Multiwavelength Observations of the Subaru/XMM-Newton Deep Field

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Abstract. The Subaru/XMM-Newton Deep Survey (SXDS) is a new deep Optical/X-ray survey, whose purpose is to provide an accurate census of the contents of the Universe without suffering from the biasing effects of large-scale structures. The SXDS is part of an ambitious project to obtain extensive multi-wavelength data across a $\sim 1.3\,\mathrm{deg}^2$ region of sky. Other wavelength observations ranging from the X-ray to the radio are being pursued and/or planned through various facilities. These multiwavelength data would allow us a comprehensive approach to investigate the mass assembly history of galaxies over a broad span of cosmic history.

1 Introduction

Understanding the contents and its distribution in the universe is a key issue of the study of cosmology. We have initiated a multiwavelength wide area and deep survey to provide an accurate census of objects in the Universe hence allow us to investigate the formation and evolution of structure. The available galaxy survey data are either sampling wide area but bright limiting magnitude or deep limiting magnitude but covering a small area. The wide area surveys like the 2dFGRS ([1]) and the SDSS ([2]) show us only the end result of galaxy formation. The ultra-deep pencil-beam surveys from space, like the HDFs, can provide the shape of the luminosity function of distant objects. However, the results drawn from the small volume is limited not only by the small number statistics, but also by the intrinsic spatial correlations between galaxies, which causes fluctuations of measurements much larger than they would be. A statistically sound, large volume, large numbers of high redshift sample of various different classes of objects are needed to determine the global properties and the formation and evolution of these objects.

Detailed simulations ([3]) indicate substantial Large Scale Structure (LSS), including voids, filaments, clusters and groups, occurs on scales a few x 10 Mpc up to ~ 100 Mpc (comoving). Thus, we must cover a large enough area ($> 1\,\mathrm{deg}^2$) to minimize the effects by the cosmic variance and at the same time we must observe sufficiently deep limiting magnitude so that we can accurately determine the global properties of different class of objects. Furthermore, the value of the survey dataset grows exponentially by adding the data at other wavelengths.

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Therefore, we took a multiwavelength approach for the SXDS from the very start. In this paper we describe the status of the SXDS and its multiwavelength companion surveys. See [4] for the location, size and depth of the survey. Detailed information on the strategies, the observations and the data set of the SXDS will be described in elsewhere.

2 The SXDS

Our initial survey consists of optical imaging (B, R, i', z') with Suprime-Cam ([5]) on Subaru Telescope and X-ray imaging with the EPIC camera ([6]) on the ESA XMM-Newton satellite. These instruments provide the fastest survey speeds available at present in their wavelength ranges of operation. The survey field is centered at J0218−05. The field is accessible and suitable for observations at all wavelengths by making use of the wide range of currently available and of planned major observational facilities.

2.1 The X-Ray Imaging

The X-ray observations were taken as part of the XMM Survey Science Centre (SSC) guaranteed time. The X-ray survey consists of mosaic of 7 partially overlapping pointings of the EPIC camera. A total of 400 ksec were allocated for this program. The nominal exposure times of 100 ksec for the central field, and 50 ksec each for the six flanking fields. The image of the central field approaches the confusion limit for the XMM-Newton in the soft (0.5-2 keV) band ([7]), while together these data form one of the largest contiguous area over which deep X-ray observations have been performed. Fig. 1 gives a composite X-ray image of the SXDS field.

Source detection and parameterization of the X-ray data were completed. Preliminary analysis of the X-ray colours, spectra, morphology, and X-ray variability were performed. Over 1,000 X-ray sources were detected down to $\sim 10^{-15}$ $\mathrm{erg}^{-1}\,\mathrm{s}^{-1}\,\mathrm{cm}^{-1}$ for point sources in the 0.5-2 keV band. We obtained the X-ray colours for nearly 1,000 sources and the X-ray spectra for ~ 300 sources. There are ~ 25 cluster candidates selected on the basis of their extended X-ray emission.

2.2 The Optical Imaging

Most of the optical imaging observations were conducted as one of three Subaru Telescope's Observatory Key Projects. Five Suprime-Cam fields, as indicated in Fig. 2, were observed to cover a $\sim 1.3\,\mathrm{deg}^2$ region of sky. Our observations reached limiting magnitudes at $B = 28.1$, $R = 27.5$, $i' = 27.4$ & $z' = 26.8$ (AB magnitude, 3σ detection with 2" aperture). The observations were completed in mid-November 2003. Currently, complementary V-band observations are pursued.