The stellar content of the Chandra Deep Field North survey

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1. Introduction

We present our ongoing work on the stellar content of Chandra Deep Field North survey based on the analysis of the 1 Msec data (Brandt et al. 2001) in the 0.5-2.0 keV band.

The optical identifications, complete at V=22, provide a well defined and complete X-ray selected sample of normal stars. Optical spectra for our stellar sample have been obtained, allowing the determination of spectral types. Optical photometry has been obtained from Barger et al. (2002) in the V and I bands. The JHK photometry is from the 2μm All-Sky Survey (2MASS, Cutri et al. 2000) and from Barger et al. (2002) for the faintest stars.

We have predicted the number of stellar X-ray sources and their properties with our X-ray galactic stellar model (XCOUNT, Favata et al. 1992, Micela et al. 1993) and in the following we discuss the results of the comparison between our predictions and the observations.

2. Results

We predict about twice the number of stars observed (20 predicted with V$<$ 22, 12 observed). A more careful analysis shows that the number of expected dM stars is in agreement with the observations (7.42 predicted, 8 observed), while we overpredict the dF, dG, and dK stars (2.3, 3.4, 6.7 predicted, respectively, where only 0, 2, 2 observed).

The observed discrepancy is in the opposite direction of the discrepancy observed in the shallower surveys of *Einstein* and *EXOSAT*, where an excess of *observed* yellow stars with respect to the predictions was found (cf. Sciortino et al. 1995). The main difference with these surveys is the stellar population dominating the detected stars as the previous surveys were dominated by young stars, well detectable at large distances. In deep high latitude surveys, such as the Chandra Deep Field, the stellar population is largely dominated by old stars, because of the small scale height and the intrisic high X-ray luminosity of young stars.

Some of the possible reasons for the observed lack of yellow stars together with the possible observational tests to discriminate the different hypotheses include:

- The involved numbers are small, and it is possible that we are observing just a statistical fluctuations. Since the probability to observe 4 objects or less when the expected number is 12.4 is 0.6% (assuming a Poisson distribution) we consider this case implausible. A deeper survey or a larger sky coverage will help in firmly rejecting this hypothesis.
- The spatial distribution assumed in the model is wrong, and the actual scale height is smaller than assumed. To explain the observed difference we require that the scale height of the old population is about half than assumed. The analysis of the 2 Msec catalog and deeper optical observations, permitting us to determine a reliable log(N)-log(S) for dM and dG-dK stars, will help in testing this hypothesis. Furthermore X-ray surveys spanning a large range of latitudes will constrain the scale heights.
- The adopted X-ray luminosity function of old dG and dK stars is incorrect. If the age distribution in the solar neighborhood is not representative of that of the Galaxy and X-ray luminosity decreases more quickly at ages greater than 10^9 years than previously assumed, then we would overpredict the number of detected stars. A better determination of age dependence of coronal emission after the first billion years is crucial to test this hypothesis. In particular deep X-ray observations of old open clusters or of well-dated old field stars will help.

References

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