	0.6	4
							−8.9	0.9	5
135599	64.19	0.97	172.5	2.1	−137	2.1	−3.1	0.2	26
136901	3.58	0.89	+9.5	2.4	−10	2.2	−19.7	0.2	8, 9, 11, 27
137006	18.20	0.78	+75.0	0.6	−30	0.7	−9.4	1.1	2
							−2.2	2.5	5
137107/8...............	53.70	1.24	+141.2	5.2	−185	4.7	−6.9	0.1	4, 6 (1″), 8?
							−6.0	?	3, 6 (1″), 8
138481	3.74	0.54	+11.3	0.4	−7	0.5	−11.8	1.7	2
							−10.6	0.7	5
139006	43.65	0.79	+121.9	0.3	−89	0.3	+19.8	0.9	2, Algol var.
							+1.7	1.5	4
							+1.4	2.0	3, 8
139194	33.37	0.88	+124.7	4.2	−99	4.3	−14.0	0.3	1
139798	27.98	0.55	+90.4	0.7	−126	0.7	+3.0	0.4	2
							−1.8	2.5	3
140775	8.49	0.73	+32.9	4.5	+1	4.5	−7.3	0.5	2
							−9.8	2.0	3
141003A................	21.31	0.86	+66.5	0.4	−45	0.5	−6.4	1.5	2, 9 (35″?)
							+1.4	0.3	4
							−0.8	1.7	3
141003B................	21.31	0.86	+66.5	0.4	−45	0.5	+0.8	0.4	6, 7 (35″?), 28
146738	3.95	0.68	+23.6	1.5	−16	1.9	+1.0	0.7	2
							+6.5	3?	3
147513A................	77.69	0.86	+74.4	1.9	+1	1.9	+13.0	0.1	4
							+10.1	1.5	3
147584	82.61	0.57	+196.2	1.1	+108	1.2	+8.5	1.5	4, 8?, 11
							+7.6	3?	3, 8, 11
148112AB	13.87	0.94	+43.7	0.5	−59	0.6	+17.2	1.4	2, 9
							−5.9	1.0	3, 9
GJ 625...................	151.93	1.11	+432.3	1.3	−170.7	1.2	−12.8	0.5	1, 15
							−28.0	3.7	5, 15
150706	36.73	0.56	+94.4	2.0	−93	2.0	−16.8	0.3	4
							−15.0	2.4	5
151044	34.00	0.50	+134.2	1.9	−105	2.6	−12.3	0.3	2
							−13.2	0.2	4
							−12.5	0.9	5

TABLE 3—*Continued*

HD/Name	π (mas)	$\sigma(\pi)$ (mas)	μ_α (km s^{-1})	$\sigma(\mu_\alpha)$ (km s^{-1})	μ_δ (km s^{-1})	$\sigma(\mu_\delta)$ (km s^{-1})	V_r (km s^{-1})	$\sigma(V_r)$ (km s^{-1})	Notes
152107	18.62	0.53	+21.9	5.0	−50	5.1	−3.1	1.0	2, 6 (1″.8)
							−1.0	1.0	3, 6 (1″.8)
							−0.5	0.3	6 (1″.8), 29
152863A................	7.14	0.67	+13.5	2.8	−24	2.5	+0.3	0.6	5, 9 (17″)
152863B................	. . .	. . .	. . .	. . .	. . .	. . .	−0.7	0.2	7, 9 (17″)
							−1.7	0.5	6, (17″), 7
153751	9.41	0.67	+17.0	0.3	+5	0.4	−10.6	1.0	3, 9, 11, RS CVn var.
153751Aab............	. . .	. . .	. . .	. . .	. . .	. . .	−11.0	0.1	8, 9, 11, 30, RS CVn var.
GJ 3991.................	137.84	8.95	+333.9	8.1	−278	10.3	−9.7	2.0	1, 9, 11
155674A................	47.14	1.88	+78.4	4.0	−110	4.0	+3.3	1.0	5, 6 (22″)
							+3.0	0.1	1, 6 (22″)
							+3.0	0.1	4, 6 (22″)
155674B................	47.86	3.11	+94.1	4.1	−102	4.3	+1.9	0.9	5, 6 (22″)
							+2.5	0.1	1, 6 (22″)
							+3.0	0.1	4, 6 (22″)
156498AB	12.03	1.50	+29.5	2.3	−30	2.2	+11.5	3.1	1, 6 (0″.3), 11
159561	69.84	0.88	+120.1	0.3	−226	0.3	+12.1	1.6	2
							+12.4	3.6	5
160269AB	70.98	0.55	+253.8	3.5	−515	3.1	−15.9	0.5	4, 6 (1″.6)
							−15.1	0.2	5, 6 (1″.6)
							−13.4	0.6	6 (1″.6), 7
165185	57.58	0.77	+116.5	2.7	+1	3.0	+15.2	0.2	4
							+13.2	?	3
167389	29.91	0.59	+53.9	2.0	−129	2.0	−3.0	2.6	1
169981	7.63	0.60	+26.0	0.7	−22	0.9	−8.3	0.2	2, 11
							+7.5	2.0	3, 8, 11
							+2.9	3.4	8? , 11, 13
171746AB	29.23	1.54	+40.2	4.9	−78	4.9	+9.0	0.6	5, 6 (1″.7)
							+7.9	0.2	6 (1″.7), 7
173654A................	12.62	1.48	+21.0	4.1	−12	4.5	+19.1	5.0?	3, 6 (13″), 8
							−0.3	0.2	2, 6 (13″)
							+19.1	0.4	6 (13″), 8, 31
173654B................	13.11	7.71	+6.0	3.9	−15	3.9	+9.2	5.0?	3, 6 (13″)
							+36.6	0.3	2, 6 (13″)
173667	52.37	0.68	−8.43	0.4	−335	0.5	+22.8	0.2	4
							+23.2	0.6	5
173950AB	27.01	0.93	+17.6	2.9	−81	2.7	+8.2	0.8	1, 6 (0″.5)
							+6.7	0.2	6 (0″.5), 7
175742	46.64	1.03	+132.0	1.8	280	1.9	+10.3	1.5	3, 8, 11, BY Dra var.
176303A................	20.99	0.69	+5.8	2.6	−124	2.7	+15.9	0.7	2, 6 (20″)
							+15.9	0.3	4, 6 (20″)
							+15.5	0.4	5, 6 (20″)
177196A................	25.54	0.46	+27.7	4.9	−79	4.8	+5.0	1.1	2, 6 (46″)
							+7.6	2.0	3, 6 (46″)
178428	47.72	0.77	+63.2	2.8	−306	2.8	+14.8	0.1	4, 9 (26″), 11
							+14.8	2.0	3, 8, 9 (26″), 11
180777	36.64	0.49	+47.1	1.5	−123	2.4	−5.3	0.7	2
							−4.0	1.5	4
							−4.3	0.7	5
184960	39.08	0.47	+30.1	2.5	−183	2.5	+1.9	0.3	2
							+1.0	0.3	4
							+0.9	0.9	5
193592AB	11.21	0.64	−11.1	5.8	−18	5.4	−2.0	0.2	2, 6 (4″)
							+1.0	2.5	5, 6 (4″)
194943AB	33.04	0.86	−14.3	3.8	−39.0	3.7	+18.4	1.5	3, 6 (1″.2)
CG Cyg AB...........	9.25	4.95	+5.7	3.2	−15.9	4.2	+1.7	0.4	6 (1″.2), 8, 11, 15, 32, RS CVn var.
199951A................	14.59	0.79	−2.5	0.8	+5.0	0.9	+17.6	1.0	3, 9 (25″)
202908AabB	19.79	1.18	+26.5	4.9	−59	4.1	+6.2	0.1	6 (0″.2), 11, 33
							+11.0	5.4	5, 6 (0″.2), 11
203454	37.64	0.59	−12.6	2.3	−229	2.2	+10.5	1.7	2, 11
							−5.8	1.1	4, 11
							+0.3	2.5	5, 8, 11
BD −05° 5480AB...	37.91	2.28	−59.8	2.4	−5.0	2.5	+6.6	0.5	1, 6 (0″.3)

TABLE 3—*Continued*

HD/Name	π (mas)	$\sigma(\pi)$ (mas)	μ_α (km s^{-1})	$\sigma(\mu_\alpha)$ (km s^{-1})	μ_δ (km s^{-1})	$\sigma(\mu_\delta)$ (km s^{-1})	V_r (km s^{-1})	$\sigma(V_r)$ (km s^{-1})	Notes
205435	26.20	0.51	−23.1	0.6	−94	0.6	+7.4	1.0	2
							+7.0	0.7	5
							+6.9	0.9	1
205765A................	8.18	0.99	−21.0	2.1	−27	2.2	+9.4	1.1	2, 9 (31″)
							+16.9	2.0	3, 9 (31″)
205765B................	...	...	−27.0	3.6	−31	3.7	...	...	6 (31″)
206538A................	7.16	0.57	−23.8	4.0	−53	4.1	−8.2	0.9	2, 9 (53″)
							−3.3	3.1	5, 9 (53″)
206538B................	...	...	−4.5	3.9	−13	3.8	...	...	6 (53″)
209515AB.............	6.16	0.67	−23.5	4.5	−36	4.8	−11.0	0.9	2, 6 (1″)
							−1.2	2.0	3, 6 (1″)
209625	14.10	0.82	−16.5	4.1	−63	4.1	+13.9	0.2	2, 11
							+18.9	2.5	3, 8, 11
210459	11.51	0.64	−59.0	0.5	−67	0.6	+6.0	1.7	2
							+2.0	2.0	3
210873	6.38	0.48	−14.7	4.6	−29	5.1	−4.1	0.9	2
							−3.4	1.2	5
							−4.6	0.9	34
211575	24.11	0.92	−42.0	2.0	−54	2.2	+15.2	1.2	5
							+14.8	0.5	35
GJ 873..................	198.07	2.05	−704.9	2.6	−456	2.4	−5.8	1.5	5, 9 (5″)
							+0.5	0.3	9 (5″), 36
217813	41.19	0.87	−113.5	2.1	−28	2.1	+0.0	1.2	5
216627	20.44	2.26	−40.4	0.4	−25	0.6	+17.8	0.6	2
							+18.0	1.5	4
220096	9.92	0.87	−13.4	0.9	−12	1.0	+13.9	0.8	5, 11
221756	13.97	0.63	−17.2	0.7	−46	0.7	+15.6	0.9	2
							+12.1	2.7	5
222603	32.38	0.84	−128.9	0.5	−155	0.6	+9.3	0.8	2
							+10.7	1.1	5

NOTES.—(1) Radial velocity from Montes et al. 2001; (2) RV from this work; (3) Duflot et al. 1995 WEB catalog; (4) RV and σ(RV) from SM93; (5) Barbier-Brossat & Figon 2000 catalog; (6) double/multiple component in *Hipparcos* Catalogue, though some objects have relatively large (a few arcseconds) separations; (7) radial velocity from Tokovinin & Smekhov 2002; (8) systemic velocity of orbital barycenter; (9) close double/multiple component not resolved or detected by *Hipparcos*; (10) the proper motions for HD 18520 are assumed equal to the primary component HD 18519; (11) known spectroscopic binary; (12) radial velocity from Strassmeier et al. 2000; (13) radial velocities, parallax, and proper motions for HD 29875AB are those of the A component except the Montes et al. 2001 radial velocity, which is for the B component; (14) radial velocity from Grenier et al. 1999; (15) no PPM proper motions, *Hipparcos* proper motion used; (16) Tokovinin & Smekhov 2002 radial velocity for HD 56537AB is for the B component; (17) the parallax for HD 61606B is assumed equal to that for HD 61606A; (18) radial velocity from Delfosse et al. 1999 and is systemic velocity of component Aab; (19) radial velocity from de Medeiros & Mayor 1999; (20) radial velocity assumed to be that for HD 80388; (21) UMa nucleus star; (22) radial velocity from Nordstrom et al. 1997; (23) RV from M. Mayor (1997, private communication); (24) the proper motions for HD 116656 are assumed to be equal to those for HD 116657 since they do not have separate entries in the PPM catalog; (25) radial velocity from Marcy, Lindsay, & Wilson 1987; (26) radial velocity from Gaidos et al. 2000; (27) radial velocity from Fekel et al. 1999; (28) the *Hipparcos* parallax and PPM proper motions for HD 141003A are assumed for HD 141003B; (29) radial velocity from Hildebrandt, Scholz, & Lehmann 2000; (30) radial velocity from de Medeiros & Udry 1999; (31) systemic radial velocity from Abt & Levy 1985; (32) radial velocity from Popper 1994; (33) systemic radial velocity from Fekel et al. 1997; (34) radial velocity from Stickland & Weatherby 1984; (35) radial velocity from Andersen et al. 1985; (36) radial velocity from Marcy & Benitz 1989.

TABLE 4

Final Adopted UVW-Velocities and Uncertainties

HD/Name	U	$\sigma(U)$	V	$\sigma(V)$	W	$\sigma(W)$	RV Source
745	+20.904	3.161	−4.325	1.687	−5.532	1.533	1
2410	+15.273	3.069	+3.008	1.946	−16.266	2.408	2
1404	+16.806	0.887	−2.948	1.632	−2.458	0.891	2, 3
4813	+21.698	0.369	−3.043	0.122	−12.221	0.394	3, 4, 5
6116	+9.302	2.140	+7.782	1.641	−7.460	2.233	2, 3
6763	+47.048	1.648	+7.951	0.395	−29.426	0.930	2, 3
6920	+36.247	1.173	+5.256	0.719	−6.840	0.734	4
7804	+14.775	0.937	+3.702	0.288	−7.560	0.543	2, 3
11131	+18.726	1.796	+2.136	0.373	−2.363	0.680	4
11171	+18.513	0.517	+1.956	0.125	−5.486	0.941	3, 4
11257	+7.369	1.005	+8.763	0.888	−15.755	0.732	3, 5
12471	+11.824	2.086	+11.421	2.199	−3.829	2.098	3
13594AB	+18.874	0.906	−2.092	0.854	−12.582	1.085	3, 4
13959AB	+17.116	2.479	+5.152	1.066	−11.085	1.679	4, 6
15144AB	+19.665	1.505	−2.105	0.758	−11.055	1.119	5
16161AB	+10.137	1.941	+1.017	0.308	−18.738	1.670	3, 5
16861	+13.599	2.613	−0.988	1.778	−22.796	2.677	2, 3
16970AB	+22.211	1.887	−3.464	1.213	−10.701	2.081	2, 3
18331	+20.198	1.970	−2.721	0.366	+1.390	2.426	2, 3
18519	+9.902	2.318	+4.088	1.889	−0.979	1.984	2
18520	+11.394	1.996	+3.506	1.832	+0.042	1.813	2
18645	+10.539	1.508	−8.476	1.575	−5.897	1.359	1, 7
18778	+12.987	2.628	+3.297	3.124	−6.713	1.959	2
21447	+6.609	1.461	+8.007	1.421	−11.188	1.372	2, 3
24160	+18.403	0.834	−0.236	0.583	−10.210	0.863	4
24916AB	+7.436	0.786	+0.342	0.196	−17.652	0.730	1, 2
26913	+13.512	0.333	−1.297	0.219	−8.735	0.380	4
26923	+13.859	0.233	−0.256	0.240	−9.328	0.367	4
27820	+12.189	1.756	+4.213	2.846	−8.989	2.920	2, 3
27861	+17.059	1.186	−2.134	0.400	−15.576	1.150	3, 8
28495	+14.418	0.353	+3.288	0.430	−7.348	0.366	1
29697	+5.909	0.221	−3.104	0.132	−21.295	0.378	1
29875AB	+10.153	0.251	+5.622	0.487	−10.000	0.481	1, 5, 8
30834	+19.884	1.282	+6.916	2.970	−16.162	3.638	2
31000	+6.089	0.399	−0.487	0.372	+2.203	0.377	1
31278	+15.596	2.631	+14.114	3.180	−13.460	2.961	2
33111	+14.024	1.236	+2.633	0.583	−10.750	0.707	2, 3
33564	+19.536	0.295	+5.552	0.302	−3.994	0.161	5
38104	+7.156	0.404	+1.851	0.658	−6.847	0.788	2, 3
38393	+18.026	0.094	+4.156	0.070	−11.949	0.097	4
38656A	+16.851	0.408	−5.502	1.475	−15.716	1.641	3, 5
39587	+13.007	0.198	+2.582	0.095	−7.968	0.123	3, 5
40183	+16.054	1.440	−0.267	0.332	−9.021	0.299	2
41593	+10.583	0.112	+0.196	0.215	−11.413	0.271	4
42581	+11.890	0.332	−11.347	0.363	−11.639	0.184	5
43244	+9.425	1.776	+4.719	1.607	−10.889	1.650	2, 3
43318	+49.55	0.492	+3.838	0.544	−35.296	1.172	4
44691	+14.178	2.392	+11.100	2.324	−9.952	2.111	2
44762A	+16.486	2.158	−0.958	1.762	−11.867	2.202	4
45088AC	+8.926	0.198	−4.283	0.179	−13.398	0.252	4
48682A	+25.254	0.193	+8.833	0.152	−2.830	0.088	4
48915	+13.989	0.672	−0.425	0.726	−11.496	0.163	2
50692	+12.974	0.205	+6.023	0.232	−5.535	0.250	4
50973	+6.916	2.799	−0.005	0.680	−9.901	1.144	2, 3
GJ 268.3	+7.013	0.104	−8.616	0.314	−8.298	0.220	1
56168	+8.734	0.415	+5.566	0.434	−11.034	0.381	1
56537	+6.955	0.456	+0.648	0.192	−9.836	0.245	6
59747	+13.060	0.384	+3.471	0.264	−10.283	0.309	1
60491	+6.041	0.538	+5.824	0.525	−12.351	0.452	1
61245A	+17.278	2.062	−7.775	0.704	+11.387	1.900	1, 5
61606A	+26.159	0.549	−1.859	0.513	−7.934	0.192	5

TABLE 4—*Continued*

HD/Name	U	$\sigma(U)$	V	$\sigma(V)$	W	$\sigma(W)$	RV Source
61606B	+24.005	1.412	−4.126	1.270	−7.811	0.337	5
62668A	+20.435	1.839	−10.747	3.572	−19.109	2.938	7
63433	+16.400	0.895	+2.903	0.307	−8.621	0.463	5
64096	+28.001	0.296	+2.308	0.271	−19.657	0.337	4
64942	+10.689	0.708	+1.918	0.722	+1.319	0.520	1
71974	+12.506	0.343	+3.501	0.386	−10.764	0.379	1, 6
GJ 2069Aab/BC	−10.244	0.554	−4.894	0.314	−10.628	0.992	9
72905	+9.830	0.196	+0.667	0.205	−9.365	0.195	3, 4
75605	+14.299	1.677	+2.436	1.178	−9.810	1.502	4, 10
75935	+16.716	2.771	+2.771	0.822	−9.422	0.797	1
76218	+7.787	0.445	−0.253	0.339	−10.755	0.422	1
77350	+10.117	2.604	−3.310	2.773	−12.731	2.679	2
79028	+7.998	0.418	−7.079	0.328	−9.794	0.411	4
79439	+19.855	1.777	+6.545	0.657	−7.720	1.705	2, 3
80388	+14.492	1.542	−1.947	1.577	−4.503	1.470	2
80389	+15.945	1.609	−1.787	1.600	−3.178	1.491	2
81659	+25.370	0.866	+0.738	0.703	−16.462	0.548	1
81858AB	+11.203	0.576	+3.506	0.482	+0.624	0.549	4, 6
85364	+11.014	0.688	+1.862	1.100	−7.541	0.902	4
85444	+5.801	1.226	+3.666	1.019	−19.635	1.419	5
85512	+34.836	0.364	+10.028	1.979	−4.833	0.327	5
87696	+13.636	0.901	+1.922	0.773	−7.157	0.952	3, 5
GJ 378.2	+5.321	0.199	−0.139	0.441	−18.915	0.419	5
88355	+19.293	1.050	−3.383	0.944	−10.226	0.566	3, 4
88654	+17.851	1.607	−2.986	0.962	−7.240	0.721	1
89025	+16.717	0.685	+4.840	0.373	−13.810	0.929	3, 5
89025	+13.741	0.852	+3.106	0.475	−8.898	1.249	4
89025	+16.072	0.685	+4.464	0.373	−12.746	0.929	3, 4, 5
91480	+13.638	0.457	+2.988	0.264	−7.202	0.629	3, 5
91752	+20.232	0.983	−4.183	0.671	−16.042	1.349	2
95418	+13.689	0.419	+2.824	0.259	−7.352	0.651	5
95650	+12.765	0.391	+3.696	0.328	−10.692	0.821	5
97305	+9.216	4.631	−14.699	5.808	+2.221	1.802	7
97603	+20.575	0.314	−0.177	0.238	−16.020	0.737	3, 5
98712AB	+13.487	0.401	−3.414	1.971	+1.794	1.535	5
99028	+21.859	1.255	+4.671	1.050	−6.328	0.630	3, 10
99648/9?	+20.232	3.125	+2.433	0.539	−7.267	0.298	4
100043	+15.777	1.112	−3.519	0.909	−7.195	0.931	11
100310	+16.118	0.795	−0.364	0.458	−3.259	0.497	1
102070	+20.382	1.847	+1.158	0.569	−9.306	0.775	5
GJ 447	+17.684	0.134	+4.146	0.613	−31.227	1.036	5
103287	+13.936	0.343	+2.730	0.267	−8.202	0.703	3, 5
BD +19°2531	+24.086	1.468	−1.841	0.682	−4.138	0.423	1
238087	+15.760	1.348	+1.453	1.395	−11.702	2.560	2
106591	+15.350	0.380	+1.172	0.390	−11.519	0.861	3, 4
109011	+14.107	0.882	+2.452	0.684	−10.261	0.568	4, 12
238090	+16.637	1.024	+8.376	1.034	−13.786	2.471	5
109647	+14.975	0.594	+4.370	0.512	−7.169	0.340	4
109799	+17.491	0.854	+0.426	1.106	−12.920	0.989	4
110463	+14.102	0.544	+3.834	0.500	−8.533	0.355	4, 5, 12
111397	+17.629	2.958	+4.197	2.384	−7.770	1.385	3, 5
111456	+15.606	0.985	−0.773	0.805	−13.090	0.948	3, 4
112097AB	+18.330	1.679	+2.822	1.439	−6.205	3.209	5
112185	+13.965	0.187	+2.500	0.138	−8.771	0.177	3, 4
112196	+9.356	0.660	−0.843	0.394	−7.834	1.594	1
113139	+14.314	0.670	+4.310	0.697	−7.954	0.917	2, 5
238179	+52.391	5.477	+3.390	3.313	−38.407	1.074	4, 12
114260	+25.281	0.812	−5.336	0.462	−41.814	0.859	4
114723AB	+8.417	1.731	+1.099	1.429	−12.345	1.796	5
115043	+13.914	0.409	+2.984	0.441	−8.418	0.627	5
238208	+32.229	1.864	−16.488	1.161	−39.739	0.650	4, 12
116656	+13.340	0.207	+4.186	0.243	−5.618	0.440	4, 5

TABLE 4—*Continued*

HD/Name	U	$\sigma(U)$	V	$\sigma(V)$	W	$\sigma(W)$	RV Source
116657	+14.031	0.416	+2.567	0.882	−8.872	1.759	5
116842	+13.166	0.677	+3.445	0.620	−9.246	0.463	3, 5
238224	+14.943	0.748	+3.785	0.616	−8.360	0.524	12
GJ 516AB	+20.821	12.140	−1.463	2.275	−7.032	5.703	1
GJ 519	+13.662	0.451	+5.443	0.757	−12.614	2.924	5
118022	+8.719	0.617	+4.741	0.250	−13.978	0.424	3, 5
120528	+37.470	2.755	+3.472	1.581	−22.776	0.716	4, 12
120818	+7.777	1.407	+3.193	1.315	−9.023	0.943	3
122408AB(?)	+5.335	0.659	−0.588	0.245	−8.247	0.902	3, 5
124752	+21.928	1.013	+12.118	1.440	−12.156	1.527	4, 5
124674	+17.407	4.936	+1.346	3.729	−24.257	2.194	5
124675	+9.032	0.789	−1.587	1.385	−18.583	2.215	5
125451A	+11.390	0.419	+5.608	0.152	−4.718	0.735	3, 5
125642	+14.495	3.374	−3.055	2.938	−17.012	1.398	2, 3
128311	+16.238	0.428	−4.596	0.190	−20.402	0.409	1
129246/7	+11.564	2.628	+5.909	2.627	−10.019	2.217	3, 5
129674	−0.709	0.860	−1.013	2.620	−8.479	3.997	5, 7, 13
129798AB	+15.020	0.990	+3.613	0.976	−7.374	0.975	1, 2, 3
129989AB	−16.274	1.479	−10.295	1.430	−8.156	0.789	3, 5, 10
131156AB	+6.405	0.146	+0.841	0.129	−1.803	0.186	4, 5
GJ 569ABab	+7.758	0.244	+3.199	0.115	−13.415	0.287	5, 14
134083	+17.421	0.485	−1.536	0.277	−17.323	0.791	3, 5
135599	+9.632	0.251	+0.845	0.156	−13.446	0.247	15
136901	+7.795	4.894	−7.291	2.924	−24.653	2.757	16
137006	+7.688	1.560	+6.961	0.353	−20.059	1.521	3, 5
137107/8	+16.479	0.594	−4.782	0.406	−13.239	0.316	4
138481	+11.889	2.170	−0.929	0.918	−16.072	1.231	3, 5
139006	+14.257	0.915	+3.147	0.791	−7.582	1.621	2
139194	+15.624	0.787	−3.142	0.553	−21.299	0.500	1
139798	+26.180	0.523	+2.172	0.257	−3.032	0.340	3
140775	+2.574	1.928	+11.276	2.702	−16.041	2.088	3
141003A	+13.738	1.320	+3.074	0.606	−11.040	1.559	2, 3, 4
141003B	+13.617	0.588	+3.016	0.189	−11.188	0.564	6
146738	+25.537	4.749	+7.816	2.162	−21.418	4.050	3
147513	+13.633	0.103	−1.152	0.119	−1.559	0.121	4
147584	+13.305	1.106	+4.579	0.946	−6.280	0.384	4
148112AB	+29.668	1.553	+2.443	0.632	−6.280	1.454	3
148112AB	+13.954	1.402	−6.432	0.508	−20.699	1.319	2
GJ 625	+7.997	0.088	−2.232	0.369	−17.471	0.347	1
GJ 625	+6.678	0.330	−13.309	2.697	−27.795	2.514	5
150706	+19.756	0.341	−4.328	0.313	−12.874	0.277	4
151044	+16.233	0.448	−2.195	0.312	−21.512	0.340	3, 4, 5
152107	+13.045	1.315	−1.306	0.904	−4.679	1.002	2, 3, 17
152863AB	+15.185	2.010	−2.714	1.562	−9.875	1.866	6
153751Aab	+3.633	0.191	−3.720	0.365	−13.178	0.555	18
GJ 3991	+7.807	0.964	−3.650	1.535	−15.591	1.364	1
155674A	+12.283	0.622	+5.108	0.277	−4.069	0.404	1, 4
155674B	+11.505	0.842	+5.900	0.353	−5.418	0.566	1, 4
156498AB	+17.542	2.673	+4.122	1.675	−9.078	2.346	1
159561	+19.545	1.204	+1.061	0.869	−8.066	0.635	3
160269AB	+35.272	0.342	−3.896	0.366	−20.955	0.308	4, 5, 6
165185	+14.290	0.201	+3.649	0.249	−10.272	0.253	4
167389	+17.291	0.979	−3.596	2.213	−13.716	1.139	1
169981	+12.920	1.331	+7.671	1.639	−16.681	1.677	2, 19, 20
171746AB	+13.173	0.743	+1.296	0.641	−9.556	0.976	5, 6
173654A	+16.588	0.934	+9.686	1.431	−8.854	1.899	21
173654B	+18.331	1.453	+6.738	2.265	−4.185	2.950	21
173667	+37.083	0.324	+1.542	0.257	−7.903	0.165	4
173950AB	+15.100	0.647	+4.856	0.585	−5.224	0.578	5, 6
175742	+24.454	0.963	+0.049	1.224	−22.317	0.614	2
176303A	+29.100	0.793	−5.010	0.737	−12.547	0.744	3, 5
177196A	+13.435	0.929	+5.559	1.075	−7.836	0.943	2, 3

TABLE 4—*Continued*

HD/Name	U	$\sigma(U)$	V	$\sigma(V)$	W	$\sigma(W)$	RV Source
178428	+28.894	0.384	−3.283	0.306	−18.355	0.418	4
180777	+13.891	0.387	+4.029	0.626	−10.210	0.366	3, 5
184960	+18.897	0.378	+2.465	0.301	−12.039	0.338	3, 4, 5
193592AB	+8.956	2.390	−1.864	0.492	−0.533	2.362	3
194943AB	+16.944	1.219	+1.883	0.778	−9.134	0.873	2
CG Cyg AB	+4.397	2.890	−0.090	1.126	−7.648	4.396	1
199951A	+13.474	0.765	+4.444	0.342	−10.571	0.679	2
202908AabB	+6.313	1.026	−3.615	0.784	−15.019	1.241	22
203454	+21.420	0.482	−3.677	2.476	−19.029	0.503	5
BD −05° 5480AB	+9.233	0.500	+3.425	0.393	+1.701	0.486	1
205435	+14.515	0.304	+6.493	0.698	−10.213	0.224	1, 3, 5
205765AB	+24.448	2.465	+0.221	2.091	−8.988	1.553	2
	+20.944	2.338	−4.696	1.781	−4.539	1.196	3
206538A	+34.805	3.864	−11.470	1.023	−14.238	2.931	3
	+34.928	3.865	−6.632	3.102	−15.055	2.968	5
209515AB	+31.956	4.905	−10.296	1.062	−9.403	3.770	3
	+31.267	4.906	−0.630	2.057	−10.865	3.780	2
209625	+21.703	1.801	−3.186	2.106	−18.854	1.998	2
210459	+36.129	2.013	+1.144	1.624	−8.321	0.695	2, 3
210873	+20.606	3.605	+6.443	1.818	−11.553	3.661	3, 5, 23
211575	+16.703	0.613	+3.021	0.520	−10.645	0.456	24
GJ 873	+19.663	0.220	+3.799	0.290	−1.714	0.090	25
216627	+16.046	1.169	+4.221	0.370	−12.766	0.607	3
217813	+12.878	0.365	+2.474	0.991	+3.010	0.723	5
220096	+12.005	0.838	−0.755	0.551	−11.064	0.786	5
221756	+7.027	0.612	+12.410	0.814	−17.475	0.671	3, 5
222603	+27.484	0.717	−3.538	0.503	−14.116	0.687	3, 5

REFERENCES.—(1) Radial velocity from Montes et al. 2001; (2) Duflot et al. 1995 WEB catalog; (3) RV from this work; (4) RV and σ(RV) from SM93; (5) Barbier-Brossat & Figon 2000 catalog; (6) radial velocity from Tokovinin & Smekhov 2002; (7) radial velocity from Strassmeier et al. 2000; (8) radial velocity from Grenier et al. 1999; (9) radial velocity from Delfosse et al. 1999 and is systemic velocity of component Aab; (10) radial velocity from de Medeiros & Mayor 1999; (11) radial velocity from Nordstrom et al. 1997; (12) RV from M. Mayor (1997, private communication); (13) radial velocity from Fehrenbach et al. 1997; (14) radial velocity from Marcy et al. 1987; (15) radial velocity from Gaidos et al. 2000; (16) radial velocity from Fekel et al. 1999; (17) radial velocity from Hildebrandt et al. 2000; (18) radial velocity from de Medeiros & Udry 1999; (19) systemic velocity of orbital barycenter; (20) known spectroscopic binary; (21) systemic radial velocity from Abt & Levy 1985; (22) systemic radial velocity from Fekel et al. 1997; (23) radial velocity from Stickland & Weatherby 1984; (24) radial velocity from Andersen et al. 1985; (25) radial velocity from Marcy & Benitz 1989.

TABLE 5
PHOTOMETRY AND MEMBERSHIP ASSIGNMENTS

HD/Name	M_V	σ_{M_V}	V	$B-V$	σ_{B-V}	$V-I$	σ_{V-I}	$\log R'_{\mathrm{HK}}$	Kin. Memb.	Phot. Memb.	Literature [Fe/H]	σ_{Fe} (dex)	Final Memb.
UMa nucleus stars:													
91480	3.05	0.04	5.16	0.345	0.004	0.39	0.03	...	Y	Y	...	...	Y
95418	0.42	0.03	2.35	0.029	0.002	0.02	0.03	...	Y	Y	+0.16	...	Y
103287	0.38	0.04	2.43	0.041	0.002	0.06	0.00	...	Y	Y	...	...	Y
106591	1.31	0.04	3.30	0.092	0.003	0.03	0.05	...	Y?	Y	...	...	Y
109011	6.22	0.16	8.10	0.948	0.011	0.93	0.00	−4.414	Y	Y	...	...	Y
109647	6.43	0.07	8.53	0.967	0.014	1.00	0.01	−4.447	Y	Y	...	...	Y
110463	6.45	0.04	8.28	0.974	0.014	1.00	0.00	−4.468	Y	Y	...	...	Y
111456	3.92	0.17	5.84	0.480	0.003	0.56	0.03	...	?	Y	...	...	Y?
112185	−0.21	0.04	1.76	0.041	0.007	−0.04	0.03	...	Y	Y	+0.01?	0.12	Y
113139A[a]	3.02	0.05	5.01	0.350	0.020	0.43	0.04	...	Y	Y?	...	...	Y
113139B[a]	5.84	0.05	7.83	0.905	0.020	...	...	...	(Y)	?	...	...	?
115043	4.77	0.04	6.82	0.610	0.006	0.66	0.03	−4.476	Y	Y	−0.03	...	Y
116656	0.32	0.03	2.22	0.053	0.003	0.07	0.00	...	Y	Y?	+0.24	...	Y
116657	1.96	0.03	3.86	0.159	0.007	...	...	...	Y	Y	+0.24	...	Y
116842	2.02	0.03	4.00	0.183	0.003	0.19	0.03	...	Y	Y	...	...	Y
Probable activity-based members:													
26923	4.60	0.05	6.23	0.582	0.008	0.64	0.01	−4.50	Y?	Y	+0.08	0.10	Y?
28495	5.56	0.06	7.76	0.772	0.011	0.80	0.01	−4.388	Y	Y	...	...	Y
31000	5.50	0.07	7.77	0.748	0.018	0.79	0.01	−4.419	N?	Y?	...	...	N?
39587	4.71	0.03	4.40	0.597	0.003	0.66	0.02	−4.38	Y	Y	−0.04	0.09	Y
41593	5.81	0.04	6.76	0.823	0.009	0.85	0.01	−4.414	N?/?	Y	+0.07	0.02	N?/?
60491	6.19	0.07	8.16	0.875	0.017	0.94	0.01	−4.246	N?/?	Y?	...	...	N?/?
61606A	6.42	0.04	7.18	0.921	0.030	1.01	0.02	−4.400	N?	Y?	−0.01	0.15	N?
61606B	8.17	0.04	8.93	1.303	0.037	1.59	0.03	...	N?	?	...	...	N?
63433	5.23	0.05	6.92	0.676	0.010	0.74	0.01	−4.417	Y?	?	...	...	?
64942	4.96	0.13	8.38	0.654	0.019	0.73	0.02	−4.410	N?	?	...	...	N?
72905	4.87	0.03	5.64	0.616	0.004	0.66	0.03	−4.369	?/Y?	Y?	−0.05	0.07	Y?
75935	5.41	0.12	8.45	0.785	0.018	0.81	0.01	−4.443	Y?	?	...	...	?
76218	5.59	0.06	7.68	0.773	0.012	0.81	0.01	−4.424	N?/?	Y	...	...	?
88654[b]	2.85	0.21	7.68	0.861	0.009	0.88	0.01	−4.357	N?	N?	...	...	N?
112196	4.33	0.13	7.00	0.531	0.008	0.65	0.01	−4.304	N?/?	?	...	...	N?/?
134083	3.46	0.04	4.93	0.435	0.003	0.51	0.05	...	N?	?	+0.05	0.10	N?
141003A[c]	0.30	0.09	3.66	0.073	0.004	0.09	0.02	...	Y	?	...	...	Y?
141003B[c]	6.59	0.10	9.95	0.99	0.02	...	...	...	(Y)	Y?	...	...	Y
147513A	4.82	0.03	5.37	0.631	0.003	0.68	0.02	−4.418	N?/?	Y?	+0.04	0.01	N?/?
150706	4.85	0.04	7.02	0.604	0.007	0.68	0.01	−4.448	N?/?	Y?	...	...	N?/?
165185	4.74	0.03	5.94	0.602	0.006	0.68	0.02	−4.406	Y	Y?	−0.06	...	Y
217813	4.73	0.04	6.66	0.616	0.011	0.69	0.01	−4.454	?	?	...	...	?
Possible activity-based members:													
745	1.92	0.28	7.46	0.887	0.004	0.90	0.01	−4.432	N?	N?	...	...	N?
4813	4.22	0.04	5.17	0.512	0.004	0.59	0.02	−4.630	N?	Y?	−0.16	0.03	?
11131	4.91	0.23	6.72	0.638	0.009	0.73	0.07	−4.532	?	Y?	−0.10	0.06	Y?
13959A[a]	6.87	0.31	9.76	0.995	0.060	1.11	0.04	...	Y?	Y?	...	...	Y?
13959B[a]	6.96	0.31	9.85	1.235	0.080	...	...	...	Y?	N?	...	...	?

TABLE 5—*Continued*

HD/Name	M_V	σ_{M_V}	V	$B-V$	σ_{B-V}	$V-I$	σ_{V-I}	log $R'_{\rm HK}$	Kin. Memb.	Phot. Memb.	Literature [Fe/H]	$\sigma_{\rm Fe}$ (dex)	Final Memb.
18645[b]	2.58	0.32	7.88	0.780	0.028	0.83	0.01	−4.071	?	N?	. . .	. . .	N?
26913	5.36	0.05	6.96	0.669	0.013	0.74	0.01	−4.417	?	?	−0.13	0.14	?
45088AC	5.98	0.04	6.81	0.954	0.012	0.98	0.01	−4.299	N?	?	. . .	. . .	N?
56168	6.35	0.06	8.39	0.892	0.013	0.93	0.01	−4.460	?	Y?	. . .	. . .	?
59747	6.23	0.06	7.70	0.867	0.019	0.88	0.01	−4.437	Y	Y?	. . .	. . .	Y
62668A[b]	1.21	0.54	7.73	1.095	0.015	1.06	0.02	−3.921	N?	N?	. . .	. . .	N?
71974A[a]	5.22	0.09	7.51	0.67	0.02	0.76	0.03	−4.451	Y	Y?	. . .	. . .	Y
71974B[a]	6.80	0.09	9.09	1.02	0.04	. . .	. . .	. . .	Y	Y?	. . .	. . .	Y
81659	4.89	0.09	7.89	0.700	0.014	0.76	0.01	−4.566	N?	N?	. . .	. . .	N?
81858A[a]	3.20	0.10	5.88	0.680	0.02	(0.67)	0.08	. . .	?	N?	. . .	. . .	N?
81858B[a]	3.92	0.10	6.60	0.480	0.02	. . .	. . .	. . .	?	?	. . .	. . .	?
128311	6.38	0.04	7.48	0.971	0.015	1.02	0.01	−4.490	N?	?	. . .	. . .	?
129674[b]	3.39	0.10	7.55	0.399	0.006	0.47	0.01	−4.292	N?	Y?	. . .	. . .	?
131156A	5.54	0.03	4.67	0.725	0.01	0.82	0.03	−4.39	N?	?	−0.06	0.20	?
131156B	7.69	0.04	6.82	1.155	0.02	. . .	. . .	. . .	N?	Y?	(−0.06)	0.20	?
136901[d]	0.01	0.55	7.24	1.251	0.007	1.20	0.01	−3.959	N?	?	. . .	. . .	N?
147584	4.50	0.02	4.91	0.554	0.002	0.64	0.02	. . .	Y	Y	−0.19	0.08	Y
160269A[a]	4.56	0.02	5.30	0.585	0.025	0.65	0.02	−4.606	N?	Y?	. . .	. . .	?
160269B[a]	7.65	0.03	8.39	1.32	0.03	. . .	. . .	. . .	N?	N?	. . .	. . .	N?
171746A[a]	4.28	0.12	6.95	0.545	0.02	0.63	0.07	−4.459	Y	Y?	. . .	. . .	Y
171746B[a]	4.37	0.12	7.04	0.545	0.02	(0.630)	0.07	. . .	Y	Y?	. . .	. . .	Y
173950AB	5.24	0.08	8.08	0.841	0.014	0.87	0.01	−4.461	Y?	?	. . .	. . .	Y?
175742	6.51	0.04	8.17	0.924	0.014	0.95	0.01	−4.175	N?	Y?	. . .	. . .	?
CG Cyg A[a,b,e]	5.12	1.30	10.29	0.82	0.05	. . .	. . .	−3.921	?	Y?	. . .	. . .	?
CG Cyg B[b,e,f]	6.36	1.30	11.53	0.97	0.05	. . .	. . .	−4.444	(?)	Y?	. . .	. . .	?
203454	4.28	0.04	6.40	0.546	0.004	0.63	0.03	−4.296	N?	Y?	−0.16	0.05	?
Probable activity-based nonmembers:													
6920	2.06	0.08	5.67	0.598	0.003	0.67	0.01	. . .	?	N?	−0.13	0.08	N?
33564	3.48	0.03	5.09	0.500	0.005	0.58	0.01	−4.754	N?	N?	. . .	. . .	N?
38393[g]	3.84	0.02	3.60	0.495	0.003	0.57	0.02	−4.774	?/Y?	Y?	−0.07	0.06	Y?
43318	2.86	0.06	5.62	0.498	0.004	0.58	0.01	. . .	N?	N?	−0.18	0.02	N?
48682A	4.16	0.03	5.25	0.567	0.005	0.65	0.01	−4.865	N?	N?	+0.15?	. . .	N?
50692	4.56	0.04	5.75	0.597	0.004	0.70	0.07	−4.903	?	?	. . .	. . .	?
64096A[a]	4.46	0.04	5.57	0.565	0.020	0.63	0.04	−4.827	N?	Y?	. . .	. . .	?
64096B[a]	5.33	0.04	6.44	0.705	0.020	. . .	. . .	. . .	(N?)	Y?	. . .	. . .	?
79028	3.73	0.03	5.19	0.601	0.003	0.67	0.01	−4.996	N?	N?	−0.06	0.02	N?
88355A	2.24	0.13	6.43	0.480	0.006	0.53	0.03	. . .	N?	N?	+0.00	. . .	N?
94686A	3.36	0.14	7.34	0.545	0.008	0.62	0.01	. . .	. . .	N?	−0.14	0.08	N?
97305[b]	1.28	0.72	8.63	1.667	0.014	1.68	0.04	−5.824	N?	N?	. . .	. . .	N?
100310	5.58	0.12	8.84	0.723	0.019	0.77	0.01	−4.683	N?	?	. . .	. . .	N?
BD +19°2531	6.20	0.12	9.19	0.884	0.029	0.89	0.02	−4.523	N?	Y?	. . .	. . .	N?
114260	5.17	0.05	7.34	0.735	0.010	0.76	0.02	−4.859	N?	Y?	. . .	. . .	N?
124752A	5.59	0.09	8.52	0.810	0.016	0.88	0.01	−4.805	N?	Y?	. . .	. . .	N?
135599	5.96	0.04	6.92	0.830	0.010	0.87	0.01	−4.583	?	Y	. . .	. . .	?
137107[a]	4.29	0.06	5.64	0.550	0.020	0.63	0.03	−4.748	N?	Y?	. . .	. . .	?
137108[a]	4.55	0.06	5.90	0.610	0.020	0.67	0.03	. . .	N?	Y?	. . .	. . .	?

TABLE 5—*Continued*

HD/Name	M_V	σ_{M_V}	V	$B-V$	σ_{B-V}	$V-I$	σ_{V-I}	log $R'_{\rm HK}$	Kin. Memb.	Phot. Memb.	Literature [Fe/H]	$\sigma_{\rm Fe}$ (dex)	Final Memb.
139194	6.25	0.06	8.63	0.870	0.016	0.88	0.01	−4.588	N?	Y?	...	...	N?
151044	4.13	0.03	6.47	0.544	0.006	0.55	0.03	−4.958	N?	Y?	−0.01	0.02	N?
167389	4.77	0.04	7.39	0.602	0.010	0.71	0.01	−4.740	N?	?	...	...	N?/?
173667	2.81	0.03	4.21	0.473	0.002	0.55	0.01	...	?	N?	−0.10	0.13	N?
178428	4.47	0.04	6.08	0.705	0.006	0.76	0.01	−4.978	N?	?	+0.11	0.02	N?
184960	3.68	0.03	5.72	0.492	0.003	0.58	0.03	...	?/Y?	?	−0.14	0.03	?/Y?
211575[h]	3.30	0.08	6.39	0.455	0.007	0.51	0.01	−4.71	Y?	?	...	...	?/Y?
Additional UMa candidates:													
1404	1.33	0.07	4.51	0.072	0.002	0.06	0.04	...	N?	Y	...	...	?
2410	0.32	0.30	6.39	0.987	0.007	0.97	0.01	...	?	Y?	...	...	?
6116	0.83	0.20	5.94	0.177	0.005	0.17	0.03	...	N?	N?	...	...	N?
6763	2.73	0.07	5.51	0.336	0.005	0.41	0.01	...	N?	?	−0.04	...	?
7804	1.01	0.13	5.15	0.073	0.004	0.11	0.03	...	Y	Y?	...	...	Y
11171	2.79	0.05	4.66	0.348	0.003	0.38	0.02	...	?/Y?	Y?	−0.02	...	Y?
11257	2.78	0.09	5.93	0.300	0.007	0.39	0.03	...	N?	Y?	−0.29	0.03	?
12471	0.25	0.21	5.52	0.038	0.004	0.07	0.03	...	N?	Y?	...	...	?
13594A	3.46	0.09	6.55	0.370	0.015	(0.44)	0.04	...	N?	?	−0.26	...	N?/?
13594B	4.09	0.09	7.18	0.480	0.015	...	...	...	(N?)	Y?	(−0.26)	...	?
15144A	1.77	0.13	5.86	0.145	0.004	0.12	0.03	...	N?	Y	+0.03?	...	?
15144B	4.96	0.13	9.05	0.544	0.026	...	...	...	(N?)	N?	(+0.03)?	...	N?
16161A	−0.41	0.28	4.88	0.875	0.015	0.89	0.02	...	N?	Y?	−0.38	...	?
16161B	3.79	0.28	9.08	0.56	0.02	...	...	...	(N?)	N?	(−0.38)	...	N?
16861	0.74	0.27	6.32	0.048	0.009	0.05	0.03	...	N?	Y	...	...	?
16970AB	1.57	0.05	3.57	0.095	0.008	0.10	0.02	...	N?	Y	...	...	?
18331	1.36	0.12	5.17	0.077	0.009	0.10	0.02	...	N?	Y?	...	...	?
18519[a]	0.82	0.29	5.58	0.06	0.015	0.05	0.03	...	?	Y	...	...	?
18520[a]	0.48	0.29	5.24	0.05	0.015	(0.05)	0.03	...	?	Y?	...	...	?
18778	1.95	0.07	5.91	0.173	0.004	0.16	0.03	...	Y	Y	+0.26?	...	Y
21447	1.26	0.09	5.10	0.041	0.004	0.06	0.03	...	N?	Y?	...	...	?
24160	3.45	0.09	7.49	1.193	0.014	1.15	0.01	...	?	N?	...	...	N?
24916A	7.08	0.07	8.07	1.127	0.012	1.19	0.02	...	N?	?	...	...	N?
24916B	10.49	0.07	11.48	1.52	0.04	...	...	...	(N?)	Y?	...	...	?
27820AB	−0.31	0.25	5.11	0.082	0.004	0.12	0.03	...	Y?	Y?	...	...	Y?
27861	1.14	0.11	5.17	0.077	0.005	0.10	0.03	...	N?	Y?	...	...	?
29697	7.45	0.04	8.10	1.103	0.010	1.16	0.01	...	N?	Y?	...	...	?
29875A	2.93	0.03	4.45	0.332	0.003	0.40	0.02	...	?	Y?	...	...	?
30834	−1.40	0.31	4.78	1.399	0.006	1.46	0.03	...	N?	Y?	−0.21	0.16	?
31278A[a]	−0.79	0.21	4.52	−0.030	0.02	0.06	0.03	...	?	?	...	...	?
31278B[a]	2.34	0.21	7.65	0.435	0.02	...	...	...	(?)	N?	...	...	N?
33111	0.61	0.05	2.79	0.156	0.005	0.16	0.02	...	Y	N?	...	...	?
38104	−0.39	0.28	5.46	0.041	0.006	0.07	0.03	...	?/Y?	Y?	...	...	?
38656A	0.45	0.12	4.52	0.951	0.004	0.95	0.03	...	N?	Y?	−0.27	...	?
40183	−0.10	0.05	1.90	0.072	0.006	0.05	0.03	...	?/Y?	Y	−0.02	0.03	Y?
42581	9.36	0.03	8.17	1.435	0.052	2.01	0.02	...	N?	?	...	...	N?
43244	2.23	0.13	6.52	0.271	0.005	0.32	0.03	...	Y?	?	...	...	?
44691	0.94	0.18	5.54	0.234	0.012	0.27	0.02	...	?	?	+0.04	0.32	?

TABLE 5—*Continued*

HD/Name	M_V	σ_{M_V}	V	$B-V$	σ_{B-V}	$V-I$	σ_{V-I}	log $R'_{\rm HK}$	Kin. Memb.	Phot. Memb.	Literature [Fe/H]	$\sigma_{\rm Fe}$ (dex)	Final Memb.
44762A	−0.46	0.10	3.85	0.863	0.002	0.88	0.02	...	N?	?	−0.31	...	?
48915A	1.45	0.02	−1.44	0.009	0.007	−0.02	0.01	...	Y?	?	+0.32	0.16	?
50973	0.71	0.11	4.90	0.034	0.003	0.05	0.03	...	?	Y?	...	...	?
GJ 268.3^{i}	10.39	0.06	10.85	1.540	0.020	2.35	0.03	...	N?	?	...	...	N?
56537A	1.27	0.06	3.58	0.114	0.003	0.12	0.02	...	?	Y?	...	...	?
61245A	1.67	0.14	6.90	1.027	0.009	1.00	0.01	...	N?	N?	...	...	N?
GJ 2069Aab^{i}	11.36	0.16	11.90	...	...	2.68	?	...	N?	Y	...	...	?
GJ 2069BC^{i}	12.78	0.16	13.32	...	...	2.94	?	...	(N?)	N?	...	...	N?
75605	0.97	0.19	5.20	0.868	0.003	0.90	0.01	...	Y	?	...	...	Y?
77350	−0.27	0.30	5.46	−0.039	0.005	−0.02	0.03	...	N?	Y?	+0.09	0.13	?
79439	2.02	0.06	4.82	0.204	0.003	0.26	0.03	...	N?	Y?	...	...	?
80388	4.72	0.11	8.30	0.591	0.004	0.66	0.01	...	N?	Y	...	...	?
80389	4.86	0.14	8.66	0.685	0.022	...	...	...	N?	Y?	...	...	?
85364	2.09	0.11	6.03	0.161	0.007	0.19	0.01	...	Y?	Y	...	...	Y?
85444	−0.51	0.15	4.11	0.925	0.002	0.92	0.02	...	N?	Y?	...	...	?
85512	7.43	0.03	7.67	1.156	0.012	1.34	0.01	...	N?	?	...	...	N?
87696	2.26	0.05	4.49	0.190	0.003	0.19	0.012	...	Y	Y?	...	...	Y?
GJ 378.2	8.15	0.10	9.90	1.347	1.017	1.71	0.01	...	N?	?	...	...	N?
89025	−1.07	0.14	3.44	0.318	0.004	0.39	0.03	...	Y?	?	−0.03	...	Y?
91752	2.96	0.07	6.29	0.429	0.008	0.50	0.01	...	N?	?	−0.24	0.09	N?
95650	9.35	0.04	9.68	1.369	0.07	1.77	0.04	...	Y	Y?	...	...	Y
97603	1.32	0.03	2.56	0.152	0.003	0.12	0.03	...	N?	Y?	...	...	?
98712A	8.04	0.07	8.64	1.343	0.014	1.66	0.02	...	N?	?	...	...	N?
99028A^{a}	2.11	0.06	4.03	0.405	0.020	0.45	0.03	...	?	N?	+0.07	0.02	N?
99028B^{a}	4.81	0.06	6.73	0.810	0.020	...	...	...	(?)	N?	(+0.07)	(0.02)	N?
99648	−1.45	0.35	4.95	1.000	0.005	0.95	0.02	...	?	N?	+0.36	...	N?
99649	1.02	0.35	7.42	0.359	0.019	...	...	...	?	N?	...	...	N?
100043	3.01	0.12	7.05	0.368	0.008	0.45	0.01	...	N?	?	...	...	?
102070	−0.45	0.19	4.71	0.965	0.003	0.94	0.02	...	?/Y?	Y?	−0.11	...	Y?
GJ 447	13.50	0.03	11.12	1.746	0.02	2.97	0.01	...	N?	N?	...	...	N?
238087	7.71	0.08	9.97	1.328	0.051	1.46	0.01	...	Y?	?	...	...	?
238090	8.80	0.06	9.73	1.380	0.012	1.63	0.02	...	N?	Y	...	...	?
109799	2.72	0.06	5.41	0.336	0.006	0.39	0.03	...	?	Y?	−0.08	0.18	Y?
111397	0.25	0.21	5.71	0.023	0.006	0.02	0.03	...	Y?	Y?	...	...	Y?
112097AB	2.31	0.11	6.24	0.286	0.007	0.31	0.03	...	Y?	Y?	...	...	Y?
238179	4.82	0.26	9.71	0.712	0.031	0.76	0.01	...	N?	?	...	...	N?
114723A^{a}	2.92	0.27	7.38	0.460	0.012	0.55	0.03	...	?	N?	...	...	?
114723B^{a}	3.22	0.27	7.68	0.456	0.012	(0.55)	(0.03)	...	(?)	N?	...	...	?
238208	5.94	0.15	9.68	0.835	0.034	0.85	0.02	...	N?	Y	...	...	?
238224	7.72	0.08	9.72	1.177	0.057	1.43	0.01	...	Y	?	...	...	Y?
GJ 516A^{j}	10.71	?	11.40	1.542	0.01?	...	...	...	?	Y?	...	...	?
GJ 519	8.87	0.04	9.06	1.384	0.007	1.65	0.03	...	Y?	Y?	...	...	Y?
118022	1.17	0.10	4.92	0.049	0.002	0.03	0.02	...	N?	Y	+0.73	0.86	?
120528	4.22	0.15	8.55	0.690	0.014	0.73	0.01	...	N?	N?	...	...	N?
120818	1.88	0.13	6.63	0.126	0.006	0.07	0.03	...	?	Y?	...	...	?
122408A	0.11	0.13	4.24	0.110	0.011	0.14	0.02	...	N?	N?	...	...	N?

TABLE 5—*Continued*

HD/Name	M_V	σ_{M_V}	V	$B-V$	σ_{B-V}	$V-I$	σ_{V-I}	$\log R'_{\mathrm{HK}}$	Kin. Memb.	Phot. Memb.	Literature [Fe/H]	σ_{Fe} (dex)	Final Memb.
122408B	5.35	0.13	9.48	0.45	0.03	...	...	...	(N?)	N?	...	...	N?
124674	2.70	0.70	6.59	0.390	0.004	0.48	0.02	...	N?	?	−0.14	...	N?
124675	1.14	0.08	4.53	0.220	0.013	0.23	0.03	...	N?	N?	−0.14	...	N?
125451A	3.32	0.05	5.40	0.402	0.003	0.41	0.03	...	?/Y?	Y	−0.02	...	Y?
125642	0.64	0.18	6.32	0.056	0.004	0.02	0.03	...	N?	Y	...	...	?
129246[a]	0.84	0.15	4.56	0.080	0.020	(0.07)	0.02	...	Y?/?	Y?	...	...	Y?
129247[a]	0.80	0.15	4.52	0.065	0.020	(0.06)	0.02	...	Y?/?	Y?	...	...	Y?
129798A	3.12	0.05	6.27	0.387	0.005	0.44	0.03	...	Y	Y?	...	...	Y
129798B	5.92	0.05	9.07	0.875	0.063	...	...	...	(Y)	Y	...	...	Y
129989A	−1.54	0.11	2.50	1.129	0.005	0.95	0.02	...	N?	N?	+0.12	0.25	N?
129989B	0.62	0.11	4.66	0.162	0.010	...	...	...	(N?)	N?	+0.12	0.25	N?
GJ 569A	10.21	0.05	10.17	1.372	0.128	1.93	0.33	...	N?	?	−0.15	...	?
137006	2.41	0.09	6.11	0.264	0.005	0.28	0.03	...	N?	Y	...	...	?
138481	−2.11	0.32	5.03	1.595	0.005	1.71	0.03	...	N?	Y?	+0.20	...	N?
139006	0.42	0.04	2.22	0.028	0.003	0.05	0.01	...	Y	Y	...	...	Y
139798	3.00	0.05	5.76	0.352	0.004	0.40	0.03	...	N?	Y	−0.13	...	?
140775	0.21	0.19	5.57	0.030	0.005	0.02	0.03	...	N?	Y	...	...	?
146738	−1.23	0.38	5.79	0.061	0.003	0.04	0.04	...	N?	?	...	...	?
148112AB	0.29	0.15	4.58	0.012	0.002	0.02	0.03	...	?	Y?	+0.00?	...	?
GJ 625	11.01	0.04	10.10	1.591	0.027	2.58	0.06	...	N?	Y?	...	...	?
152107A[a]	1.21	0.06	4.86	0.090	0.02	0.10	0.02	...	N?	Y?	...	...	?
152107B[a]	4.73	0.06	8.38	0.675	0.02	...	...	...	(N?)	?	...	...	N?
152863A	0.34	0.21	6.07	0.921	0.006	0.92	0.03	...	?	Y?	...	...	?
152863B	5.07	0.21	10.80	0.70	0.03	...	...	...	(?)	Y?	...	...	?
153751Aab	−0.91	0.16	4.22	0.894	0.004	0.91	0.03	...	N?	?	...	...	?
GJ 3991	12.47	0.15	11.77	1.696	0.020	2.86	0.06	...	N?	?	...	...	N?
155674A	7.18	0.09	8.81	1.175	0.023	1.25	0.03	...	?	?	...	...	?
155674B	7.67	0.09	9.30	1.241	0.016	1.42	0.01	...	?	?	...	...	?
156498A[a]	4.19	0.28	8.79	0.715	0.03	0.77	0.01	...	Y?	N?	...	...	?
156498B[a]	5.38	0.28	9.98	0.810	0.06	...	...	...	Y?	Y?	...	...	Y?
159561	1.31	0.03	2.09	0.190	0.004	0.17	0.03	...	?	N?	...	...	N?
169981	0.23	0.18	5.82	0.064	0.004	0.09	0.03	...	N?	Y?	...	...	?
173654A	1.40	0.28	5.89	0.133	0.004	0.17	0.03	...	N?	Y?	...	...	?
173654B	3.07	1.47	7.49	0.303	0.006	0.29	0.05	...	N?	Y?	...	...	?
176303A	1.88	0.07	5.27	0.544	0.004	0.56	0.03	...	N?	N?	−0.06	0.01	N?
177196A	2.05	0.04	5.01	0.195	0.004	0.23	0.03	...	Y?	Y?	...	...	Y?
180777	2.94	0.03	5.12	0.311	0.004	0.37	0.03	...	Y	Y	−0.03	...	Y
193592AB	1.01	0.13	5.76	0.118	0.003	0.15	0.03	...	N?	?	...	...	?
194943A[a]	2.55	0.06	4.95	0.340	0.020	0.42	0.03	...	Y?	?	−0.22	...	?
194943B[a]	4.47	0.06	6.87	0.635	0.020	...	...	...	Y?	?	(−0.22)	(...)	?
199951A	0.49	0.12	4.67	0.885	0.005	0.90	0.02	...	Y	Y?	−0.12	0.22	Y
202908Aa[k]	4.44	0.15	7.96	0.575	0.02	0.64	0.02	...	N?	Y?	...	...	N?
202908Ab[k]	4.65	0.15	8.17	0.600	0.02	0.67	0.02	...	N?	Y	...	...	N?
202908B[k]	5.05	0.15	8.57	0.630	0.02	0.70	0.02	...	N?	Y?	...	...	N?
BD −05°5480A[l]	7.31	0.13	9.42	1.14	0.02	1.36	0.02	...	N?	?	...	...	N?
BD −05°5480B	11.29	0.13	13.40	1.63	0.02	...	...	...	(N?)	Y?	...	...	?

TABLE 5—*Continued*

HD/Name	M_V	σ_{M_V}	V	$B-V$	σ_{B-V}	$V-I$	σ_{V-I}	log $R'_{\rm HK}$	Kin. Memb.	Phot. Memb.	Literature [Fe/H]	$\sigma_{\rm Fe}$ (dex)	Final Memb.
205435	1.08	0.04	3.99	0.879	0.003	0.94	0.03	. . .	?/Y?	?	−0.16	0.11	?
205765A	0.78	0.28	6.22	0.059	0.003	0.08	0.03	. . .	?	Y?	. . .	. . .	?
205765B	3.87	0.28	9.31	0.485	0.035	. . .	. . .	. . .	?	Y	. . .	. . .	?
206538A	0.35	0.18	6.08	0.065	0.004	0.12	0.03	. . .	N?	Y?	. . .	. . .	?
209515A[a]	−0.30	0.25	5.75	−0.050	0.02	−0.02	0.02	. . .	N?	Y?	. . .	. . .	?
209515B[a]	1.74	0.25	7.79	0.155	0.02	. . .	. . .	. . .	(N?)	Y	. . .	. . .	?
209625Aab	1.03	0.13	5.28	0.255	0.005	0.23	0.03	. . .	N?	?	+0.28?	0.26	N?
210459	−0.40	0.11	4.29	0.477	0.002	0.52	0.03	. . .	?	Y?	−0.24	. . .	?
210873	0.38	0.15	6.36	−0.050	0.004	−0.03	0.01	. . .	N?	?	. . .	. . .	?
GJ 873[i]	11.71	0.07	10.25	1.61	0.094	. . .	. . .	. . .	N?	Y?	. . .	. . .	?
216627	−0.18	0.24	3.27	0.075	0.002	0.08	0.02	. . .	Y?	Y	−0.15	. . .	Y?
220096	0.64	0.20	5.66	0.814	0.004	0.84	0.01	. . .	?/Y?	Y?	−0.08	0.04	Y?
221756	1.29	0.10	5.56	0.093	0.003	0.14	0.03	. . .	N?	?	. . .	. . .	?
222603	2.05	0.06	4.50	0.204	0.005	0.22	0.02	. . .	N?	Y?	. . .	. . .	?

[a] Resolved photometry for HD 13959AB, 18519/20, 31278AB, 64096AB, 71974AB, 81858AB, 99028AB, 113139AB, 114723AB, 129246/7, 137107/8, 152107AB, 156498AB, 160269AB, 171746AB, and 194943AB, CG Cyg A, and HD 209515AB comes from Fabricius & Makarov 2000 and the transformations of Bessell 2000. For these resolved stars, the presumably " unresolved " activity is listed under the first component.

[b] Activity measures for HD 18645, 62668A, 88654, 97305, and 129674 and CG Cyg AB are from Strassmeier et al. 2000.

[c] Probable spectroscopic membership is assigned to HD 141003A based on activity classification of HD 141003B in SM93.

[d] Activity measure for HD 136901 from Strassmeier et al. 1990.

[e] Colors for CG Cyg A and B from Strassmeier et al. 2000.

[f] V magnitude for CG Cyg B is that needed to yield an integrated magnitude of A and B components of $V = 9.97$ from Strassmeier et al. 2000.

[g] Activity measure for HD 38393 from Henry et al. 1996.

[h] Activity measure for HD 211575 from Soderblom, Duncan, & Johnson 1991.

[i] Photometry for GJ 268.3, 2069, and 873 from Weis 1991, 1993.

[j] Photometry for GJ 516A from Rucinski 1981.

[k] V magnitudes for the HD 202908 components come from the integrated V magnitude and the component differences estimated by Fekel et al. 1997. Colors are estimated by ascribing the integrated values to the Ab component and utilizing the Yale isochrone main-sequence M_V-color slope in a differential sense.

[l] Photometry for BD −05° 5480B from Poveda et al. 1994.

by using chromospheric activity measures. This was done to investigate the relationship between other membership criteria and activity measures, rather than using the activity as a criterion proper. Thus, we can later use our final memberships to investigate chromospheric activity scatter in the UMa group without recourse to circular argumentation. Below, we infer a UMa cluster or group age of ∼500 ± 100 Myr, intermediate to the well-studied Hyades and M34 open clusters, having canonical ages of 800 and 200 Myr. As we later show, comparison of UMa group candidate stars' with these clusters' activity distributions can efficiently exclude UMa group nonmembers and provide confirmation of apparent members. Given our ongoing Ca II H and K study of several thousand nearby stars noted above, we have chosen Ca II H and K as our activity indicator.

Soderblom, Jones, & Fischer (2001) present Hα and 8498 Å Ca II infrared triplet (IRT) based activity measures for a large selection of M34 dwarfs in their Table 1.These have been transformed to log $R'_{\rm HK}$ values by using the regressions deduced from Figures 3 and 4 of Herbig (1985):

$$R_{\rm HK} = 2.725 R_{\rm H\alpha} + (1.35 \times 10^{-6}) \,, \tag{1}$$

$$R_{\rm HK} = 5.102 R_{8498} - (5.00 \times 10^{-6}) \,. \tag{2}$$

The transformed Hα-based log $R'_{\rm HK}$ values are plotted versus the transformed Ca II IRT–based values in Figure 1*a*. The correlation coefficient is significant at the greater than 99.9% confidence level, and a ∼0.2 dex mean offset noted for UMa candidates by SM93 is apparently present, as is considerable scatter of ∼0.25 dex about a mean relation. While SM93 simply made a 0.2 dex adjustment to the IRT-based values, this is not the optimum procedure for M34. Figure 1*b* shows the difference between the transformed IRT- and Hα-based M34 measures versus dereddened color and indicates a significant portion of the scatter in Figure 1*a* is correlated with color.

The trend in Figure 1*b* was fitted with a third-order Legendre polynomial using 2.0 σ clipping. The power series

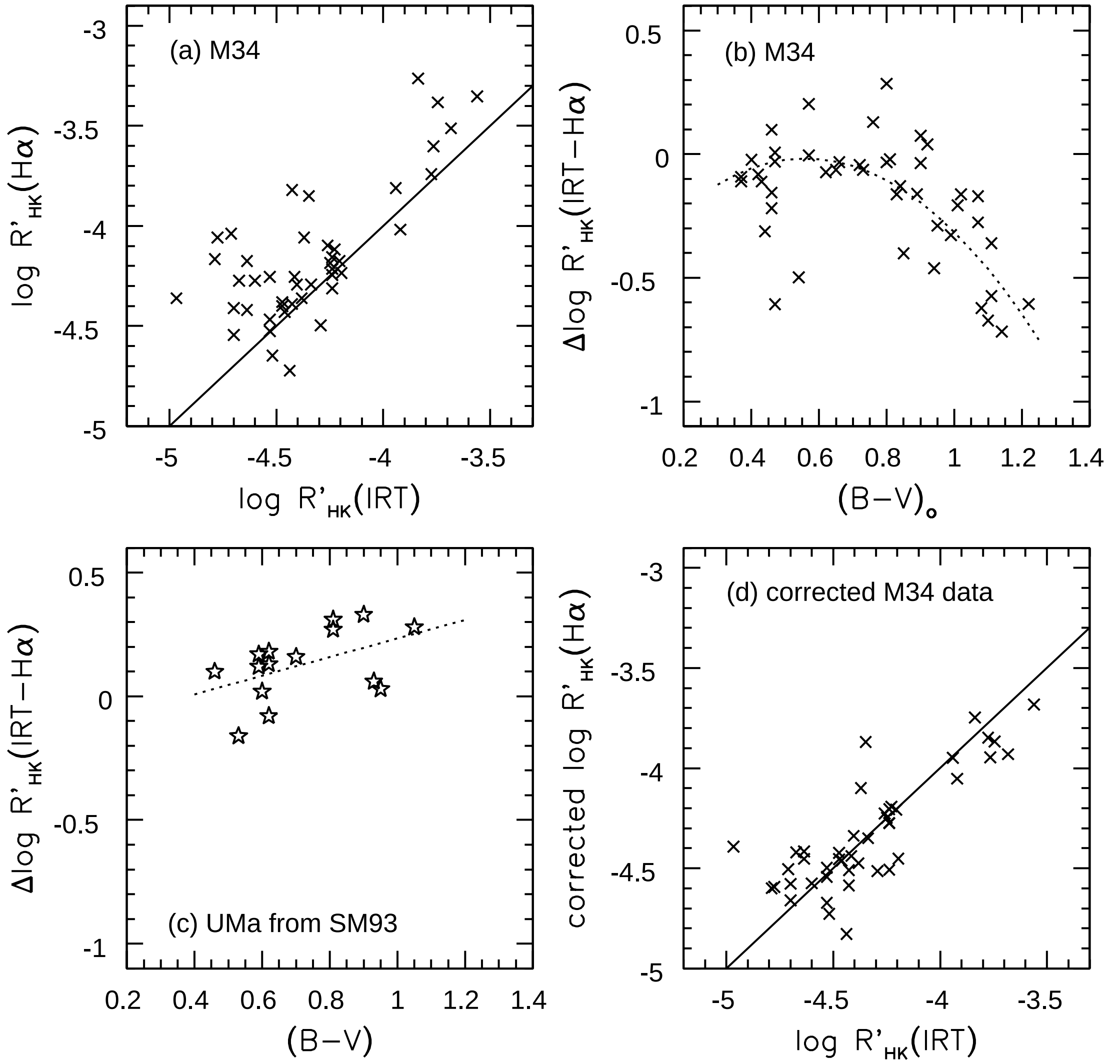

FIG. 1.—(*a*) Residual chromospheric fluxes (relative to photospheric) of the Ca II H and K lines as derived from the Hα and Ca II infrared triplet lines utilizing the transformation in Herbig (1985), compared for the sample of M34 (200 Myr) dwarfs from Soderblom et al. (2001), depicting an identical relationship (*solid line*). (*b*) Difference between the Hα-based and Ca II IRT–based residual fluxes plotted against color, showing a quadratic fit to the data (*dotted line*). (*c*) Differenced residual chromospheric fluxes for UMa candidate stars from SM93, showing a least-squares linear fit (*dotted line*). (*d*) Same as (*a*) except the Hα-based residual fluxes on the ordinates have been corrected using the fitted relation in (*b*).

expansion of the fit (Fig. 1*b*, *dotted line*) is given by

$$\Delta \log R'_{\rm HK} = -(5.0506 \times 10^{-1}) + 1.7352(B-V) - 1.5453(B-V)^2 \,. \qquad (3)$$

Curiously, the same color-dependent difference is not seen for the UMa data from SM93. The difference between these transformed Hα- and IRT-based activity measures is plotted versus color in Figure 1*c*. The correlation coefficient suggests the positive slope is marginally significant (92.5% confidence level); if real, it is opposite in sign to that for the M34 data in Figure 1*b*. These differences must be intrinsic ones or due to measurement, since the transformations are the same. Figure 1*d* shows transformed Hα-based $\log R'_{\rm HK}$ values that have been corrected using equation (3) from the fit in Figure 1*b* versus the Ca II IRT–based values; reduced scatter about the one-to-one relation is readily evident. We explicitly note here that our choice has been to correct the Hα-based activity measures onto the Ca II IRT–based scale; this is different than the procedure of SM93 and is not an arbitrary decision (see the Appendix).

Figure 2 displays the situation for ~100 Myr old Pleiades dwarfs whose Hα-based and 8542 Å Ca II IRT–based data come from Soderblom et al. (1993); these measures were transformed as before, except using the relation for the 8542 Å feature deduced from Herbig's (1985) Figure 4:

$$R_{\rm HK} = 2.939 R_{8542} - (5.00 \times 10^{-6}) \,. \qquad (4)$$

The deviation from a one-to-one relation between the transformed activity indicators (Fig. 2*a*) is similar to that demonstrated by the M34 data. The Pleiades differences are also a function of color, as shown in Figure 2*b*, where the solid line indicates the fitted quadratic relation

$$\Delta \log R'_{\rm HK} = -(4.2440 \times 10^{-1}) + 1.4977(B-V) - 1.2465(B-V)^2 \,, \qquad (5)$$

which is similar to equation (3) for M34 (Fig. 1*b*, *dotted line*). The more satisfactory state of affairs upon correcting the Hα-based values to the Ca II IRT scale can be seen in Figure 2*c*.

Figure 3 shows the mean of the transformed IRT- and *corrected* Hα-based values versus dereddened $B-V$ color

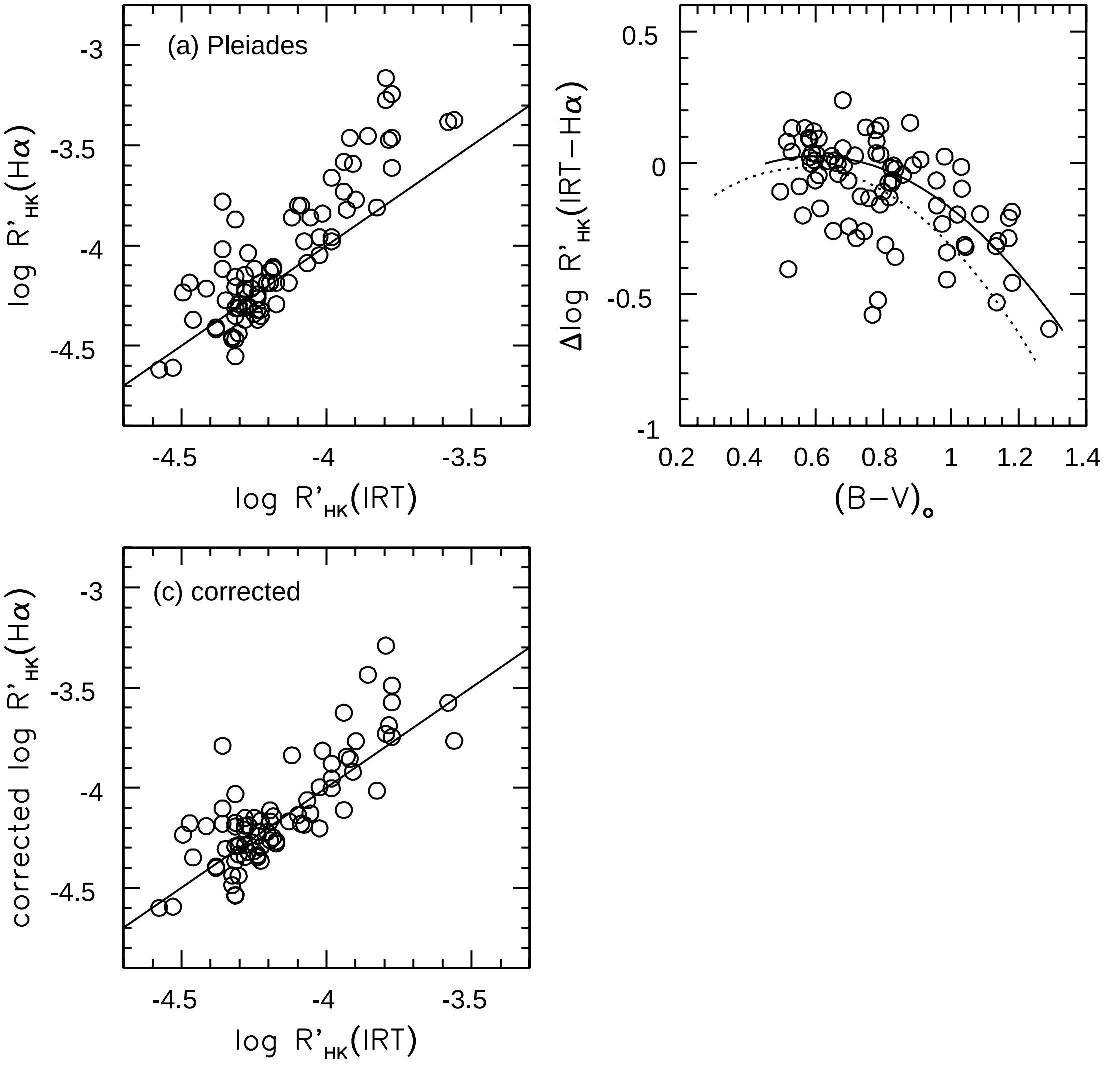

FIG. 2.—(*a*) Same as Fig. 1*a*, but for Pleiades dwarf data from Soderblom et al. (1993). (*b*) Same as Fig. 1*b*, but for Pleiades dwarfs, and showing the fitted quadratic Pleiades relation (*solid line*) and the fit to the M34 data from Fig. 1*b* (*dotted line*). (*c*) Same as Fig. 1*d*, but for Pleiades dwarfs with their Hα-based residual fluxes corrected by the fitted relation (eq. [5]) in (*b*).

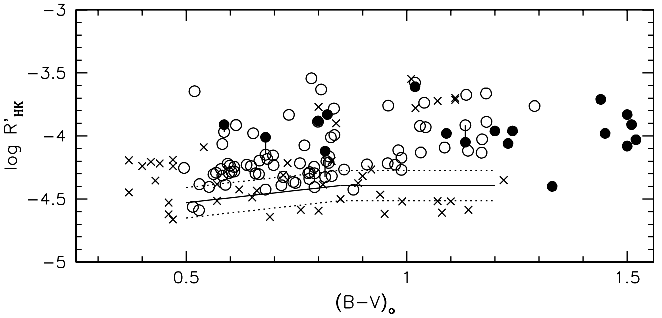

FIG. 3.—Residual chromospheric flux in Ca II H and K vs. $B-V$ color. The crosses are the averaged IRT-based and corrected (as in Fig. 2*d*) Hα-based data for M34 dwarfs (from Soderblom et al. 2001) transformed to Ca II H and K by using the relations from Herbig (1985). The open circles are similar data for Pleiades dwarfs from Soderblom et al. (1993) shown in Fig. 2; filled circles are *actual* H and K Pleiades measurements from Soderblom et al. (1993) and are connected to the averaged transformed Hα- and IRT-based values by vertical lines. The solid and dotted lines show the mean Hyades relation and full extent of its scatter from Soderblom (1985), respectively.

for M34 (*crosses*) and Pleiades (*open circles*) dwarfs. Here, the Hα values have been corrected onto the IRT scale using the fitted relation for the Pleiades dwarfs (Fig. 2*b*) for both the Pleiades and M34 stars, the reasoning being that the more numerous Pleiades data result in a better determined mean relation, given the significant star-to-star scatter (Fig. 1*b*). The filled circles are the *directly measured* Pleiades H and K indices from Soderblom et al. (1993); these are connected to the transformed values for six stars in common. The solid line and dotted lines depict the mean Hyades relation and the full extent of its scatter from direct H and K measurements in Soderblom (1985), respectively; the flatness of the relation for $B-V \geq 0.85$ was not derived from Hyades data but simply argued for by Soderblom (1985); however, the flatness in the *directly measured* log $R'_{\rm HK}$ values for similarly cool Pleiades stars seems consistent with this.

The lower envelope to the M34 data may show an unexpected decline with increasing color; utilizing the specific M34-based corrections from Figure 1*b* actually exacerbates (slightly) this trend. Such a trend could suggest the IRT-Hα corrections are not as steep a function of color as for the Pleiades. Thus, the color dependence of the relative robustness of the transformed IRT and Hα indices as proxies for the Ca II H and K index may be activity- or age-dependent. While a seemingly elaborate explanation, this is consistent with the near lack of a color-dependent difference for the older UMa objects in Figure 2*b* and the consistency (essentially forced to yield our transformations) of the less active field stars from Herbig (1985).

For our purposes, there are several notable features about Figure 3. First, the vast majority of the younger M34 and Pleaides stars lie above the mean Hyades relation; essentially all the Pleiades stars do for $B-V \geq 0.8$. Second, the spread in activity for the younger M34 and Pleiades stars is significantly larger than for the older Hyades dwarfs. We have thus followed the approach of SM93 in assigning a provisional activity-based membership classification to our objects where possible. Those apparently single objects that lie within a few hundredths of a dex or lie above the Hyades relation are classed as *probable spectroscopic members*. Close binaries that meet the same criterion are deemed *possible spectroscopic members* (since high levels of activity may be related to binarity), as are apparently single objects lying significantly beneath the mean Hyades relation but within the Hyades scatter. Other objects are considered *probable spectroscopic nonmembers*. Objects not having chromospheric emission measurements are referred to as *additional candidate members*. The scatter in Figure 3 should also prepare one for occasionally encountering objects with sub-Hyades activity that might be younger bona fide UMa members.

3.2. *UMa Nucleus Stars*

Our new log $R'_{\rm HK}$ values for four canonical UMa nucleus stars (listed in Table 5) are in good accord with the average SM93 values; the deviations (in the sense new values minus SM93 values) are −0.08, −0.19, −0.10, and −0.08 dex. While a slight ~0.1 dex offset may be present, the new activity indicators still indicate probable spectroscopic membership; even though the indices for HD 109011, 109647, and 110463 lie a couple hundredths of a dex below the red end of the Hyades relation, they are well within the small Hyades scatter. Moreover, the preponderance of other activity measurements (SM93) suggests probable spectroscopic membership by using the mean Hyades relation criterion.

Canonical UMa nucleus stars are shown in the *V*-*U* and *V*-*W* kinematic planes in Figures 4*a*–4*b*. The ellipse is centered on the (inverse variance) weighted mean velocities and has semimajor and semiminor axes equal to 3 times the respective formal rms velocity dispersions. The vital kinematic statistics for all activity-based subgroups are reported in Table 6. The weighted rms dispersions are reduced slightly (by 0.1, 0.0, and 0.3 km s^{-1} in *U*, *V*, and *W*, respectively) compared with the results of SM93; the unweighted dispersions (a fairer comparison with SM93) are somewhat larger, however (by 0.0, 0.4, and 0.2 km s^{-1} in *UVW*). This increase can be traced to the marginal outlier HD 111456, whose kinematic differences from SM93 values can be traced to the adopted radial velocities (adopting the *Hipparcos* proper motions, e.g., only increases differences in *U* and *V*); this illustrates the continued importance of additional radial velocity measures. Indeed, HD 111456 and the marginally outlying HD 106591 are among the few objects whose new radial velocities and previous measures disagree by considerably more than the respective errors. Excluding HD 111456, the unweighted dispersions are equivalent or slightly lower than the SM93 values.

On an absolute basis, comparison of the mean *UVW* with the SM93 values is at the level of "fine tuning." The mean *W*-velocities are essentially identical, while the *V*-velocities differ at only the ~1 σ level. The most significant, though small, difference is in the mean *U*-velocity. Our 1.3–1.4 km s^{-1} larger value represents a 4–5 σ level difference given the respective inferred mean uncertainties.

Figures 4*c*–4*d* contain the *Hipparcos*-based M_V-$(B-V)$ and M_V-$(V-I)$ color-magnitude diagrams of the UMa nucleus stars. Shown for comparison are the latest-generation Yale isochrones (Yi et al. 2001) for 600 Myr $(B-V)$ and 400 Myr $(V-I)$ for both scaled solar $Z = 0.01$ and $Z = 0.02$ mixtures and for both the color-temperature conversions of Lejeune, Cuisinier, & Buser (1998) and Green, Demarque, & King (1987). The metallicity study of Boesgaard & Friel (1990) suggests $[\mathrm{Fe/H}] = -0.09$ for UMa, which corresponds to an intermediate $Z = 0.016$ for $Z_\odot = 0.02$. The data points form a very tight main sequence and turnoff (reflecting the quality of the parallaxes now

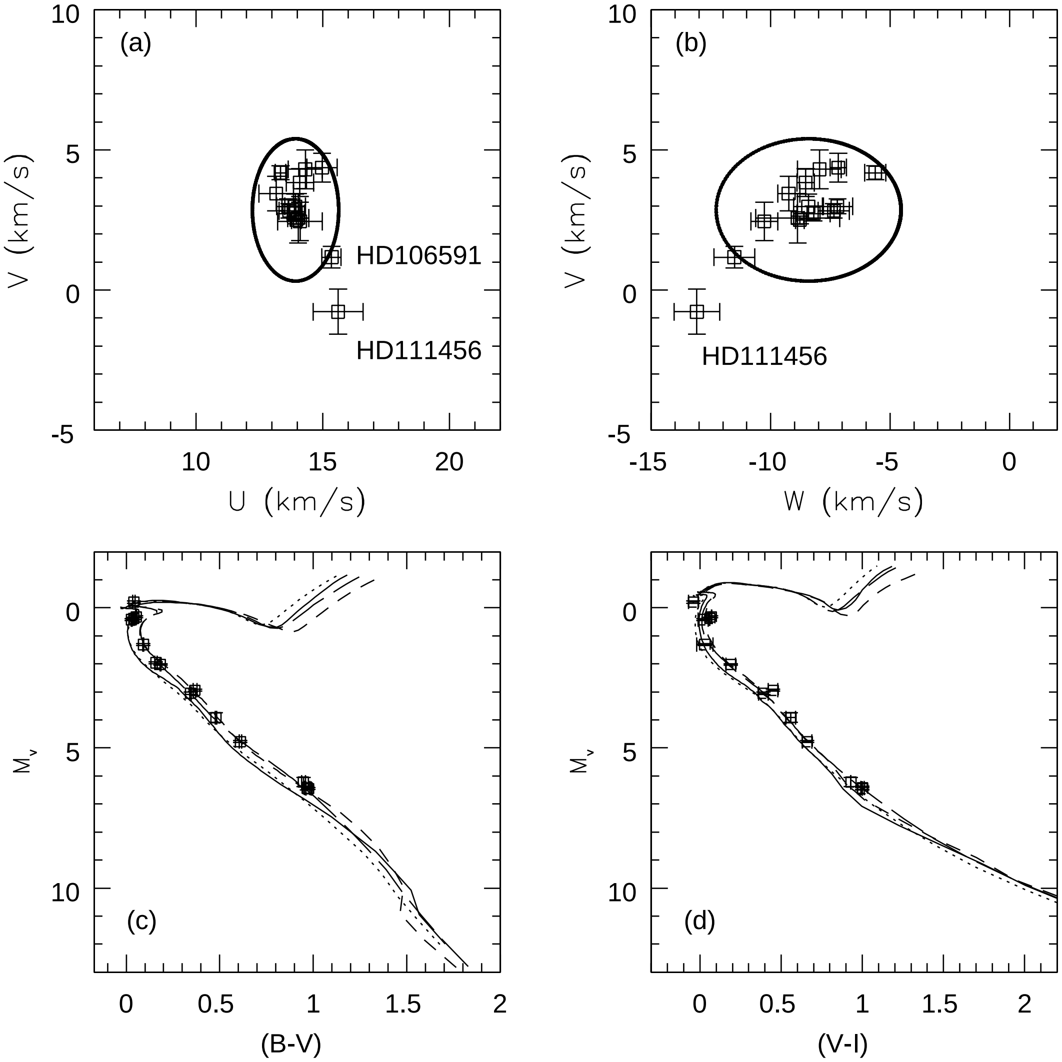

FIG. 4.—(*a*) UMa nucleus stars in the *V*-*U* kinematic plane; the ellipse denotes 3 times the velocity dispersion. (*b*) UMa nucleus stars in the *V*-*W* plane with the 3 σ velocity dispersion ellipse. (*c*) UMa nucleus stars in the *Hipparcos*-based M_V-$(B-V)$ H-R diagram. The lines are the newest Yale isochrones (Yi et al. 2001) for 600 Myr. Plotted are the Lejeune et al. (1998) color transformation–based isochrones for $Z = 0.01$ (*solid line*) and $Z = 0.02$ (*short-dashed line*) and the Green et al. (1987) color transformation–based isochrones for $Z = 0.01$ (*dotted line*) and $Z = 0.02$ (*long-dashed line*). (*d*) UMa nucleus M_V-$(V-I)$ H-R diagram with the same isochrones, but for a 400 Myr age.

available) and lie close to the assumed isochrones. The M_V-$(B-V)$ data are best fitted by the 600 Myr isochrones, whereas the data based on $V-I$ are best fitted by the 400 Myr isochrones. Statistical uncertainties in these values pale in comparison with the color-based differences, which may be due to systematic errors in the photometry or the isochrones' assumed color-$T_{\rm eff}$ conversions. We thus infer an UMa age of 500 ± 100 Myr, and we use the 600 and 400 Myr isochrones as fiducials to evaluate photometric membership.

3.3. *Membership Assignments*

Kinematic, photometric, and final membership assignments are listed for all objects in Table 5, where for these qualitative assessments "Y" indicates certain membership, "Y?" indicates probable membership, "N?" indicates probable nonmembership, and "?" indicates uncertain membership. The final membership assessments are conservative in the sense that the possibility of contaminating the nonmembers category with true members or contaminating the member categories with true nonmembers was avoided at the cost of relegating objects with conflicting or questionable criteria to the uncertain category for future study. In this sense, an uncertain designation is not necessarily to be equated with a lower true membership and/or higher nonmembership probability on a star-by-star basis; rather, we simply required more consistent evidence for a definitive classification.

The *V*-*U* and *V*-*W* kinematic planes are shown in Figures 5–8 (*top*) for the *probable spectroscopic* (i.e., activity based) *member*, *possible spectroscopic member*, *probable spectroscopic nonmember*, and *additional candidate member* (which lack activity measures) subgroups, respectively. The velocity ellipses are those of the canonical UMa nucleus stars from Figures 4*a*–4*b*. A "Y" kinematic membership is given those stars that fall within both planes' ellipses. A "Y?" kinematic membership is given those stars that fall within both ellipses only within the stellar kinematic uncertainties. An "N?" kinematic designation is assigned those stars that lie outside both kinematic planes' ellipses even within the stellar kinematic uncertainties; generally, this signals a signifi-

TABLE 6

Kinematic Characteristics

Sample	$\langle U \rangle$ (km s^{-1})	$\langle U^2 \rangle^{1/2}$ (km s^{-1})	$\langle V \rangle$ (km s^{-1})	$\langle V^2 \rangle^{1/2}$ (km s^{-1})	$\langle W \rangle$ (km s^{-1})	$\langle W^2 \rangle^{1/2}$ (km s^{-1})
Nucleus (weighted)	+13.93	±0.57	+2.86	±0.85	−8.41	±1.29
Excluding HD 111456	+13.91	±0.54	+2.90	±0.76	−8.34	±1.16
Nucleus (uweighted)	+14.15	±0.68	+2.83	±1.31	−8.73	±1.83
Excluding HD 111456	+14.04	±0.57	+3.10	±0.87	−8.39	±1.42
Nucleus (SM93)	+12.6	±0.7	+2.2	±0.9	−8.4	±1.6
Probable spectroscopic members (weighted)	+12.60	±2.88	+0.99	±2.10	−6.90	±4.12
Probable spectroscopic members (unweighted)	+14.01	±5.00	+0.66	±2.64	−7.96	±4.93
Possible spectroscopic members (weighted)	+12.180	±7.828	−1.197	±2.993	−10.100	±6.833
Possible spectroscopic members (unweighted)	+14.982	±7.616	−0.710	±4.441	−11.359	±6.762
Spectroscopic nonmembers (weighted)	+19.650	±7.290	+3.244	±3.484	−8.286	±5.745
Spectroscopic nonmembers (unweighted)	+22.319	±9.578	+0.272	±5.689	−12.931	±9.952
Additional members (weighted)	+11.400	±6.762	+1.355	±3.771	−8.142	±6.098
Additional members (unweighted)	+15.285	±8.880	+1.499	±5.097	−11.325	±7.192
Nucleus plus final Y and Y? (weighted)	+14.560	±2.275	+2.808	±1.753	−8.369	±3.417
Nucleus plus final Y and Y? (unweighted)	+14.445	±2.044	+3.011	±1.657	−8.784	±2.419
Sirius SC (Asiain et al. 1999)	+8.7	±6.6	+2.8	±4.1	−6.9	±5.8
Sirius SC (Chereul et al. 1999)	+14.0	±7.3	+1.0	±6.4	−7.8	±5.5
Sirius SC1 (Chereul et al. 1999)	+12.4	±4.0	+0.7	±4.6	−7.7	±4.7
Sirius SC2 (Chereul et al. 1999)	+12.4	±3.7	+4.2	±3.3	−9.0	±2.9
UMa group (Montes et al. 2001)	+14.9	...	+1.0	...	−10.7	...
UMa moving group (Orlov et al. 1995)	+13.5	...	+3.4	...	−7.4	...

cant departure from all three canonical UMa nucleus stars' mean *UVW*-values. Other objects are assigned a " ? " designation, which usually indicates contradictory findings; generally, this signals a significant departure from one or two (but not all three) of the canonical UMa nucleus stars' mean *UVW*-values. Photometric memberships are assigned in a similar fashion, replacing the nucleus stars' velocity ellipses with a band of occupation through the H-R diagram outlined by the nucleus stars. For candidate objects lying outside these regions (cool dwarfs or evolved subgiants), we rely on the placement relative to the selected isochrones for guidance. The *Hipparcos*-based H-R diagrams for the different activity-based subgroups are shown in Figures 5–8 (*bottom*). The kinematically and photometrically based assignments are listed in Table 5 for all objects.

Final membership assignments, also listed in Table 5, combine the kinematic and photometric results and any spectroscopic [Fe/H] determinations available. Care was taken in the relative consideration of these criteria. In particular, the main use of photometric and metallicity criteria is to veto positive membership and not grant it, since a warm or cool UMa nonmember dwarf lying on the lower UMa main sequence or having a near-UMa metallicity ([Fe/H] ~ -0.09) is hardly remarkable. In other words, photometric membership and abundance-based membership are necessary but far from sufficient conditions to guarantee UMa membership. Their most powerful use is in identifying nonmembers, particularly older disk stars that lie in the Hertzsprung gap far below the UMa subgiant branch. The H-R diagrams in Figures 6 and 7 provide examples of this.

Exceptions to this use do exist. Photometric membership near and above the UMa main-sequence turnoff is a more stringent affirmative indicator of membership, since it implies, at the very least, a conspiracy of age and opacity identical to the UMa nucleus stars'. Abundance information for the A stars in our sample is, in most cases, best considered neither inclusive nor exclusive, given the variety of abundance-anomaly phenomena (Am, λ Boo, etc.) that occur in this region of the H-R diagram. Additional leeway is given for a few stars after a careful star-by-star consideration, in particular, for those stars with known or suspected companions that lack individual photometry or systemic radial velocity determinations. These additional considerations are conservative in the sense described above. For example, a kinematic nonmember (N?) that was classified as a photometric member (Y) generally is assigned an uncertain (?) final membership, despite the fact that its kinematic nonmembership designation is likely secure. In this way, possible " contaminants " are relegated to the uncertain category.

4. DISCUSSION AND COMPARISON WITH PREVIOUS RESULTS

4.1. *Final Membership*

The kinematic planes and H-R diagrams of the nucleus stars and those objects having final membership designations of " Y " and " Y? " are shown in Figure 9. The final mean *UVW*-velocities are given in Table 6; the values (+14.5, +2.9, and −8.6 km s^{-1}) are within a few tenths of a kilometer per second of the UMa nucleus values discussed above. Our values are also in excellent agreement—typically within a couple kilometers per second, that is, within the mean uncertainties deduced from the formal dispersions—with the mean kinematics deduced from the studies of Asiain et al. (1999), Chereul et al. (1999), and Orlov et al. (1995), which utilize statistically sophisticated membership identification algorithms lacking a priori assumptions implicitly incorporated here, and the recent study of Montes et al. (2001) employing Eggen's proper-motion–based peculiar-velocity and moving-cluster predicted radial velocity criteria. These determinations are listed at the bottom of Table 6. The agreement given the different samples and membership criteria employed is pleasing and perhaps lends some confidence to the reality of the UMa moving group.

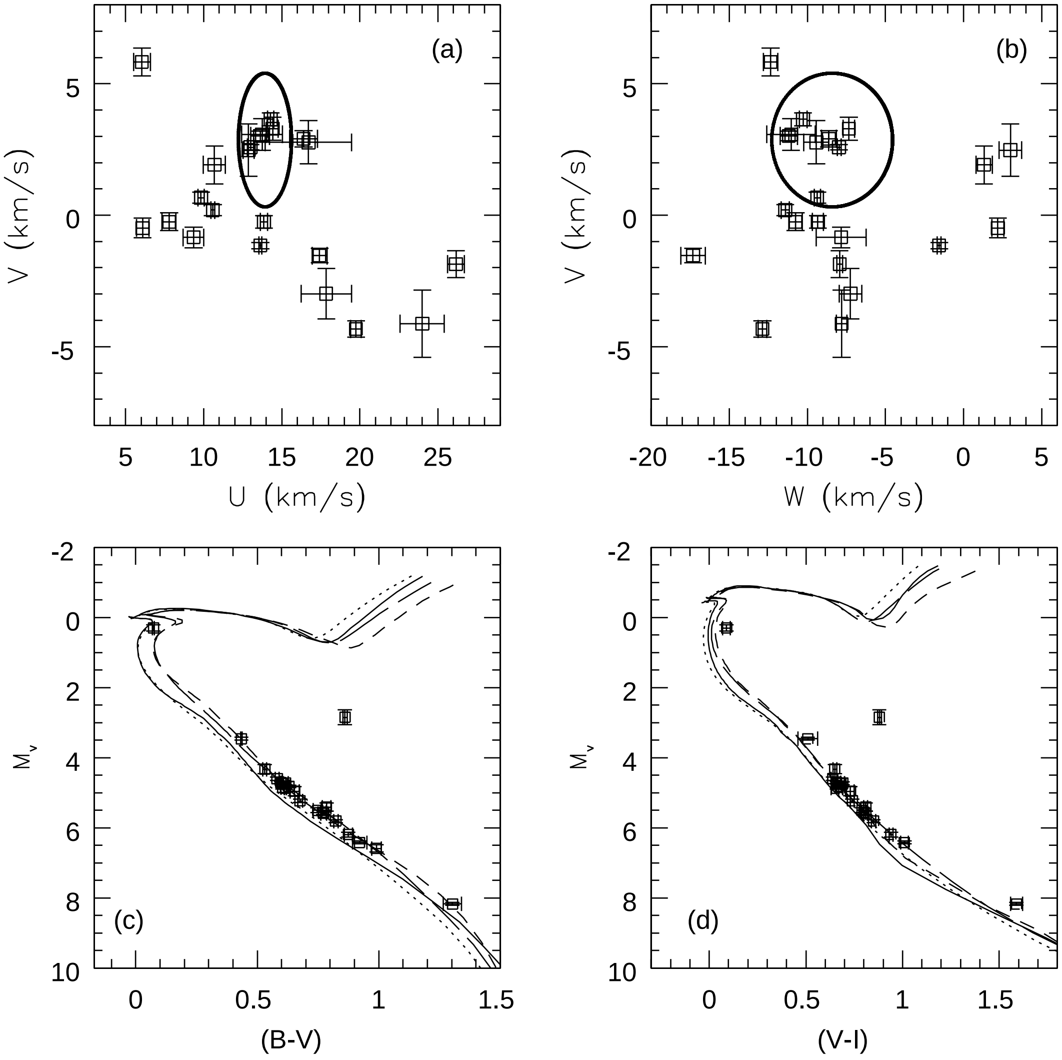

FIG. 5.—Same as Fig. 4, but for the probable activity-based UMa group members. The velocity ellipses are those from the UMa nucleus stars.

Inspection of the Bottlinger diagrams in Figure 9 reveals asymmetries in the *U*- and *W*-distributions indicative of a nonzero vertex deviation. This particular deviation and others are also seen in the recent studies of Asiain et al. (1999, their Fig. 6), Chereul et al. (1999, their Figs. 15 and 17), Skuljan et al. (1999, their Figs. 5, 8, and 10), and Montes et al. (2001, their Fig. 2); these studies cover a much larger range in the Bottlinger diagram, revealing significant structures on larger kinematic scales than shown here. That nearby young disk stars exhibit nonzero vertex deviations has been known for some time (e.g., Mihalas & Binney 1981), though Mihalas & Binney (1981) also note that this behavior may not be a general property of the global Galactic young disk field, but attributable to the nearby young disk field being dominated by kinematic moving groups that demonstrate significant vertex deviation. Nevertheless, an interesting question is how these " branchlike " (as opposed to elliptical) structures in the Bottlinger diagram arise for moving-group stars. As suggested by Mihalas & Binney (1981), perhaps the most plausible explanation is that they are due to a peculiar spatially and temporally localized convolution of the Galactic potential and velocity field at the time of these stars' en masse formation, in particular, the influence of density waves related to Galactic spiral structure; Skuljan et al. (1999) suggest that their branchlike kinematic structures (even if of different age) in the Bottlinger diagram are related to spiral structure. Alternatively, inspection of Figures 15 and 17 of Chereul et al. (1999) might suggest that these structures may arise from the close proximity (in the Bottlinger diagram) of distinct moving groups with nearly zero vertex deviation that, when merged together under coarse resolution, then take on a branchlike nonzero vertex deviation appearance. However, one must still ask why such distinct groups are in such proximity and in a branchlike configuration to begin with. Thus, this alternative explanation may, itself, simply reduce to a relation with spiral structure.

The final H-R diagrams in Figure 9 confirm our earlier nucleus-based age estimate of 500 ± 100 Myr for the UMa group. This is in outstanding agreement with the Strömgren photometry–based estimate of 520 ± 160 Myr of early-type Sirius supercluster members identified by Asiain et al. (1999) and the 600 Myr age of the dominant Sirius supercluster component found by Chereul et al. (1999). Our age estimate is larger than the usually quoted value of 300 Myr previously assigned to the UMa cluster (e.g., SM93 and references therein) on the basis of disparate methods. Our upward revision is important inasmuch as it provides a rare

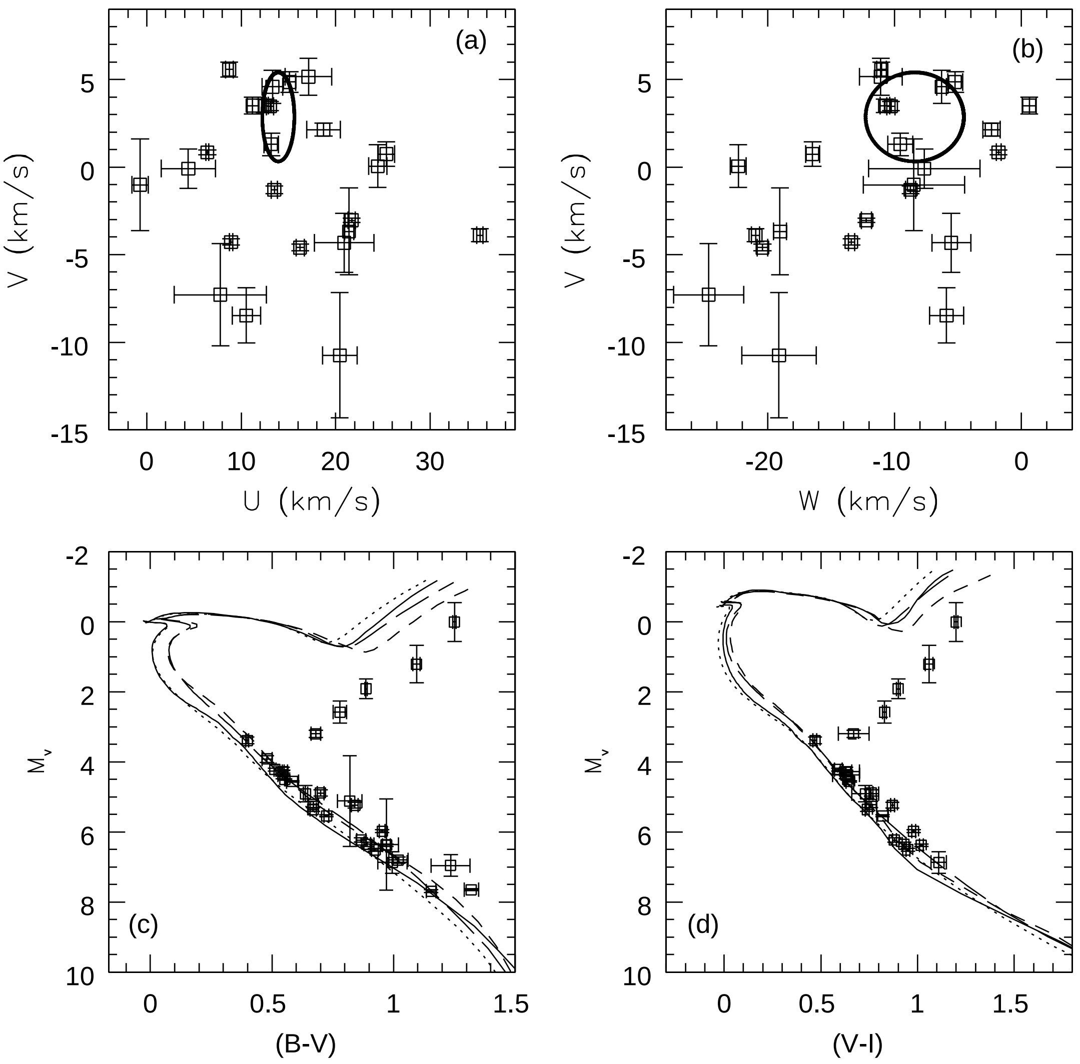

FIG. 6.—Same as Fig. 5, but for the possible activity-based UMa group members

age-based data point between the well-studied younger Pleiades (100 Myr; Meynet, Mermilliod, & Maeder 1993; Yi et al. 2001) and M34 (200 Myr; Meynet et al. 1993; Jones et al. 1997) open clusters and the slightly older Hyades (650 ± 150 Myr; Castellani et al. 2001; Perryman et al. 1998) and Praesepe (itself apparently of Hyades age; Mermilliod 1981) open clusters for age-sensitive abundance or stellar evolution studies. We acknowledge, however, that it remains to be rigorously demonstrated that these disk clusters (and others) are truly on a homogeneous age scale.

An intriguing result of the *Hipparcos* mission was a suggested Pleiades distance modulus some 0.3 mag fainter than that inferred from main-sequence fitting; controversy has erupted over whether the parallaxes or assumptions and/or details of the modeling are at fault (see, e.g., Pinsonneault et al. 1998). Soderblom et al. (1998) suggested that other such subluminous stars seemed to be absent among nearby young field stars identified via chromospheric emission. We find the same to be true in this work. The final UMa member H-R diagram in Figure 9 shows that the *Hipparcos*-based observed dwarf locus lies close to, but slightly beneath, the new Yale $Z = 0.02$ isochrones (*short- and long-dashed lines*); this is as expected given previous limited UMa abundance studies. A 0.3 mag subluminosity would place the observed locus essentially on the Yale $Z = 0.01$ isochrones (*solid and dotted lines*), which is not the case. The same appears to be true of the probable and possible activity-based stars (whether final UMa members or not) in Figures 5 and 6, respectively. Since it seems likely that these objects are young disk members, comparison with the Pleiades is highly relevant. In sum, our results also suggest that the *Hipparcos* distance problem, whatever its cause, seems to be limited to the Pleiades (and perhaps a couple other less well studied open clusters).

The coherence between the scatter in the kinematic and H-R diagrams can be seen by comparing Figures 4–8. The photometric and kinematic discriminants seem to work together in large measure. The velocity dispersions of our nucleus stars plus stars with final "Y" and "Y?" assessments are smaller than for any group based on activity alone, demonstrating that the kinematic and photometric criteria have added great value to employment by SM93 of an activity criterion. Comparison with other results (§ 4.2) also indicates the reliability of our results. We strongly caution readers first, though, that our velocity dispersions of the nucleus plus final member stars should *not* be taken as robust estimates of the true UMa group values; the former are certainly biased by using the *UVW*-plane as a

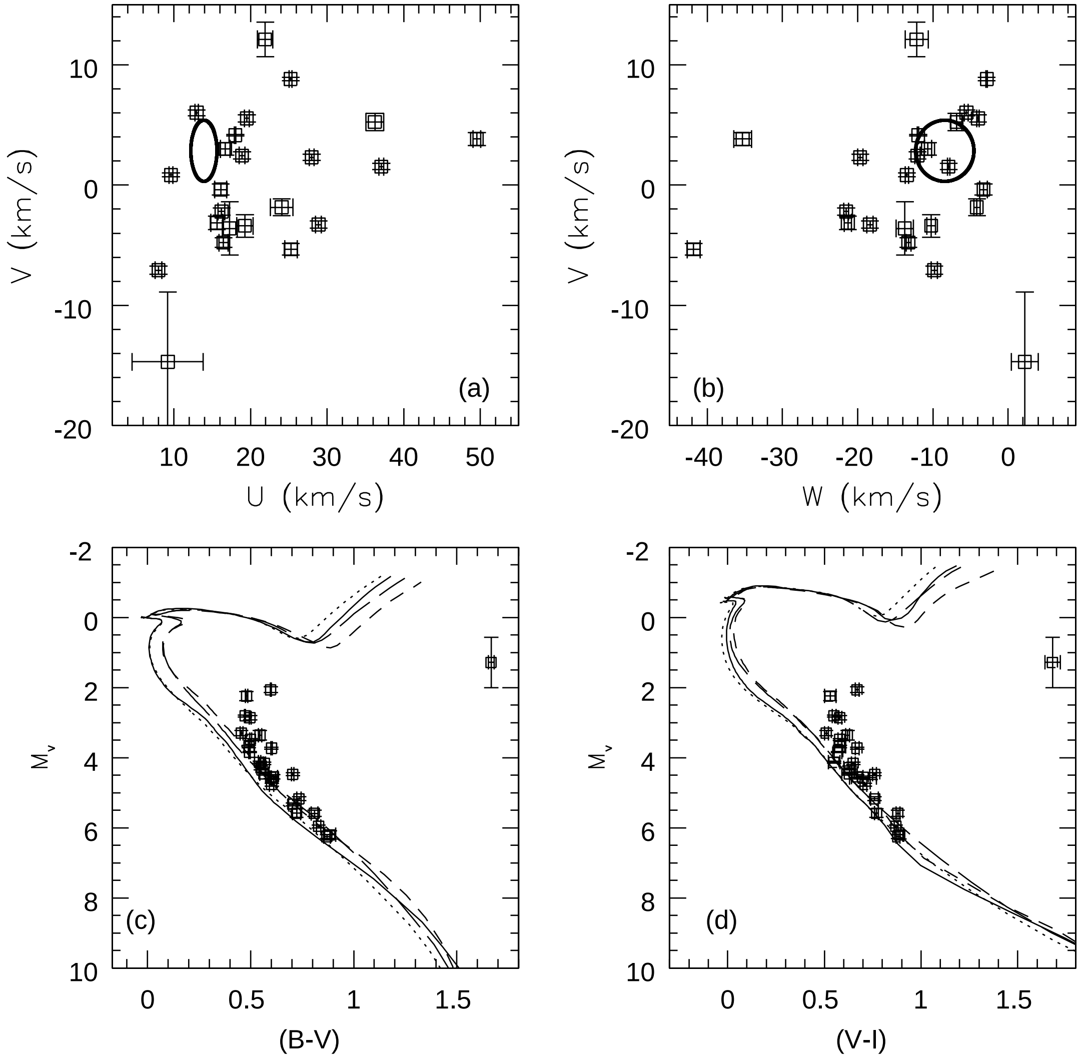

FIG. 7.—Same as Fig. 5, but for the probable activity-based UMa group nonmembers

membership discriminant. Even with the lack of kinematic membership criteria, other subtle and insidious biases induced by measurement availability, initial sample selection, or both may also be present (see, e.g., the discussion in Skuljan et al. 1999).

4.2. *Alternative Kinematic Criteria*

That the true velocity UMa group dispersions are expected to be larger than our estimates is not surprising, since appreciable dispersion must exist for the group to be unbound and spatially extended in the Galactic disk. Some investigators have focused on heavily weighted V-motions in considering kinematic membership, given dynamical calculations indicating that diffusion in the UW-directions leads to epicyclic oscillations of a star about these mean motions, which is not true in V (Wielen 1977; Binney & Tremaine 1987). The usefulness of V-motion as a sole or heavily weighted kinematic criterion receives some observational support. SM93 noted that if one allowed for plausible parallax uncertainties, all their probable spectroscopic members could have V-motions in agreement with the UMa nucleus mean without creating any additional spread in U and W. Moreover, examination of our final members and our activity-based spectroscopic groups in Table 6 indicates that the V velocity dispersion is significantly less than the U- and W-dispersions.

Despite the theoretical expectations and these observational findings, we have made no attempt at using a more restrictive V-based criterion here. This is for three reasons. First, the dispersions of our final members are biased estimates. Second, the estimates of Asiain et al. (1999) and Chereul et al. (1999)—who use nonparametric methods, which make no a priori assumptions regarding the mean group kinematics—listed in Table 6 do not seem to indicate that the velocity dispersion in V is significantly smaller than those in U and W. Third, and perhaps relatedly, Chereul et al. (1999) find evidence that Eggen's Sirius supercluster (which harbors the UMa group) can be broken down into two superclusters mostly distinguished by differing V velocity[3] (+0.7 vs. +4.2 km s^{-1}).

At the same time, it is likely that the results of these nonparametric statistical studies would refine our results in the

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[3] A Kolmogorov-Smirnov test reveals that our observed cumulative V-distribution seen in Fig. 9 is statistically indistinguishable from that of a single Gaussian having $\mu = 2.9$ km s^{-1} and $\sigma = 1.7$ km s^{-1} (Table 6).

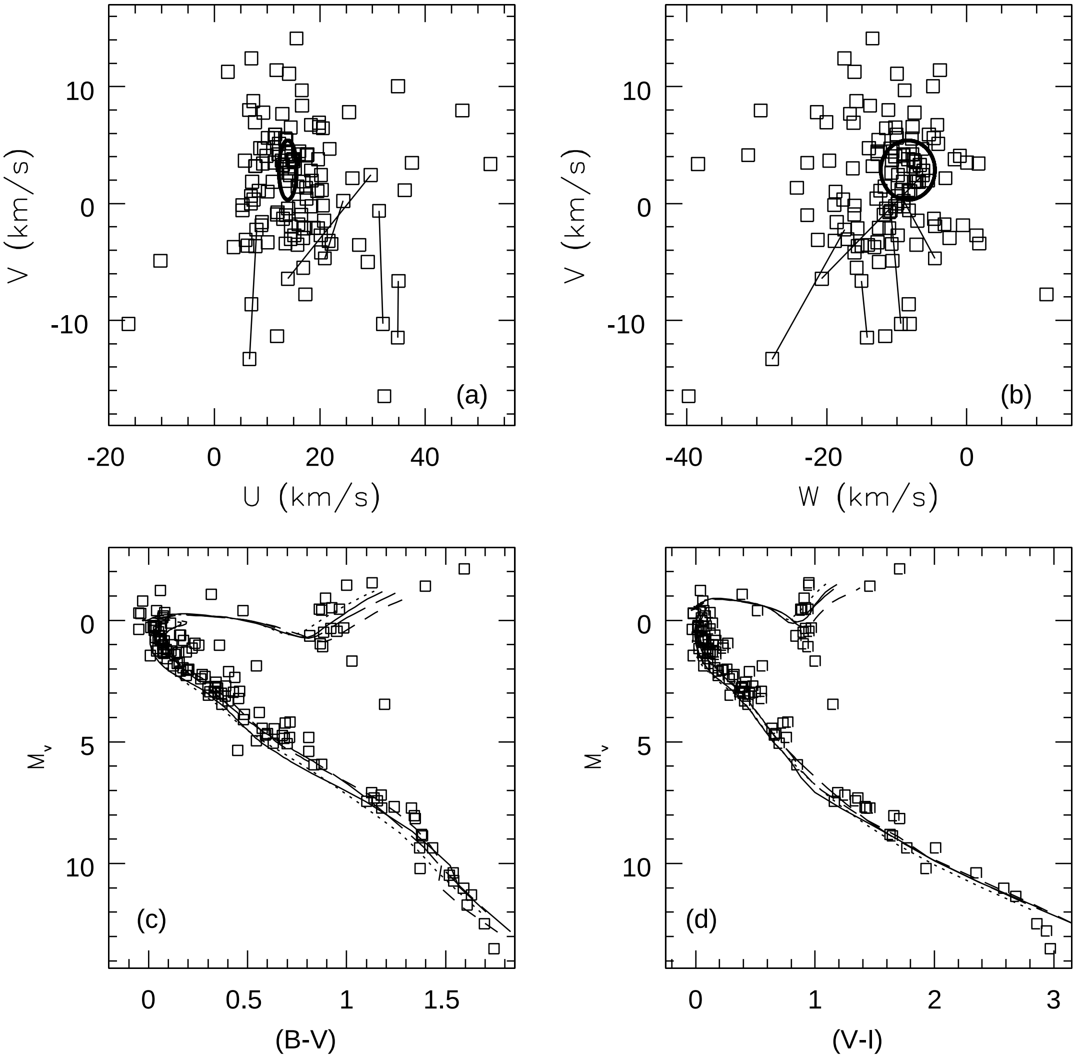

FIG. 8.—Same as Fig. 5, but for the additional UMa group candidates lacking activity measures. Error bars have been omitted for clarity.

sense that some stars classified with uncertain membership (flagged "?") because of their mildly deviant kinematics would be bona fide UMa group members. This is simply because these presumably unbiased (or less biased) velocity dispersions are 5–7 km s^{-1} as opposed to our 3 σ dispersions of 2–3 km s^{-1} from UMa nucleus stars. Montes et al. (2001) suggest even larger values from the *Hipparcos*-based wavelet analysis of stellar velocities in the solar neighborhood by Skuljan et al. (1999), whose kinematic "branches" of late-type stars in the *UV*-plane can be measured in tens of kilometers per second. Inasmuch as we focus on producing a list of clean assigned UMa members and have taken care to avoid wrongly classifying possible bona fide members as nonmembers, we deem the bias in our results acceptable. Interesting subgroups of stars, including possible bona fide members not classified as such here, are considered later.

While the recent UMa group membership study of Montes et al. (2001) uses different criteria from ours to establish membership and takes advantage of convergent points and total space velocities, their approach is not wholly independent of ours, since they also employ three-dimensional velocities—proper motions and radial velocities as opposed to our transformed *UVW*-values. Their approach may appear more quantitative, but their use of Eggen's criteria is arbitrary to some degree, since any kinematic membership cutoffs depend on a convolution of a priori knowledge or assumptions about intrinsic dispersion and measurement uncertainties. Given these subtle intrinsic similarities, comparison of our results is of interest; in doing so, we have included the binary stars available in the Web database of Montes et al. (2001).

The comparison of our final memberships with the kinematic results of Montes et al. (2001) is shown in the form of a contingency table in Table 7, in which memberships for

TABLE 7

COMPARISON OF OUR FINAL MEMBERSHIP ASSESSMENTS WITH MONTES ET AL.

OUR FINAL MEMBERSHIP	MONTES ET AL. MEMBERSHIP		
	YY	NY or YN	NN
Y+Y?	16/37 (43.2%)	20/37 (54.1%)	1/37 (2.7%)
?	12/45 (26.7%)	26/45 (57.8%)	7/45 (15.6%)
N?	6/40 (15.0%)	22/40 (55.0%)	12/40 (30.0%)
Y....................	7/19 (36.8%)	11/19 (57.9%)	1/19 (5.3%)
Y?	9/18 (50.0%)	9/18 (50.0%)	0/18 (0.0%)

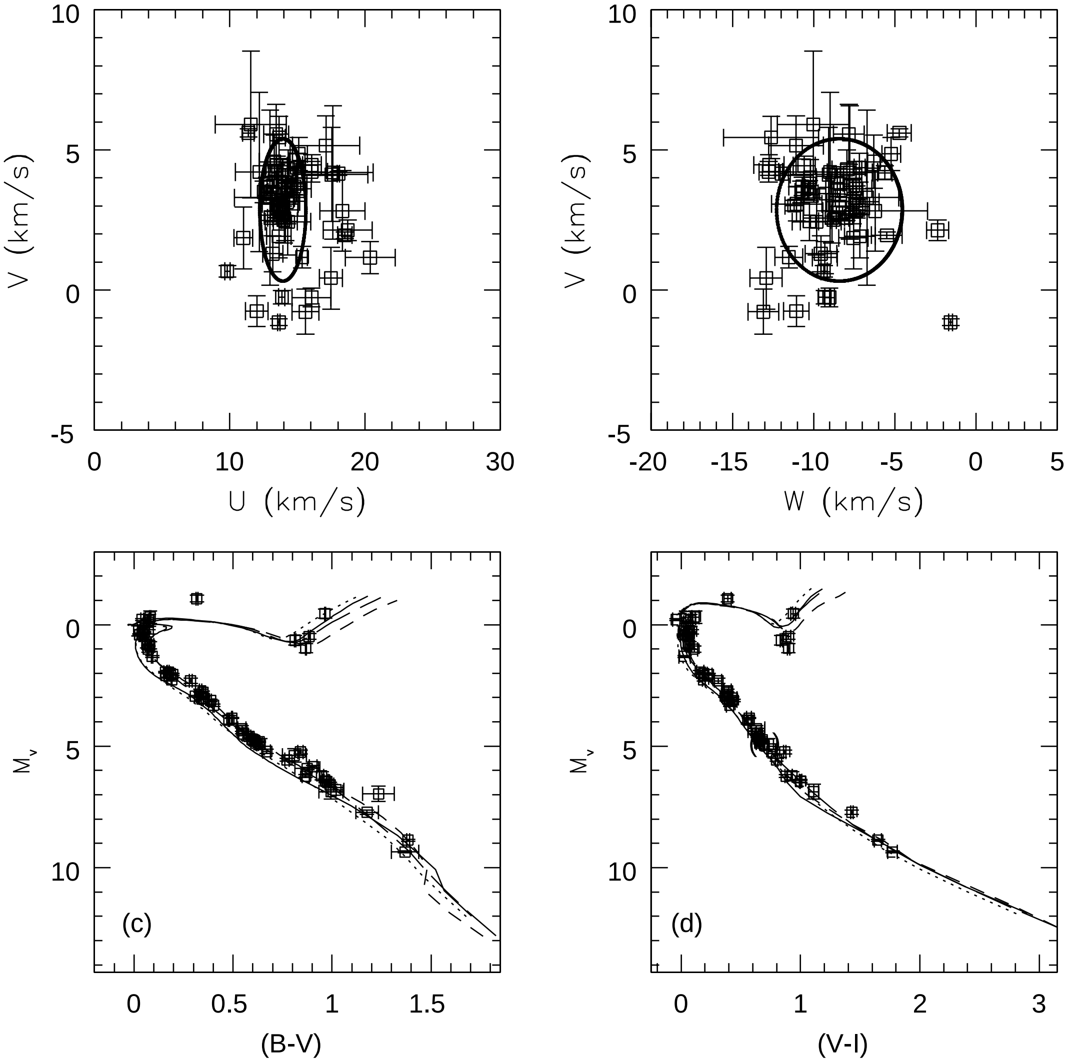

FIG. 9.—Same as Fig. 5, but for our final probable and possible UMa group members

discrete components of the same system have been counted separately. We note that the kinematic values themselves are in outstanding agreement, and differences in our final classifications are due to those in methodology. In the case of exact agreement, the 3 × 3 contingency table formed by the top three rows and final three columns would be dominated by the diagonal components having negative slope. The percentages indicate, however, that this is not the case, though we believe the detailed state of affairs to be satisfactory. The nonnegligible off-diagonal elements are simply the result of tolerable bin "diffusion" of two types. First are cases in which our use of photometric and abundance data has been able to resolve the Montes et al. (2001) uncertain memberships into affirmative or negative membership categories; this occurs for a substantial 34.4% of the total objects. Second are cases in which our evaluation of the kinematics and use of photometric and abundance data in a conservative manner (assigning affirmative or negative membership only if this can be done at high confidence level) has moved the affirmative or negative kinematic membership assignments of Montes et al. (2001) to our uncertain category; this is a moderate effect, influencing only 15.6% of the total objects.

The remaining two diagonal elements in the 3 × 3 contingency subtable are more important. Only one star we finally classify as a member (2.7% of our members) is listed as a kinematic nonmember by Montes et al. (2001); this is encouraging and speaks to the cleanness of our final member sample. A modest 15.0% of our final nonmembers, however, are classified as kinematic members by Montes et al. (2001); these are HD 13594, 24160, 24916, 81659, 112196, and 167389. While this does not speak to the success of our primary goal in compiling a clean sample of UMa group members, it may suggest that our secondary goal of avoiding definitive misclassifications may not be fully met. Besides deviant kinematics, our photometry indicates nonmembership for HD 81659 and strongly for HD 24160. Two kinematic components are deviant for both HD 24916 and HD 167389; the photometric criteria provide uncertain information here, and the activity of HD 167389 is low for a UMa member. We acknowledge, however, that the deviant *U*-velocities seen for HD 13594 and HD 112196 would not exclude membership if we allowed real dispersion of only 4–5 km s^{-1} (consistent with unbiased literature results in Table 6); moreover, HD 112196 is a probable activity-based member. Even if misclassified, these few cases are not intolerable.

We have labeled final memberships of the latter two stars as " N?/? " so as not to relegate them to the obscurity of the general disk field, and we deem the other four objects worthy of continued study (particularly for undetected companions and abundance determinations).

4.3. *Evidence of an Older Stream?*

The outlying evolved stars in Figures 5 and 6 appear to form a well-defined sequence in the color-magnitude diagram. These objects (HD 745, 18645, 62668A, 81858A, 81858B, 88654, and 136901) are plotted again in Figure 10 with the same isochrones used in Figures 4–9. The two additional fiducials are 2 and 3 Gyr isochrones from the same Yale-Yonsei set for solar metallicity and the Lejeune et al. (1998) color transformations. Comparison suggests that these evolved stars do form a genuine evolutionary sequence of uniform age. In their $d = 125$ pc volume-limited study of A–F stars, Chereul et al. (1999) noted with surprise the existence of $\sim$2 Gyr old velocity structures discernible when employing coarse-resolution (velocity dispersions corresponding to 6.3 km s^{-1}) filters. Are the objects in Figure 10 late-type members of these structures?

In principle, kinematic assessment of alleged intermediate-age structures is difficult, since the velocity components may not exhibit the relative coherence of younger structures such as UMa. Nevertheless, the *UVW*-components of HD 745 and HD 88654 are indistinguishable within the uncertainties, as are the *VW*- and *UV*-components of HD 18645 and HD 62668A. Chereul et al. (1999) note a distinctive kinematic feature of their intermediate-age streams is a positive and large (often $\geq$20 km s^{-1}) *U*-component. Our evolved stars in Figure 10 show the same characteristic: *all* six systems have positive *U*, with a mean of $+15$ km s^{-1}. This kinematic characteristic is distinct in an absolute sense as well. The mean disk field defined by B, A, and F stars shows a mean *U*-component of about -12 km s^{-1} (Asiain et al. 1999). In addition, inspection of the disk field kernel density function and its projection in the *UV*-plane at $W = 0$ (Figs. 3 and 4 of Asiain et al. 1999; also their Fig. 5) shows that the *UV*-space occupied by our evolved late-type stars is otherwise poorly populated. High-resolution spectroscopy could establish the chemical abundance uniformity of the objects in Figure 10 and thus address the question of the reality of such candidate old star streams.

4.4. *Robustness of Activity as a Membership Criterion*

The utility of activity measures to establish membership is illustrated by the results in Table 6 and Figures 5–7. Table 6 indicates a clear increase in all the velocity dispersions as one proceeds from probable activity-based members to possible activity-based members and then to activity-based nonmembers. This suggests some overall relation between membership and activity level. Inspection of the H-R diagrams too shows how the photometric scatter increases in moving from probable activity-based members to possible ones, and finally to activity-based nonmembers; again, this suggests a general relation between activity level and membership.

SM93 ask a more specific fundamental question: " Is the use of chromospheric emission infallible for determining [UMa group] membership? " Despite the results above, we believe the general answer is as one might expect—not unless all young disk stars are UMa group members. However, the question above can be parsed into two distinct important ones: Is chromospheric activity a reliable indicator of positive/negative membership? These can be answered using the comparison of our activity-based classifications and our final membership assessments, presented as a contingency table in Table 8. A similar comparison utilizing the kinematic membership assessments of Montes et al. (2001) is shown in Table 9. Only a third of our probable (and possible, as well) activity-based members are classified by us as final members; the results are the same (for both probable and possible activity-based members) utilizing the final membership assessments of Montes et al. (2001) as well. Half our probable activity-based members and a quarter of our possible activity-based member samples are designated final nonmembers. Is this a failure in the use of chromospheric activity as a membership diagnostic? We believe this is not demonstrated, since it may simply reflect a number of (presumably young) disk stars that are not UMa group members in our initial sample. In this light, our

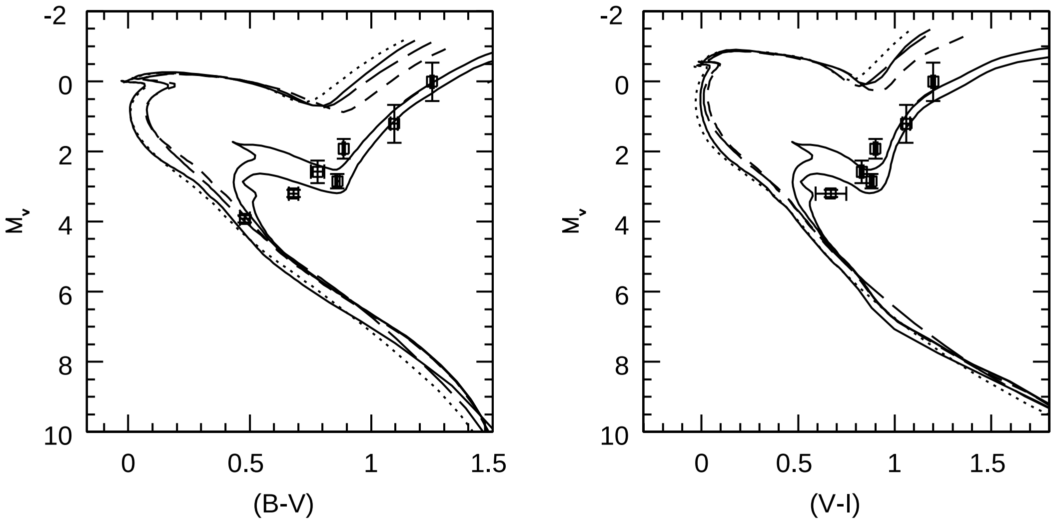

FIG. 10.—Color-magnitude diagrams of outlying evolved stars from Figs. 5 and 6 and the same 400 and 600 Myr Yale-Yonsei isochrones plotted in Figs. 4–9; the two older fiducials are 2 and 3 Gyr Yale-Yonsei isochrones.

TABLE 8

COMPARISON OF ACTIVITY-BASED AND FINAL MEMBERSHIP ASSESSMENTS

	FINAL MEMBERSHIP DESIGNATION			
ACTIVITY-BASED MEMBERSHIP	Y	Y?	N?	?
Probable members	4/22 (18.2%)	3/22 (13.6%)	11/22 (50.0%)	4/22 (18.2%)
Possible members....................	6/31 (19.4%)	3/31 (9.7%)	8/31 (25.6%)	14/31 (45.2%)
Nonmembers	0/26 (0.0%)	1/26 (3.8%)	17/26 (65.4%)	8/26 (30.8%)
Additional	8/144 (5.6%)	20/144 (13.9%)	38/144 (26.4%)	78/144 (54.2%)

starting sample may simply be less clean than that of, e.g., SM93, though we note that nine of 11 of their possible activity-based members were assigned eventual kinematics-based nonmembership by them.

The second, more important question that SM93 were really asking is whether chromospheric activity can be used to exclude membership; a negative result here would have direct impact on the issue of age-activity correlations. Table 8 indicates that of our 26 activity-based nonmembers, only a single one (HD 38393) is classified as a final member. This suggests that activity, then, is a very robust discriminant of nonmembership. Montes et al. (2001) classify three additional activity-based nonmembers (HD 167389, 184960, and 211575) as kinematic members, however. Indeed, the kinematics for the latter two objects suggest possible membership; the only deviations are mild ones in U, easily allowed if we had utilized the velocity dispersions from nonbiased studies listed at the bottom of Table 6; moreover, kinematic membership would even be favored for HD 167389 utilizing these unbiased criteria. The photometric membership criteria, however, are inconclusive for all stars. This results in our final uncertain and probable nonmembership assignments. Given these comparisons, we have listed final memberships of "?/Y?" for HD 184960 and HD 21175 and a final membership of "N?/?" for HD 167389 in Table 5 for those interested in following up the present study with more definitive classifications, as opposed to our primary goal of an ultraclean member list. Even considering these four remarkable exceptions (15% of our activity-based nonmembers), activity remains a remarkably robust indicator of nonmembership. The most pessimistic interpretation of our results we envision is that age-activity relations are best considered in a statistical sense because of the presence of (apparently infrequent) scatter.

4.5. *UMa Group Chromospheric Activity*

Residual chromospheric emission ($\log R'_{\rm HK}$) is plotted against color for our final UMa members (*filled symbols*) in Figure 11. Values for HD 91480, 113139A, and 184960 (−4.47, −4.48, and −4.95, respectively) are deduced from the C II λ1335 measures of Simon & Landsman (1991), the He I D3 measures of García López et al. (1993), and the Mg II h and k measurement of Soderblom & Clements (1987); transformations to the Ca II H and K system were made using the regressions of Soderblom & Clements (1987) and the observed relations in García López et al. (1993). Also shown are the Pleiades, M34, and schematic Hyades data from Figure 3. Several interesting notes can be made. First, the scatter in UMa activity is very small, comparable to that seen in the slightly older ($\sim$700 ± 100 Myr) Hyades, and considerably smaller than that seen in the younger Pleiades ($\sim$100 Myr) and M34 ($\sim$200 Myr) clusters. Second, the mean level of activity also appears indistinguishable from that in the Hyades. The former suggests that the young solar-type star decline in global activity levels and their star-to-star scatter must be relatively rapid, occurring sometime within 200–500 Myr. The latter observation is consistent

TABLE 9

OUR ACTIVITY-BASED KINEMATIC MEMBERSHIP AND THAT OF MONTES ET AL.

	MONTES ET AL. MEMBERSHIP DESIGNATION		
ACTIVITY-BASED MEMBERSHIP	YY	NN	NY or YN
Probable members	6/21 (28.6%)	4/21 (19.0%)	11/21 (52.4%)
Possible members........	8/23 (34.8%)	6/23 (26.1%)	9/23 (39.1%)
Nonmembers	4/12 (33.3%)	1/12 (8.5%)	7/12 (58.3%)
Additional	13/47 (27.7%)	9/47 (19.1%)	25/47 (53.2%

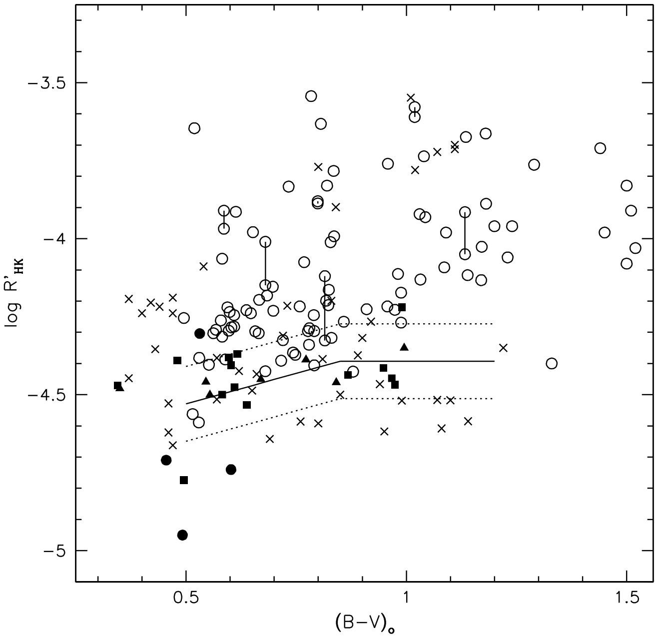

FIG. 11.—Chromospheric emission–color plane with the Hyades relation (*lines*), M34 data (*crosses*), and Pleiades data (*open circles only*) from Fig. 3. The squares are our final probable and possible UMa group members (single or wide binaries). Triangles are final probable and possible members that are spectroscopic binaries, close visual binaries, or known active variables. Filled circles are four kinematic members from Montes et al. (2001) that are indeed likely UMa group members but are not within our final clean member sample.

with the revised similar UMa and Hyades ages; thus, the similarity of mean Hyades or UMa activity levels is perhaps not as remarkable as originally thought by Soderblom & Clements (1987). In this case, the (power law?) decline in chromospheric emission need not occur very close to the age of UMa or the Hyades.

Given the small Hyades-like scatter in chromospheric emission in the UMa group, an interesting question is whether the spread in rotation is also small, like that seen in the Hyades. Homogeneous rotational velocity determinations of a larger number of UMa members are needed to address this satisfactorily; unlike directly measured chromospheric emission values, *projected* rotational velocities require larger samples to develop a statistical picture on firm footing. However, the literature-based positions of a dozen or so UMa members in the $v \sin i$–$(B-V)$ plane (see Fig. 1 of Soderblom et al. 2001) reveal that (1) the majority of stars have Hyades or slightly *sub*-Hyades (projected) rotational velocities and (2) with the exception of HD 184960 ($v \sin i = 3$ km s^{-1} at $B-V = 0.492$, possibly anomalously low because of the unknown projection) and HD 115043 ($v \sin i = 25$ km s^{-1} at $B-V = 0.61$), the scatter appears comparable to that evinced by Hyades dwarfs or, in the extreme, perhaps intermediate to the rotational scatter shown by M34 and the Hyades (Fig. 1 of Soderblom et al. 2001).

The lack of very low chromospheric emission (less than or equal to -5.1, say) in our UMa group members reinforces the conclusion of Soderblom & Clements (1987) that young stars having activity levels characteristic (in an absolute sense) of a Maunder-like minimum for the Sun are very rare. In comparison, the population of such very inactive field stars within 50 pc is estimated by Henry et al. (1996) to be 10%; a follow-up high-resolution spectroscopic study now in preparation by J. R. K., A. R. V., and D. R. S. suggests that indeed these objects are single, slowly rotating stars significantly older than the Hyades. If, however, one defines the Maunder minimum–like phenomenon in a relative sense—e.g., a real sustained drop in $\log R'_{\rm HK}$ by several tenths of a dex (e.g., Fig. 7 of Henry et al. 1996) compared with a mean activity level—then three warm UMa stars seen in Figure 11 might be considered to be in such a phase. While assured membership is an issue for two of these objects, the fraction (12%) is consistent with the Henry et al. (1996) estimate for older solar neighborhood field stars. If true, this might suggest that solar-type stars spend 10% of nearly their entire main-sequence life in a period of abnormally low activity.

4.6. *Trolling the Stream: Fishing for Bona Fide Unassured Members*

4.6.1. *Active Nonmembers and Questionable Members*

An interesting question is, what is the nature of the probable and possible activity-based members that are not classified as final members? None appear to be members of other kinematic structures found in the analyses of Asiain et al. (1999) or Chereul et al. (1999), which typically have significant simultaneous negative U and V velocity components not characteristic of the active unassured members. If the velocity components and/or unbiased velocity dispersions from these studies are utilized, it is possible that roughly a third of these stars (HD 26913, 41593, 56168, 60491, 63433, 75935, 76218, 112196, 147513, and 150706 and CG Cyg) are, in fact, bona fide UMa group members; this would include membership in perhaps related putative structures such as an extended Sirius branch or the new supercluster clumps lying near the Sirius supercluster in velocity phase space (Skuljan et al. 1999; Chereul et al. 1999). If not already final uncertain members, these stars are given dual " N?/? " assessments in Table 5; we note that HD 63433 and HD 75935 were found to be kinematic members, but their photometry prevented a positive final assessment.

Another third of the sample is characterized as belonging to close binary systems; thus, their significant activity levels are not very remarkable. Many of the remaining one-third of active unassured UMa members are not well studied. It remains possible that these are additional rare examples of young field stars separated from apparent regions of recent star formation; regardless, additional high-resolution spectroscopic study is certainly warranted.

4.6.2. *Photometric Members near the UMa Turnoff*

The photometric membership criterion was noted to be most effective at eliminating nonmembers. Indeed, only two photometric nonmembers are considered kinematic members here (HD 13959B and HD 156498A). Both are members of double systems, and their other component shows both consistent positive photometric and kinematic evaluations. Because we expect little-evolved UMa nonmembers to reside near the UMa main sequence, photometry is not a generally robust method to assign positive membership. An exception is near the turnoff, where evolution off the zero-age main sequence makes a star's residence near the UMa fiducial highly suggestive of (not merely consistent with) membership.

Such stars are abundant among our additional UMa candidate sample, their early spectral types probably precluding investigators from attempting activity measurements. Roughly 30 stars are present here with H-R diagram placement suggestive of membership but whose kinematics were labeled " N? " or " ?. " An interesting feature of these stars is their generally significant and positive U-values, which are not characteristic of the local young disk field or of other identified moving groups; the same intriguing feature is seen in our active but unassured members (above). Using the results of other unbiased kinematic studies as above, the stars HD 15144A, 50973, 56537, 77350, 79439, and 120818 would especially seem to be likely members. Inasmuch as there may be no such thing as a " normal " A star, precision detailed abundances will probably not be helpful in future assessments of these stars' membership.

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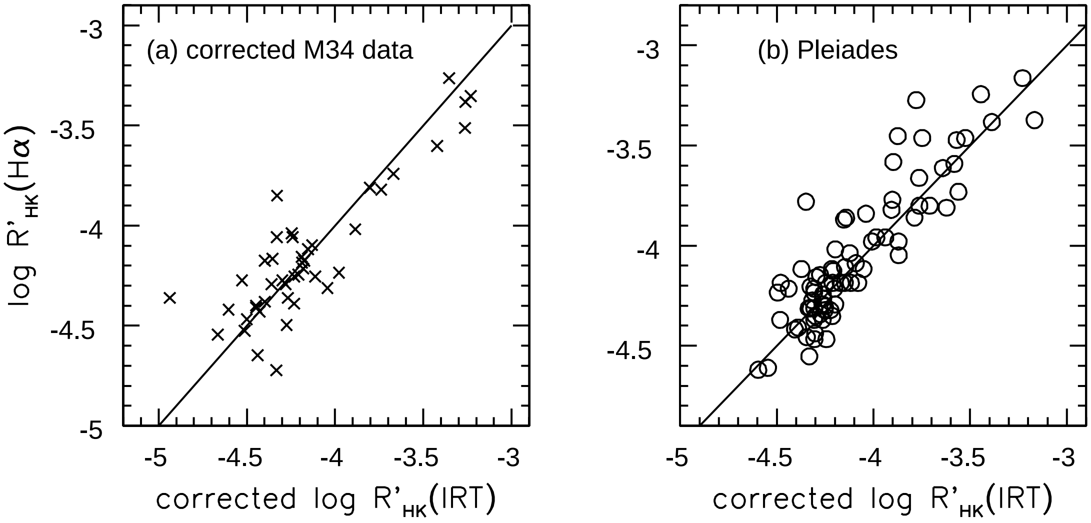

FIG. 12.—Same as Figs. 1*d* and 2*c*, respectively, except IRT-based activity measures have been corrected to an Hα-based scale utilizing eqs. (3) and (5)

APPENDIX

Hα AND Ca II IRT AS PROXIES FOR Ca II H AND K

Revisiting Figures 1*d* (M34) and 2*c* (Pleiades) now to correct instead the Ca II IRT–based activity measures to an Hα-based scale by using equations (3) and (5) also yields seemingly much improved results (shown in Fig. 12) compared with those in Figures 1*a* and 2*a*. However, such a procedure ensures only self-consistency between the Hα and Ca II IRT activity scales, not absolute consistency with a true Ca II H and K scale. Figure 13 is analogous to Figure 3 but now shows the mean of the transformed Hα-based and *corrected* IRT-based $\log R'_{\rm HK}$ values versus dereddened $B-V$ color. The filled circles are again the *directly measured* Pleiades H and K indices from Soderblom et al. (1993) and are connected to the transformed and corrected values for six stars in common.

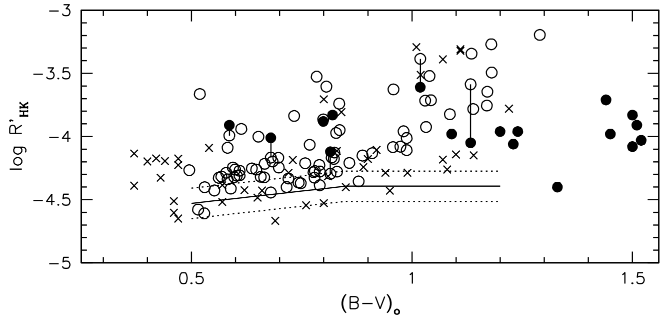

FIG. 13.—Same as Fig. 3 except the Pleiades and M34 chromospheric fluxes are from averaged Hα-based and corrected Ca II IRT–based transformations.

A troubling feature of Figure 13 is that the majority of the coolest ($B-V \geq 1.0$) M34 and Pleiades stars show *transformed* $R'_{\rm HK}$ values that are considerably larger than *directly measured* values. Figures 1*b* and 2*b* suggest why. By now correcting the IRT-based values onto the Hα scale, we have incorrectly selected the wrong index to correct, thus erroneously raising our activity measures by perhaps up to 0.5 dex for the coolest stars; that is, Figure 13 suggests that Hα is not as reliable a tracer of the Ca II H and K index as the Ca II IRT lines for cool stars.

This is not unexpected on either observational or theoretical grounds, since (1) the transformations of Herbig (1985) were derived from early G-type stars and (2) the IRT features are subordinate lines connecting the upper 4 ^2P levels of the H and K lines with 3 ^2D metastable states. Moreover, it is well known that (in the framework of complete redistribution and detailed balance for the Lyman lines anyway) the non-LTE Hα source function is dominated by photoionization and recombination in solar-type stars (Cram & Mullan 1985). This contrasts with the Ca II lines, whose non-LTE source function is dominated by collisional excitation and de-excitation. Curiously, we might expect the Hα and Ca II H and K line source functions to show greater similarity in the cooler stars, since photoionization is presumably becoming less important. However, the electron density will also determine whether Hα becomes collisionally dominated like H and K in these stars; apparently n_e is not high enough for this to occur, though it might in cooler M dwarfs (Fosbury 1974).

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