UV catalogue of the XMM-CDFS Deep Survey in the Chandra Deep Field-South

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Introduction

The XMM-CDFS Deep Survey has been conceived to investigate the X-ray spectral properties of the highly obscured AGN (Comastri et al. 2011). During the X-ray observations, XMM-OM (Mason et al. 2001) simultaneously targeted the central 17x17 arcmin² region of the X-ray FOV. The resulting XMM-OM data set can be used to build an UV catalogue of the CDF-S, taking advantage of the relatively good UV spatial resolution (≤2 arcsec, Page et al. 2012). The main aim of the catalogue is to provide complementary UV photometric measurements of known optical/UV sources in the CDF-S.

Observations and data reduction

The XMM-CDFS Deep Survey is composed of six groups of observations, which span an interval of ~8 years, for a total of 33 epochs. After re-processing the archival XMM-OM data, we stacked the exposures for each filter and each group of observations with the Science Analysis System (SAS). The detections with good SAS photometric quality flags have been selected and averaged, obtaining a preliminary catalogue of 1844 UV objects. Finally, we validated the detections by cross-correlating them with the ESO imaging survey (EIS, Arnouts et al. 2001) and the COMBO-17 survey (Wolf et al. 2004), and through the visual screening of the images. The resulting XMMOMCDFS catalogue is composed by 1129 UV sources, 1031 of which with sure EIS/COMBO-17 cross-identifications ("good subsample").

Table 1

Sources with good SAS quality flags	UVW2	UVM2	UVW1	U	B	V
Total sources before validating the catalogue	285	398	1621	2571	1811	888
Subset of sources from stacking before validation	80	138	561	863	645	205
XMMOMCDFS sources	157	301	1121	954	632	403
XMMOMCDFS sources from stacking	46	113	348	66	119	78

Presentation of the catalogue

The XMMOMCDFS catalogue contains the average astrometry and photometry of the UV detections with good quality flags from individual observations and/or stacked images (**Tab. 1**). UV magnitude distributions are shown in **Fig. 1**. Subsidiary information about the sources have been derived by matching the catalogue with the available GALEX data (Bianchi et al. 2013) and other CDF-S surveys (**Tab. 2**). We notice that

- no GALEX counterparts have been found for ~15% XMM-OM sources due to the low GALEX spatial resolution (≥5 arcsec);
- the XMM-OM photometry is in good agreement with the GALEX measures (**Fig. 2**), confirming the validity of the XMM-OM calibration (Talavera 2011);
- spectroscopic redshifts are attributed to 942 XMM-OM sources by matching the ACES survey (Cooper et al. 2012) and the ESO CDF-S Master Catalogue;
- X-ray cross-identifications are found for 164 objects in the Chandra 4 Ms source catalogue (Xue et al. 2011), but only for 33 objects in the 2-10 keV XMM catalogue by Ranalli et al. (2013), because galaxies (~85% of the XMMOMCDFS sources, **Tab. 3**) marginally emit in the hard X-ray band.

Table 2

Survey	Match radius	Sources	Good sources	False matches
GALEX DIS/MIS observations	2.5	957	877	8.9
Arizona CDF-S Environment Survey	1.0	751	694	1.2
Master Catalogue	1.0	191	173	2.5
Chandra 4 Ms source catalogue	2.0	164	158	4.1
2-10 keV XMM catalogue	3.5	33	31	12.1

Figure 1

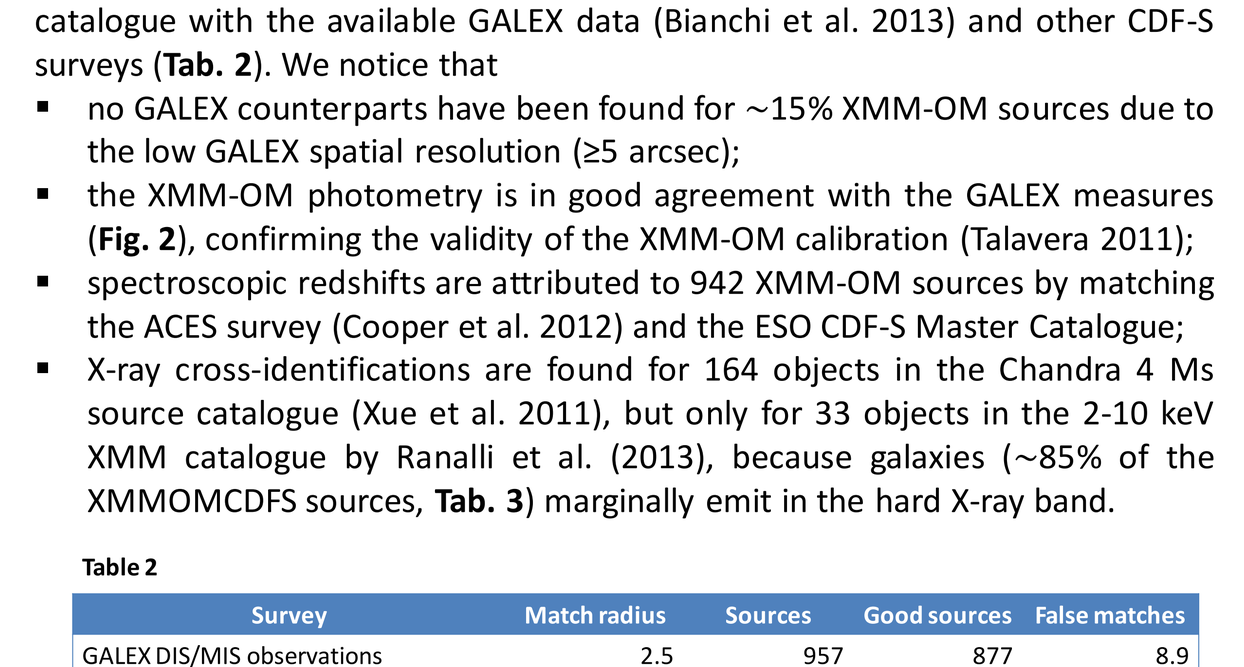


Figure 2

Combined classification of the sources. X-ray/UV ratio

The Chandra 4 Ms source catalogue provides a classification based on revealing possible AGN X-ray emission properties. The good subsample sources classified as AGN in the X-rays are 61, even if 50 of them are photometrically classified as galaxies in the COMBO-17 survey.

Table 3

Good subsample classifications	COMBO-17	Chandra	Adopted
Galaxies	862	91	814
Stars and White Dwarfs	118	6	119
AGN	11	61	11
Intermediate sources			50
Uncertain/unclassified	40		37

To characterise such "intermediate" objects, we analysed the X-ray/UV ratio of the sources with Chandra counterparts, through the $\alpha_{ox}=0.38\cdot\log(L_{2keV}/L_{250nm})$ versus $\log L_{250nm}$ relation (**Fig. 3**). The intermediate sources span a wide region in-between the AGN and galaxy loci, possibly due to the dilution of the nuclear emission by the host galaxy starlight. However, also after subtracting the galaxy component at 250 nm (small black circles in Fig. 3 refer to nuclear luminosities), part of the intermediate sources are still far from the AGN locus. This can be mainly due to X-ray obscuration. We computed de-absorbed X-ray luminosities through the available XMM spectra for a few sources, obtaining α_{ox} values close to the AGN reference α_{ox}-L_{250nm} relations (in Fig. 3, upward arrows indicate the correction for absorption).

Figure 3

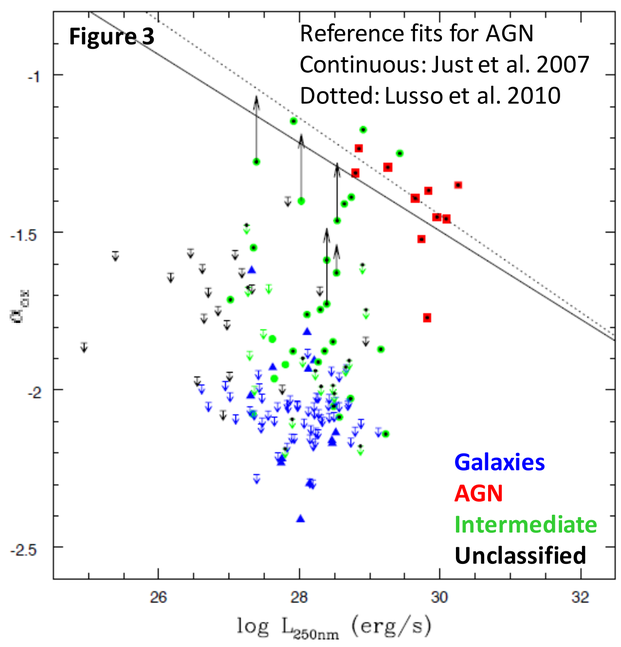
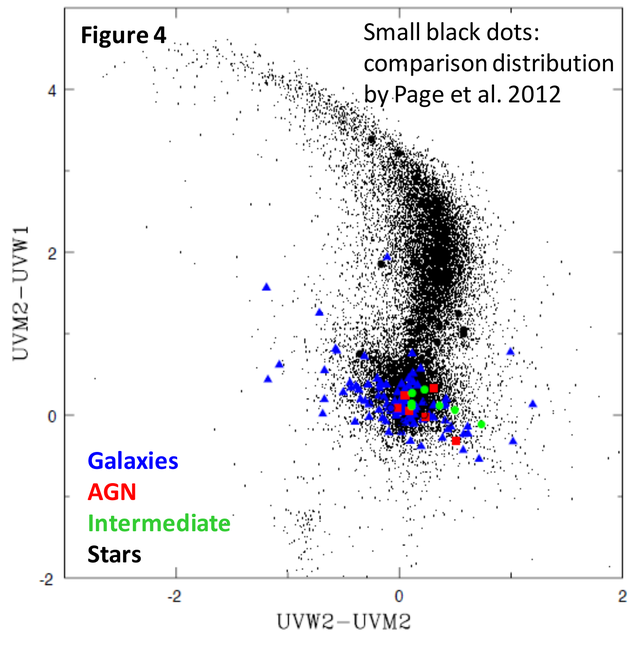


Figure 4



Colour-colour plots have been also produced to characterise the XMMOMCDFS sources. In all of them, stellar and galactic distributions agree with the models depending on age and temperature (Bianchi et al. 2007, Page et al. 2012). The UVM2-UVW1 versus UVW2-UVM2 diagram is represented as example in **Fig. 4**.

Conclusions

- The XMM-OM data integrate the GALEX and optical coverage of the CDF-S, complementing possible multi-wavelength studies of SEDs.
- The catalogue includes fainter sources w.r.t. archival source-lists by means of the stacking, which provided on average ~31% sources in each UV band.
- The intermediate sources appear to be optically diluted and/or X-ray obscured AGN; both effects contribute their low X-ray/UV ratio. Optical/UV variability analysis could provide additional evidence of AGN activity for some of these sources, as well as for galaxies hosting faint AGN without X-ray detections. We will perform in a future work an UV variability analysis of the XMMOMCDFS sources, analogously to e.g. Trevese et al. 2008, Gezari et al. 2013, De Cicco et al. submitted, Falocco et al. in preparation.

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The work presented in this poster has been submitted to A&A.