The Chandra COSMOS X-ray Survey

Vital Statistics:
1.8 Ms
1/2sq.deg
@160 ksec
1761 sources
Dec ’06-June ’07
Catalog ‘in press’
ApJS

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Fiore F., Comastri A., Salvato M., Mainieri V., Lanzuisi, G., and the
COSMOS TEAM
Another X-ray Survey?

Chandra COSMOS hits a Sweet Spot, in 3 ways

Wedding cake Diagram

CDFS

COSMOS

Champ

XBootes
Chandra COSMOS 1: Large Numbers

Statistics + Rare objects

1761 point sources

$f_x > 2 \times 10^{-16} \text{cgs} \ 0.5-2 \text{ keV}$

4 x fainter than XMM-COSMOS

Flux at 80% of the area
Chandra COSMOS: 2. Matched Opt/IR depth

>95% identified, 40+ photometric bands: instant SEDs, accurate phot-z

96% secure IDs

1.2% ambiguous IDs

0.3% blank fields
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Ly-α forest $Z=4.91$

Keck Deimos spectrum $i_{AB}=24.8$
Chandra COSMOS 3: Not Just More AGN

Chandra-COSMOS reaches to a flux where galaxies outnumber type 1 AGN

SED FITTING TEMPLATE results
Salvato et al., 2009, Civano et al. 2009
Galaxy/SMBH co-evolution via Mergers

QUASAR phase: BH fed rapidly by merger, starburst
High L/Ledd

‘RADIO’/Seyfert phase: BH fed slowly by stellar mass loss; Low L/Ledd

Hopkins et al. 2008 ApJS, 175, 356
Downsizing in Star Formation and SMBH

- Star-formation and SMBH peak at $z=1-2$
- Co-evolution? onset of AGN feedback, assembly of spheroids, hosts to quasars and relic SMBH
- Central to design of COSMOS, C-COSMOS

- DOGs” Massive, young, strongly star-forming at $z=1-2$

**Madau Plot**

C-COSMOS sensitivity
DOGs: AGNs or Starbursts?

Bright Chandra-COSMOS DOGs at z=1-2 are heavily obscured

\[ L_X > 10^{42} \text{ erg/s} \]

Lanzuisi et al., 2009, in preparation
3.5 hours of integration with DEIMOS @ Keck

$z = 1.592 \quad L_x = 5 \times 10^{44} \text{ erg s}^{-1}$

Update:~80 new redshifts from 150 C-COSMOS slits, $I_{AB} \sim 23.5$

More nights in February 2010

Salvato et al., 2009, in preparation
COSMOS MIR DOGs
Fainter DOGs also obscured

Stack of Chandra images of MIR sources not directly detected in C-COSMOS

Fiore et al., 2008
MIR Bright DOGs
99 sources with:
F24um>550uJy
MIR/O>300
R-K>4.5
All with redshifts
0.7<z<3

Fiore et al., 2009, in preparation
Z$>3$ Quasars

Good Statistics at last

54 z$>3$ quasars (phot-z)

logN-logS has small errors
⇒ Discriminates models
⇒ Cut-off at z$>2.7$

CDF-S: Fiore et al
XMM-COSMOS: Brusa et al. 2009
Chandra-COSMOS: Civano et al. 2009
Rare Objects: 1 Double Nucleus/1761 sources
Gravitational Wave Recoil?

Just-merged SMBH get kick from Gravitational Waves
Ejected at up to 4000 km/s
Accretion disk, BLR tightly bound
-> move with SMBH

Civano et al. 2009, submitted
Also Redshifted, Variable Energy Fe-K Absorption

Backlit BAL Wind?

∀ ΔE = 500 eV => 10^4 km/s/yr

0.02-0.07c FeI

0.09-0.14c FeXXVI

• BAL Wind in an Obscured AGN
Next: “The Complete Chandra COSMOS Survey”

CC-COSMOS: rare objects become common

- 2.45 Ms
- 1.7 sq.deg
- @ 160 ksec
- 3600 pt. Sources

- AGN-Galaxy CCF to z=2
- AGN lensing by z, type
- Group lensing by type
- LIRG, AGN clustering @z>1
- AGN L/L_{Edd} in SB, passive hosts
- z>7 quasars (UltraVista)

Poisson errors shrink fast for factor 2-3 more objects: Comparable to SDSS

Also: SEDS, Herschel, AzTEC, Ultra-VISTA, Keck…
The Chandra COSMOS Survey:
A high resolution X-ray legacy

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Data products available at IRSA

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Chandra-COSMOS Galaxies have high X-ray/Optical ratios

Civano et al., 2009, in preparation
GALFIT 4 component MODEL:

1 PSF --> SE nucleus (20.51 mag) --> Type 1 AGN
+ 1 compact --> NW nucleus (19.67 mag) --> Type 2 AGN
+ 1 extended --> galaxy (~15 kpc, 18.6 mag)
+ 1 asymmetric --> tail and overall light
AGN vs. Starburst Clustering

At $z \sim 1$ Starbursts & AGN do not yet avoid high density regions

Feruglio et al. 2009 in prep.
Weak Lensing around AGNs

Dark Matter halos around AGNs log\(<M>\)=12.9, same as groups

Leauthaud et al. 2009 in prep.
Off-Nuclear objects

16 Ultra-Luminous X-ray Sources (ULXs) - intermediate mass back holes?

Mainieri et al. 2009, submitted
Close AGN Pairs

19 Physical Black Hole Pairs at few kpc separation

Civano et al. 2009, in preparation
High-z AGN

Today constraints are too loose to constrain accretion physics and cosmology (handful of AGN at z>4.5 only). Both IXO and WFXT can provide breakthroughs in this field provided that a PSF with HPD<5” is achieved!!! However, these programs will not see light before 2020!

In the meantime, the problem can be attacked by dedicated Chandra Legacy programs AND by aggressive multiband data analysis exploiting synergies with HST, Spitzer, JWST and ALMA.

Tripling today z>4.5 sample can already provide errorbars comparable to SDSS ones, thus allowing us to measure the LF over >2 decades. Feasible by doubling today expo on CDFS and COSMOS.

28 sources <z>=5.76
F(Soft)~4E-18 <logLX>~42.2