The NEXXUS database
X-ray properties of nearby stars

Carolin Liefke and Jürgen H. M. M. Schmitt
Hamburger Sternwarte, Universität Hamburg
e-mail: cliefke@hs.uni-hamburg.de

Abstract

We compiled the NEXXUS database of Nearby X-ray und XUV- emitting stars. This is an X-ray equivalent to the CNS4 catalog of nearby stars. It contains the X-ray data of all stars within a distance of 25 pc. It was constructed using ROSAT data from the final all-sky survey and pointing catalogs and we begun recently to also include data from the XMM-Newton Source Catalog. This large number of sample stars (∼1300 detections) proves to be a powerful tool to investigate the X-ray properties of the solar neighbourhood. We constructed volume-limited samples of F/G- stars, K-stars, and M-stars with detection rates greater than 90%. The analysis of these samples shows that the mean X-ray luminosity decreases for later spectral types, while the X-ray surface flux distribution appears to be independent of spectral type with a lower limit corresponding to the flux level of solar coronal holes.

The data base

We searched for positional coincidences of the stars listed in the CNS4 and the X-ray sources from the ROSAT X-ray source catalogs. The results, including detailed information about the star itself and the associated X-ray source(s), were gathered in the NEXXUS data base.

The NEXXUS data base is accessible via www at `http://www.hs.uni-hamburg.de/DE/For/Gal/Xgroup/nexxus`

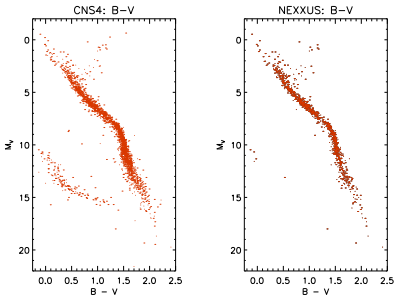

Figure 1: Color-magnitude diagrams ($B-V$ vs. M_V) for the complete CNS4 catalog (left) and for all X-ray detected stars listed in the NEXXUS data base (right). Note the paucity of X-ray emitting white dwarfs.

For all stars included in the CNS4 catalog we reach a detection rate of 41.1%. We estimate the fraction of spurious identifications to amount less than 1%.

Volume-limited samples

To compare the X-ray properties of stars of different spectral types, we sort the stars to three groups based on their absolute magnitude. These groups, with $3.0 < M_V \leq 5.8$, $5.8 < M_V \leq 8.5$, and $M_V > 8.5$ correspond approximately to the spectral types F or G, K, and M respectively. We also considered only the very nearest stars for which almost complete detections are available and excluded white dwarfs and giants.

Within a distance of 12 pc all stars of the F/G sample have been detected, up to 14 pc the detection rate is still 94%. For the K stars we find a detection rate of 96% when considering stars up to 12 pc, the M star sample had to be truncated above 6 pc to obtain 91%.

In Fig. 2 we plot the X-ray luminosity L_X (in erg/s) computed from count rate and distance of the star as a function of distance for the three samples. The absence of solar-like stars with X-ray luminosities of 10^{26} erg/s and below is conspicuous.

This becomes even clearer in a plot of X-ray luminosity as a function of the absolute magnitude as done in Fig. 3. Furthermore L_X appears to decrease with M_V. By converting the X-ray luminosity to a mean surface flux F_X this turns out to be a scaling effect resulting in the different sizes of the stars. The mean surface flux distribution of the three samples shows litte difference and the lower envelope of the distribution at $F_X \approx 10^4$ erg/cm^2/sec is the X-ray flux level observed in solar coronal holes.

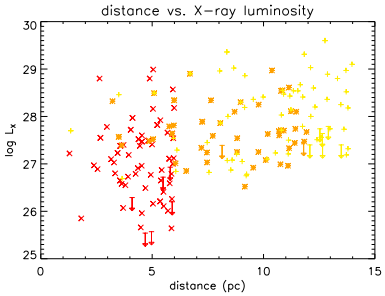

Figure 2: X-ray luminosity vs. distance for the F/G (yellow), K (orange) and M (red) star samples described above.

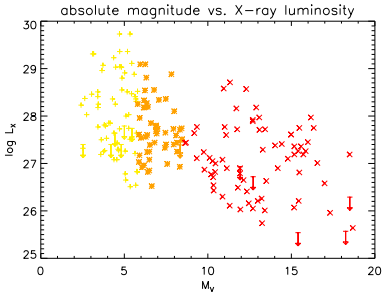

Figure 3: X-ray luminosity as function of absolute magnitude for the three samples. The range in X-ray luminosity is about three orders of magnitude independent of spectral type while the median X-ray luminosity is decreasing with increasing M_V.

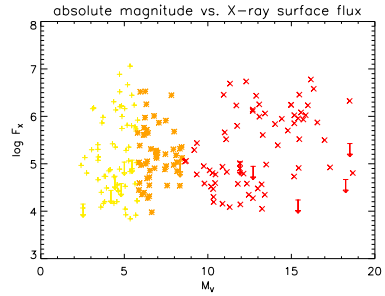

Figure 4: Mean X-ray surface flux vs. absolute magnitude M_V. Apparently there is a lower limit of about 10^4 erg/cm^2/s of the surface flux.

Variability

For many of the stars included in NEXXUS multiple X-ray detections are available. All-sky survey data and PSPC pointed observations can directly be compared because they were carried out with the same instrumental setup but have a typical difference in observation date of 1-2 years. We find that large amplitude variations are rather uncommon.

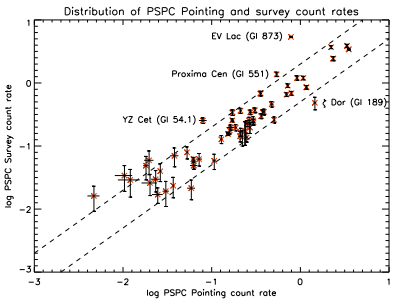

Figure 5: Comparison of X-ray count rates for stars detected both in the all-sky survey and the PSPC pointing program. The dashed lines indicate a variation of a factor of 2 from unity. Stars with large deviations are labeled, they are all known flare stars.

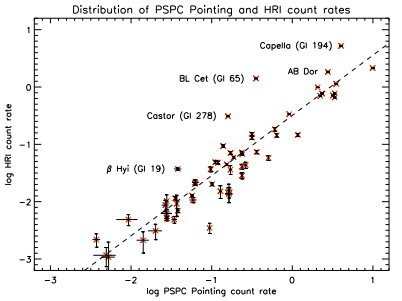

Figure 6: Comparison of X-ray count rates for stars detected both in the PSPC and HRI pointing program.

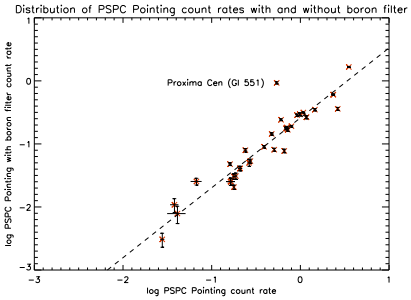

Figure 7: Comparison of X-ray count rates for stars detected in the PSPC pointing program with and without the boron filter.

Comparing the count rates observed with different instrumental setups leads to "conversion factors" of 0.337 from PSPC to HRI countrates and of 0.317 between PSPC count rates with and without boron filter.

Further development and outlook

NEXXUS will be kept up-to-date and is not limited to ROSAT data only. New stars discovered in the solar vicinity will be added as well as data from the current X-ray observatories Chandra and XMM-Newton. The first XMM-Newton Serendipitous Source Catalogue has already been included.

References

Schmitt, J.H.M.M., 1997, A&A, 318, 215

Schmitt, J.H.M.M., Fleming, T.A., & Giampapa, M.S., 1995, ApJ, 450, 92

Schmitt, J.H.M.M., & Liefke, C., 2004, A&A, 417, 651