

# ChESS: ChaMP Extended Stellar Survey

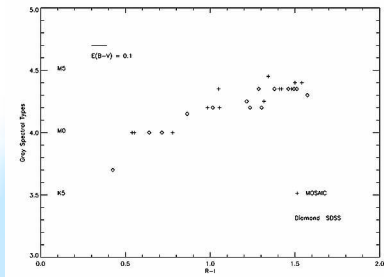
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| Type  | $L_X$ [ergs s <sup>-1</sup> ] | $d_{max}$ [pc] | $m_V$       |
|-------|-------------------------------|----------------|-------------|
| A     | $8.4 \times 10^{27}$          | 170            | 8.1 – 8.5   |
| F     | $4.5 \times 10^{28}$          | 390            | 10.5 – 12.2 |
| G     | $4.1 \times 10^{27}$          | 110            | 9.8 – 11.1  |
| K     | $5.8 \times 10^{27}$          | 140            | 11.7 – 14.3 |
| Mblue | $1.3 \times 10^{27}$          | 68             | 13.0 – 17.0 |
| Mred  | $3.1 \times 10^{27}$          | 100            | 18.8 – 21.6 |
| Sun   | $10^{36.20} - 10^{31}$        | 33 – 5900      | 7.3 – 18.6  |

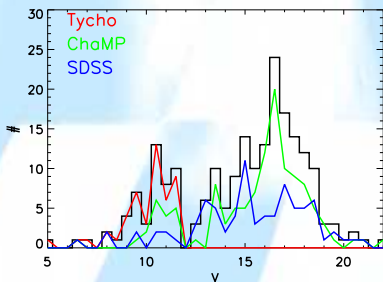
$L_X$ : Median coronal X-ray luminosity for main-sequence spectral types; range for Sun spans luminosities from Coronal Hole to Flare.

$d_{max}$ : Maximum distance to which star with given  $L_X$  will be detected by an instrument with sensitivity  $S = 10^{-16}$  ergs s<sup>-1</sup> cm<sup>-2</sup>. Absorption effects are ignored.

$m_V$ : Dimmest magnitude of star of given  $L_X$  detectable at sensitivity  $S$ ; range for spectral types represent earliest and latest type in each class (A5 is the earliest considered for A stars)

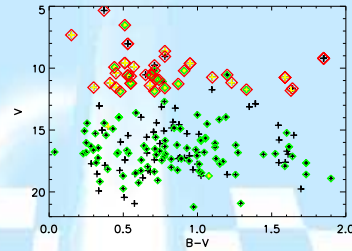


**The distribution of stars with apparent visual magnitude.** The black histogram represents all the X-ray sources from XPIPE that were identified as stellar. The red curve represents those with matches in the Tycho catalog, the green curve, with the ChaMP optical follow-up, and the blue curve, with the Sloan Digital Sky Survey.

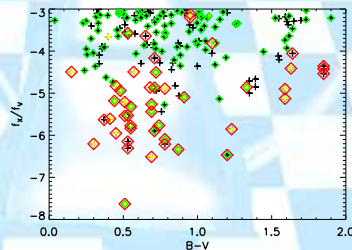


We present a catalog of stellar X-ray sources serendipitously detected in *Chandra* data from 1999-2001 (XPIPE; Kim et al. 2004a,2004b). We have systematically searched for optical matches to X-ray sources from the *Chandra* Multi-wavelength Project (ChaMP; Green et al. 2004) using the Tycho, GSC, SDSS, and ChaMP optical follow-up catalogs. We find over 200 stellar X-ray sources covering a magnitude range  $V = 10 - 19$ . This forms an X-ray selected, but otherwise unbiased sample of field stars covering a wide range of spectral types, ages, metallicities, and rotations. We have classified the spectral types of those stars which have optical spectra, and use this set to calibrate the colors of the remainder of the sample. As expected, the majority of the sources are M type stars. We compare the observed number distributions of the stars with that expected from known activity indicators.

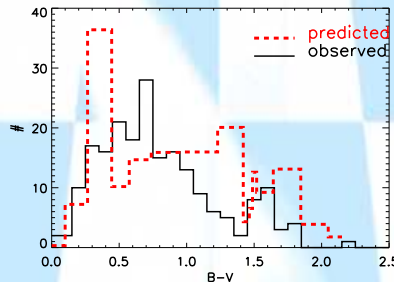
**Scatter plots of V and X-ray-to-optical flux ratio as a function of the stellar B - V color.** Points marked with a green diamond represent data from ChaMP follow-up, and those with a red diamond are matches from Tycho. GSC matches are shown with a yellow symbol.



**Color as a proxy for spectral type.** Scatter plot shows the run of  $R - I$  color for stars with spectral types derived from optical spectra. A tight correlation is evident.



**The distribution of stars with B - V color.** The black histogram represents all the X-ray sources from XPIPE that were identified as stellar. The dashed red histogram is the predicted number of stars based on known X-ray luminosity functions, the known run of stars in the Galaxy, and taking into account the different exposure times for the various ChaMP pointings. The model of the Galaxy (Bahcall & Soneira 1983) is correct only on average, and while the comparison shows some deviations between the predicted and the observed numbers, the general trends are very similar in both when possible magnitude and color errors in the data are included.



- Wide area, medium sensitivity catalog of serendipitously detected stars in ChaMP
- Complementary to targeted, small area deep surveys
- X-ray sources matched to optical catalogs Tycho, SDSS, ChaMP, and GSC
- Spectral types from optical spectra where available, calibrates color
- Limited to  $|b| > 20$  to avoid large extinction
- Representative of field star sample of coronal activity in the solar neighborhood
- Constrain X-ray activity levels for early and late spectral types, binary fractions of B stars, etc.
- Complications: patchy sky coverage, exposure vignetting, optical magnitude errors, intrinsic variability, field selection bias

## SUMMARY

- 48 in Tycho, 83 in SDSS, 125 in ChaMP follow-up, 37 in GSC; 216 unique identifications
- 61 stars have been explicitly typed using optical spectra, of which 38 are M stars
- number distribution consistent with standard model of Galaxy (Bahcall & Soneira 1984, Kashyap et al. 1992)
- number distribution of M stars consistent with  $H_\alpha$  activity index (cf. West et al. 2004)
- matching with 2MASS catalog in progress

**Activity in M dwarfs.** The number of X-ray sources conclusively identified as dM stars based on optical spectroscopy are shown as the blue histogram. Also shown are curves corresponding to the number predicted based on a Sloan study of  $H_\alpha$  emission in active M dwarfs (West et al. 2004) combined with predicted numbers of stars in the Galaxy (Bahcall & Soneira 1984). The red curve is a result of the direct conversion from  $H_\alpha$  to X-ray, and the green curve includes an additional factor of an activity fraction found by West et al.

