SACY - Present Status

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Abstract.
The scientific goal of the SACY (Search for Associations Containing Young-stars) project is to identify eventual associations of stars younger than the Local Association, spread among the optical counterparts of the ROSAT X-ray bright sources. High-resolution spectra for possible optical counterpart later than G0 belonging to HIPPARCOS and/or TYCHO-2 catalogues were obtained in order to assess both the youth and the spatial motion of each target. The newly identified young stars present a patchy distribution in UVW space and in the sky as well revealing the existence of huge nearby young associations. Here we present the associations identified in the present sample.

1. Introduction

The detection of X-ray sources by the ROSAT All-Sky Survey (RASS) associated with TTS outside star formation regions (Neuhäuser 1997) gave a tool to find new young associations. In fact, Torres et al. (2000), and Zuckerman & Webb (2000), using these sources, found evidences for two young associations near the South Celestial Pole, the Horologium (HorA) and the Tucana (TucA) Associations. To examine the possibility that these associations are the same and to search for other ones we undertook a Search for Associations Containing Young-stars (SACY) (de la Reza et al. 2001; Torres et al. 2001; Quast et al. 2001). In the SACY we selected and observed all bright RASS sources that could be associated with TYCHO-2 or HIPPARCOS stars with (B-V) > 0.6, excluding very well known RS CVn, W UMa, giants, etc in SIMBAD.

1Based on observations made under the Observatório Nacional-ESO agreement for the joint operation of the 1.52 m ESO telescope and at the Observatório do Pico dos Dias, operated by MCT/Laboratório Nacional de Astrofísica, Brazil
We obtained high resolution spectra for the selected candidates with 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 CORALIE at the Swiss Euler Telescope at ESO (Queloz et al. 2000).

From the collected spectra we have obtained spectral classifications, radial velocities and equivalent widths of Li I lines. In particular, the Li I line is important since it can provide a first age estimate (Jeffries 1995) for late type stars allowing us to select possible Post-T Tauri stars. For a given star, if its Li I resonance line equivalent width is located near or above the Li I line delimited by the members of the Local Associations clusters (Neuhäuser 1997), it is flagged as young star.

2. Results

There are 9574 ROSAT bright sources in the Southern Hemisphere, 2071 of them with $B-V > 0.6$ in TYCHO-2. Until the La Serena meeting (2002, March) we observed 687 stars, and for 170 more stars we got relevant data from the literature. From all these stars, 283 fulfill our definition for a young star (239 from our spectroscopic observations).

As most of these young stars have no HIPPARCOS parallaxes, we applied the following kinematical analysis to find possible associations: Each point in UVW velocity space is taken as a convergence point and we calculated for it the parallaxes of all stars such as to minimize the moduli of the space velocity vectors relative to this point (but, of course, preserving the parallaxes of HIPPARCOS stars). Then we calculated the density of stars in the velocity space around each point of a grid in UVW. Around some points there are density concentrations much larger than the background fluctuation, revealing possible associations. All the main concentrations are also constricted in space, but some of them cover large areas in the sky.

3. The Young Associations

In Tables 1 & 2 we present the properties of the eight young associations we found until now. For those that engulf previously known ones, we use bonafide members (not observed in the SACY) to help in their definition. The quantity of bonafide members used are indicated as the last number in Table 1. In Table 2 we indicate the distance ($\rho_{\text{max}}$) of the farthest member to the calculated center of the association, giving an idea of its size. It should be noted that the method gives no unique solution for some stars, but in almost all cases there is an obvious better membership. As there are important areas not covered until now by the SACY, and specially the Sco-Cen Association region, these identifications are preliminary.

The young association found up to now are the following:
Figure 1. **Top.** Celestial polar projection of the stars observed in SACY. Stars classified as young according to their Li I equivalent width are plotted as filled circles. More evolved stars are indicated as crosses. **Bottom left.** Li I equivalent width as a function of the effective temperature for the members of GAYA (filled circles), TWA (open circles) and YSSA (crosses). The continuous line indicates the upper limit of the Li I equivalent width observed in the members of the Local Association clusters. **Bottom right.** The same as bottom left for $\epsilon$ Cha (filled circles), $\beta$ Pic (open circles), OctA (crosses) and AnA (open triangles).
Table 1. Space motions and parallaxes of SACY’s Young Associations

| Name   | U   | σ | V   | σ | W   | σ | π   | σ | N* |
|--------|-----|---|-----|---|-----|---|-----|---|----|
| GAYA1  | -9.8| 0.9| -21.7| 1.0| -0.9| 0.9| 16.3| 2.2| 31 |
| GAYA2  | -10.9| 0.9| -22.4| 0.8| -4.7| 1.1| 11.8| 4.4| 36 |
| TWA    | -10.8| 1.2| -17.7| 1.1| -5.6| 1.2| 21.2| 8.3| 5+5|
| YSSA   | -3.7| 1.4| -13.5| 1.1| -8.2| 1.3| 8.5 | 1.9| 20+8|
| ε ChaA | -7.9| 0.5| -18.9| 0.6| -7.7| 1.0| 11.4| 0.6| 8+2|
| β PicA | -9.3| 1.3| -16.1| 0.8| -8.8| 0.9| 29.9| 24.5| 11+2|
| OctA   | -9.9| 0.5| -1.6 | 0.6| -7.3| 0.4| 9.7 | 1.3| 6  |
| AnA    | -8.5| 0.7| -28.7| 0.6| -10.1| 1.1| 11.6| 7.9| 9  |

Table 2. Positions relative to the Sun

| Name   | X   | σ | Y   | σ | Z   | σ | ρmax | N* |
|--------|-----|---|-----|---|-----|---|------|----|
| GAYA1  | 18  | 22| -57 | 41| -30 | 10| 88   | 31 |
| GAYA2  | 8   | 25| -77 | 34| -38 | 24| 88   | 36 |
| TWA    | 14  | 13| -49 | 24| 21  | 7 | 50   | 10 |
| YSSA   | 118 | 22| -67 | 7 | -50 | 4 | 52   | 13 |
| ε ChaA | 44  | 4 | -74 | 6 | -16 | 6 | 14   | 10 |
| β PicA | 37  | 32| -9  | 16| -15 | 6 | 52   | 13 |
| OctA   | 59  | 25| -67 | 7 | -50 | 4 | 42   | 6  |
| AnA    | 74  | 68| -46 | 46| -32 | 36| 130  | 9  |

a) GAYA - The Great Austral Young Association (Torres et al. 2001) seems to split into two parts, although it is not clear if both are actually distinct associations or if this split was created by some bias or by our method. Their separation is mainly in W velocity and in distance. The previous HorA and TucA are within GAYA. Some of the proposed members of TucA are outside of the velocities definition (mainly the eastern ones). Until now both GAYAs seem deficient in binaries. There is a proposed SB2 member for GAYA2 but a radial velocity search on 28 members (more than a third of the members) has given no other SBs. The western proposed members are near the present survey limit.

b) TWA - Until now we have found no new members. Of the known ones only five fulfill the SACY criteria. Our kinematical solutions put some stars farther away. TWA12 and TWA19 would be at about 100pc.

c) YSSA - There is a group of young stars, spread from ρ Oph to R Cra, with very similar properties, that we are now calling the Young Sco-Sgr Association. As we have no data yet for the Upper Sco subgroup we cannot be sure if YSSA belongs or not to it. The eastern border of YSSA is at one of the present limits of SACY. The western border engulfs the stars mentioned in Quast et al. (2001) and Neuhäuser et al. (2000). Note the very well defined distance, near the assumed for the R CrA clouds.

d) ε ChaA - This association is defined by Mamajek, Lawson & Feigelson (2000). We propose new members, enlarging it. The well defined distance found by us indicates it is in front of the Cha complex. As in YSSA, the northern
border being in the Sacy’s limits, we can not be sure if this group is not a part of Lower Cen-Crux subgroup.

e) \( \beta \) PicA - As described by Zuckerman et al.(2001) this association is very close to the Sun, containing members with distances between 10 and 50 pc. We proposed new members, someones at larger distances, among them V4046 Sgr, a notorious object, classified before as an isolated SB Classical T Tauri star.

f) OctA - Is a very homogeneous small group of almost aligned stars (all young G stars) near the South Celestial Pole. As this region belongs to a completely surveyed area of the SACY, new members have too be found by other means.

g) AnA - Another small group, very concentrated in velocity but spread out in space. Having only two stars with measured parallaxes, it should be viewed with caution.

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References

de la Reza, J. R., da Silva, L., Jilinski, E., Torres, C. A. O., Quast, G. R. 2001, in ASP Conf. Ser. Vol. 244, Young stars near earth: progress and prospects, ed. R. Jayawardhana & T. P. Greene (San Francisco: ASP), 37
Jeffries, R. D. 1995, MNRAS, 273, 559
Kaufer, A., Stahl, S., Tubbesing, S., Norregaard, P., Avila, G., Francois, P., Pasquini, L., & Pizzella, A. 1999, Messenger, 95, 8
Mamajek, E. E., Lawson, W. A., & Feigelson, E. D. 2000, ApJ, 544, 356
Neuhäuser, R. 1997, Science, 276, 1363
Neuhäuser, R., Walter, F. M., Covino, E., Alcalá, J. M., Wolk, S. J., Frink, S., Guillout, P., Sterzik, M. F., Comerón, F. 2000, A&AS, 146, 323
Quast, G. R., Torres, C. A. O., de la Reza, J. R., da Silva, L., Drake, N. 2001, in ASP Conf. Ser. Vol. 244, Young stars near earth: progress and prospects, ed. R. Jayawardhana & T. P. Greene (San Francisco: ASP), 49
Queloz, D., Mayor, M., Naef, D., Santos, N., Udry, S., Burnet, M., Confino, B. 2000, in VLT Opening Symposium ¿From Extrasolar Planets to Brown Dwarfs, ESO Astrophys. Symp., Springer Verlag, Heidelberg, 548
Torres, C. A. O., da Silva, L., Quast, G., de la Reza, R., & Jilinski, E. 2000, AJ, 120, 1410
Torres, C. A. O., Quast, G. R., de la Reza, J. R., da Silva, L., Melo, C. H. F. 2001, in ASP Conf. Ser. Vol. 244, Young stars near earth: progress and prospects, ed. R. Jayawardhana & T. P. Greene (San Francisco: ASP), 43
Zuckerman, B., Sing, I., Bessell, M. S., & Webb, R. A 2001, ApJ, 562, L87
Zuckerman, B., & Webb, R. A. 2000, ApJ, 535, 959