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T Tauri Stars in Taurus-Auriga – Members of the Pleiades Supercluster?

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Abstract. We examine the possibility that a number of T Tauri stars found in the vicinity of the Taurus-Auriga star forming region are members of the Pleiades Supercluster, as indicated by the Tycho-2 proper motions of these stars. A new convergent point for the Pleiades Supercluster based on Hipparcos proper motions for the known members is determined. Assuming cluster membership, this enables us to derive accurate kinematical parallaxes for the T Tauri stars and to place them into the Hertzsprung-Russell diagram.

1. Pleiades Supercluster

The concept of the Pleiades Supercluster, encompassing the α Persei cluster, the Pleiades cluster, and a number of field stars in the solar neighbourhood, has been suggested and studied by Eggen (1992; 1995). The age range of the member stars is quite large, including a few times 10^6 year-old pre-main sequence stars, the Pleiades with an age of about 10^8 years as well as a few times 10^8 year-old zero-age main sequence stars.

The reality of superclusters has been confirmed by the analysis of the phase-space density of A and F type stars in Hipparcos (Chen et al. 1997; Chereul et al. 1998). The velocity dispersion found by Chereul et al. (1998) for the Pleiades Supercluster is 5–7 km/s, although at smaller scales the supercluster decomposes into two separate streams with smaller velocity dispersions (2.2 and 3.0 km/s) and different ages (roughly 10^7 and 10^9 years, respectively). Whether these streams are somehow physically related to each other (e.g. Weidemann 1992) or not is currently under debate; Chereul et al. (1998) note the high probability of chance coincidences in the probed phase space.

2. Kinematics

Optical follow-up spectroscopy of ROSAT X-ray sources in and around the Taurus-Auriga association has revealed a number of new pre-main sequence and zero-age main sequence stars (Wichmann et al. 1996, Neuhäuser et al. 1997). Seven of these as well as three T Tauri stars known before ROSAT have Tycho-2 proper motions which are more typical for the Pleiades than for the Taurus-Auriga association. In a previous paper (Frink et al. 1997) we investigated the

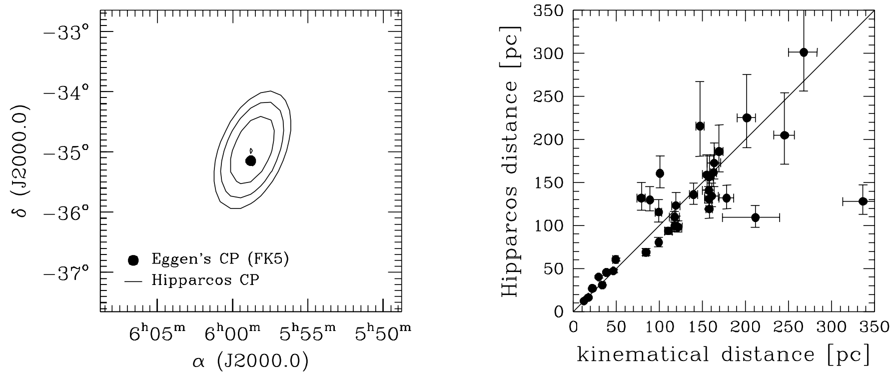


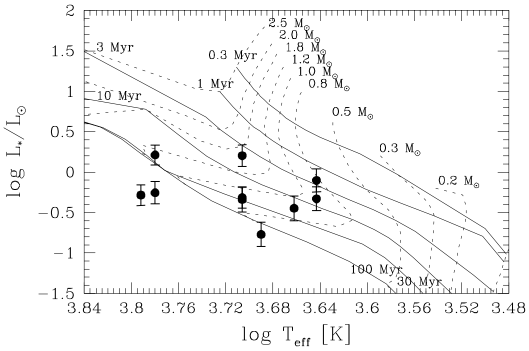
Figure 1. Left panel: Comparison of the convergent point determined by Eggen (1992) using FK5 proper motions and of the new convergent point based on Hipparcos proper motions (the outermost contours represent 1, 2 and 3 sigma errors). Right panel: Comparison of the derived cluster parallaxes with the Hipparcos parallaxes for 36 know Pleiades Supercluster members.

possibility that these stars have been ejected from the Pleiades cluster in the direction of Taurus-Auriga. Here we discuss the alternative scenario of Pleiades Supercluster membership, which has been mentioned already by Martín & Magazzù 1999) and would be more consistent with the very young age for at least some of the stars. Note also that Oppenheimer et al. (1997) have identified two very young M dwarfs which also could be part of the Pleiades Supercluster, given their ages, proper motions and radial velocities.

We compare the convergent point calculated by Eggen (1992), based on FK5 proper motions, to our new convergent point determined on the basis of Hipparcos proper motions for the same set of 36 bright stars as used by Eggen (Fig. 1, left panel). The convergent points agree extremely well, presumably because the convergent point determination for superclusters is facilitated by the huge spatial extent of the member stars on the sky. This allows for the derivation of very precise cluster parallaxes (Fig. 1, right panel). With only one or two exceptions, the 'kinematical parallaxes' derived via the convergent point method agree very well with the Hipparcos parallaxes, especially for the nearby stars. For the more distant stars, cluster parallaxes are much more precise than the Hipparcos parallaxes. We conclude that the method works rather well, which enables us to derive cluster parallaxes for the new pre-main sequence members for which Hipparcos parallaxes are not available.

The new possible Pleiades Supercluster member stars were placed into the Hertzsprung-Russell diagram (Fig. 2). As expected, they span the whole age range from the pre-main sequence to the zero-age main sequence. The distances and ages for both components of the visual binary SAO 76411 agree well with each other. Two stars however fall below the main sequence, either because only Tycho B_T and V_T colours are available for them or because they are spectroscopic binaries, which could make their distances wrong.

For those stars with measured radial velocities we can also calculate the corrsponding space velocities. They are rather well defined, with dispersions



NTTS 032641+2420	K1	$118.3^{+7.1}_{-6.3}$ pc
NTTS 034903+2431	K5	$100.9^{+5.4}_{-4.9}$ pc
SAO 76411 A	G0	$75.1^{+2.7}_{-2.5}$ pc
SAO 76411 B	K1	$74.1^{+3.0}_{-2.8}$ pc
RXJ 0407.9+1750	K4	$93.2^{+5.4}_{-4.8}$ pc
RXJ 0409.2+2901	K1	$153.5^{+8.9}_{-7.9}$ pc
HD 285579	G0/G1	$122.4^{+6.9}_{-6.2}$ pc
RXJ 0439.4+3332A	K5	$119.6^{+7.0}_{-6.3}$ pc
HD 287017	F8/F9	$52.6^{+2.9}_{-2.6}$ pc
RXJ 0448.0+0738	K1e/K3	$71.6^{+5.1}_{-4.4}$ pc

Figure 2. Hertzsprung-Russell diagram for the new possible Pleiades Supercluster member stars, based on distances derived via the convergent point method and I or J photometry, where available. Otherwise we use the Tycho B_T and V_T colours.

around the mean of only 1.8 km/s, 2.5 km/s and 2.8 km/s in the U-, V- and W-directions, respectively. The extension of the supercluster is largest in the X-direction, spanning almost 400 pc.

3. Conclusions

The convergent point of the Pleiades Supercluster is very well defined and yields precise cluster parallaxes for member stars. Ten pre-main sequence and zero-age main sequence stars in the general direction of the Taurus-Auriga association have Tycho-2 proper motions consistent with Pleiades Supercluster membership. Ages and masses derived for them via comparison with appropriate tracks in the Hertzsprung Russell diagram are consistent with the spectroscopic classifications. Finding more Pleiades Supercluster member stars could help to unravel the origin of this structure as well as enhance our understanding of star formation.

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