Stellar sources in the eROSITA All-Sky-Survey

IDs and MWL counterparts

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Stellar cross-matching Pt. I

All-sky surveys for all-sky data

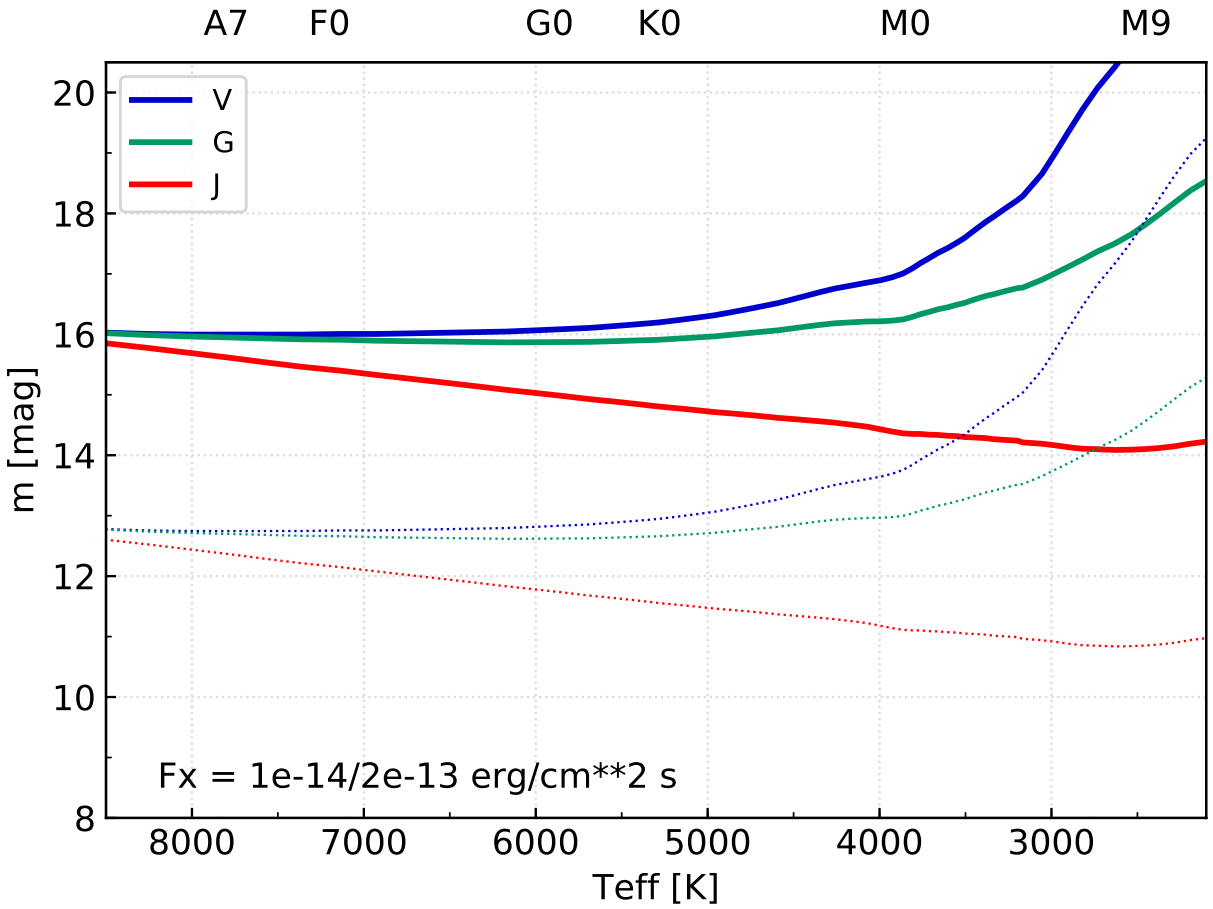
Main identifications:

- Gaia – $\mathbf{1.1 \times 10^9}$ objects, G ($\lesssim 20$ mag) + BP/RP & RVS spectra
- 2MASS – $\mathbf{4.5 \times 10^8}$ objects, J/H/K ($\lesssim 16/15/14$ mag)
- ALLWISE – $\mathbf{7.5 \times 10^8}$ objects, 3.4, 4.6, 12 and 22 μm (W1 $\lesssim 16$ mag)
- TYCHO-2 – $\mathbf{2.5 \times 10^6}$ objects, B/V (V $\lesssim 11$ mag)

- full eRASS coverage (completeness $\gtrsim 99\,\%$)
- fairly homogeneous datasets
- diverse wavelength for different stellar populations

- ongoing X-ID project @HS (XMMSL, RASS...)

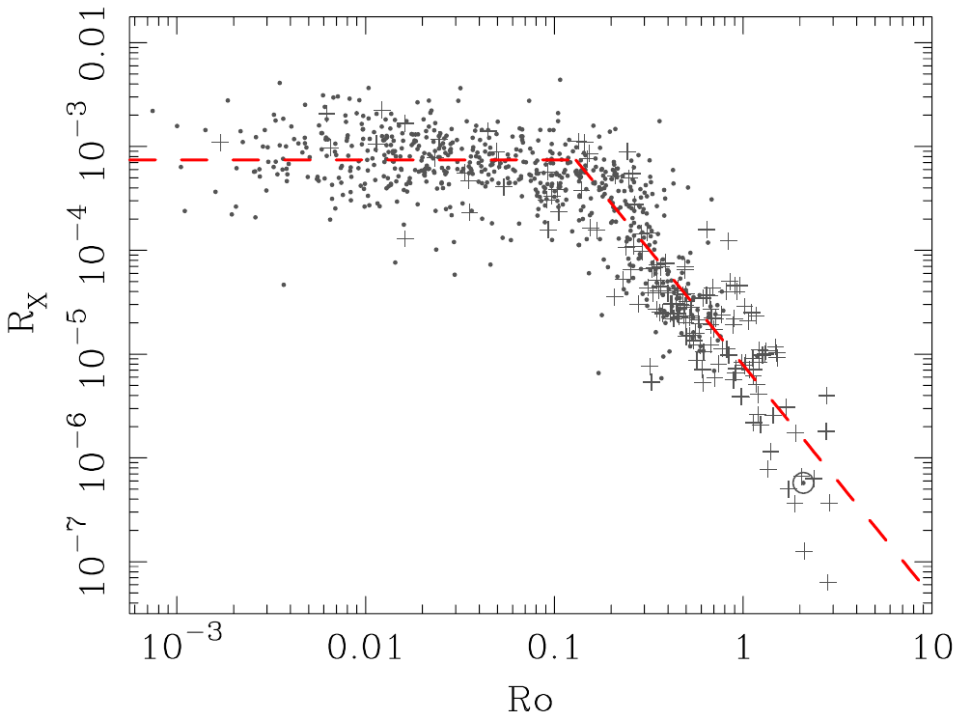
Stellar cross-matching Pt. II

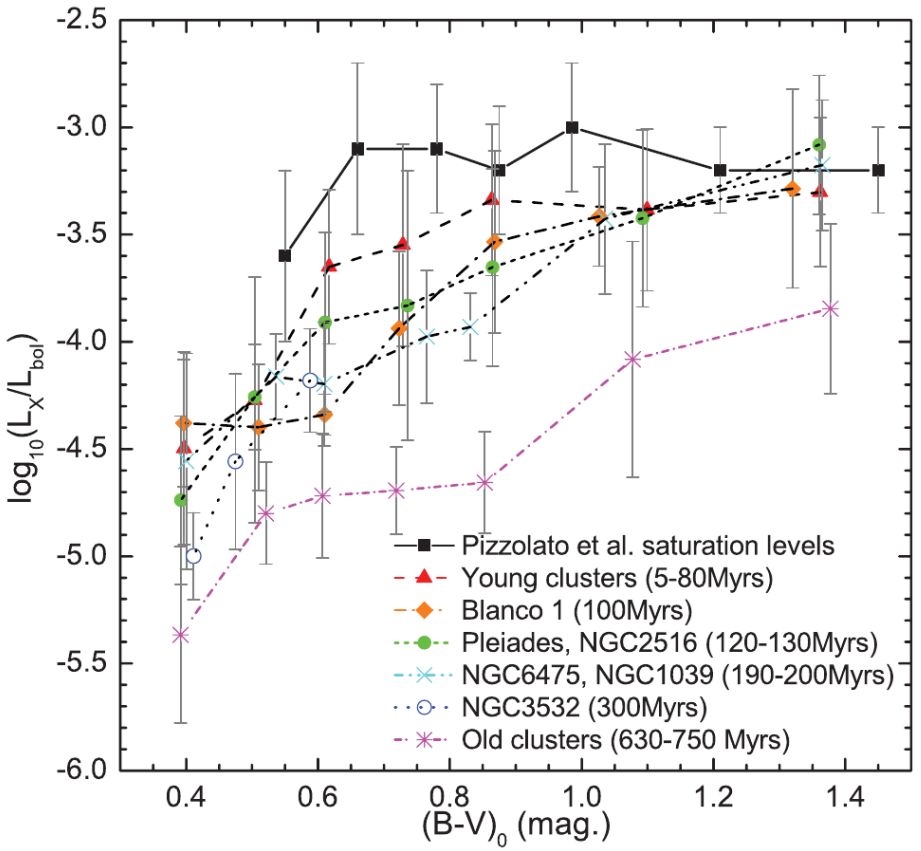


Brightness
at
saturation limit
($\log L_X/L_{bol} = -3$)
declines at SpT early/mid F

- coronal sources: know activity range, $\log L_X/L_{bol} \approx -3 \ldots -7$
- lim. $F_X \Longrightarrow$ lim. F_{opt} per spT/color/T_{eff} and phot. band
- massive stars: $\log L_X/L_{bol} \approx -6 \ldots -7$

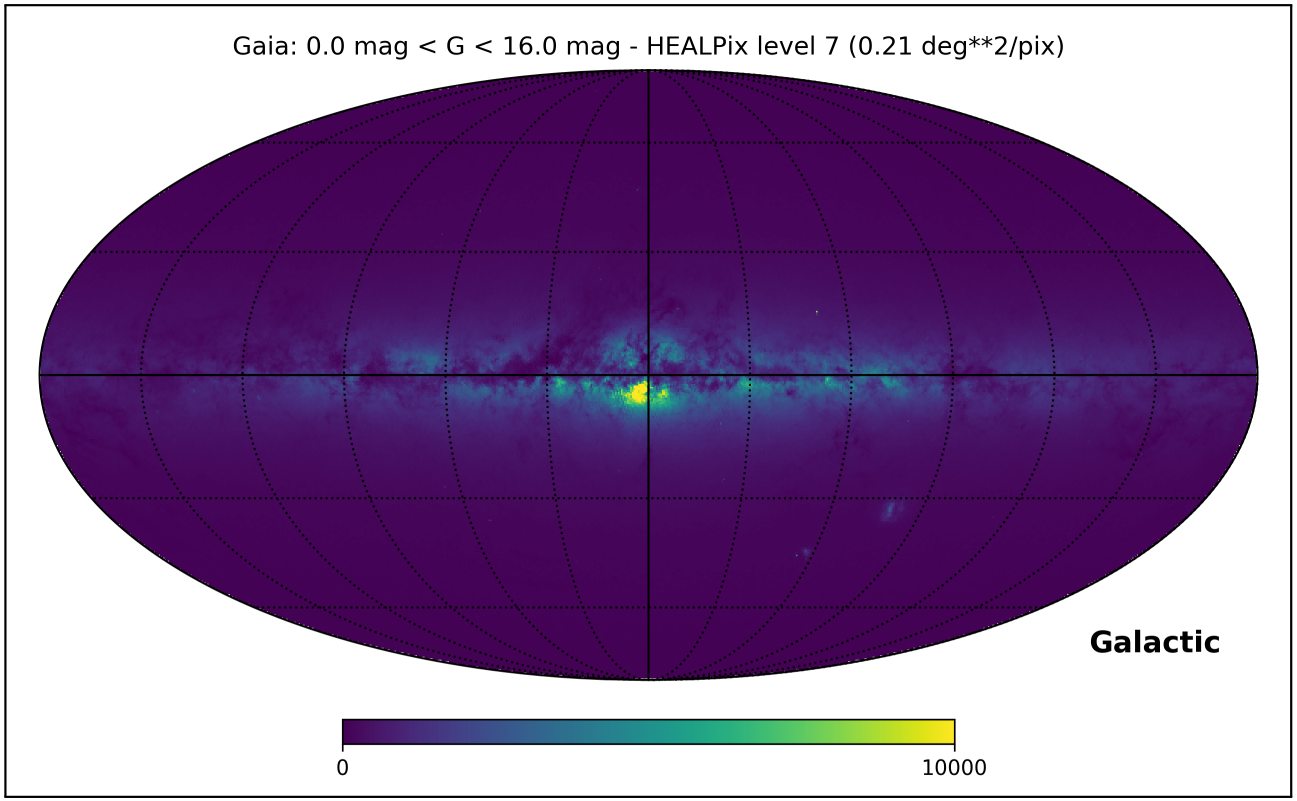
Activity & saturation limits





Wright+ 2011 (late F to mid M), Jackson+ 2012 (mid F to early M)

Stellar cross-matching Pt. III



$\sim 10^8$ DR1 sources
moderate
counterpart
surface density
($\lesssim 1$ @ r $= 10''$)

Gaia DR2 (2018/04) + 2MASS etc.

- accurate parallaxes for eRASS stars ($F \rightarrow L$)
- opt. fainter sources are nearby, VLM stars $\lesssim 50$ pc

ID-space: position, distance, colors

Stellar cross-matching Pt. IV

more & upcoming

- Gaia: R/B photometer + RVS data (G $\lesssim 16, 1.5 \times 10^8$ stars)
  - 3-D space motions + $T_{\rm eff}$, log(g), [Fe/H], $P_{\rm rot}$, CaII IRT...
- TESS (launch 2018, all-sky, |ecl. lat.| $\geq$ 6 deg)
  - 600-1000 nm, $\lesssim$ 12 mag, 2×10^5 monit. stars + full frame (30 min.)
- X-rays: RASS, eRASS

ID-space: activity indicators, X-ray properties, variability

Large area and local additions

Selections depending on science focus

Sky regions, spectral or temporal domains

- partial sky but large area, e.g. Pan-STARRS, SDSS...
- dedicated programs like K2 fields, Spitzer surveys (e.g. SFRs)
- X-ray (XMM, Chandra...), UV (GALEX - 26000 deg^2), IR (Spitzer, Herschel...), sub-mm/Radio (ALMA, VLA...)
- auxiliary catalogs - stellar properties
  - activity+age indicators, pm+members, nearby stars/planet hosts etc.

ID-space: characterization of stars/stellar populations

...lot's of future facilities

Software, requirements & caveats

Software: **PYTHON**

- web: astroquery (e.g. Simbad, VizieR), TAP/ADQL, Requests...
- local: STILTS, Nway...
- stellar sources: filter & selection routines (self-made)

Requirements: **eRASS DB**

- X-ray catalogs, dataproducts, photons

Caveats:

- proper motion (within 4 yr eRASS), few hundred with $>$ 1 arcsec/yr
- stellar cluster, multiples/binaries
- $\Rightarrow$ pseudo-multiple/extended and blended sources
- focus on stars - cross-check with XRBs, AGN etc.

(Near-)simultaneous and follow up observations

Focus: characterization of potential stellar counterparts

- shadowing/simultaneous photometric coverage
- spectroscopic characterization of outstanding sources
- monitoring of activity indicators, near-simultaneous spectroscopy

- dedicated observing campaigns
- piggyback programs on large surveys