

THE PLEIADES AND α PERSEI CLUSTERS

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ABSTRACT

The upper-main-sequence members of the Pleiades and α Persei clusters, considered as members of the Local Association, yield mean parallaxes that are only 4% larger than the mean values from *Hipparcos* observations. The $(\log T_{\text{eff}}, M_V)$ diagram reveals that in the temperature range from 6000 to 8000 K, the Hyades and α Persei main-sequence members are nearly identical and several tenths of a magnitude brighter than similar stars on the Pleiades main sequence. The departure of the Pleiades main sequence cannot be traced to either age or heavy-element abundance differences in the range thought to apply to these clusters. A 50% increase in the helium abundance of Pleiades over Hyades stars could account for the luminosity difference. Alternative explanations are that the Pleiades cluster is rejected from supercluster membership and/or that the *Hipparcos* parallax results for the Pleiades are in error by some 10%.

Key words: astrometry — open clusters and associations: individual (Pleiades, α Persei)

1. INTRODUCTION

The Local Association of young stars, possibly containing the α Persei as well as the Pleiades cluster, has been extensively discussed elsewhere (e.g., Eggen 1977, 1992). The parameters of the association's motion are

$$(A, D) = (5^{\text{h}}98, -35^{\circ}15), \quad (1)$$

$$V_{\text{tot}} = 26.5 + 0.025X(\text{pc}), \quad (2)$$

$$\pi_{\text{clus}} = 4.47v/(V_{\text{tot}} \sin \lambda), \quad (3)$$

$$\text{P.V.} = 4.47\tau D(\text{pc}) \text{ km s}^{-1}, \quad (4)$$

where (A, D) is the convergent point of the proper motions, X is the radial distance from the Sun, v is the component of the proper motion in the direction of (A, D) , τ is the proper-motion component perpendicular to that direction, and λ is the angular separation between the star and (A, D) . The convergent point could possibly be improved, but the value determined from 36 FK5 stars (Eggen 1992) has been adopted here. The noncluster association members will be discussed in investigations published elsewhere, and only the early main-sequence members of the two clusters are included in the present study.

The 19 known members of the Pleiades cluster brighter than $V \sim 7$ mag and contained in the *Hipparcos* Catalogue (ESA 1997) are listed in Table 1 in order of decreasing visual magnitude. The 14 brightest members of the α Persei cluster in the *Hipparcos* Catalogue are listed in Table 2. In both cases the mean parallax has a dispersion similar to that of the individual stars. Comparison of the *Hipparcos* parallaxes with the values obtained from the *Hipparcos* astrometry and the cluster motion yields

$$\begin{aligned} \alpha \text{ Per: } & \pi_{\text{clus}} = 5.28 \text{ mas}, \quad \pi_{\text{Hip}} = 5.55 \text{ mas}; \\ \text{Pleiades: } & \pi_{\text{clus}} = 8.46 \text{ mas}, \quad \pi_{\text{Hip}} = 8.72 \text{ mas}. \end{aligned}$$

The cluster parallaxes are about 4% smaller than the *Hipparcos* results, which would indicate a 1 km s^{-1} increase in the adopted V_{tot} . Pinsonneault et al. (1998) quote a somewhat smaller parallax of 8.61 ± 0.23 mas, based on a larger selection of fainter cluster stars and a more sophisticated system of averaging the *Hipparcos* results.

The predicted radial velocity, from $V_{\text{tot}} \cos \lambda$, is $+11.3 \text{ km s}^{-1}$ for the Pleiades cluster and -0.9 km s^{-1} for the α Persei cluster. Pearce & Hill (1975) found $+7.6 \pm 2.3 \text{ km s}^{-1}$ from 45 bright Pleiades stars, and Stauffer, Liebert, & Giampapa (1995) find $+7.1 \pm 5.6 \text{ km s}^{-1}$ from 12 red dwarfs. Heard & Petrie (1967) derived $-1.7 \pm 0.5 \text{ km s}^{-1}$ for 45 members of the α Persei cluster whereas Kraft (1967) found $-0.9 \pm 0.7 \text{ km s}^{-1}$. The observed values for the α Persei stars have small dispersion and compare well with the computed cluster value. The peculiar velocity of the cluster is therefore mainly in the proper motion, $\text{P.V.} = 5 \text{ km s}^{-1}$. On the other hand, the dispersion in the observed radial velocities of Pleiades stars is large, but the mean value is within 2σ of the predicted one. The peculiar velocity from the proper motions of Pleiades members is $\text{P.V.} = -2.7 \text{ km s}^{-1}$, but the total peculiar velocity may be the same as for the α Persei stars when the uncertainty of the observed radial velocities is considered.

Luminosities derived from the cluster parallaxes and other photometric data for intermediate-mass stars are listed in Table 3. The values of $\log T_{\text{eff}} = 3.881 + 0.53 \times (\beta - 2.800)$ (Eggen 1995) are based on β -values published by Crawford & Barnes (1974) for members of the α Persei cluster and by Crawford & Perry (1976) for the Pleiades. The luminosity (c_1) and metallicity (m_1) parameters published by these authors are suspect (see, e.g., Eggen 1986a) because of the effect of the large range in the band-passes of the filter sets used in the observations, especially for the critical v filter, so the equivalent d and m_2 indices from the Geneva photometry (Rufener 1988), which are based on a single observer and filter set, are preferred. The β , d , and m_2 indices are reddening-free, and the luminosities in Table 3 are based on the published V magnitudes, cleared of the small reddening $[E(b - y) = 0.02 \text{ mag}$ for the Pleiades and about 0.07 mag for α Per].

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TABLE 1
Hipparcos ASTROMETRY OF PLEIADES STARS

HR (HD)	HIP	μ_α (mas yr ⁻¹)	μ_δ (mas yr ⁻¹)	π_{Hip} (mas)	σ (mas)
1165.....	17702	19.35	-48.11	8.87	0.99
1178.....	17847	17.11	-44.70	8.57	1.03
1142.....	17499	21.55	-44.92	8.80	0.89
1149.....	17573	21.09	-45.03	9.06	1.03
1156.....	17608	21.17	-42.67	9.08	1.04
1145.....	17531	19.35	-41.63	8.75	1.08
1150.....	17851	18.71	-46.74	8.42	0.86
1140.....	17489	20.73	-44.00	9.75	1.05
1172.....	17776	19.14	-46.80	9.64	0.91
1144.....	17527	19.03	-46.64	8.87	0.89
1151.....	17579	19.44	-43.46	8.43	0.89
1183.....	17900	16.50	-44.53	8.59	0.93
1152.....	17568	19.63	-44.38	9.21	0.92
(23964).....	17923	18.74	-44.35	6.30	1.46
(23642).....	17702	19.35	-43.11	8.87	0.99
(23568).....	17664	21.47	-45.43	6.65	0.99
(24076).....	17999	16.80	-45.76	9.83	1.00
(23410).....	17572	21.06	-44.49	9.68	1.03
(23632).....	17692	19.75	-43.97	8.35	7.00
Mean.....		19.57	-44.73	8.72	
σ		± 1.53	± 1.52	± 0.92	

NOTE.—In order of decreasing visual magnitude.

The ($M_V, \log T_{\text{eff}}$) diagram for the clusters is shown in Figure 1a, where the Hyades cluster members (Eggen 1998a) in the same temperature range are represented by filled circles. The mean Hyades modulus, confirmed by *Hipparcos* parallaxes, is 3.35 mag. The same symbols designating Pleiades and α Persei stars in Figure 1a are used in the ($\log T_{\text{eff}}, d$)-plane of Figure 1b. Figure 1 presents a fundamental dilemma in that, although the assumption of associational membership of the Pleiades cluster members, as well as of the members of the α Persei cluster, leads to parallaxes that are nearly identical to the mean *Hipparcos* results for the cluster members, the Pleiades cluster presents a main sequence of AF stars that is several tenths of a magnitude fainter than that for the Hyades stars, whereas the α Persei cluster main sequence essentially matches that of the Hyades stars. A considerably smaller luminosity difference for the Pleiades, and lack of difference for the α Persei

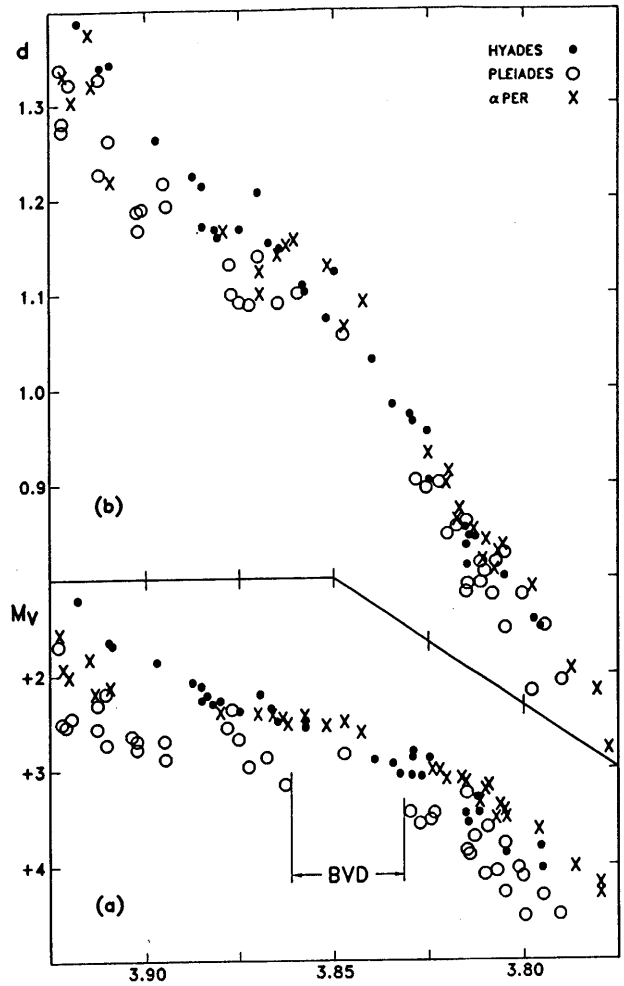


FIG. 1.—The (a) ($M_V, \log T_{\text{eff}}$) and (b) ($d, \log T_{\text{eff}}$) relations for cluster stars.

cluster members, compared with Hyades stars, is reflected in the luminosity parameter d . However, if the luminosity difference is real, and caused by a composition difference, equating the d -parameters may be incorrect.

TABLE 2
Hipparcos ASTROMETRY OF α PERSEI STARS

HR (HD)	HIP	μ_α (mas yr ⁻¹)	μ_δ (mas yr ⁻¹)	π_{Hip} (mas)	σ (mas)	BD
19624.....	14845	24.70	-23.65	5.30	0.84	+51°689
987.....	15404	22.45	-25.10	6.18	0.66	+49°899
989.....	15444	22.38	-25.26	6.78	0.68	+49°902
1011.....	15770	20.30	-24.96	5.22	0.72	+48°899
(20863).....	15819	25.02	-25.53	5.90	0.83	+48°903
1017.....	15802	28.23	-26.35	7.18	1.45	+49°917
1029.....	15988	22.75	-27.12	5.41	0.79	+48°913
(21181).....	16079	22.90	-24.83	5.55	0.81	+47°826
1034.....	16147	21.94	-26.83	5.72	0.65	+48°920
1047.....	16252	22.36	-28.61	5.66	0.34	+46°760
1051.....	16340	21.23	-24.00	3.75	0.80	+47°844
(21672).....	16450	21.21	-30.18	4.90	0.82	+48°943
1063.....	16470	22.84	-23.78	5.57	0.71	+47°847
(22136).....	16782	21.34	-24.18	4.56	0.76	+46°773
Mean.....		22.86	-25.81	5.55		
σ		± 0.95	± 1.86	± 0.85		

TABLE 3
PHOTOMETRY OF CLUSTER MEMBERS

HD/BD ^a	M_V	$\log T_{\text{eff}}$	d	m_2	HD/BD ^a	M_V	$\log T_{\text{eff}}$	d	m_2
Pleiades					α Persei				
23061.....	+4.05	3.808	0.822	-0.490	+49°863.....	+4.3	3.780	0.609	-0.422
23156.....	+2.73	3.902	1.172	-0.469	+49°868.....	+3.0	3.819	...	...
23157.....	+2.34	3.876	1.101	-0.479	+49°870.....	+3.5	3.795	0.795	-0.450
23158.....	+4.02	3.803	0.780	-0.485	+48°865.....	+2.4	3.877	1.170	-0.495
23194.....	+2.51	3.924	1.273	-0.477	+48°871.....	+3.5	3.807	0.816	-0.484
23195.....	+4.09	3.809	0.812	-0.475	+49°889.....	+3.4	3.805	0.842	-0.502
23246.....	+2.83	3.867	1.143	-0.492	+50°728.....	+2.5	3.847	1.164	-0.521
23247.....	+3.47	3.830	0.917	-0.487	(350).....	+4.2	3.780	0.684	-0.427
23289.....	+4.48	3.790	0.698	-0.451	+49°896.....	+3.2	3.820	...	...
23289.....	+3.55	3.827	0.904	-0.484	+49°897.....	+3.4	3.805	0.820	-0.492
23325.....	+2.55	3.878	1.134	-0.458	+47°808.....	+2.5	3.861	1.153	-0.503
23326.....	+3.43	3.823	0.902	-0.498	+48°892.....	+3.0	3.826	0.933	-0.506
23351.....	+3.48	3.825	0.899	-0.474	+48°894.....	+2.5	3.865	1.140	-0.490
23352.....	+4.30	3.794	0.753	-0.479	+51°723.....	+2.2	3.917	1.328	-0.502
23361.....	+2.45	3.921	1.328	-0.476	+49°914.....	+3.2	3.809	0.844	-0.493
23375.....	+3.16	3.862	1.096	-0.488	+48°905.....	+2.4	3.868	1.124	-0.482
23430.....	+2.57	3.912	1.230	-0.462	+49°918.....	+2.4	3.857	1.161	-0.503
(227).....	+3.72	3.820	0.848	-0.489	+47°816.....	+3.3	3.813	0.855	-0.491
23479.....	+2.54	3.858	1.109	-0.488	+46°745.....	+3.1	3.814	0.858	-0.491
23511.....	+3.82	3.815	0.785	-0.478	+49°921.....	+2.5	3.859	1.091	-0.474
23513.....	+3.90	3.814	0.795	-0.472	+48°909.....	+1.8	3.914	1.383	-0.512
23514.....	+3.96	3.811	0.819	-0.484	+47°819.....	+2.2	3.908	...	...
23567.....	+2.64	3.875	1.097	-0.478	(715).....	+3.1	3.808	0.866	-0.499
23584.....	+4.00	3.808	0.799	-0.494	+47°825.....	+2.8	3.844	...	...
23585.....	+2.95	3.872	1.089	-0.489	+48°916.....	+3.2	3.810	0.812	-0.486
23607.....	+2.72	3.903	1.190	-0.479	+48°923.....	+3.1	3.814	0.873	-0.488
23608.....	+3.25	3.814	0.854	-0.476	(833).....	+3.4	3.807	0.814	-0.494
23610.....	+2.71	3.895	1.195	-0.471	+48°934.....	+2.1	3.911	1.216	-0.478
(420).....	+4.28	3.806	0.832	-0.488	+47°842.....	+2.0	3.919	1.304	-0.501
(620).....	+4.49	3.798	0.684	-0.481	(917).....	+4.0	3.783	0.653	-0.437
23628.....	+2.16	3.911	1.264	-0.489	+49°953.....	+2.0	3.923	1.334	-0.498
23643.....	+2.29	3.913	1.336	-0.492	+49°957.....	+3.1	3.821	0.909	-0.505
23664.....	+2.67	3.902	1.191	-0.462	+49°958.....	+2.6	3.849	1.136	-0.507
23713.....	+3.75	3.803	0.751	-0.462	+49°859.....	+3.1	3.921	...	...
23732.....	+3.59	3.823	...	...	+48°944.....	+1.6	3.926	...	...
23733.....	+2.82	3.847	1.058	-0.492	(1005).....	+3.0	3.822	0.900	-0.504
23763.....	+1.68	3.920	1.340	-0.507	+46°780.....	+2.6	3.843	1.096	-0.480
23778.....	+3.57	3.807	0.784	-0.462					
23791.....	+2.88	3.895	1.218	-0.479					
23886.....	+2.53	3.923	1.277	-0.475					
23912.....	+3.70	3.813	0.856	-0.476					
23924.....	+2.69	3.909	1.212	-0.465					
23975.....	+4.08	3.800	0.786	-0.474					
24013.....	+2.10	3.904	...	...			

^a Parenthesized entries refer to numbers from Hertzsprung 1947 as quoted by Crawford & Perry 1976 for the Pleiades and to numbers from Heckmann, Dieckvoss, & Kox 1956 as quoted by Crawford & Barnes 1974 for α Per.

At least two explanations of the main-sequence displacement are easily imagined:

1. The agreement of the cluster and *Hipparcos* parallaxes is coincidental, and the Pleiades cluster is incorrectly assumed to be a member of the association.

2. Although both age and heavy-element abundance differences can lead to main-sequence separation, the effect for small differences is negligible. The metallicity difference between the Hyades stars and the supercluster members is probably represented by $[\text{Fe}/\text{H}] = +0.1$ dex (Hyades) and solar composition for the Pleiades. This is demonstrated in Figure 2, which represents the $(\log T_{\text{eff}}, m_2)$ relations for the clusters. The Hyades abundance is well established at $[\text{Fe}/\text{H}] = +0.1$ dex (see, e.g., Eggen 1982), and the small separation from the Hyades of the Pleiades and α Persei stars in Figure 2, which is near 0.015 mag in the mean, leads to $[\text{Fe}/\text{H}]_{\text{Pl}} = [\text{Fe}/\text{H}]_{\text{Hy}} - 10\Delta m_2 = -0.05$ dex. The ratio $\Delta[\text{Fe}/\text{H}]/\Delta m_2 = 10$ is from Eggen (1992). The heavy-

element abundance may be somewhat lower for the α Persei cluster members. Therefore, some more effective parameter needs to be invoked to explain a substantial separation of the Hyades and Pleiades main sequences.

The helium abundance may be the difference. Three models, all with $Z = 0.01$ but at two ages, 10^9 and 1.5×10^8 yr, with $Y = 0.30$ and one at 10^9 yr but with $Y = 0.20$, yield the $(M_V, \log T_{\text{eff}})$ relations in Figure 3 (Green, Demarque, & King 1987). The Hyades stars have ages ranging from 6×10^8 to about 10^9 yr (Eggen 1998a). The Pleiades and α Persei stars of type earlier than about A0 are shown in the $(M_V, [u - b])$ -plane in Figure 4. The values of $[u - b] = 2[m_1] + [c_1]$ are reddening-free and formed from observations by Crawford & Barnes (1974; α Per) and Crawford & Perry (1976; Pleiades). The isochrones are from models by Maeder & Meynet (1991) and Bertelli et al. (1990) using the $(T_{\text{eff}}, [u - b])$ relation by Kurucz (1979). The heavy-element abundance difference between the Pleiades and

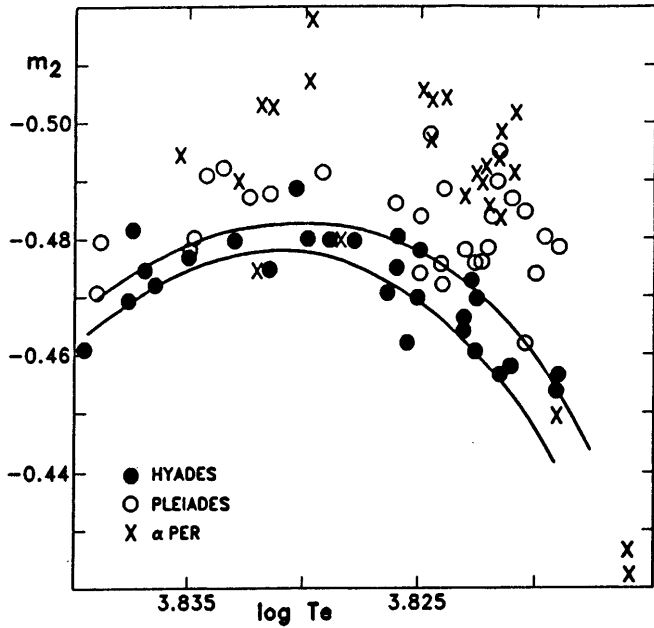


FIG. 2.—The ($m_2, \log T_{\text{eff}}$) relation for cluster stars

Hyades stars leads to less than 0.1 mag in the main-sequence luminosity at a given temperature (see, e.g., Eggen 1986a, Fig. 19), and this is essentially offset by the age difference (Fig. 3). We are left with the possibility that the

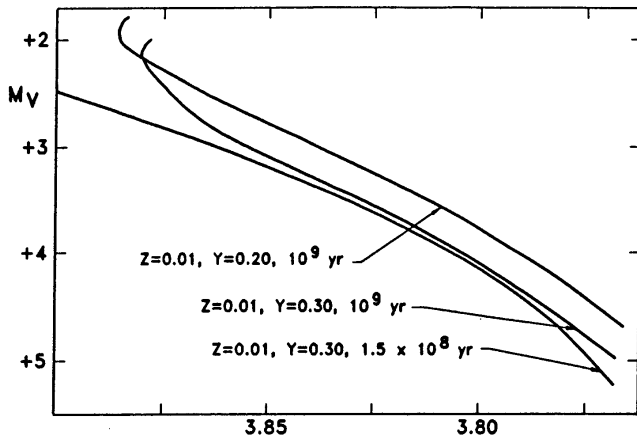


FIG. 3.—Model isochrones (Green, Demarque, & King 1987)

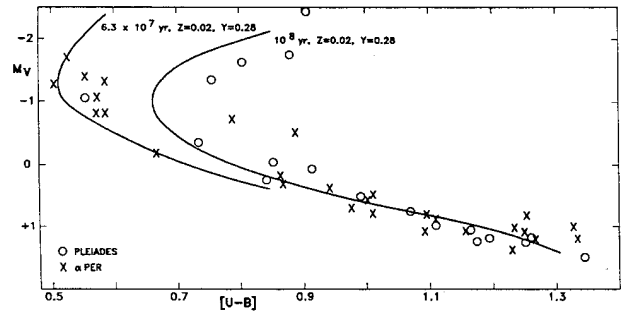


FIG. 4.—B-type stars in the Pleiades and α Per clusters

Pleiades cluster has some 50% stronger helium than the Hyades cluster whereas the α Persei stars have about the same helium abundance as the Hyades.

It should be noted in Figure 1 that although the bulk of Pleiades stars are well separated from the luminosity of the Hyades and α Persei stars, as well as from the mean values, two of three Pleiades stars are more closely identified with Hyades and α Persei cluster members (see Table 4). The near-equality in luminosity is confirmed in the first three cases by the luminosity index, d , so the explanation of undetected duplicity in the Pleiades stars is not applicable. The last star, HD 218396 (HR 8799), is an association member:

$$(\mu_\alpha, \mu_\delta)_{\text{Hip}} = (106.68, -50.08) \text{ mas},$$

$$\pi_{\text{Hip}} = 25.04 \text{ mas}, \quad \pi_{\text{clus}} = 22.67 \text{ mas},$$

$$X = 2 \text{ pc}, \quad V_{\text{tot}} = 26.55 \text{ km s}^{-1},$$

$$P.V. = 2.2 \text{ km s}^{-1}, \quad \rho_{\text{comp}} = -10.0 \text{ km s}^{-1}.$$

The observed radial velocity is -11.0 to -13.6 km s^{-1} from four observations by Harper (1937). The star is a light variable (Rodriguez & Zerbi 1995) with a period of 0.51 days and $\Delta V \sim 0.05 \text{ mag}$. It appears to be a member of a class of variables that occur within the Böhm-Vitense decrement (BVD). This decrement (Böhm-Vitense & Canterna 1974) is probably caused by an abrupt onset of convection. The variables in this gap (Eggen 1995) are typified by γ Dor. The fact that the only constant (?) Pleiades cluster member in the decrement appears to be elevated some 0.5 mag to the Hyades main sequence may be connected with this convection change. It is striking to note that the α Persei main

TABLE 4

PLEIADES STARS IDENTIFIED WITH CLUSTER MEMBERS

Cluster	Star	$\log T_{\text{eff}}$	M_V	d	m_2
Pleiades	HD 23479	3.858	+2.5	1.109	-0.450
α Per	BD +49°921	3.859	+2.5	1.091	-0.474
Hyades	HR 1368	3.858	+2.55	1.104	-0.463
Pleiades	HD 23608	3.814	+3.25	0.838	-0.476
α Per	BD +46°816	3.813	+3.3	0.835	-0.491
Hyades	HR 1233	3.812	+3.3	0.846	-0.469
Pleiades	HD 23643	3.913	+2.3	1.336	-0.492
α Per	BD +51°723	3.917	+2.2	1.328	-0.502
Pleiades	HD 23733	3.847	+2.8	1.058	-0.492
Supercluster	HD 218396	3.851	+2.75	1.107	-0.528

TABLE 5
COMPARISON OF FK5 STANDARDS WITH *Hipparcos* RESULTS

HR	μ_x (mas yr ⁻¹)		μ_δ (mas yr ⁻¹)		m.e. μ_x (mas yr ⁻¹)		m.e. μ_δ (mas yr ⁻¹)	
	FK5	HIP	FK5	HIP	FK5	HIP	FK5	HIP
1142.....	19.4	21.55	-46.11	-44.92	0.47	0.85	0.54	0.64
1165.....	18.6	19.35	-46.0	-48.11	0.39	0.82	0.40	0.58
1178.....	17.8	17.99	-46.7	-44.90	0.32	0.96	0.39	0.70
Mean.....	18.6	19.63	-46.3	-45.97				
σ	± 0.8	± 1.80	± 0.4	± 1.85				

sequence also shows the BVD, but shifted to slightly lower temperature.

The possibility that the helium abundance of the α Persei cluster stars is about two-thirds that of the Pleiades members has such far-reaching implications that its basis needs thorough investigation. The most vulnerable aspects of this conclusion are the fact that such main-sequence displacement is not found in other clusters and associations in the supercluster (see, e.g., Eggen 1998b), and the accuracy of the available astrometry and photometry.

2. PROPER MOTION

An earlier investigation of the Pleiades motion (Eggen 1992) was based on the mean proper motion for three FK5 stars and five of high-quality motion in the catalog of Röser & Bastian (1991). The three FK5 standards compare with the *Hipparcos* results as shown in Table 5. The cluster parallaxes resulting from three sources of proper motion are listed in Table 6. The results for the 18 HIP stars are from Table 1, excluding the brightest cluster member, HR 1165, as obviously deviant.

The five high-quality stars are listed in Table 7. The mean *Hipparcos* value agrees well with that of the six high-quality stars, but there appears to be a small magnitude effect in both sets of proper motions, with the brightest star deviating from the remaining objects in *Hipparcos* astrometry and the three brightest stars (FK5) deviating from the five high-quality, fainter objects. It should be noted that the small difference between the epochs 1991 and 1950, respectively, for the *Hipparcos* and ground-based results has been ignored. It would appear that the *Hipparcos* proper motions generally agree with the best available ground-based results and are not the cause of any systematic displacement of parallaxes.

3. RADIAL VELOCITY

The mean radial velocity of 45 bright Pleiades stars, $+7.6 \pm 2.3$ km s⁻¹, published by Pearce & Hill (1975) is

probably as accurate a result as can be obtained from these early-type stars with rotationally broadened spectral lines. The Stauffer et al. (1995) value of $+7.1 \pm 5.6$ km s⁻¹ for 12 red dwarfs is in agreement with more recent results by Rosvick, Mermilliod, & Mayor (1992) from CORAVEL observations for 55 F5- to K0-type cluster members, 5.6 ± 1.7 km s⁻¹. These stars are in the halo of the cluster, and Rosvick et al. find a total cluster depth of some 23 pc. This depth will, of course, contribute scatter in the proper motions, discussed above. Rosvick et al. predict a velocity gradient of some -5 km s⁻¹ across the cluster. The predicted radial velocity is $\rho_c = V_{\text{tot}} \cos \lambda = 11.3$ km s⁻¹ at the cluster center, with a spread of ± 2 km s⁻¹ caused by the cluster depth. If the cluster is a member of the association, the difference between the observed and computed velocities is understandable as being caused by the peculiar velocity of the cluster. As already discussed, the peculiar velocity from the proper motions of the α Persei cluster is twice that of the Pleiades cluster members. The observed radial velocity of the α Persei cluster agrees well with the predicted value, so it is possible that the total peculiar velocity for the two clusters is the same, leaving some 4 km s⁻¹ peculiar radial velocity that might be expected in the Pleiades. The discussion of the peculiar velocities in other complexes within the association may throw light on this matter (e.g., Eggen 1998b, 1998c). In this regard, an improved value for the convergent point (A, D) may result. Rosvick et al. (1992) find (6^h1, -48° 3) for the Pleiades from the radial velocities alone, agreeing with the present value in right ascension but with some 15° displacement in declination.

4. PHOTOMETRY

The value of the luminosity parameter d in the Geneva system is used to differentiate between the α Persei and Pleiades cluster stars (Fig. 1), but it is not as well calibrated as the $[c_1]$ parameter in the Strömgren system. Assuming that the difficulty in the filter bandpasses of the Strömgren system, alluded to above, is small for stars of approximately the same heavy-element abundance, a previous investiga-

TABLE 6
CLUSTER PARALLAXES FROM THREE PROPER-MOTION SOURCES

Source	N	μ_x, μ_δ (mas yr ⁻¹)	π (mas)	P.V. (km s ⁻¹)	Modulus (mag)
FK5.....	3	18.60, -46.3	8.81	-3.4	5.28
HIP.....	18	19.57, -44.59	8.56	-2.3	5.34
H ^a	6	20, -44	8.56	-2.3	5.34

^a Stars with high-quality motion in the catalog of Röser & Bastian 1991.

TABLE 7
HIGH-QUALITY STARS FROM RÖSER & BASTIAN

HD	μ_x, μ_δ (mas yr ⁻¹)	m.e. μ_x, μ_δ (mas yr ⁻¹)	pg (mag)	Spectral Type
22637.....	20, -46	2.5, 2.9	7.5	A0
23336.....	23, -51	2.6, 2.5	7.6	A2
23402.....	20, -39	2.2, 2.6	8.1	A0
23489.....	14, -43	1.8, 1.7	7.1	A0
24178.....	25, -43	1.8, 1.9	7.6	B9

TABLE 8
THE NEAREST ASSOCIATION MEMBERS

HR	μ_α (mas yr ⁻¹)	μ_δ (mas yr ⁻¹)	π (mas)			X (pc)	V_{tot} (km s ⁻¹)
			Cluster	<i>Hip.</i>	σ		
517	97.86	-45.12	23.56	23.16	0.81	7	26.65
857	398.11	-189.55	103.519	96.33	0.77	5	26.6
5825	-168.70	-265.69	57.13	57.09	0.72	-15	26.1
5897	-188.45	-401.92	81.79	81.24	0.62	-10	26.25
8314	231.08	-113.45	56.86	54.37	0.85	-5	26.35

HR	P.V. (km s ⁻¹)	M_V	log T_{eff}	d	$M_V - M_V(\text{Hy})$	$d - d(\text{Hy})$	HIP
857	+3.5	+6.12	3.700	0.425	-0.05	(0.0)	13402
5825	-1.8	+3.42	3.815	0.851	-0.10	0.00	46829
5897	+0.5	+2.40	3.854	1.136	-0.15	+0.01	77952
8314	+2.6	+4.71	3.773	0.604	+0.30	-0.02	107350

tion (Eggen 1986b) of the luminosity of Pleiades stars led to moduli of 5.65 ± 0.38 mag for 14 B-type members and 5.70 ± 0.19 mag for 11 A0-type members. These results are consistent with other main-sequence fitting procedures (e.g., Pinsonneault et al. 1998). The results for Strömgren photometry of A-type stars, however, such as those represented in Figure 1, have usually given a smaller modulus (e.g., Crawford & Perry 1976) near 5.40 ± 0.19 mag, or a parallax of 8.30 mas.

It should be noted that if the displacement of the Pleiades main sequence is caused by a compositional difference, the luminosity parameters d and c may be affected by that difference.

5. CONCLUSION

In summary, the mean *Hipparcos* parallaxes for the α Persei and Pleiades clusters are consistent with the cluster parallax, obtained on the assumption that they are members of the Pleiades association. However, these results place the Pleiades A-star main sequence several tenths of a magnitude below those of the α Persei and Hyades clusters.

The noncluster, supercluster members will be discussed in detail in later investigations, but a preview of the results is shown in Table 8. The five nearest, noncluster association members are listed in the table, together with the *Hipparcos* astrometry and parallax. The association parameters and the resulting parallaxes are also tabulated. The mean difference, $\pi_{\text{clus}} - \pi_{\text{Hip}} = 3\% \pm 3\%$, and the deviations from the Hyades main sequence and (log T_{eff} , d) relation are quite small. Similar results were obtained for the Sco OB2 association, as a member of the association (Eggen 1998b). It seems unlikely, therefore, that the departure of the Pleiades main sequence is the result of a unique helium abundance in that cluster. On the other hand, although the proper motions and trigonometric parallaxes of cluster stars are intimately connected, the *Hipparcos* proper motions do not show substantial differences from the best determined ground-based results. It is therefore unclear how a systematic error could be introduced into the Pleiades *Hipparcos* parallaxes alone.

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