The ChaMP Extended Stellar Survey (ChESS)

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Abstract

We present 348 X-ray emitting stars identified from correlating the Extended *Chandra* Multiwavelength Project (ChaMP) with the Sloan Digital Sky Survey (SDSS). 42 catalog members have spectroscopic classifications available in the literature. We present new spectral classifications and Hα measurements for an additional 79 stars. The catalog is dominated by main sequence stars; we estimate the fraction of giants in ChESS to be no more than 10%.

These stars lie in a unique space in the L_x-distance plane, filling the gap between the nearby stars identified as counterparts to sources in the *ROSAT* All-Sky Survey and the more distant stars detected in deep *Chandra* and *XMM* surveys.

For 36 newly identified X-ray emitting M stars we calculate $L_{H\alpha}/L_{bol}$, $L_{H\alpha}/L_{bol}$ and L_x/L_{bol} are linearly related below $L_x/L_{bol} \sim 3 * 10^{-4}$, while $L_{H\alpha}/L_{bol}$ appears to turn over at larger L_x/L_{bol} values.

Stars with reliable SDSS photometry have an ~0.1 mag blue excess in *u-g*, likely due to increased chromospheric continuum emission. Photometric metallicity estimates suggest that the sample is split evenly between the young and old disk populations of the Galaxy; the lowest activity sources belong to the old disk population, a clear signature of the decay of magnetic activity with age.

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Table 1 *Stages in catalog construction. Columns 3 and 4 give the number of spectroscopically confirmed stars and galaxies present in the catalog at each stage. The numbers in parentheses correspond to the fraction of the original number of these objects that is retained.*

	Total Objects	Spectroscopic Stars	Spectroscopic Galaxies
Matched ChaMP/SDSS catalog	**2121**	**89 (100%)**	**684 (100%)**
... point sources	**1373**	**87 (98%)**	**388 (57%)**
... not in DR5 QSO catalog	**546**	**86 (97%)**	**47 (7%)**
... with i < 16.2 + 0.7 * (g-i)	**363[a]**	**82 (92%)**	**3 (<0.1%)**
... with clean X-ray properties	**351**	**81 (91%)**	**3 (<0.1%)**
Final catalog	**348[b]**	**81 (91%)**	**0 (0%)**

[a] Includes 27 saturated stars that do not meet this color-magnitude cut.
[b] Three spectroscopically confirmed QSOs and 11 sources with sub-standard X-ray detections are removed manually.

Feigelson, E.D., et al. 2004, ApJ, 611, 1107
Green, P., et al. ApJS, 2004
Hünsch, M., et al. 1999, A&AS, 135, 319
López-Santiago, J., et al. 2007, A&A, 463, 165
Schmitt, J.H.M.M. & Liefke, C. 2004, A&A, 417, 651

http://hea-www.harvard.edu/CHAMP/

I. The Extended ChaMP

- ChaMP is a wide-area serendipitous survey based on archival ACIS images of the |b| > 20 deg sky.
- Green et al. (2004) used r ~ 25 mag images and follow-up spectroscopy to identify X-ray sources over 14 deg² of the Cycle 1-2 survey.
- Green et al. (2004) classified 125 X-ray counterparts with optical spectroscopy. Of these, 90% are extragalactic, as expected.
- The Extended ChaMP covers images from Cycles 1-6, but only within the SDSS footprint (see Fig. 1). There are 392 ACIS fields covering a total area ~ 33 deg², and including ~ 17,000 sources.
- The median exposure time is 21 ksec; individual exposures range from 1 to 119 ksec.
- SDSS photometry within 20' of the aimpoint for each cataloged *Chandra* observation were obtained to cover the combined ACIS-I and ACIS-S fields of view.
- While primarily an extragalactic survey, the ChaMP lends itself well to stellar research. Counterpart identification is very secure at high Galactic latitudes, crowded-field photometry is not an issue, and reddening is moderate.

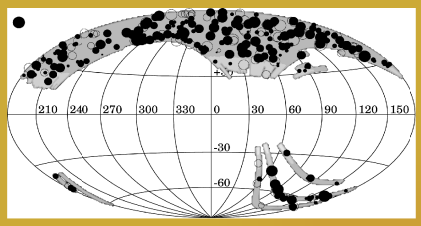

Fig. 1 *The Extended ChaMP footprint in Galactic coordinates. Open circles are fields observed with ACIS-I, filled circles are observed with ACIS-S. The symbol size is proportional to log t_{exp}; the symbol in the upper left corresponds to 100 ksec. The shaded region is the SDSS footprint.*

II. Identifying Stellar Sources

- We use morphological star/galaxy separation, matching to an SDSS quasar catalog, an optical color-magnitude cut, and X-ray data quality tests to create the ChaMP Extended Stellar Survey (ChESS) from a sample of 2121 matched ChaMP/SDSS sources.
- Our cuts retain 92% of the spectroscopically confirmed stars in the original sample and excludes 99.6% of the confirmed extragalactic sources.
- By comparing the distribution of the ChESS sample to that of simulated SDSS/2MASS observations generated by TRILEGAL, we estimate that the total fraction of giants in the catalog is ~ 10%.
- In addition to seven confirmed giants, we identify three cataclysmic variables.
- < 3% of the sources in our final catalog are previously identified stellar X-ray emitters.

III. Some Results

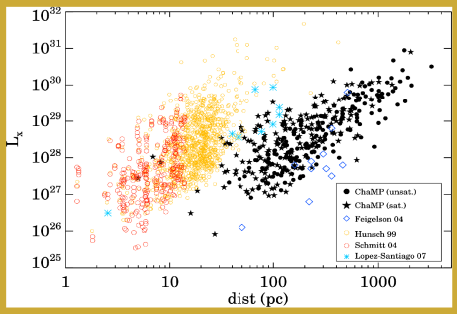

Fig. 2 *L_x as a function of distance for several samples of X-ray emitting stars. ChESS stars with unsaturated SDSS photometry and clean X-ray detections are shown as filled circles; those with saturated SDSS photometry and/or flagged X-ray detections are shown as stars. Also shown are the samples of Schmitt & Liefke (2004; red circles), Hünsch et al. (1999; yellow circles), Feigelson et al. (2004; blue diamonds), and López-Santiago (2007; cyan asterisks).*

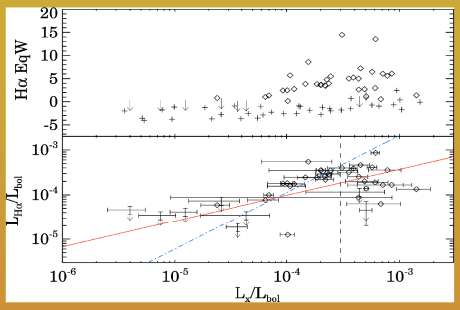

Fig. 3 ***Top Panel:*** *Hα EqW vs. L_x/L_{bol} for stars with ChaMP spectra. Negative EqWs indicate the presence of absorption lines. F, G, and K stars are shown with plus signs; M stars are indicated with diamonds. The downward-pointing arrows indicate the EqW upper limits for M stars with no detected Hα emission.* ***Bottom panel:*** *$L_{H\alpha}/L_{bol}$ vs. L_x/L_{bol} for the M stars in the spectroscopic sample, with symbols as above. The red line is the best fit relation between $L_{H\alpha}/L_{bol}$ and L_x/L_{bol} for the entire sample. The blue-dot dashed line is the relation for the stars with $L_x/L_{bol} < 3 * 10^{-4}$, a value indicated by the dashed line.*

For more details, see Covey, K.R., et al. ApJS in press; astro-ph/0805.2615

Future papers will present analyses of source variability and comparisons of this catalog to models of stellar activity in the Galactic disk.

Also see D.-W. Kim's poster: "Extended Chandra Multi-wavelength Project (ChaMPx)" (I.7)