New Southern Groups

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Abstract. Since the eighties we have begun, in Brazil, a search for Post-T Tauri stars. Here we describe the main steps of this research that resulted in the discovery of the nearby TW Hya and Horologium associations. A very recent survey resulted in the detection of three different kinematical groups: 1) the Great Austral Young Association, which is a very extended complex region involving the Horologium and Tucana associations, 2) a CrA extend association and 3) a new group in Pisces.

1. Introduction

Post-T Tauri stars (PTTS) are young low mass stars which are in an evolutionary stage between T Tauri stars (TTS) inserted in their forming clouds with ages less than 10 Myrs and young active main sequence (MS) stars with ages near 100 Myrs as the Pleiades stars (see also Jensen in this volume). Our definition of PTTS also includes an ensemble of stellar properties, that evolve during that period of time. These properties keep, in general, characteristic values between those found in TTS and those of active main sequence stars. These are: X-ray emission, Lithium abundance, weak absorption or emission $H\alpha$ lines and relative high stellar rotation. Together with this definition, we add a supplementary constraint used also as an strategy to discover these PTTS, and is that they belong to a moving group with similar spatial velocities. One consequence, for instance, of this evolutive definition of PTTS, considering also the group concept, is that the evolution of the stellar disks can be studied. We can see that very few PTTS exist such as TW Hya, Hen 600A and V4046 Sgr still having their dusty disks, probably in their last stages of life. The large majority of the PTTS if they have not lost their accreting disks, they have probably transformed them into rocky disks, preparing the formation of the first planets.

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Our search for PTTS started in the early eighties by studying TTS isolated from clouds. The favorite targets were at that time V4046 Sgr (HD 319139), AS216, AS218, FKSer and AB Dor (Quast et al. 1987). We learned later that a similar list of stars including TW Hya had already been proposed by Herbig (1978) as being good candidates for PTTS. Our systematic observations of V4046 Sgr over the period of several years enabled us to detect this star as the first Classical TTS being a double line spectroscopic binary (de la Reza et al. 1986, Quast 1998, Quast et al. 2000). The explanation of the isolated status of V4046 Sgr has been a problem since. It is only now that we are probably finding a solution by considering this star to be a member of the CrA extended association (see Quast et al. in this volume).

At the end of the eighties we began a survey to detect new isolated TTS based on IRAS sources properties. This survey called “the Pico dos Dias Survey” (PDS) covered all the southern sky up to DEC < +30 deg. As a test for the methodology to be used in the PDS, we decided to search around TW Hya. This initial operation was a success because the first members of the future TW Hya association (TWA) were discovered. That was the case of Hen 600AB and CoD-2988879 (de la Reza et al. 1989). Already during the PDS, two more members were added to this group, these were HD 98800 and CoD-337795 (Gregorio-Hetem et al. 1992). Later, the knowledge of Hipparcos parallaxes gave to TWA its nearby association status (Kastner et al. 1997).

During the PDS, we detected a number of other interesting astrophysical objects, but no more isolated groups of PTTS. The reason became clear only later; examples of Classical isolated TTS as TW Hya, Hen 600 A, HD 98800 and V4046 Sgr, contained in these stellar associations, are very rare due to the rapid evolution of their dusty disk stages, marking probably their end.

2. The New Southern Hemisphere Survey

It became clear that a much more efficient way to detect new PTTS consists in using X-ray sources. Because of their relatively high velocity rotation, PTTS result in efficient X-ray emitters. This turn to be evident when ROSAT X-ray measurements were used to detect additional members of TWA (Jensen et al. 1998, Webb et al. 1999, Sterzik et al. 1999, Jayawardhana et al. 1999 and Zuckerman et al. 2001). Later, at the end of the nineties, we began a new PTTS survey using this time RASS X-ray sources instead of IRAS ones. However, we operate with the same methodology as used in the discovery of TWA, that is, searching around a pre-selected candidate field PTTS. In this way, searching around PDS1 (Hen1) we discovered the nearby Horologium association (Torres et al. 2000). At the same time, independently and using a different approach based essentially on Hipparcos measurements, Zuckerman & Webb (2000) discovered another association in Tucana (TucA) having similar properties of age 30 – 40 Myrs and distance about 60 pc as HorA. It is not only because of these similarities, but also, to the fact that both associations are very close in the sky, that leave us to suppose, not only that both associations could be the same, but also that an even a larger association involving HorA and TucA could exist. A very large exploration area in the sky, going in the direction of the South Pole was then made. We explored also a new control area at high galactic latitudes
around the star BP Psc. We call this new observational campaign a Survey for Associations Containing Young stars (SACY).

3. Observations

In the SACY we selected and observed all bright RASS sources that could be associated with TYCHO-2 or HIPPARCOS stars later than G0. Until now we examined the area:

\begin{align*}
17:00 < \alpha < 09:00 & \quad \text{and} \quad \delta < -45^\circ \\
17:25 < \alpha < 20:00 & \quad \text{and} \quad -45^\circ < \delta < -23^\circ \\
00:00 < \alpha < 06:00 & \quad \text{and} \quad -45^\circ < \delta < -40^\circ \\
09:00 < \alpha < 14:10 & \quad \text{and} \quad \delta < -75^\circ
\end{align*}

This area engulfs the previous southern control region in Torres et al. (2000). The new control area around the possible CTT BP Psc was:

\begin{align*}
22:40 < \alpha < 01:00 & \quad \text{and} \quad -12^\circ < \delta < +08^\circ
\end{align*}

In all this area, which represent about 30% of the Southern Hemisphere, more than 400 stars were observed. We obtained high resolution spectra for the selected candidates, with the FEROS echelle spectrograph (Kaufer et al. 1999) (resolution of 50000; spectral coverage of 5000 Å) of the 1.52 m ESO telescope at La Silla or with the coudé spectrograph (resolution of 9000; spectral coverage of 450 Å, centered at 6500 Å) of the 1.60 m telescope of the Observatório do Pico dos Dias. For some stars we obtained radial velocities with the CORALIE at the Swiss Euler Telescope at ESO (Queloz et al. 2000).

The FEROS spectra enabled us to obtain good measurements of key lines for this type of research as: Li, Hα, Ca II and Na D and to obtain reliable radial and rotational velocities.

4. New Groups

The results of the SACY are very encouraging because three groups of PTTS with relatively well determined kinematical properties were found. The first one, and what we called the Great Austral Young Association (GAYA), is a very extended area containing the HorA and TucA groups. GAYA has nearly 44 stars with apparently very few binaries. The representative (U, V, W) space velocities for GAYA are: \((U= -9.8 \pm 1.2, \ V = -21.7 \pm 1.1, \ W = -2.0 \pm 2.2)\).

Here, U, V and W in km/s, are positively measured in the directions of the Galactic Center, Galactic Rotation and North Galactic Pole respectively. GAYA is estimated to have a size of about 60 pc, about half the members of which are at the distance of about 50 pc and to be about 30 Myr old (see Torres et al. in this volume).

A second group, independent of GAYA, was found. This one corresponds to the CrA extended region. The following are their representative (U, V, W) space velocities \((U= -3.8 \pm 1.2, \ V = -14.3 \pm 1.7, \ W = -8.3 \pm 2.0)\) (see Quast et al. in this volume).

The results obtained for the third group around BP Psc were very surprising. This is because the very few (four “probable” single stars and one “possible” binary star) Li rich objects belong to the same moving group with the
following \((U, V, W)\) space velocities, obtained from the four “probable” stars: 
\[
(U = -6.6 \pm 0.5, \quad V = -0.6 \pm 0.3, \quad W = -13.7 \pm 2.5),
\]
which are very different from the values of the two above mentioned groups.

Unfortunately, no Hipparcos distances are known for any of these Li rich objects. Nevertheless, a minimum distance of about 75 pc can be inferred, on the one hand because two of the Li-rich objects have their spectra contaminated with interstellar Na D lines and on the other hand, from the fact that five Li-poor nearby projected stars having Hipparcos distances do not present this contamination. Assuming that these stars with spectral types between G2 and K0 are on the MS, we can obtain a reasonable distance of about 100 pc. In any case, independently of distances between 75 and 125 pc, the group maintains almost the same U and V velocities. Other important properties for considering this group as an association are the following: All these stars have the same Li abundance of \(\log(e)(Li) = 3.2\) (where \(\log(e)(H) = 12.00\)) and the same X-ray ratio \((\log F_x / \log F_b) = -3.3\) (probably saturated). Also, rotational \(v_s\) values are between 15 and 53 km/s, typical for PTTS, and visual magnitudes are the same. Due to the absence of later type stars we are unable for the moment to indicate an age for this association, which we call “Pisces association” because all of its members are in this constellation. These stars are localized in the southern part of the known complex of translucid molecular clouds MBM53 and MBM55. However, we do not consider that there is any parental relation with this cloud. A detailed presentation of this association can be found in de la Reza et al. (2001).

5. Conclusions

Some results of the recent survey based on high-resolution spectra Tycho-2 optical counterparts of X-ray RAAS sources in the Southern Hemisphere consist in the detection of three independent moving groups of PTTS, very probably placed at distances between 50 and 100 pc. Their kinematical properties can maybe be understood if we place them into a general distribution of space velocities in the solar neighborhood. If we consider for instance, the general distribution of U and V velocities of nearby stars (less than 100 pc) obtained by Skuljan et al. (1999), we see that stars are mainly concentrated in three branches called the “Pleiades”, “Middle” and “Sirius” containing classical moving groups of different ages. The GAYA falls in the Pleiades branch and has similar, but not equal, space velocities to the Local Association (Pleiades supercluster) being then a fine structure of this supercluster. The same happens with TWA (Montes, 1999). The extended CrA does not belong to the Local Association and its velocities tend more to belong to the Middle branch. The Pisces association falls precisely in the Middle branch. One future possibility to understand the origin of these associations could be to investigate the global effect (spiral arms?) that produce these branches following the suggestion of Skuljan et al. (1999).

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