Mem. S.A.It. Vol. 74, 440

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# A deep cluster survey in Chandra archival data. First results

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**Abstract.** I present the first results of a deep cluster survey I have initiated using Chandra archival data. The survey concentrates on fields taken by ACIS (energy band 0.5 - 2 keV) with absolute galactic latitude $|b|$ larger than 20 degrees and exposure time larger than 10 ksec. The main goal of the survey is to select a new sample of galaxy clusters in a field of about 10 square degrees. At the present time, adopting the Voronoi Tessellation tecnique I have selected a sample of 36 cluster candidates from 5.55 degree$^2$ of surveyed area. I expect a significant fraction of them are high redshift ($z > 0.6 - 0.7$) systems. A preliminary $\log N$-$\log S$ derived from this sample is in general agreement with previous ROSAT-based deep surveys.

**Key words.** surveys – galaxies: cluster: general – X-rays: galaxies

## 1. Introduction

Clusters of galaxies are the largest gravitationally bounded systems in the universe. Since they arise from the rare highest peaks of the initial density fluctuation field, their properties are very sensitive to the nature of such fluctuations. In particular, in the scenario of hierarchical formation of cosmic structures, standard analytical arguments based on the Press & Schechter (1974) approach show that clusters abundance is highly sensitive to the amplitude of the density fluctuations on the cluster mass scale (e.g. White, Efstathiou & Frenk 1993) and on the value of the cosmic density parameter $\Omega_0$. Therefore, systematic searches of galaxy clusters offer great opportunities to test the models of structure formation and provide the basis for follow-up studies of clusters physical properties. Over the last ten years, a remarkable observational progress has been made in constructing large samples of local and distant galaxy clusters. In the X-ray band, this has been possible mainly thanks to the ROSAT satellite, both with All-Sky survey data and pointed observations (e.g. Böhringher et al. 2001; Rosati et al. 1995; Scharf et al. 1997; Vikhlinin et al. 1998). Now, the advent of Chandra observatory, with its deeper flux limits and superior spatial and spectral resolution, opens new perspectives in galaxy clusters X-ray surveys.

In the next two sections I present the methods and the first results of a deep cluster survey I have initiated on Chandra archival data.

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## 2. Data analysis and source detection

The survey is based on archival Advanced CCD Imaging Spectrometer (ACIS) X-ray data. The wide field of view (16.9×16.9 arcmin$^2$ in ACIS-I mode) and the high resolution of ACIS (PSF radius smaller than 0.5 arcsec at the aimpoint) make of this instrument an ideal tool to search for distant clusters. Selected fields have exposure times larger than 10 ksec and high galactic latitude ($|b| \geq 20^o$) to minimize the absorption of X-rays from extragalactic sources by galactic neutral hydrogen. I preferentially avoid pointings whose targets are bright extended sources (typically nearby clusters and galaxies) since they dominate the field of view and make it impossible the detection of other objects.

Each field is analyzed as it becomes available in the archive using uniform X-ray source detection and analysis techniques to produce a well-defined sample of galaxy clusters over the full survey area. Archival data are first elaborated in a standard way (i.e. by filtering good time intervals, removing high background periods, bad columns and pixels, etc) in order to produce an event file containing only the detector coordinates of the photons in the 0.3-10 keV energy band. This is done by using the dedicated software CIAO. Subsequently, source detection is performed in the soft energy band (0.5-2.0 keV) by using the Voronoi Tessellation and Percolation technique (VTP, Ebeling 1993). I adopt this procedure since it is completely non parametric, i.e. it is equally sensitive to symmetric and irregular sources, and because it detects more faint extended objects than conventional PSF/sliding cell methods (Scharf et al. 1997). The VTP procedure is implemented on a pipeline composed by the CIAO task vtpdetect and a C code representing an adaptation of the code developed by Ramella et al. (2001) to detect galaxy clusters in optical photometric surveys.

## 3. First results

In the first stage of this work, I have selected a sample of 36 candidate clusters detected in 81 Chandra ACIS observations covering an angle of 5.55 degree$^2$ (Boschin 2002). Despite the small solid angle covered so far, the survey probes a volume at high redshift comparable or higher than previous Einstein and ROSAT-based surveys. Moreover, I expect a significative fraction of the candidates are medium-high redshift systems. This makes these candidates interesting targets for optical/NIR follow-up observations. In particular, the confirmed distant clusters will be useful, for instance, to study the properties of the cluster galaxy population at high redshift (e.g. Gioia et al. 1999; Stanford et al. 2002). From this sample I also derive a preliminary $\log N$-$\log S$ relation. This relation shows a general agreement with some deep ROSAT-PSPC based cluster surveys. As soon as new data will be available in the Chandra archive, they will be reduced in order to increase the sky area and the volume probed by the survey and enrich the catalogue compiled so far.

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