Peculiar high proper motion objects in Tycho-2 and 2MASS catalogues

F. Jiménez Esteban (SVO - CAB)
J. A. Caballero (CAB)
E. Solano (SVO - CAB)

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Scientific Rationale

Bright objects with peculiar colors and high proper motions are rare.

- Objects with blue colors ⇒ high T_{eff}
- Objects with red colors ⇒ low T_{eff}
- High μ ⇒ close heliocentric distances

The closer/brighter the easier to investigate their physical properties

The data

Tycho-2 Catalogue:

- Optical B_T and V_T
- Proper motion
- 2.5 millions objects

2MASS Catalogue:

- NIR J, H and K_s
- 470 millions objects

Cross-match the full sky (41,253 square degrees)

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A perfect case for the Virtual Observatory

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F. Jiménez-Esteban - Spanish Virtual Observatory - fran@cab.inta-csic.es

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5. TopCat to analyse the huge data set
6. VO-tools to study the ***peculiar high proper motion*** candidates

Aladin: Cross-matching catalogues

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5. Cross-match Tycho-2MASS
   - Select all 2MASS sources closer than 40''
   - Transform 2MASS coordinates to Tycho2 epoch using proper motion
   - Select the closest 2MASS source

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We cross-matched the full sky in only 3 weeks

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TopCat: analyzing results

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2. Apply good detection criteria ⇒ 157,184 sources
   - 2MASS Qflg=A,B,C,D in K_s
   - $V_T \neq 0$ and error < 0.3 mag

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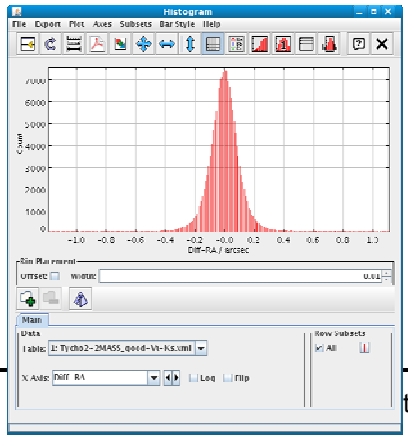
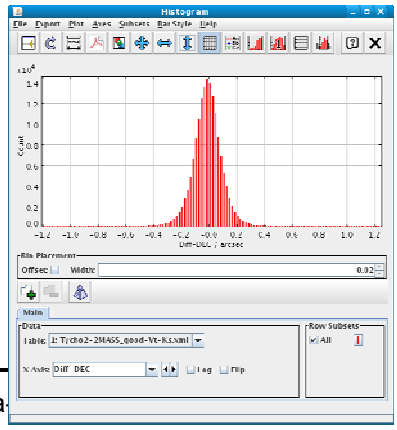
3. Histograms of the angular separation





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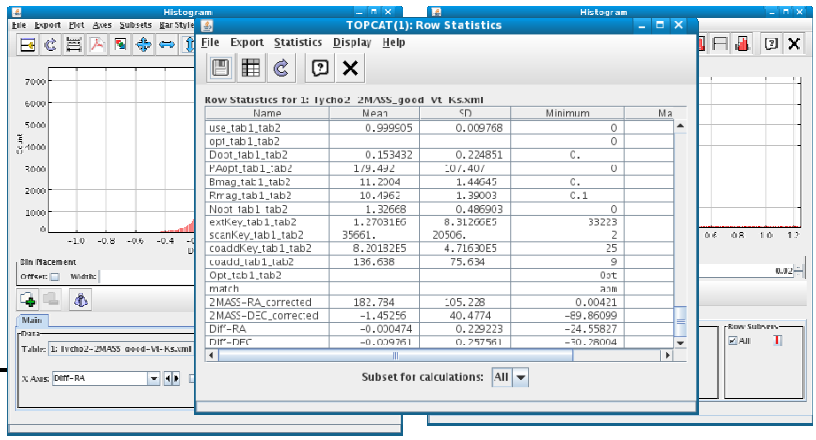
   - $\sigma\rho_{\alpha}$ < 0.69 mas

   - $\sigma\rho_{\delta}$ < 0.78 mas



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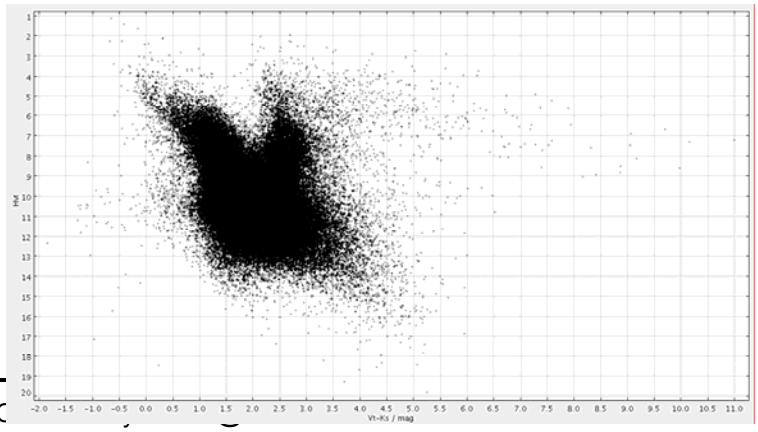
4. Plots: rpm diagram
   H_V vs. $V_T - K_s$

   $H_V = V_T + 5 \log(\mu) + 5$



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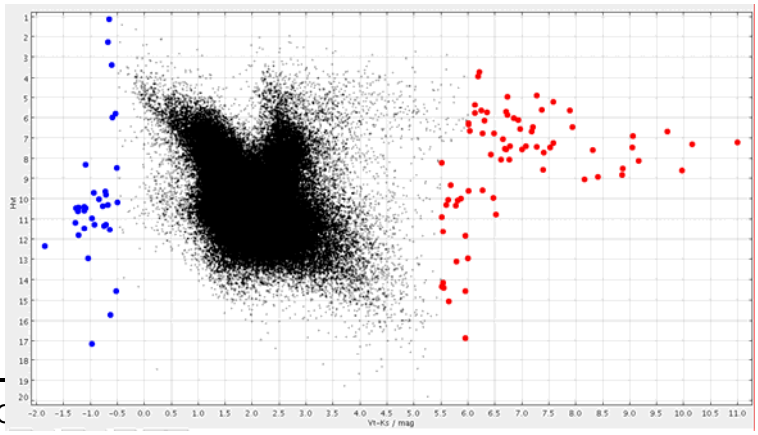
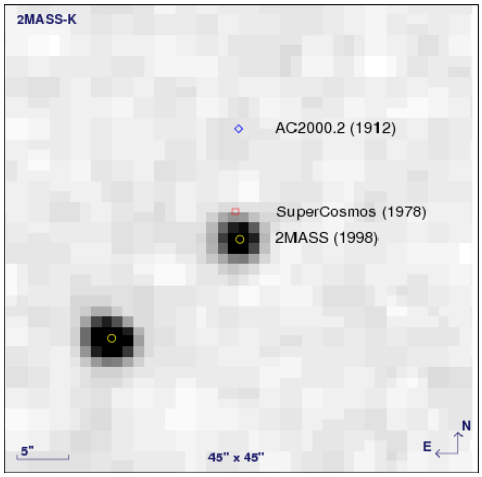
5. Colour selection criteria
   - 33 Blue
     $V_T - K_s < -0.5$
   - 73 Red
     $V_T - K_s > 6.0$
     or $5.5 < V_T - K_s < 6.0$ & $H_v > 8.0$



Aladin: Confirmation of candidates

1. Visualize inspection using optical (DSS-1) and infrared (2MASS) images separated several decades in time



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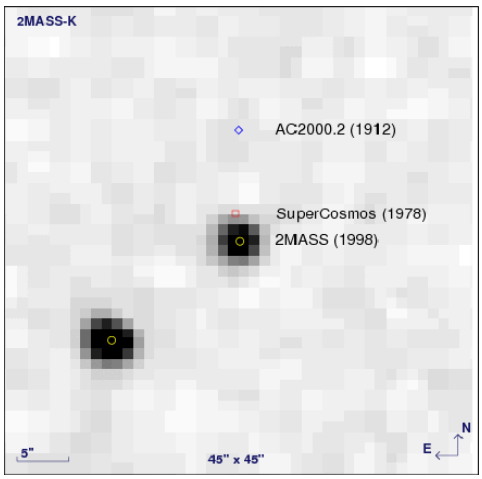
2. Superimpose astro-photometric data
   - Tycho-2
   - 2MASS
   - Astrographic Calalogue AC2000.2
   - USNO-B1
   - SuperCosmos Sky Survey
   - DENIS
   - PPMX



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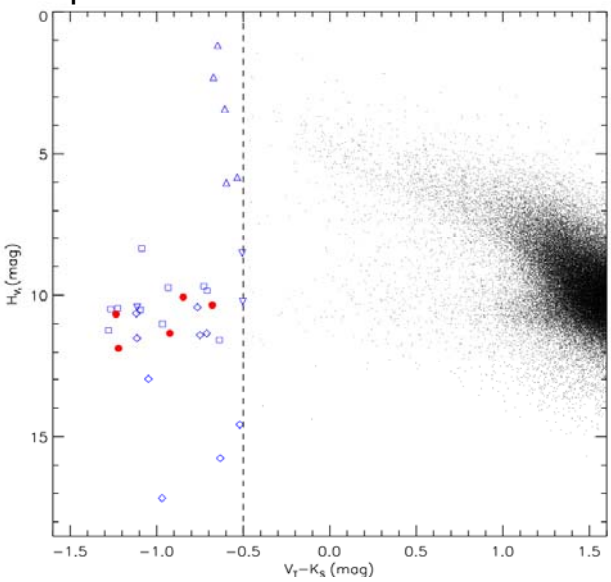
Blue high proper motion objects

Result: Of the 33 candidates

- 1 discarded object because erroneous μ
- 27 already studied
  - 10 Hot subdwarfs (squares)
  - 9 white dwarfs (diamonds)
  - 5 young MS (up-triangle)
  - 3 other stars (down-triangle)
- 5 never studied (red circles)
  "ALBUS" 4 to 8



Blue high proper motion objects

Albus objects: What are they?

1. **Aladin** to search for additional photometry
   DENIS & GRIZ

Blue high proper mo

Albus objects: What

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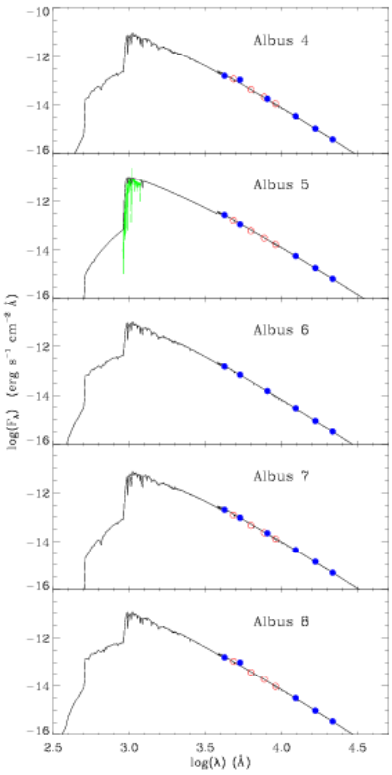
2. **VOSA** to fit the SEDs
   to theoretical models (Kurucz)

   Teff: 24,000 – 30,000 K



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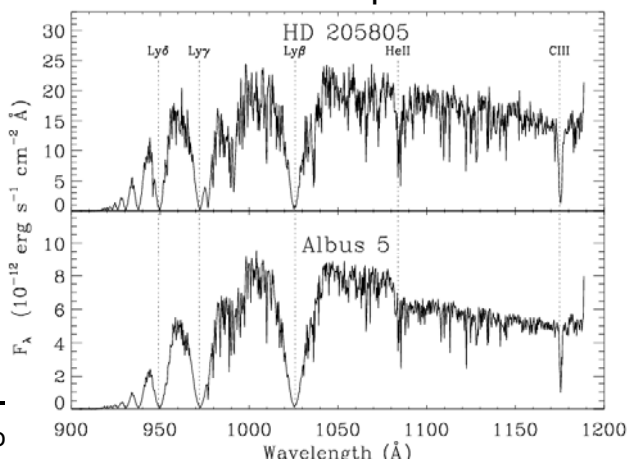
3. **VOSED** to look for spectra
   Albus 5 ⇒ sdB
   The rest ⇒ WD or sdO/B

FUSE spectra



Blue high proper motion objects

Astronomy & Astrophysics manuscript no. manuscript
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Identification of blue high proper motion objects in the Tycho-2 and 2MASS catalogues using Virtual Observatory tools

F. M. Jiménez-Esteban[1,2,3], J. A. Caballero[4], and E. Solano[1,2]

[1] Centro de Astrobiología (INTA-CSIC), Departamento de Astrofísica, PO Box 78, E-28691, Villanueva de la Cañada, Madrid, Spain
e-mail: fran.jimenez-esteban@cab.inta-csic.es
[2] Spanish Virtual Observatory
[3] Saint Louis University, Madrid Campus, Division of Science and Engineering, Avenida del Valle 34, E-28003 Madrid, Spain
[4] Centro de Astrobiología (INTA-CSIC), Departamento de Astrofísica, Carretera de Ajalvir km 4, E-28850 Torrejón de Ardoz, Spain

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ABSTRACT

Aims. With available Virtual Observatory tools, we looked for new bright blue high proper motion objects in the entire sky: white dwarfs, hot subdwarfs, runaway OB stars, and early-type stars in nearby young moving groups.
Methods. We performed an all-sky cross-match between the optical Tycho-2 and near-infrared 2MASS catalogues with Aladin, and selected objects with proper motions $\mu > 50$ mas yr^{-1} and colours $V_t - K_s < -0.5$ mag with TOPCAT. We also collected multi-wavelength photometry, constructed the spectral energy distributions and estimated effective temperatures from fits to atmospheric models with VOSA for the most interesting targets.
Results. We assembled a sample of 32 bright blue high proper motion objects, including ten sdO/B subdwarfs, nine DA white dwarfs, five young early-type stars (two of which are runaway stars), two blue horizontal branch stars, one star with poor information, and five objects reported for the first time in this work. These last five objects have magnitudes $B_T \approx 11.0 - 11.6$ mag, effective temperatures $T_{\rm eff} \approx 24{,}000 - 30{,}000$ K, and are located in the region of known white dwarfs and hot subdwarfs in a reduced proper motion-colour diagram. We confirmed the hot subdwarf nature of one of the new objects, Albus 5, with public far-ultraviolet spectroscopic data obtained with *FUSE*.

Key words. astronomical data bases: miscellaneous – virtual observatory tools – stars: early-type – stars: peculiar – subdwarfs – white dwarfs

F. Jir

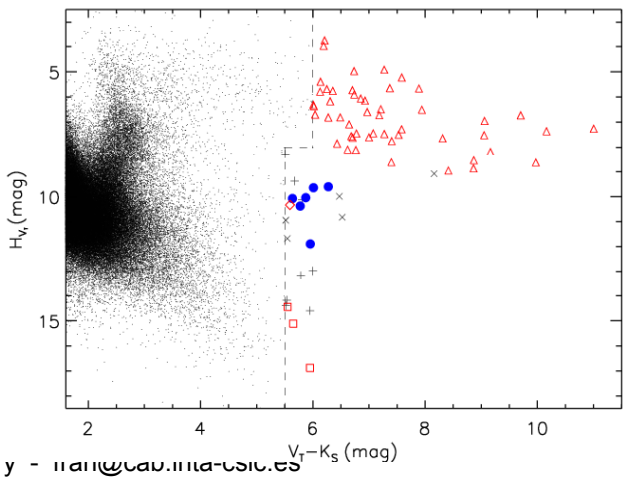
1. Introduction

prototypes, or as tracers of the Population II in the Galaxy. Their apparent high optical brightnesses facilitate the determination of

Red high proper motion objects

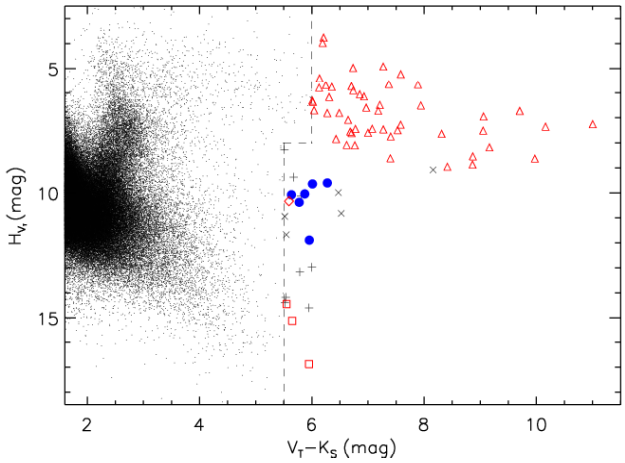
Preliminary result: Of the 73 candidates

- 13 discarded object
  - 8 binary system not resolved by 2MASS (crosses)
  - 5 erroneous μ (sails)
- 54 already studied
  - 50 red giant (triangles)
  - 3 red dwarfs (squares)
  - 1 rd spect. binary (diamond)
- 6 never studied (blue circles)
  "RUBER" 4 to 9



Future work

- Extend the limits of the “red” region



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- Follow-up spectroscopy of Albus and Ruber objects

Thanks