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

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Pleiades Supercluster

- existence of Pleiades Supercluster suggested by Eggen (1992, 1995)
- members: α Persei cluster, Pleiades cluster, a number of field stars in the solar neighbourhood
- age range quite large: from a few times 10^6 years old pre-main sequence stars over the Pleiades with an age of about 10^8 years up to a few times 10^8 years old zero-age main sequence stars
- existence of superclusters confirmed by analysis of the phase-space density of A and F type stars in Hipparcos (Chen et al. 1997, Chereul et al. 1998)
- velocity dispersion found by Chereul et al. (1998): 5–7 km/s at smaller scales however 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

Convergent Point

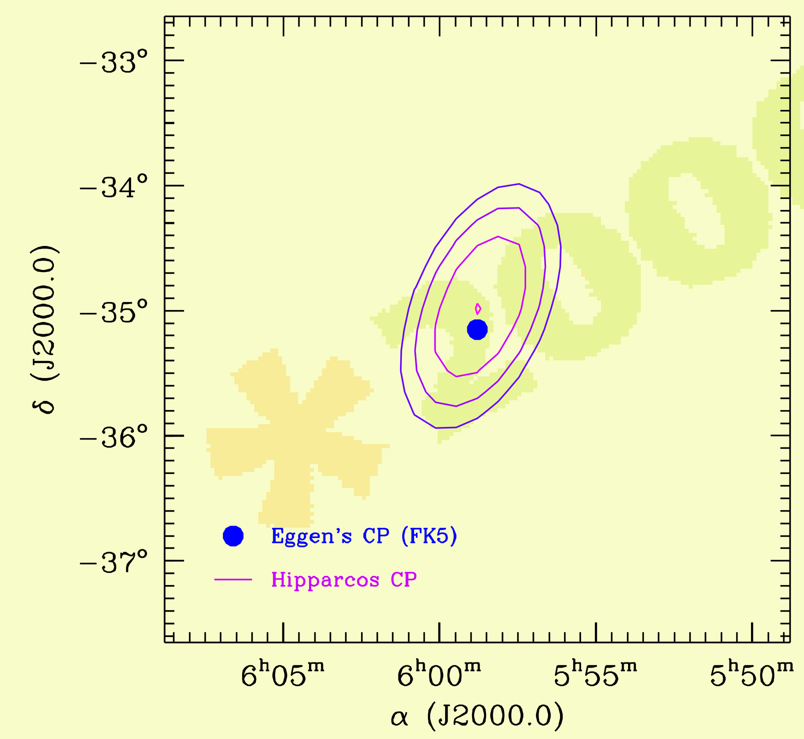

Fig. 1: Comparison of the convergent point by Eggen (1992), based on FK5 proper motions (big blue dot), and our convergent point determination based on Hipparcos proper motions for the same set of 36 bright stars (the outermost contours represent 1, 2 and 3 sigma errors). They agree extremely well with each other, 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 (see Fig. 2).

Sample

- optical follow-up spectroscopy of ROSAT X-ray sources in and around the Taurus-Auriga association revealed a number of new pre-main sequence and zero-age main sequence stars (Wichmann et al. 1996, Neuhäuser et al. 1997)
- 7 of these as well as 3 T Tauri stars known before ROSAT have Tycho-2 proper motions which are more typical for the Pleiades than for the Tau-Aur association
- in a previous paper (Frink et al. 1997) we investigated the possibility that these stars have been ejected from the Pleiades cluster in the direction of Tau-Aur
- here we discuss the alternative scenario of Pleiades Supercluster membership (mentioned already by Marín & Magazzù 1999), which 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 2 very young M dwarfs which also could be part of the Pleiades Supercluster (based on age, proper motion and radial velocities)

Distances

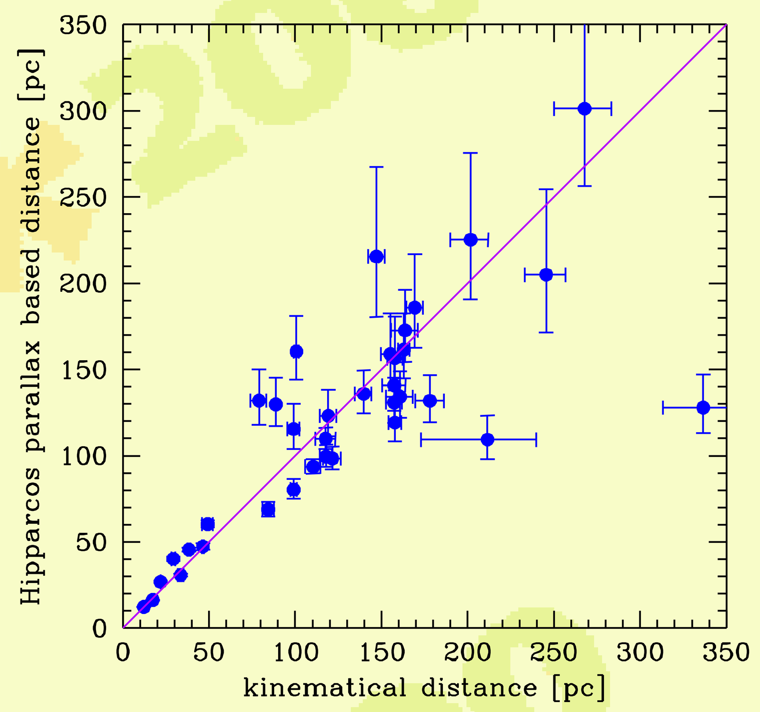

Fig. 2: With only 1 or 2 exceptions, the 'kinematical distances' derived via the convergent point method agree very well with the Hipparcos distances, especially for the nearby stars. For the more distant stars, cluster parallaxes are much more precise than the Hipparcos parallaxes. We conclude that the method works rather well, which enables us now to derive cluster parallaxes for the new pre-main sequence members for which Hipparcos parallaxes are not available.

Summary

- we demonstrated that the convergent point of the Pleiades Supercluster is very well defined
- this allows for the determination of very precise cluster parallaxes
- 10 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
- cluster parallaxes allow for the derivation of ages and masses by comparison with appropriate tracks in the Hertzsprung Russell diagram
- except for 2 stars (for which only Tycho photometry is available) 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

HR Diagram

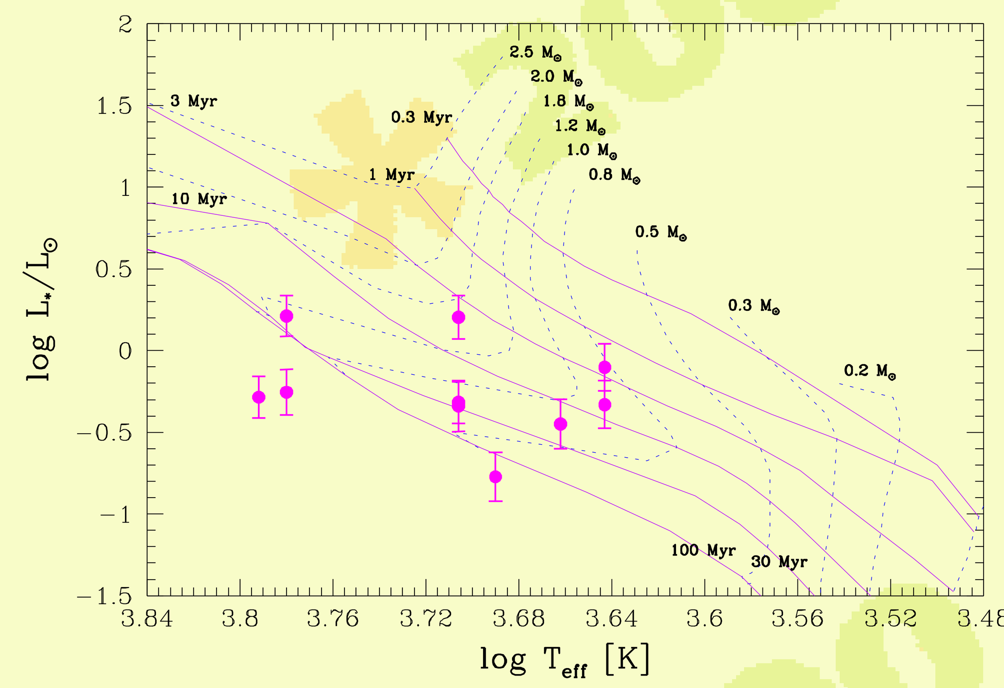

Fig. 5: Hertzsprung-Russell diagram for the new Pleiades Supercluster member stars. As expected, they span the whole age range from the pre-main sequence to the zero-age main sequence. The ages for both components of the visual binary SAO 76411 agree with each other (the two stars closest to the main sequence). 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. Pre-main sequence tracks are from D'Antona & Mazzitelli (1994).

Position and Velocity Distribution

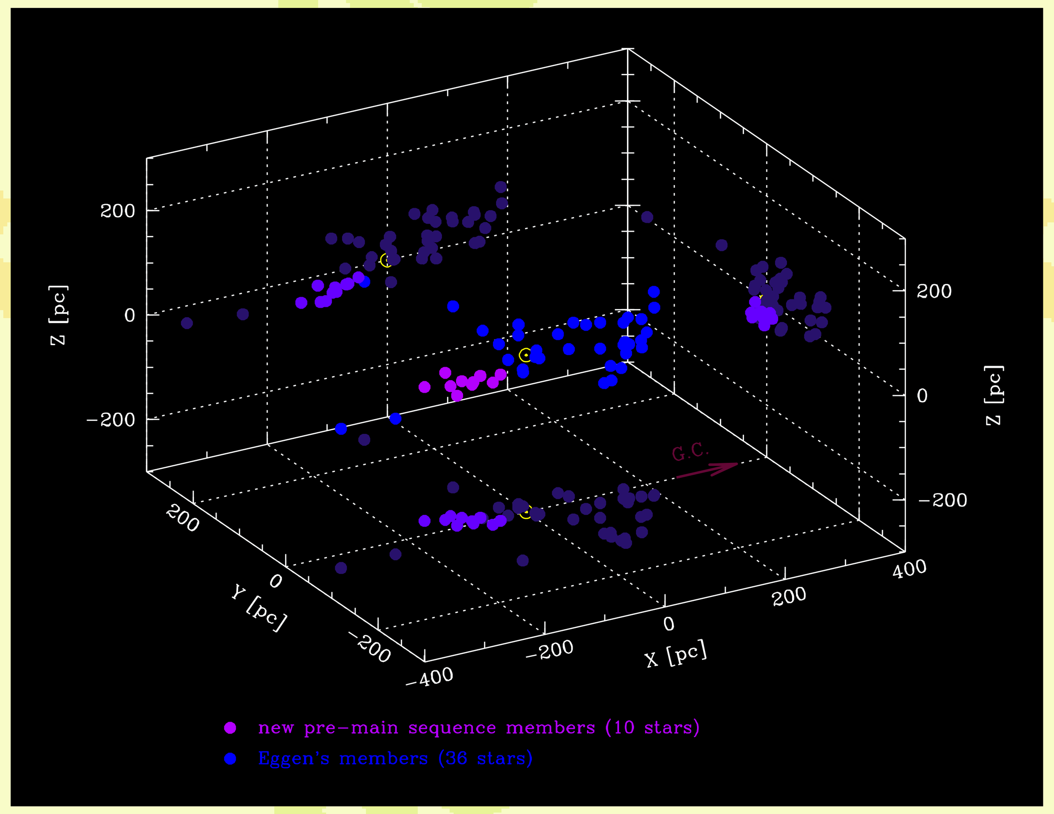

Fig. 3: Positions of the new pre-main sequence members as compared to the early-type members discussed by Eggen. As usual, X points in the direction of the galactic center, Y in the direction of galactic rotation and Z to the northern galactic pole. Obviously, the extension of the Pleiades Supercluster is largest in the X direction, spanning almost 400 pc.

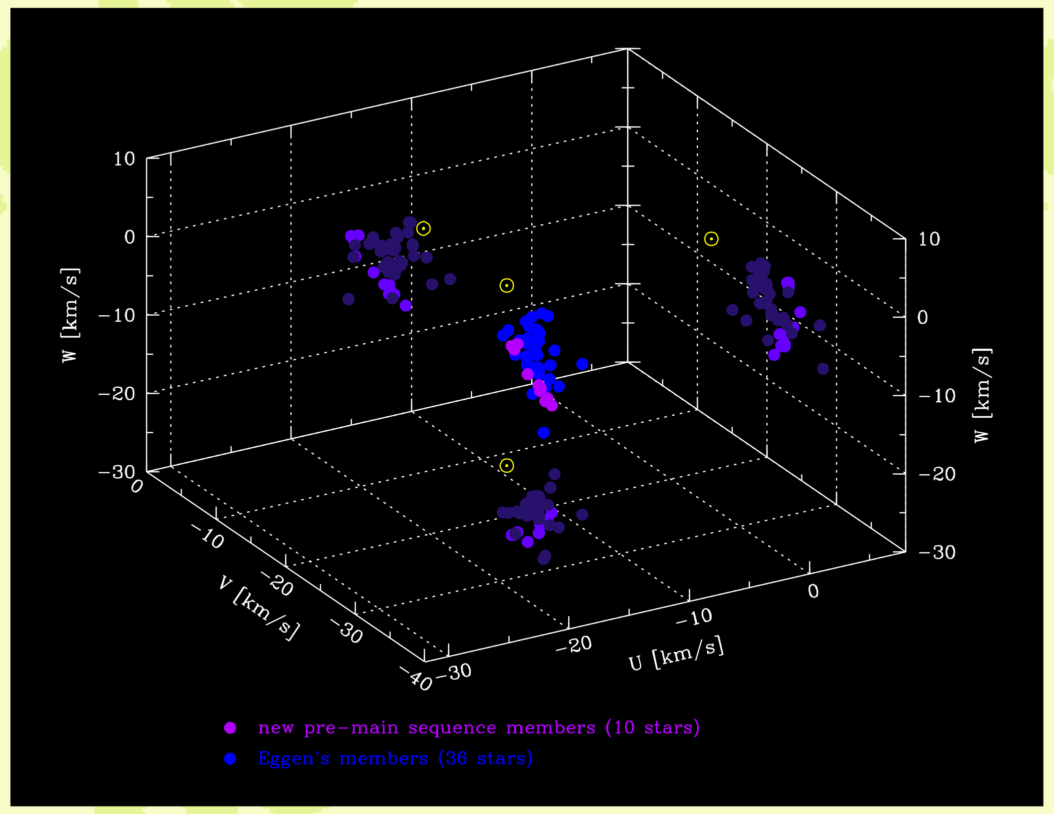

Fig. 4: Corresponding space velocities for the same stars as in Fig. 3. The space velocity of the supercluster is very well defined, with velocity dispersions of only 1.8 km/s, 2.5 km/s and 2.8 km/s in the U-, V- and W directions, respectively. The velocity of the Sun is indicated for comparison.

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