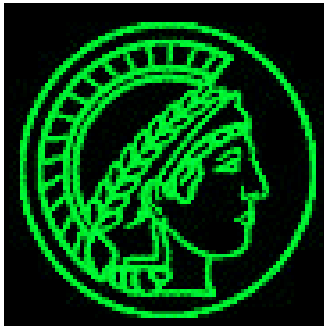


The Cosmic Evolution of Active Galactic Nuclei

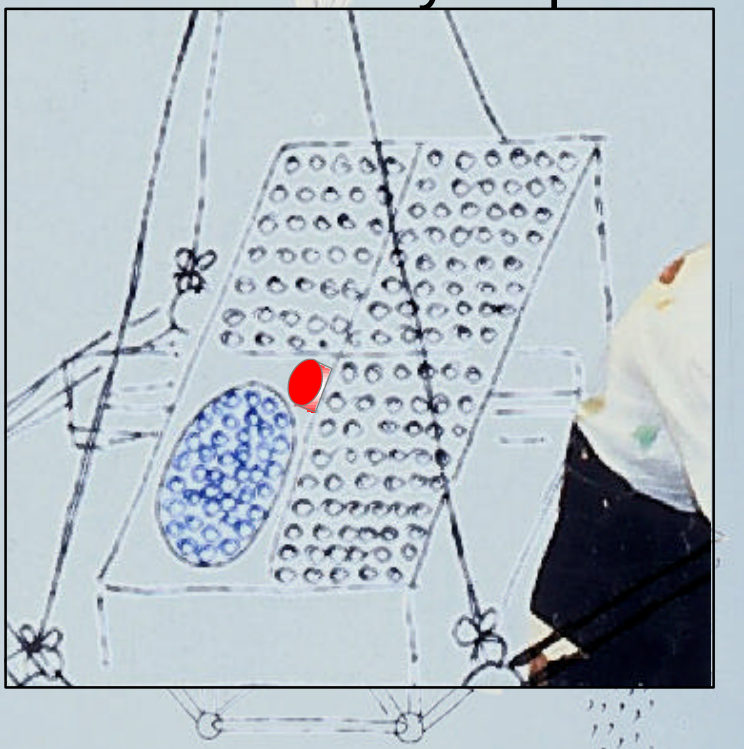
Günther Hasinger, MPE Garching

Topics in X-ray Astronomy, Workshop on the occasion of Rüdiger Staubert's 65th birthday

Tübingen, 24. Feb. 2004

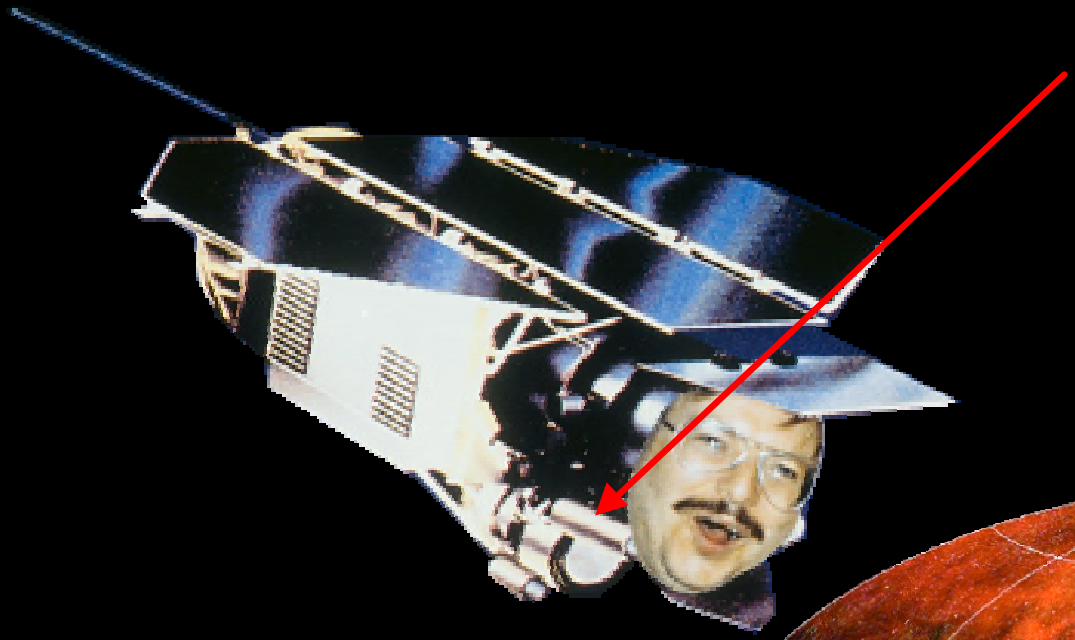
PhD Thesis at MPE Garching

High Energy
X-ray Experiment

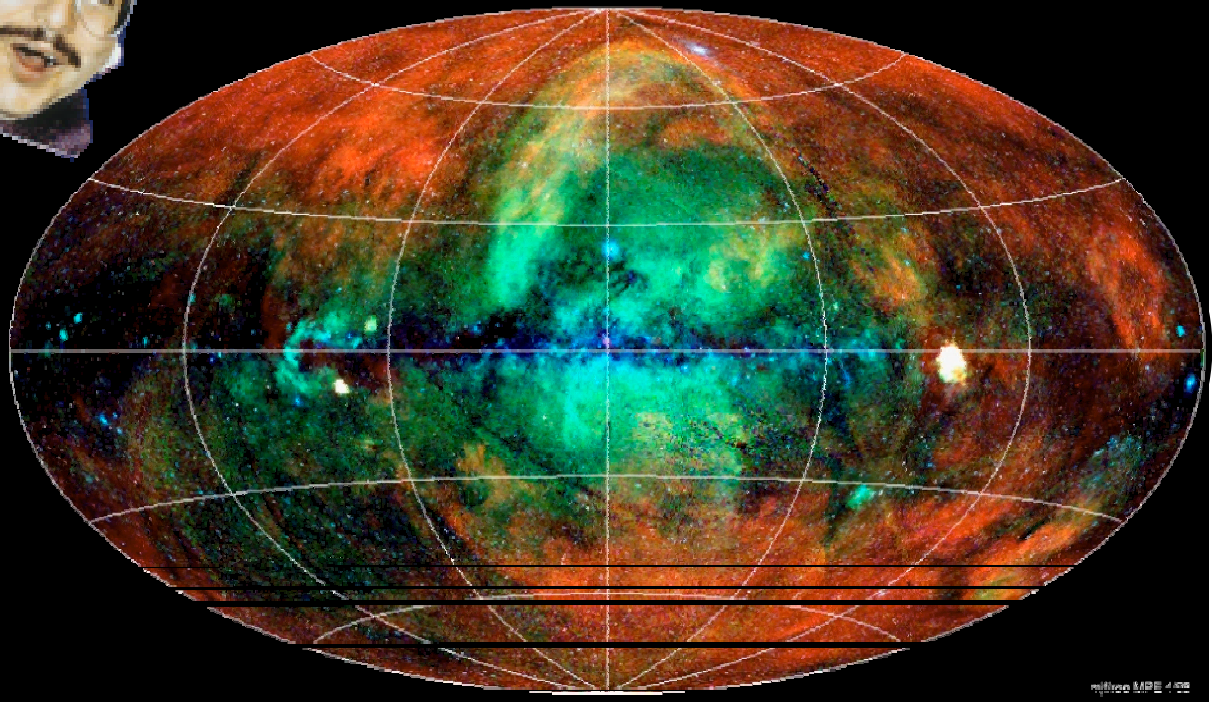


1981-1984 (under J. Trümper)

... on the wings of ROSAT...



Star Tracker
1st Gyro Failure in 1990
Magnetometer-Attitude
Mission life > 9yrs
Later used for other S/C
(SAX, Global Star, ABRIXAS)



The Cosmic Evolution of Active Galactic Nuclei

Günther Hasinger, MPE Garching

Collaborators:

CDFS: J. Bergeron, S. Borgani, R. Giacconi, R. Gilli, R. Gilmozzi, K. Kellerman, L. Kewley, A. Koekemoer, I. Lehmann, V. Mainieri, M. Nonino, C. Norman, M. Romaniello, P. Rosati, E. Schreier, G. Szokoly, P. Tozzi, J.X. Wang, W. Zheng, A. Zirm

Lockman Hole: X. Barcons, H. Böhringer, A. Fabian, Y. Hashimoto, P. Henry, I. Lehmann, V. Mainieri, I. Matute, M. Schmidt, A. Streblyanskaya, G. Szokoly, M. Worsley

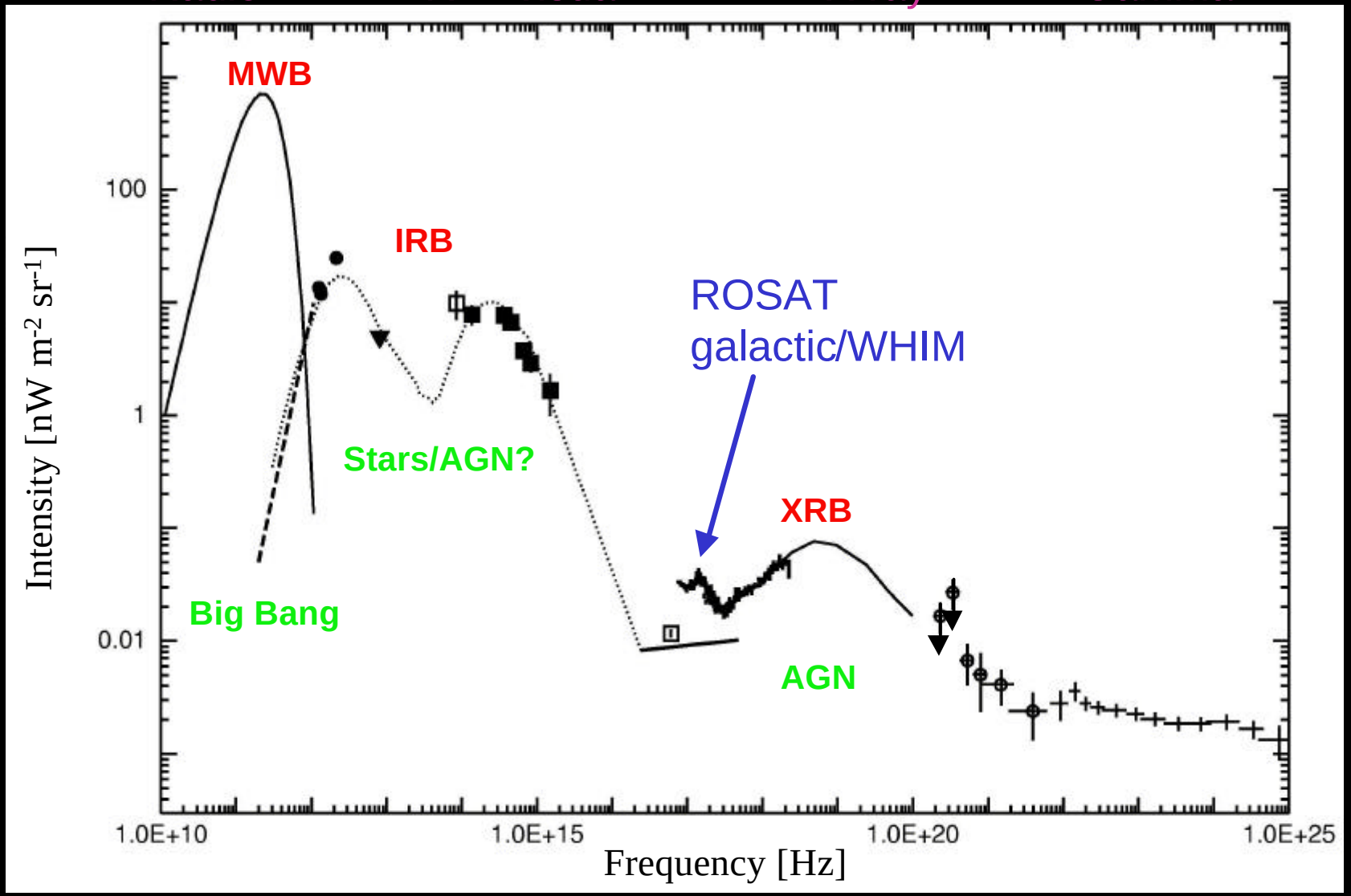
Overall Sample & Luminosity Function: T. Miyaji, M. Schmidt

Topics in X-ray Astronomy, Workshop on the occasion of Rüdiger Staubert's 65th birthday

Tübingen, 24. Feb. 2004

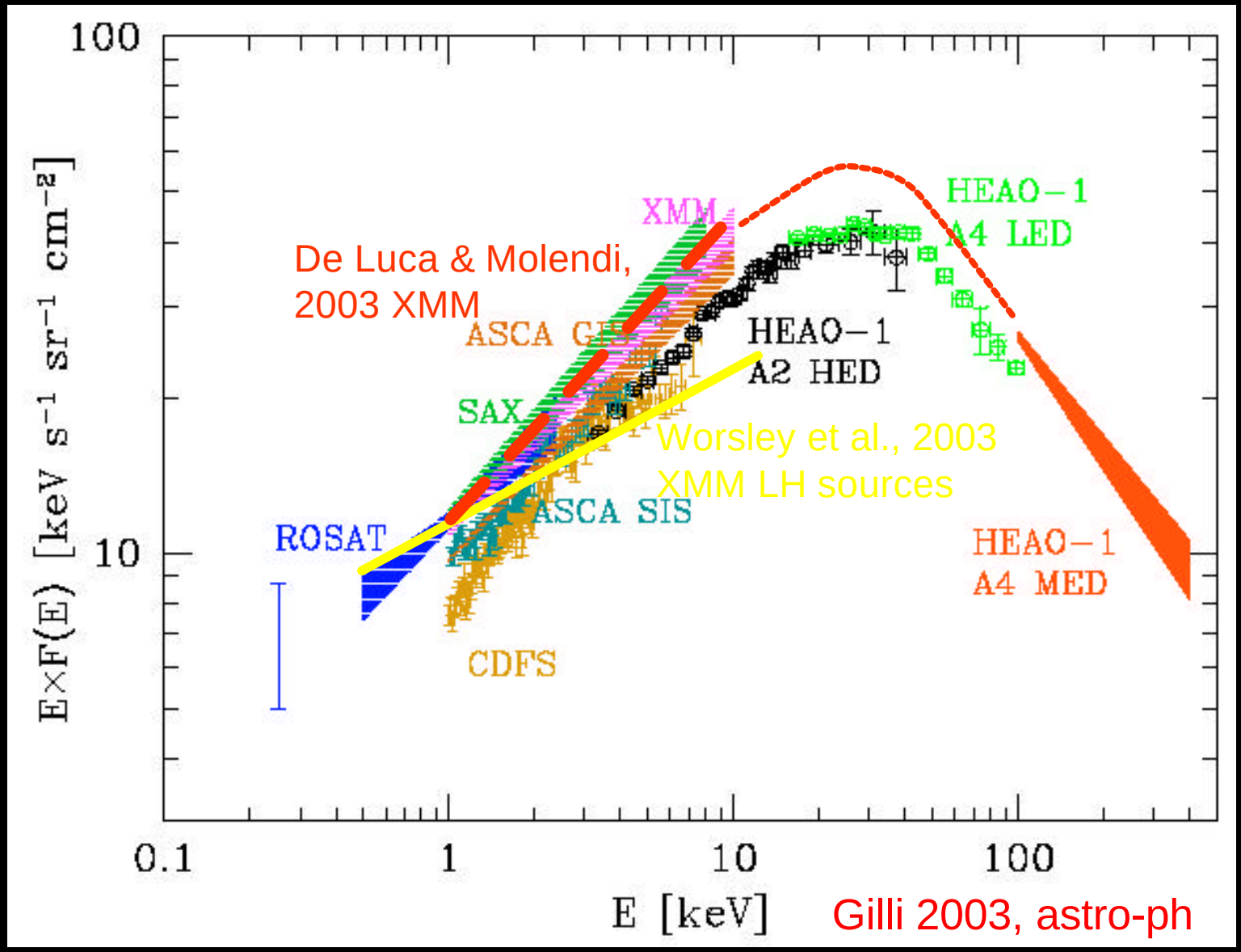
Cosmic Energy Spectrum

Radio IR visual X-ray Gamma



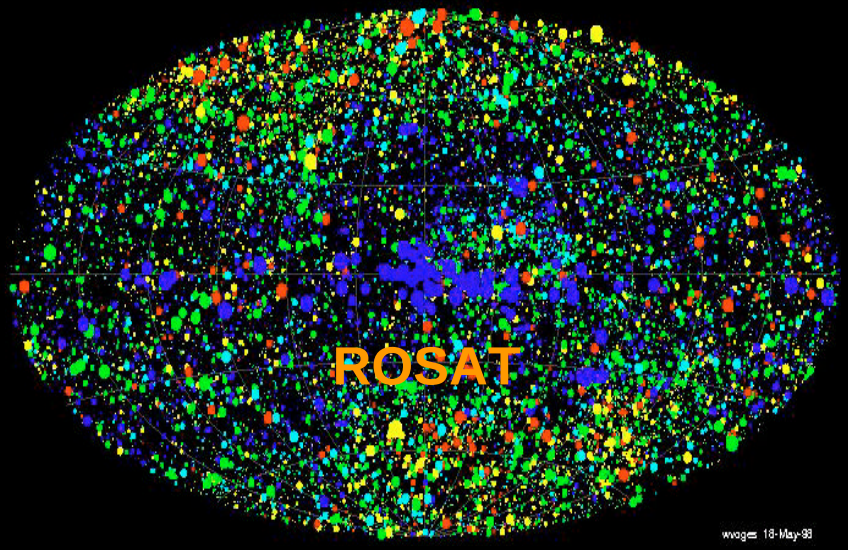
Hasinger 2000, astro-ph

The X-ray Background

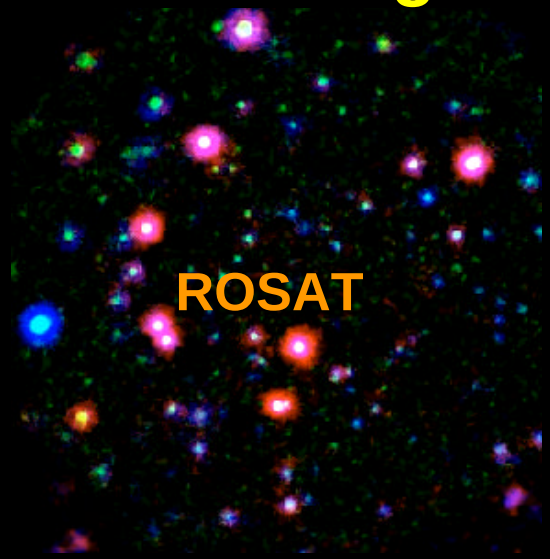


X-ray Surveys

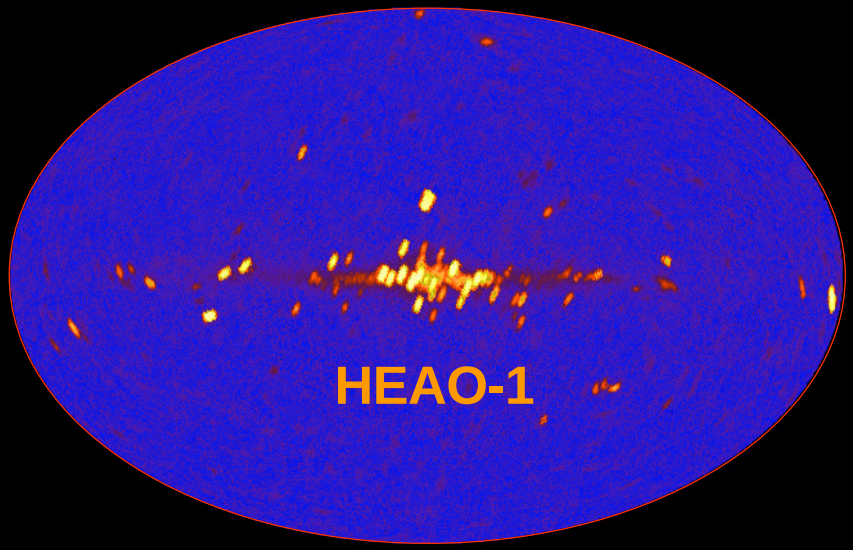
Scanning

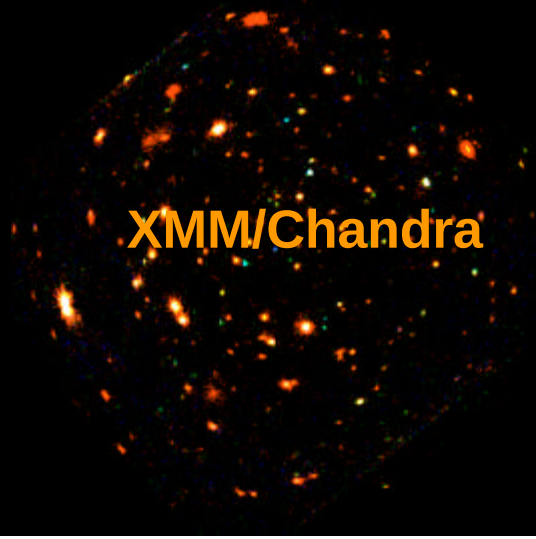


Pointing



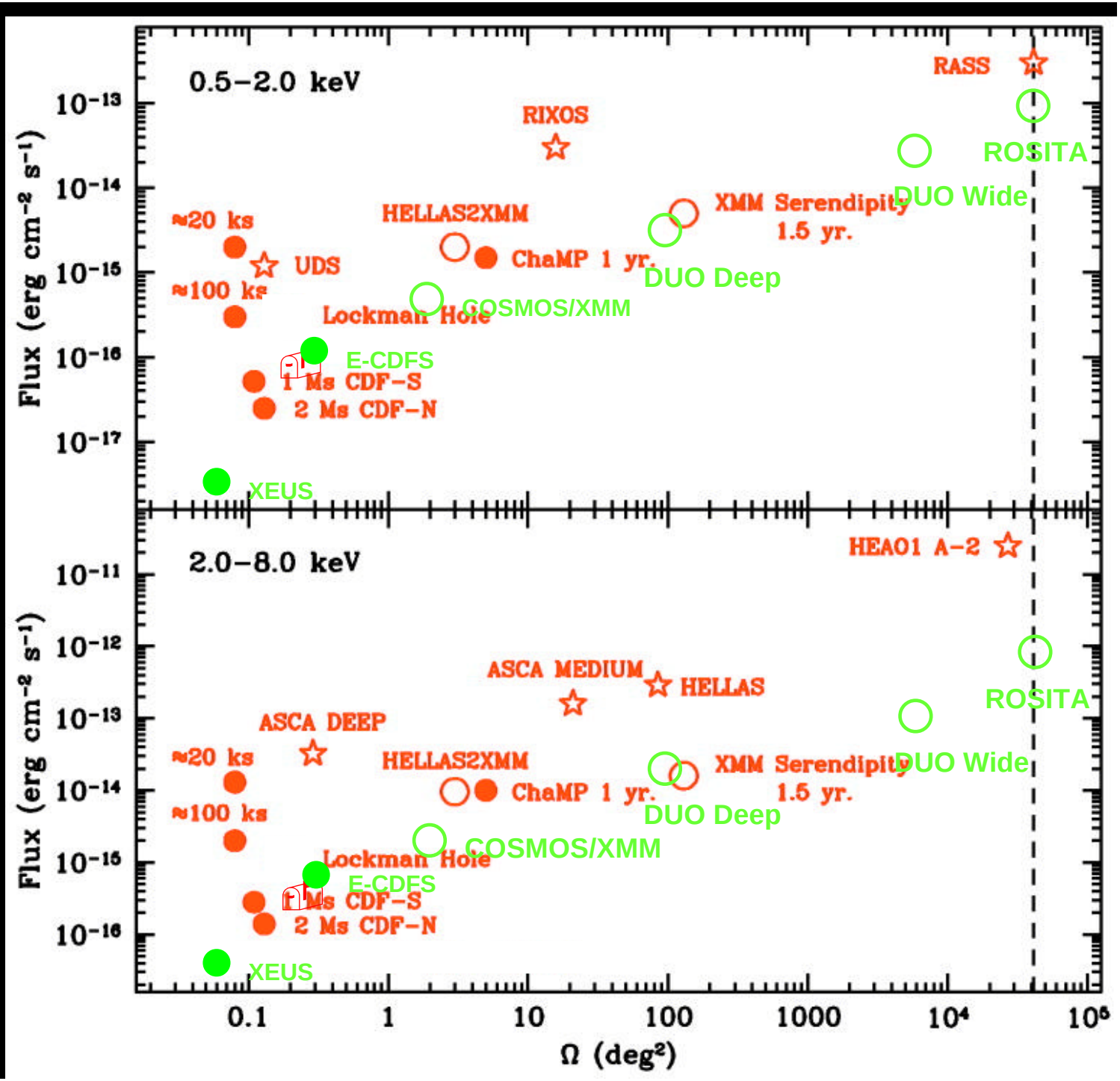
0.1-2 keV



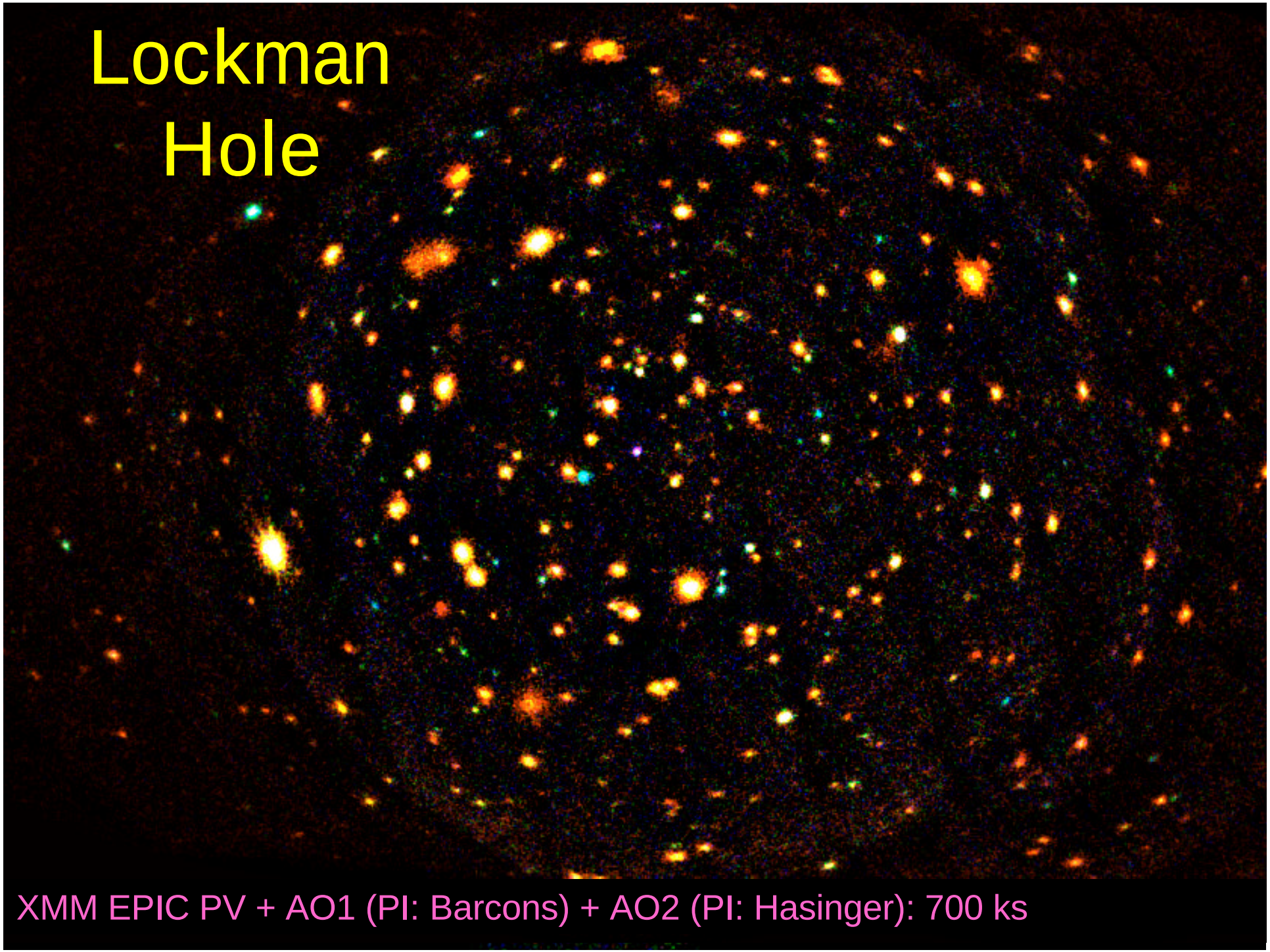


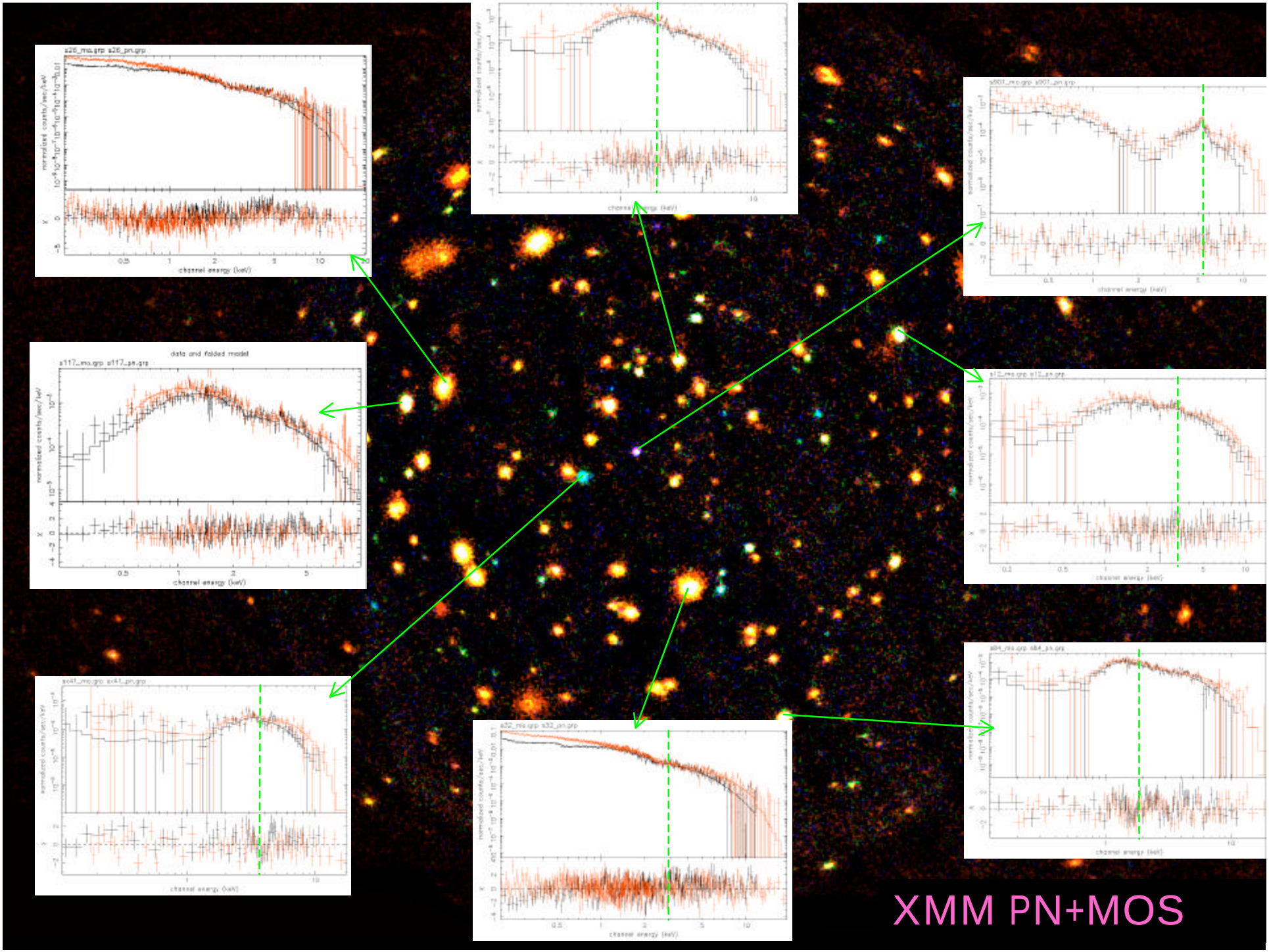
2-10 keV

X-ray surveys

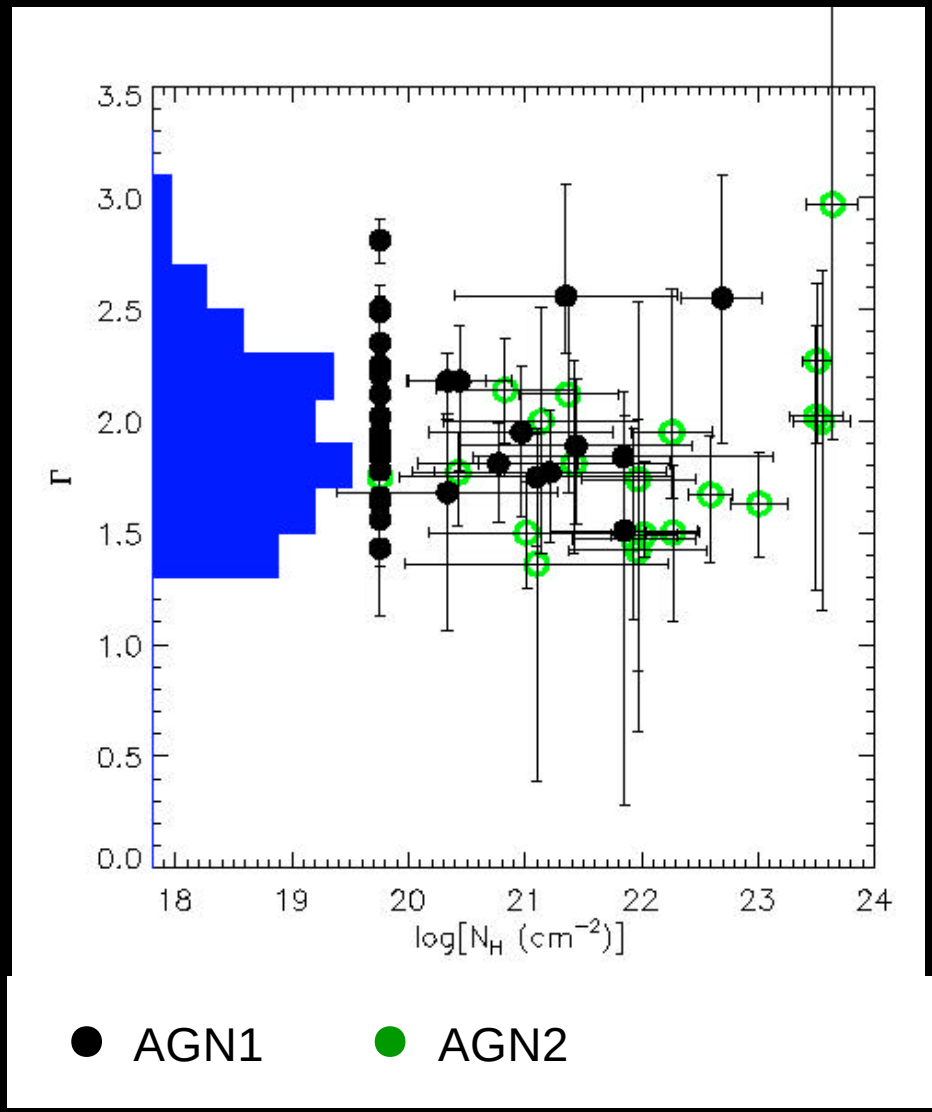


Alexander et al. 2003, AJ, 126, 539


Lockman
Hole
XMM EPIC PV + AO1 (PI: Barcons) + AO2 (PI: Hasinger): 700 ks


XMM PN+MOS

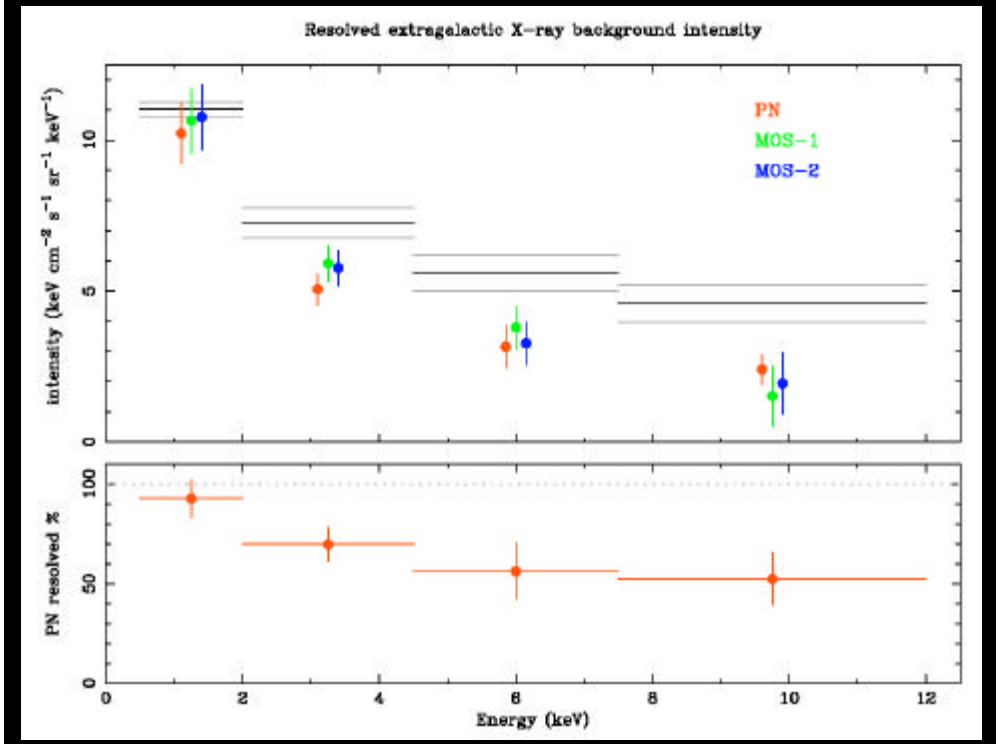
XMM LH Spectral Diagnostic



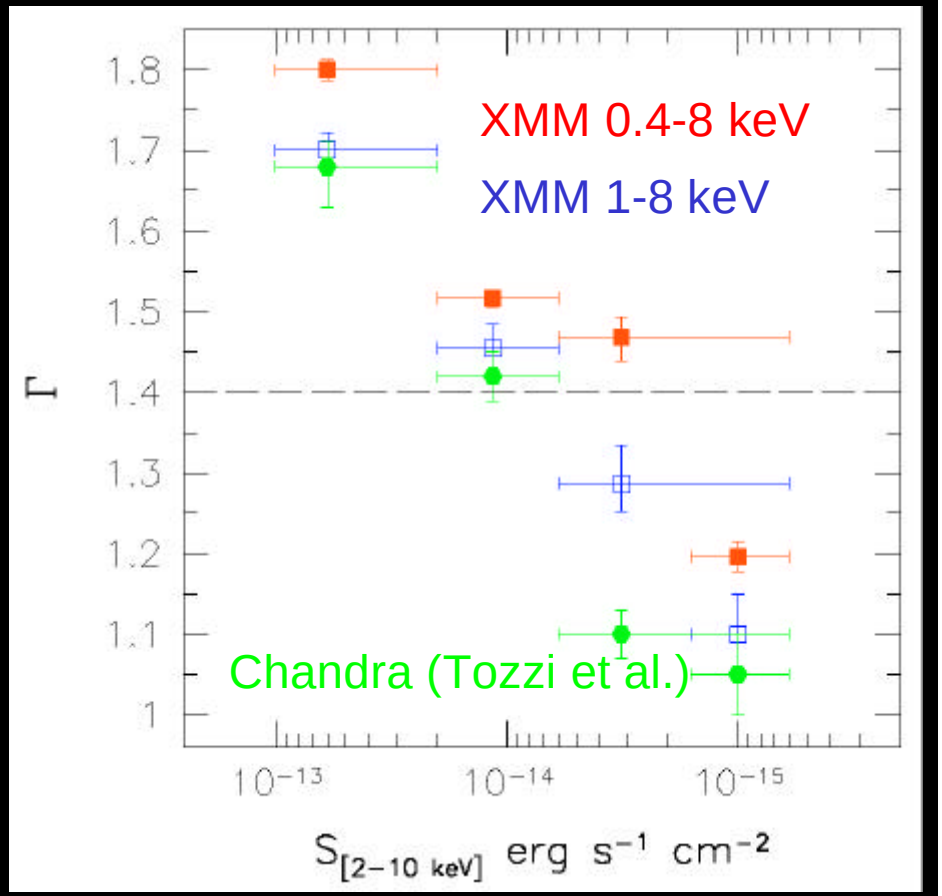
Confirming prediction of XRB synthesis models

Mainieri , Bergeron et al. 2002

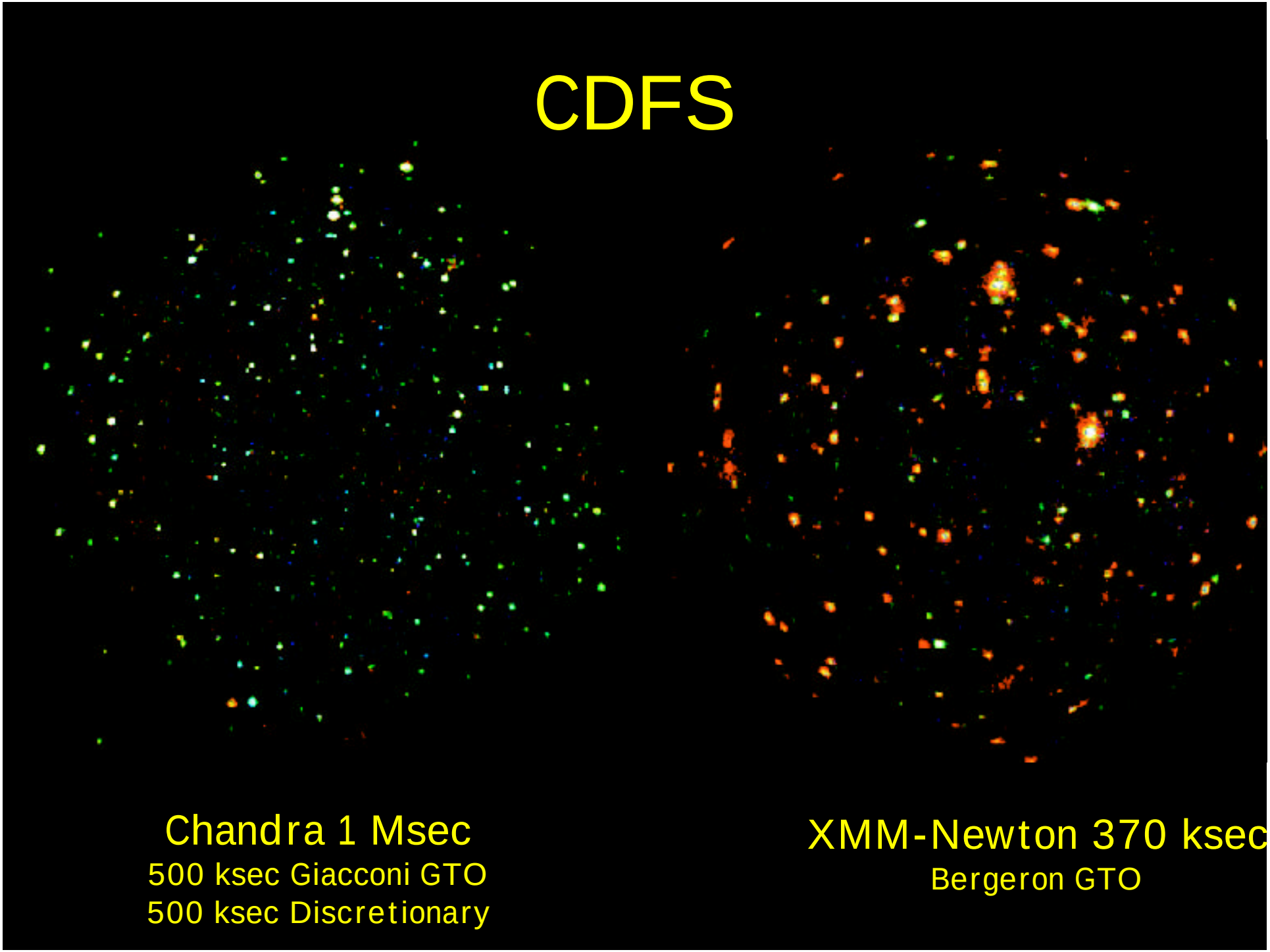
Resolved Fraction



Worsley et al., 2003

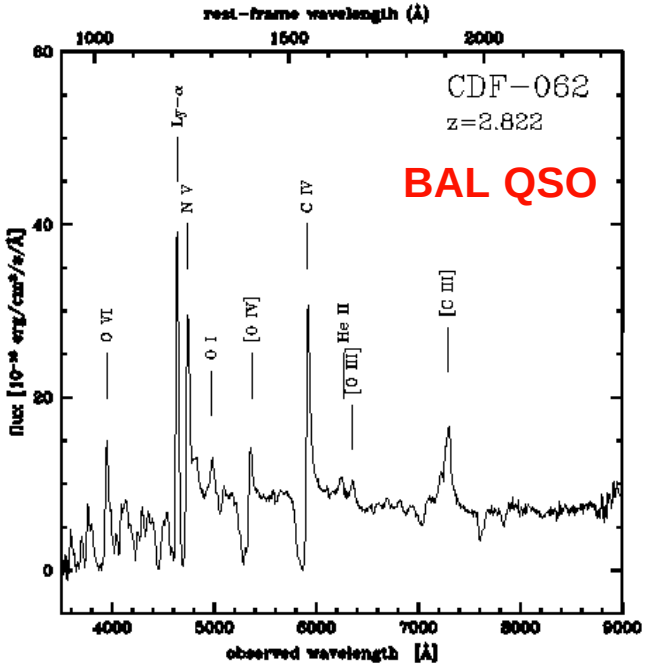


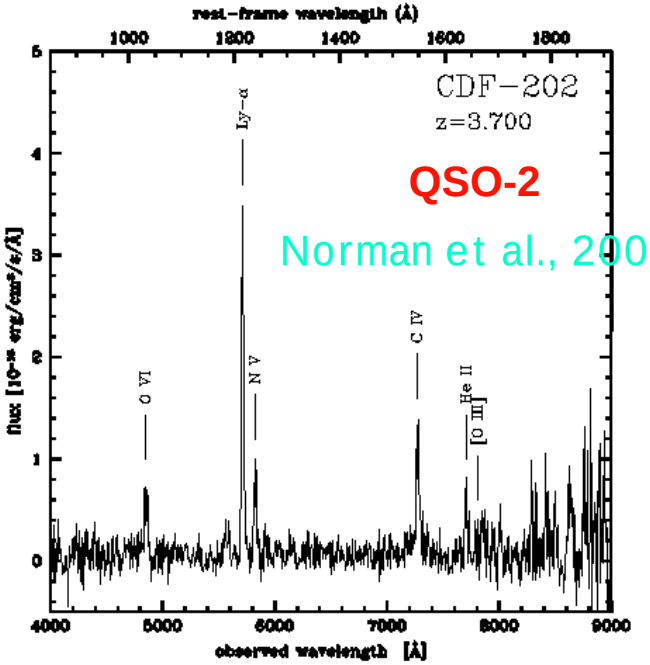
Streblyanskaya, 2003 PhD thesis


CDFS
Chandra 1 Msec
500 ksec Giacconi GTO
500 ksec Discretionary
XMM-Newton 370 ksec
Bergeron GTO

Optical Identifications

VLT FORS multiobject spectroscopy:
11 nights (2000-2001) 1-5 hrs exposures
Szokoly et al., 2003 (APJS)

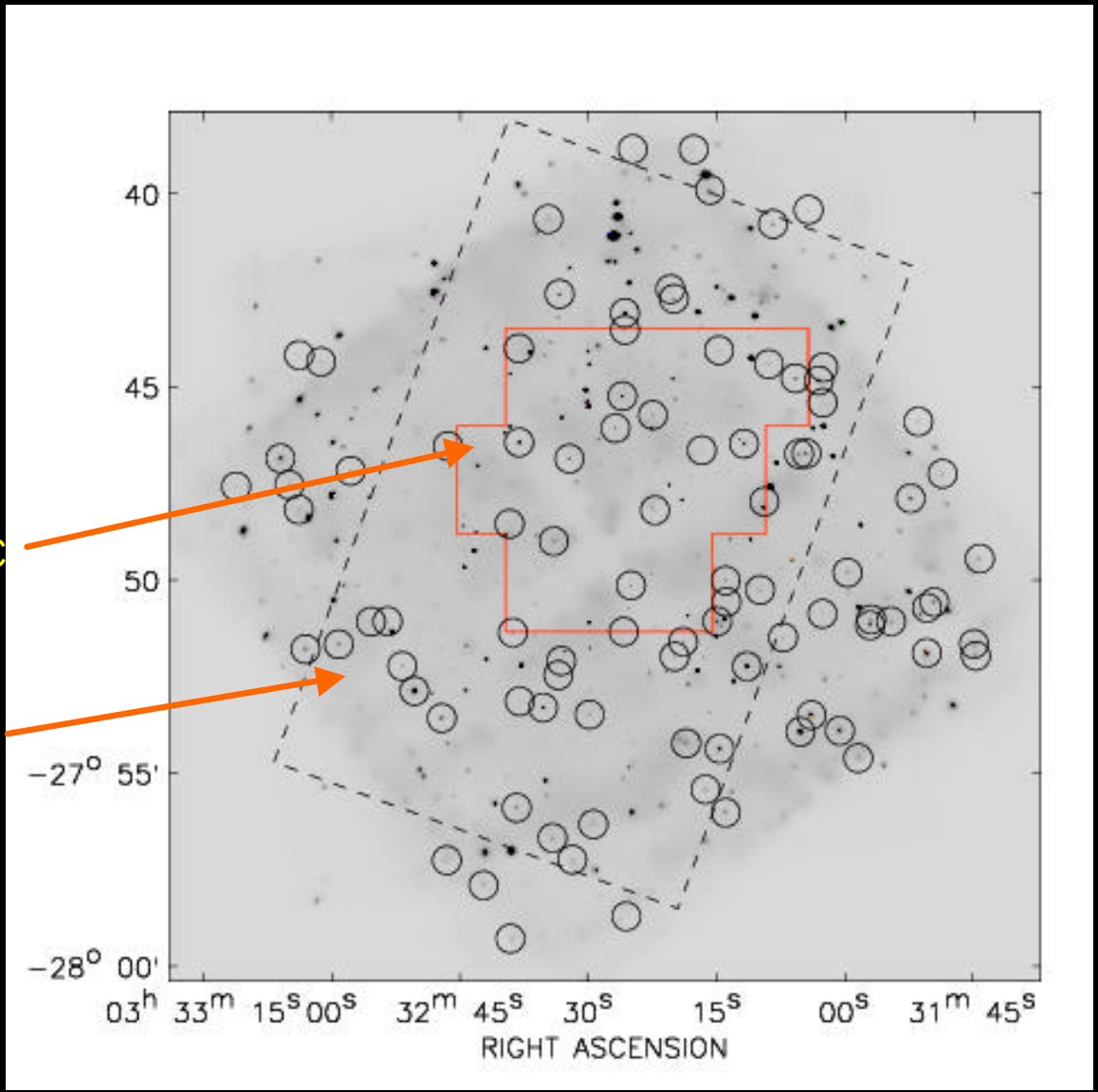




Norman et al., 2002

GOODS Survey

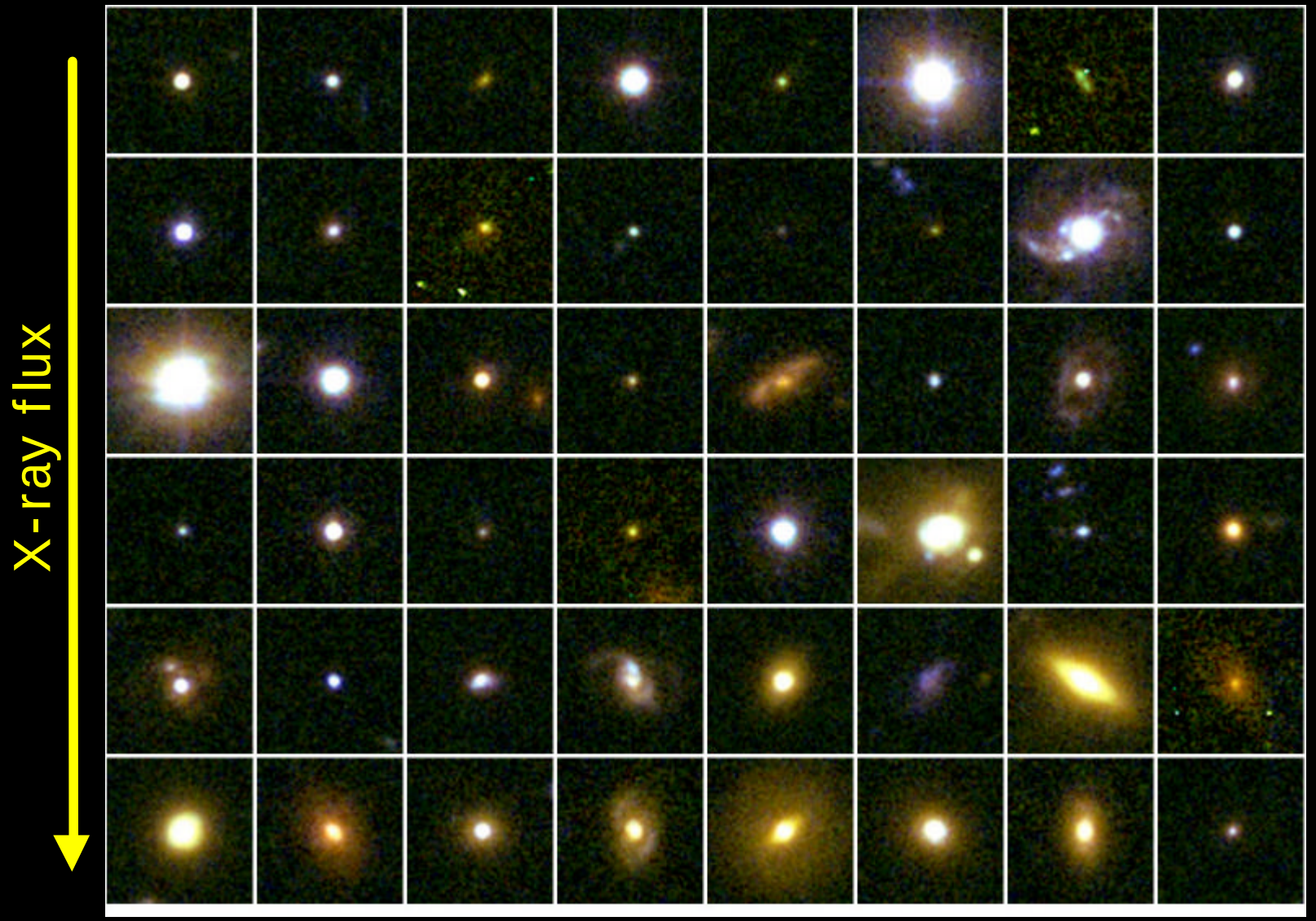
Deep multiwavelength coverage in CDFS



B(10s, 0.2") = 27.8
V(10s, 0.2") = 27.8
I(10s, 0.2") = 27.1
z(10s, 0.2") = 26.6
J(10s, 0.2") = 25.5
H(10s, 0.2") = 24.9
K(10s, 0.2") = 25.1

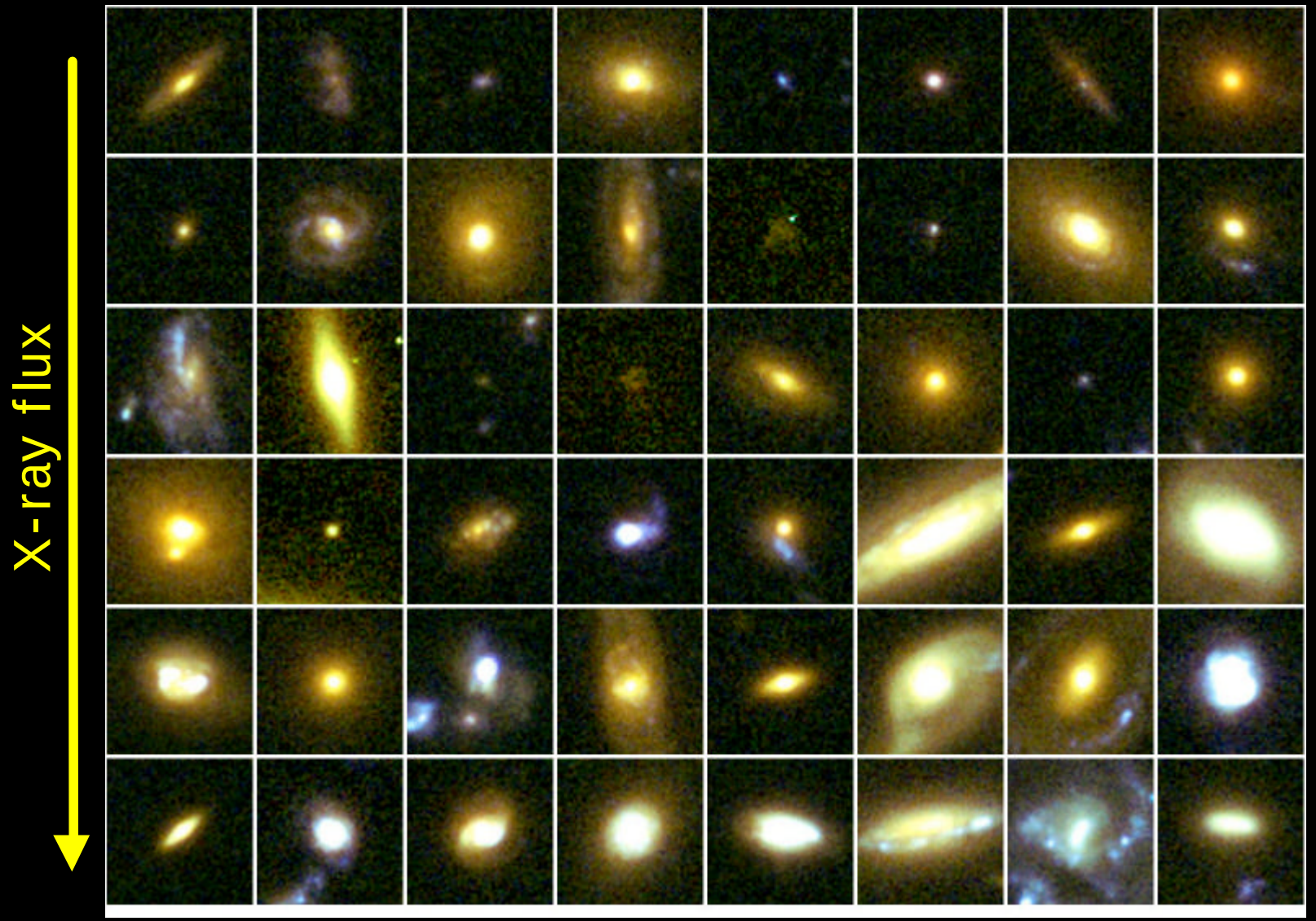
AB mags

AGN zoo (GOODS ACS data)

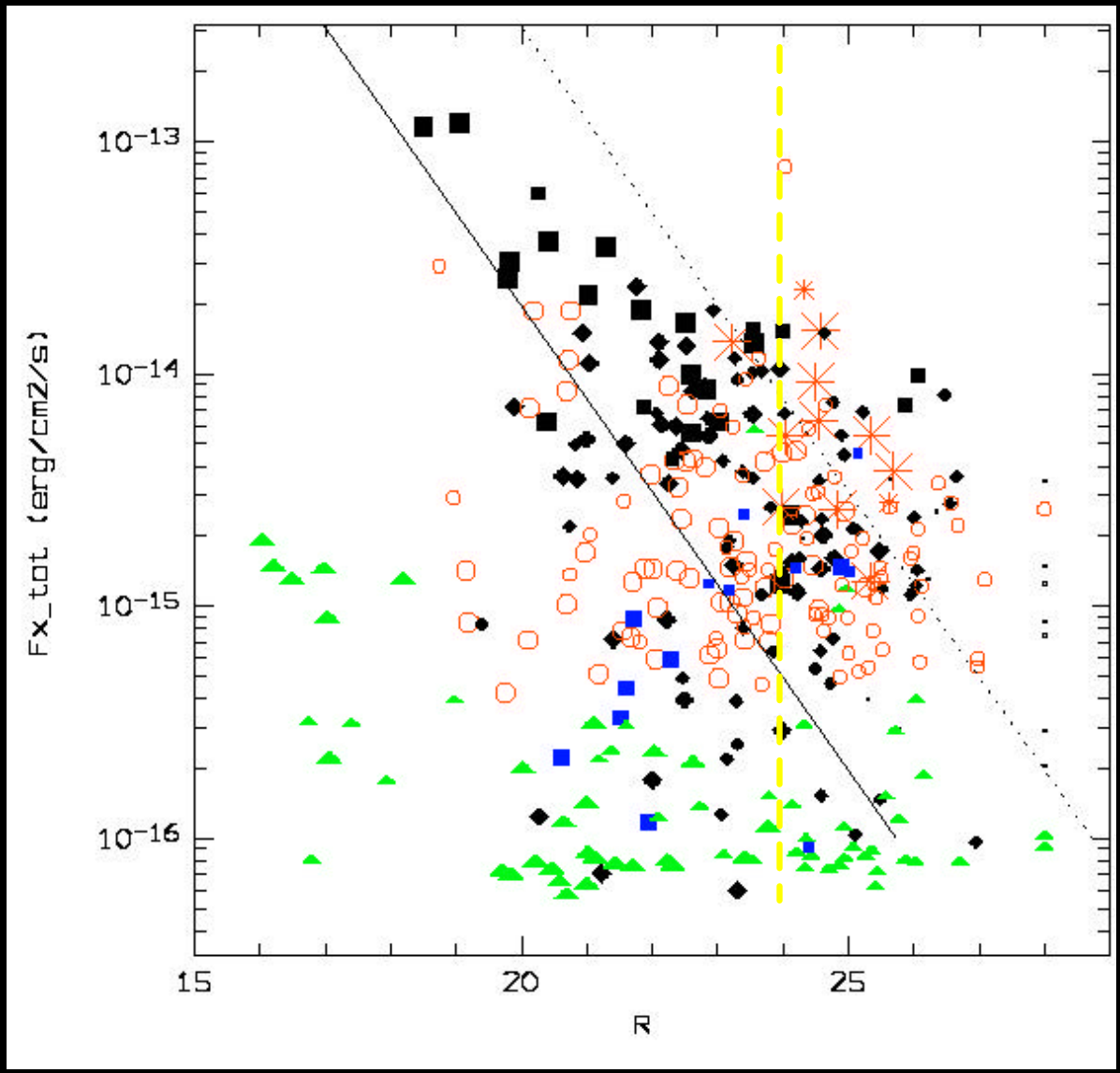


Mainieri 2003, PhD thesis

AGN zoo (GOODS ACS data)



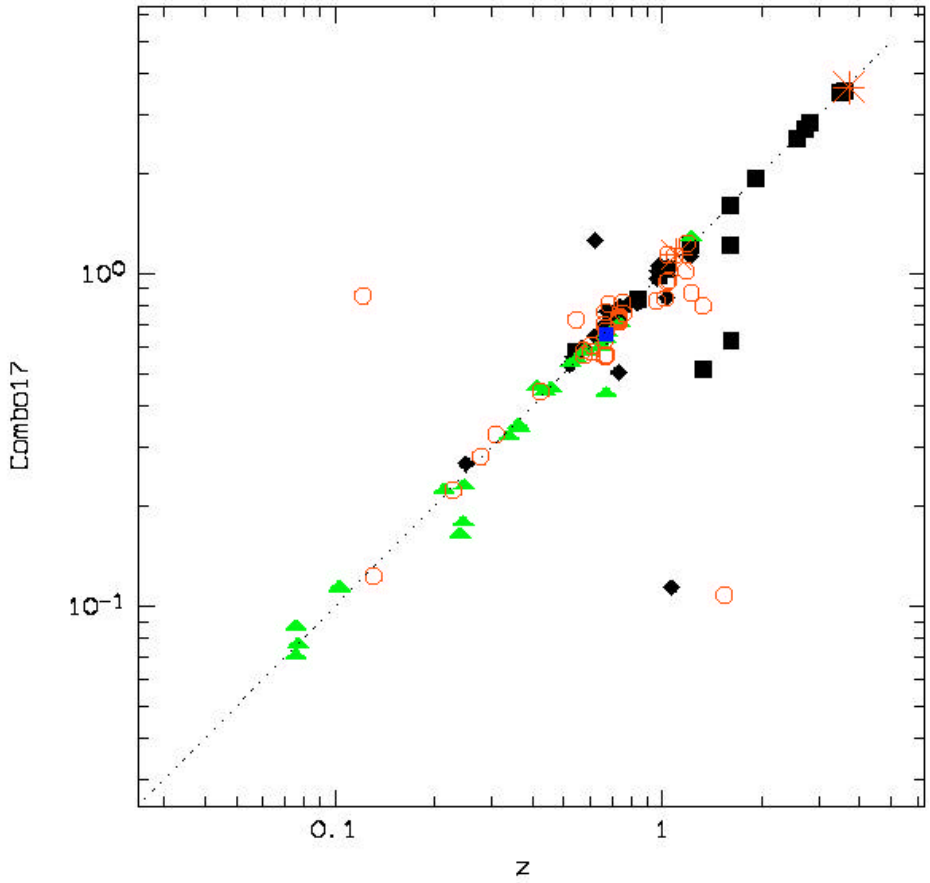
Spectro+Photo IDs



- Larger symbols: spectro-zs
- Smaller symbols: photo-zs
- Incompleteness is only 5% with HST/VLT photo-z!
- See Koekemoer et al. for the optically empty error circles

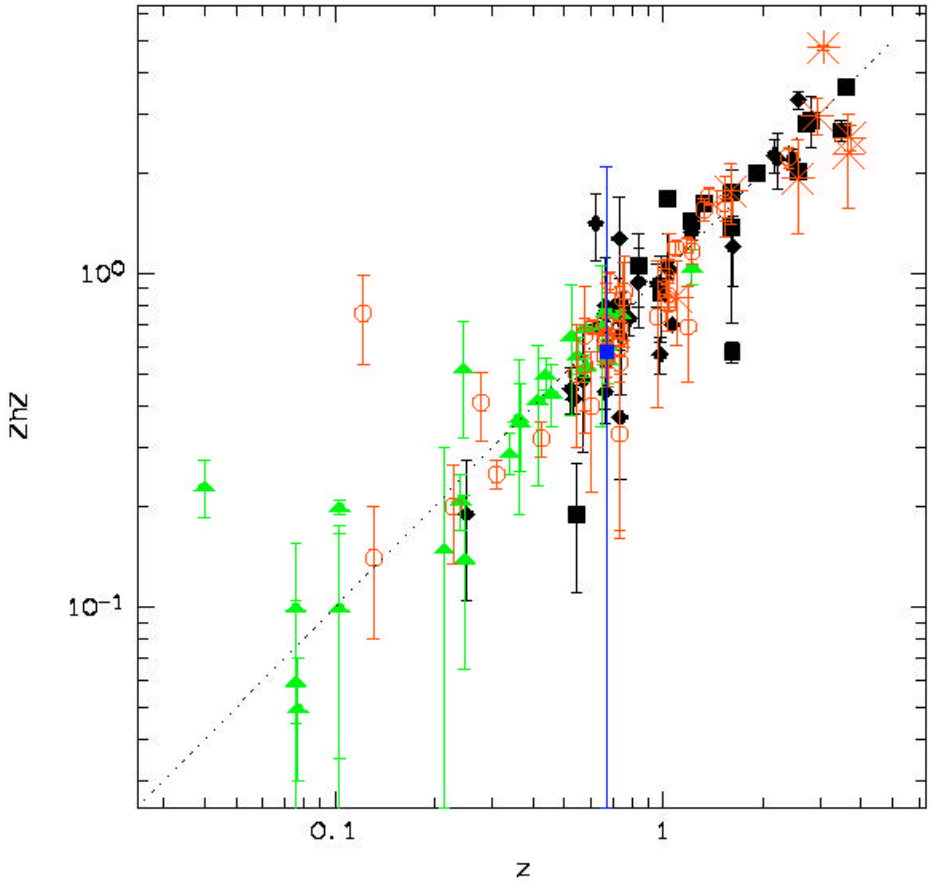
Comparison of Photo-zs

COMBO-17



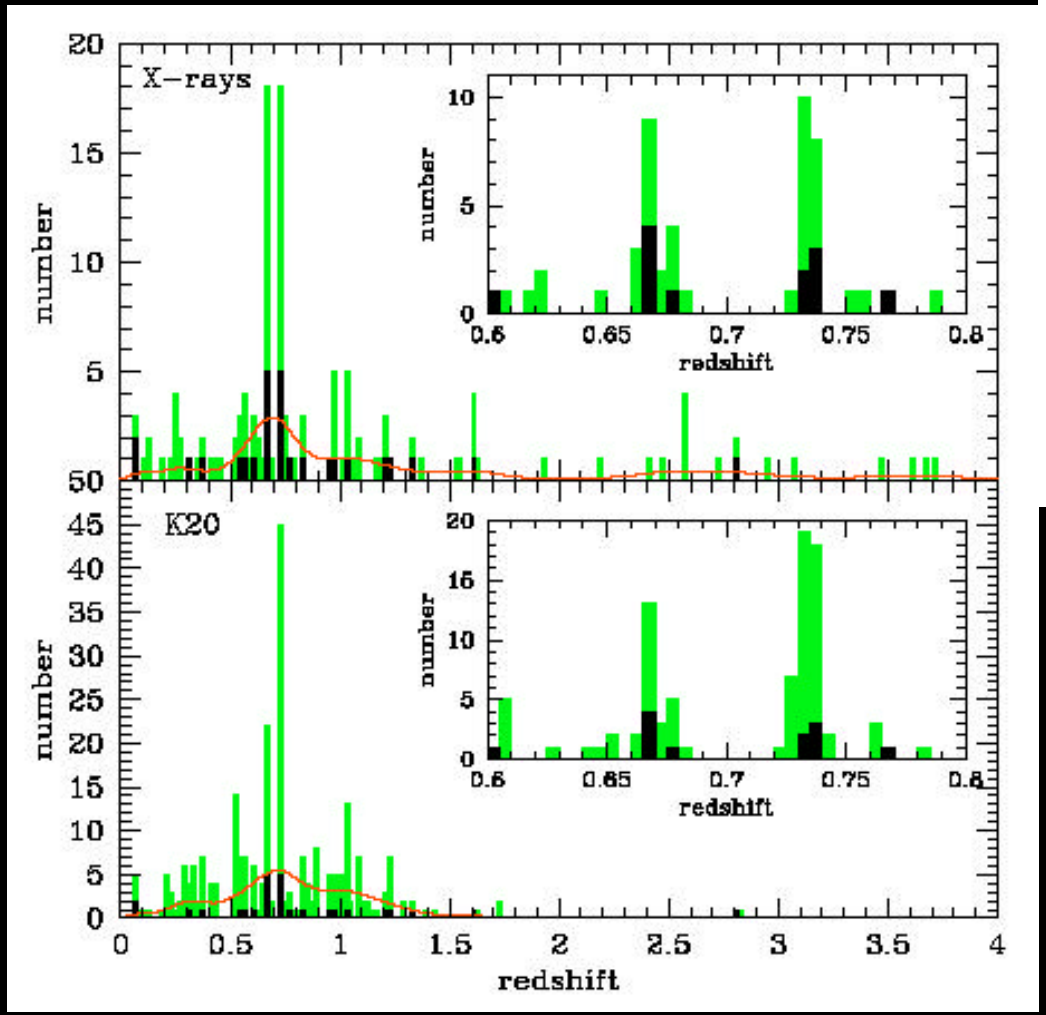
Wolf et al., 2003

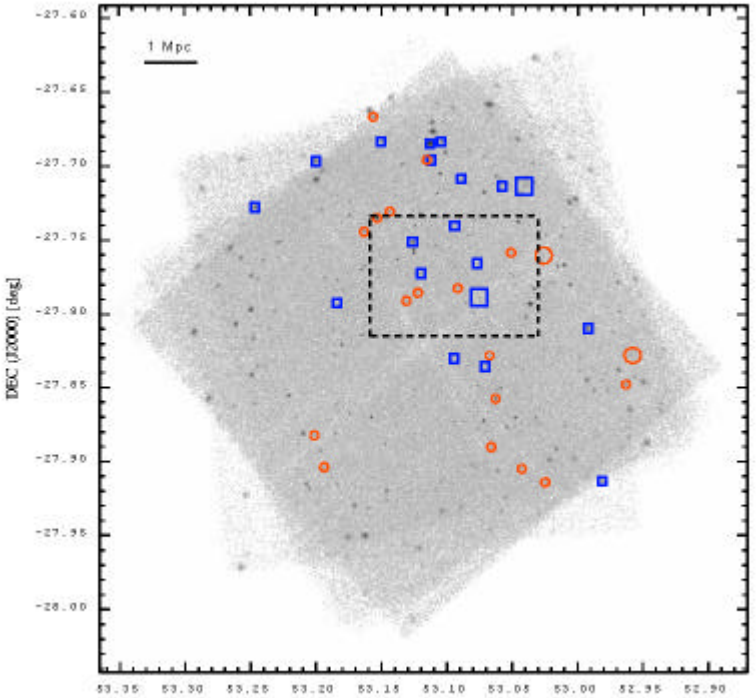
GOODS VLT+HST Photom.

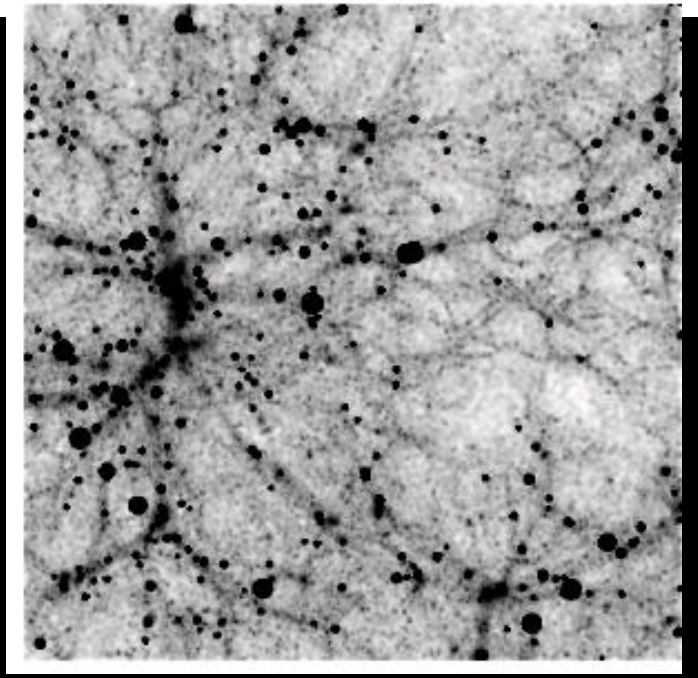


Zheng, ..., Mainieri et al., 2004

AGN in Sheets







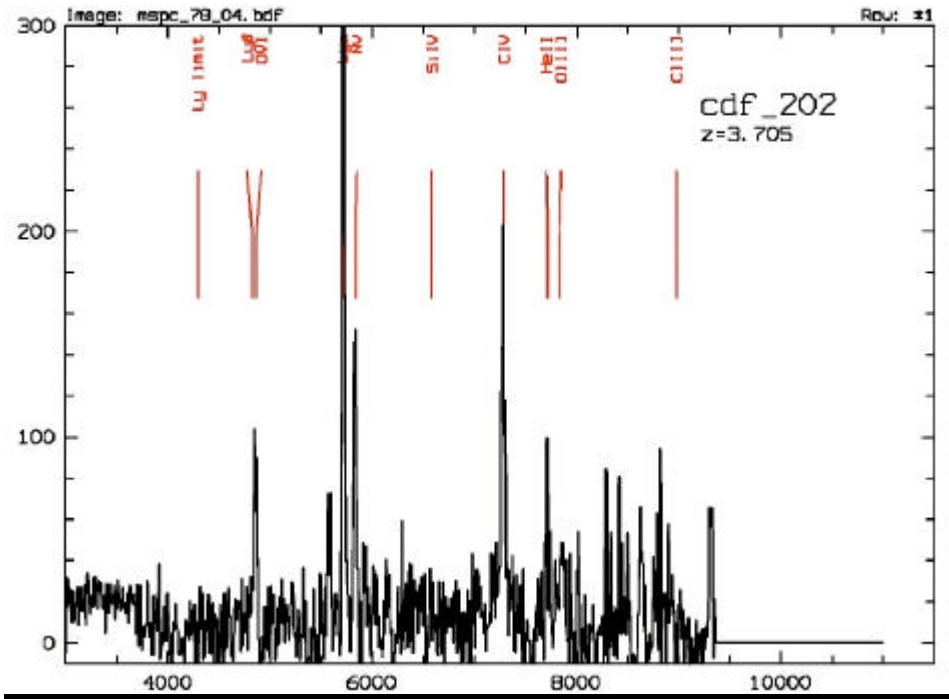
Gilli et al., 2003, CDF-S results

QSO-2 detected

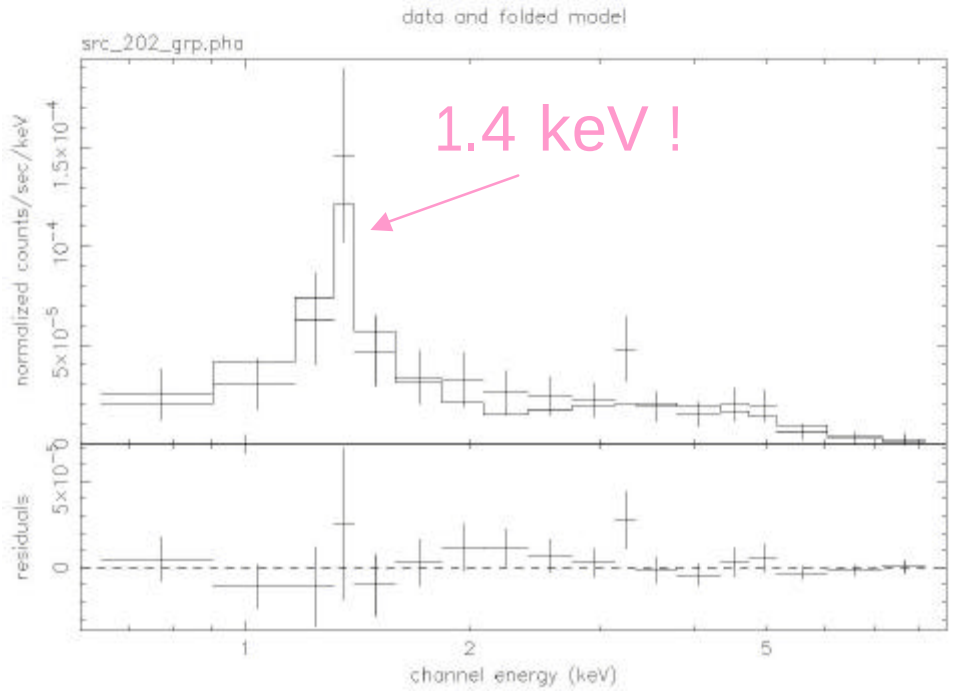
CDFS #202: type-2 QSO
z=3.705
narrow high-excitation lines

$L_X \sim 10^{45}$ erg/s
$N_H \sim 10^{24} cm^{-2}$
Fe-line @ 6.4 keV

VLT-spectrum



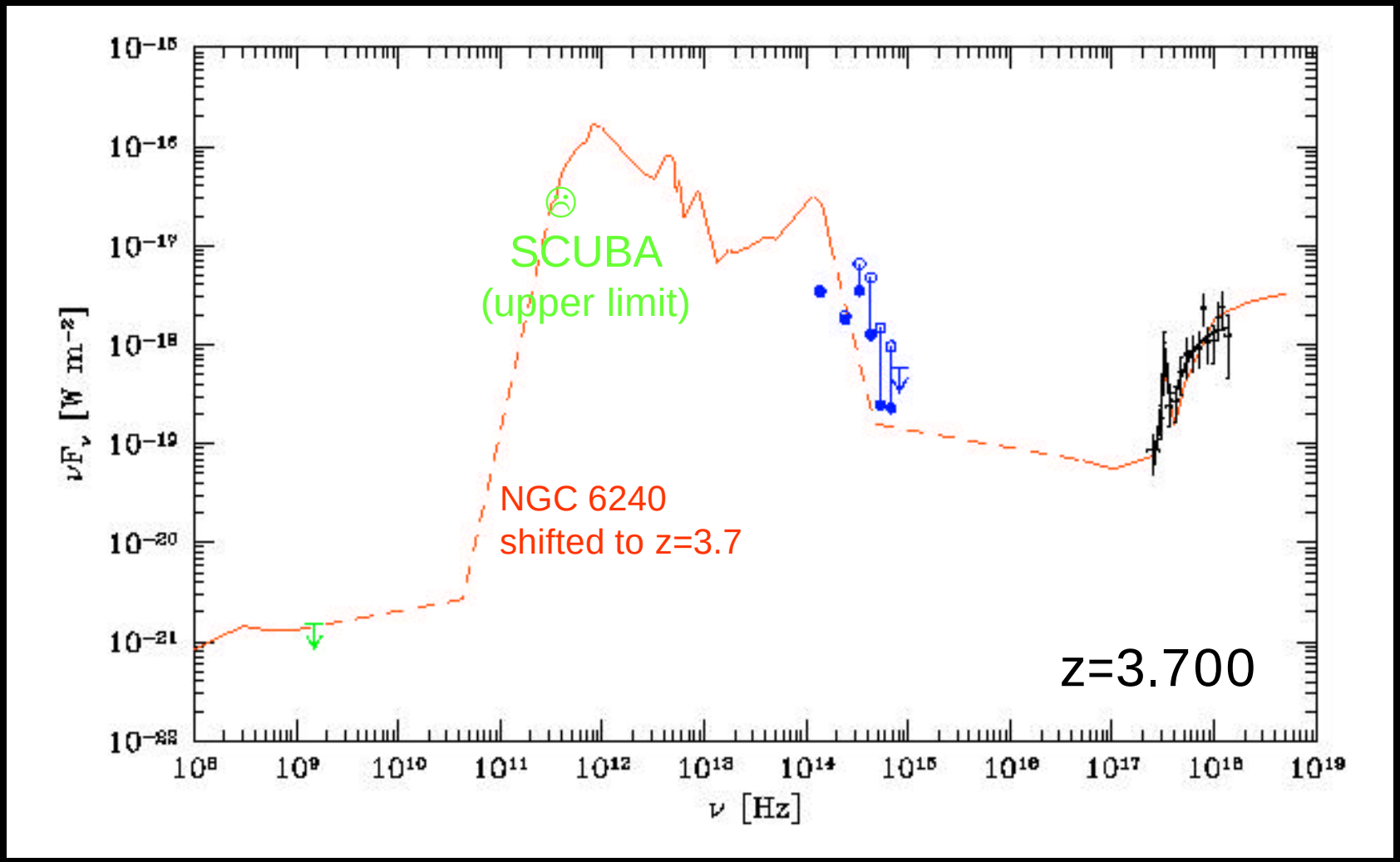
Chandra spectrum



Norman et al., 2001

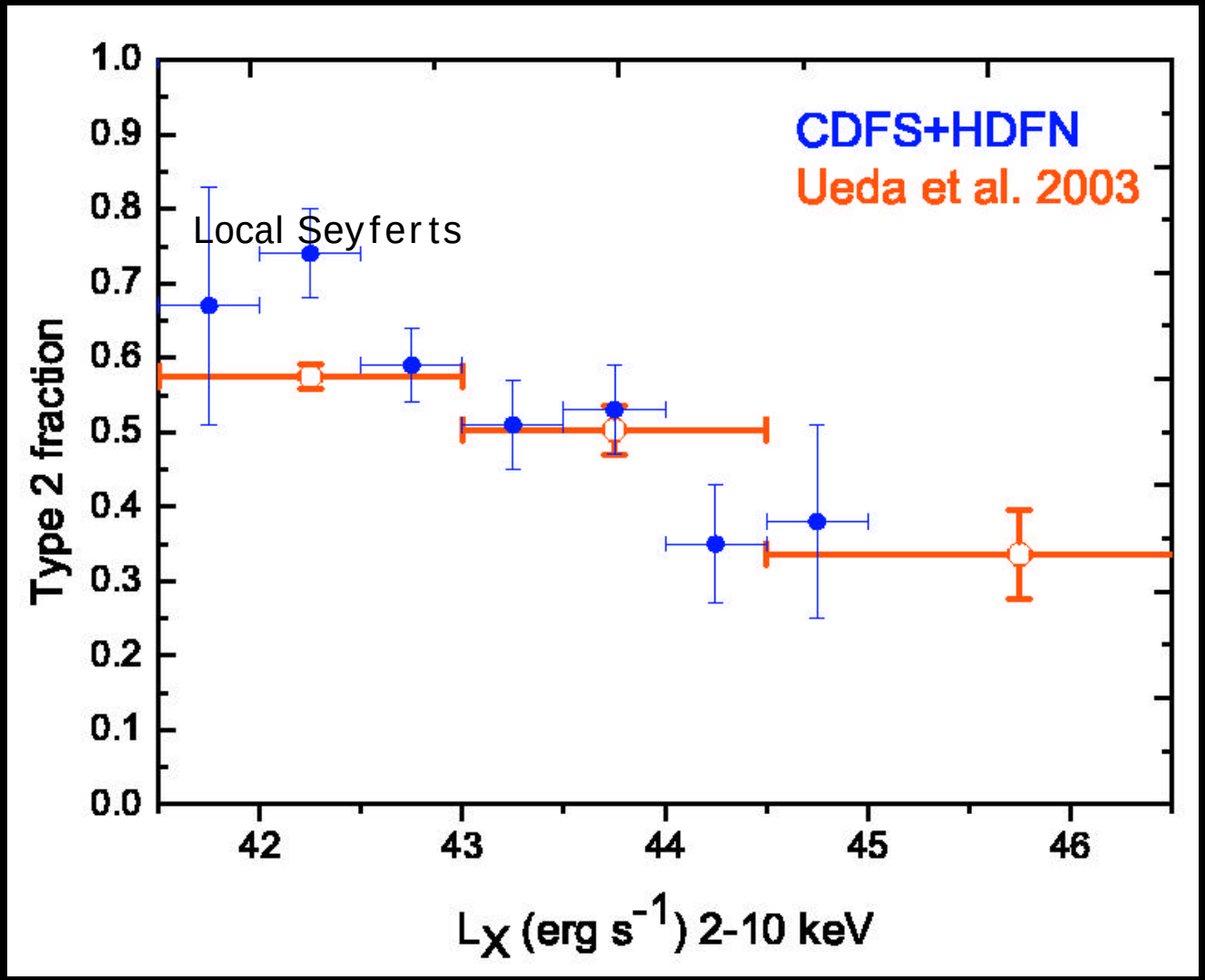
=> Rosetta-Stone for X-ray Background !!!

Prototypical QSO2 CDFS #202



⇒ High-redshift carbon copy of NGC 6240 !

Type 2 fraction



Fraction of type-2's decreses with luminosity

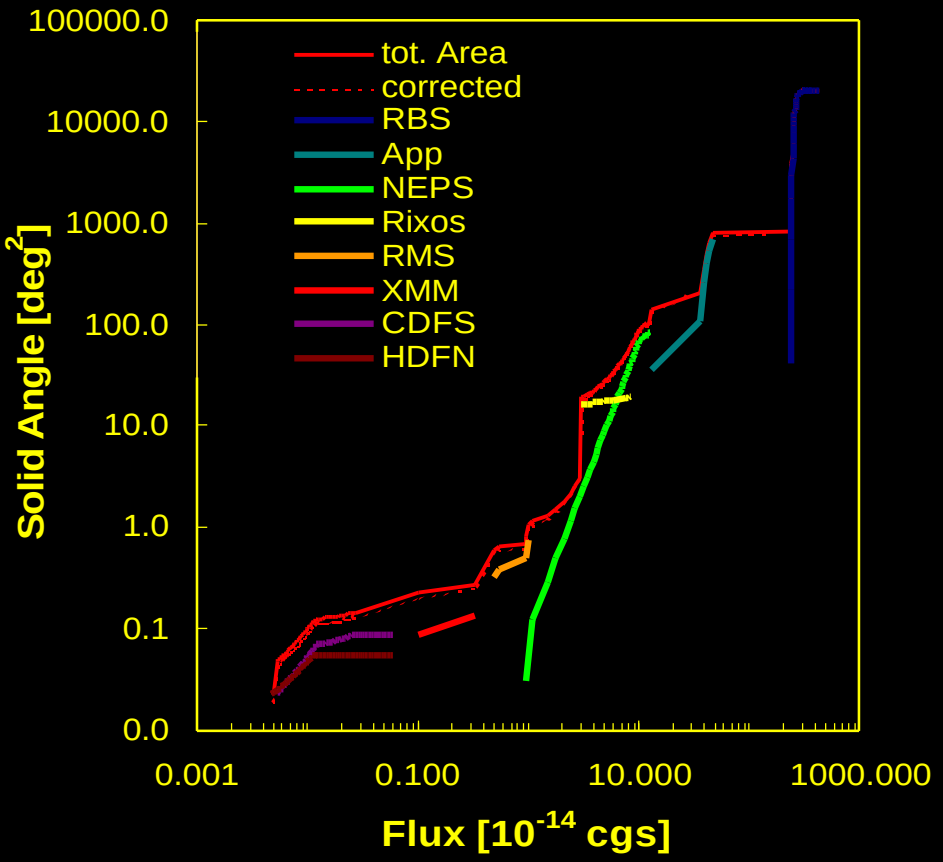
Ueda et al., 2003; Szokoly et al., 2003

Multi-Cone Surveys

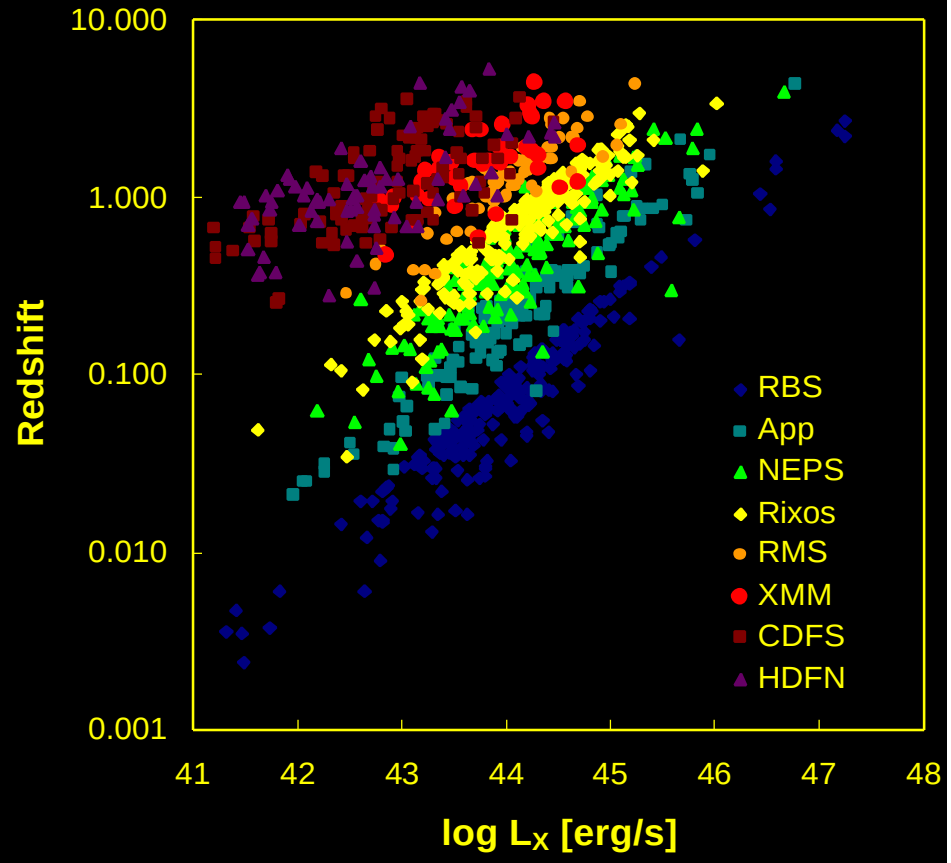
- Type-1 AGN in the 0.5-2 keV band
  - Continuation of ROSAT work, most sensitive & complete
- ROSAT Samples (Miyaji et al., 2000)
  - ROSAT Bright Survey: 217 AGN (Schwope et al., 2000)
  - RASS Selected North: 133 AGN (Appenzeller et al., 1996)
  - RASS NEP Survey: 165 AGN (Gioia et al., 2003)
  - RIXOS serendipitous: 206 AGN (Mason et al., 2000)
  - ROSAT Deep Surveys: 78 AGN (e.g. Schmidt et al., 1998)
- XMM Deep Survey (Hasinger et al., 2001)
  - Lockman Hole: 42 AGN (Lehmann et al., 2001 ++)
- Chandra Deep Surveys
  - CDF North/HDF-N: 73 AGN (Barger et al., 2003)
  - CDFS spec.+phot.: 106 AGN (Szokoly, Zheng et al. 2003)
- Total: 1020 AGN1

Multi-Cone Surveys

Survey Area

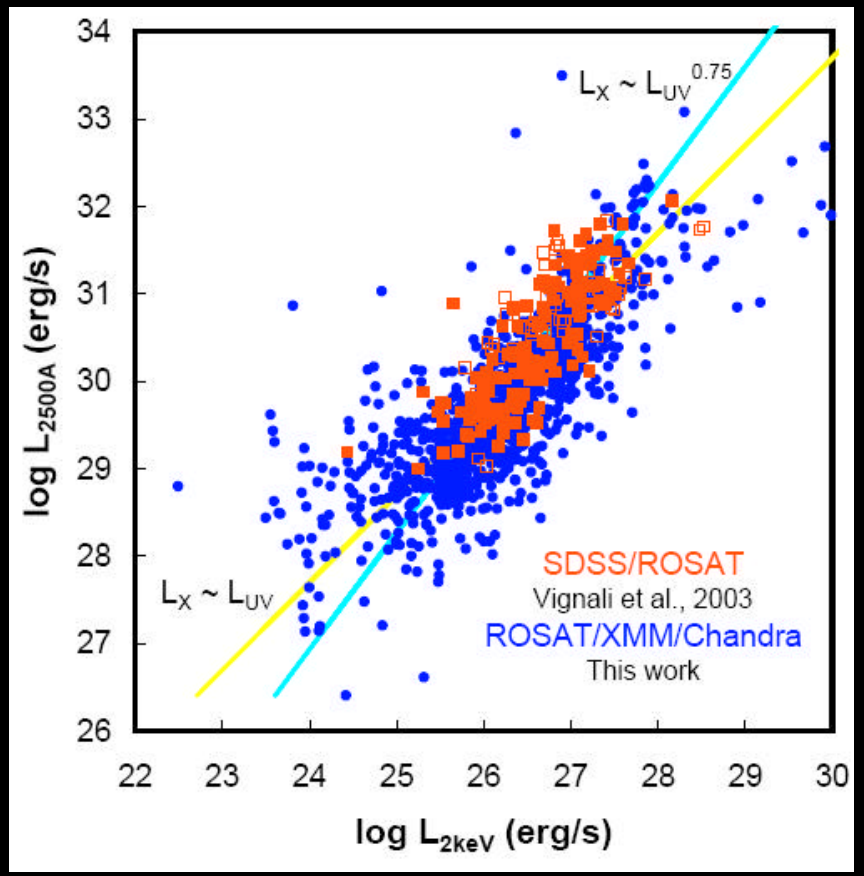


Hubble Diagram



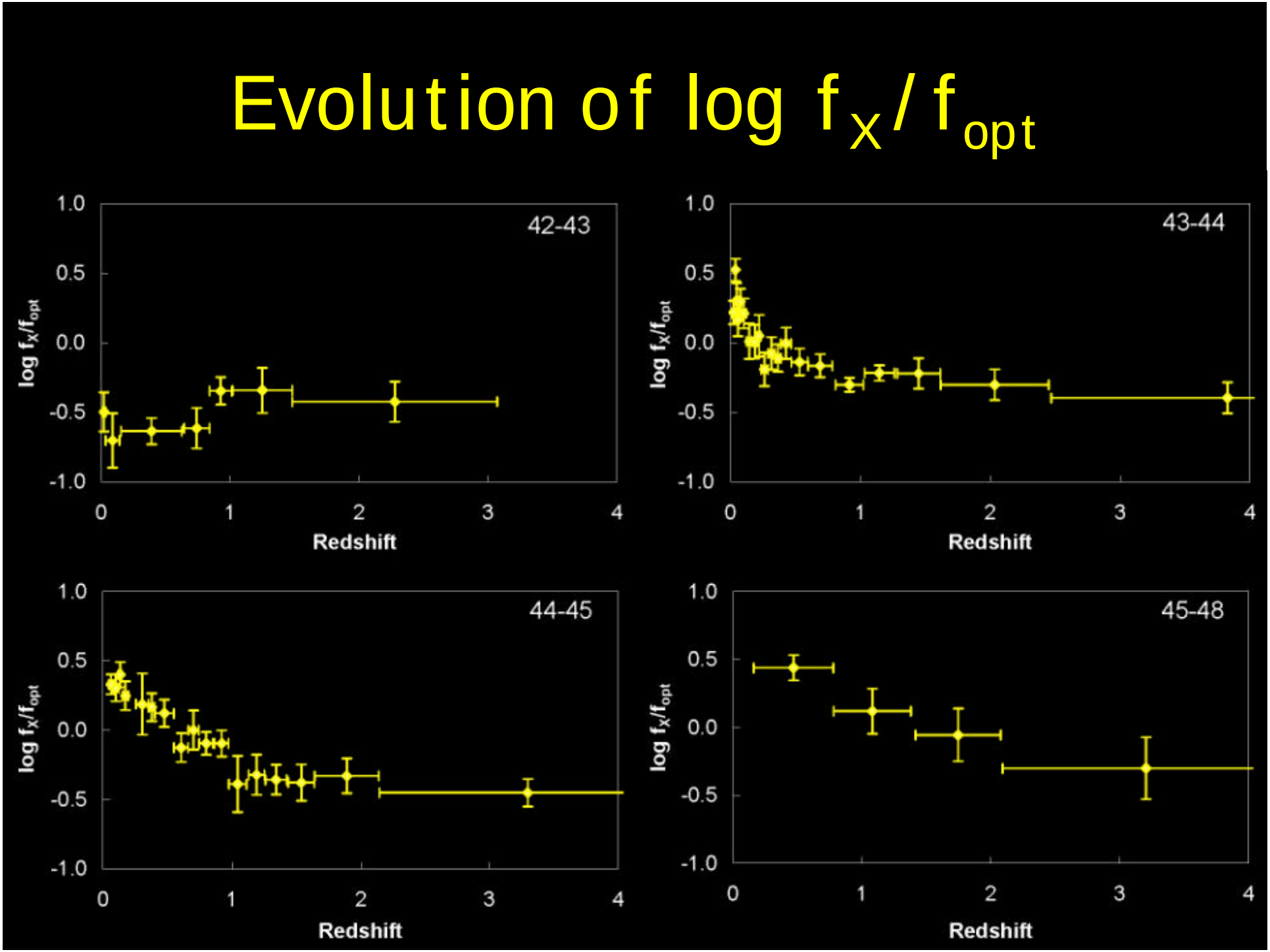
Optically vs. X-ray selected samples

flux-flux

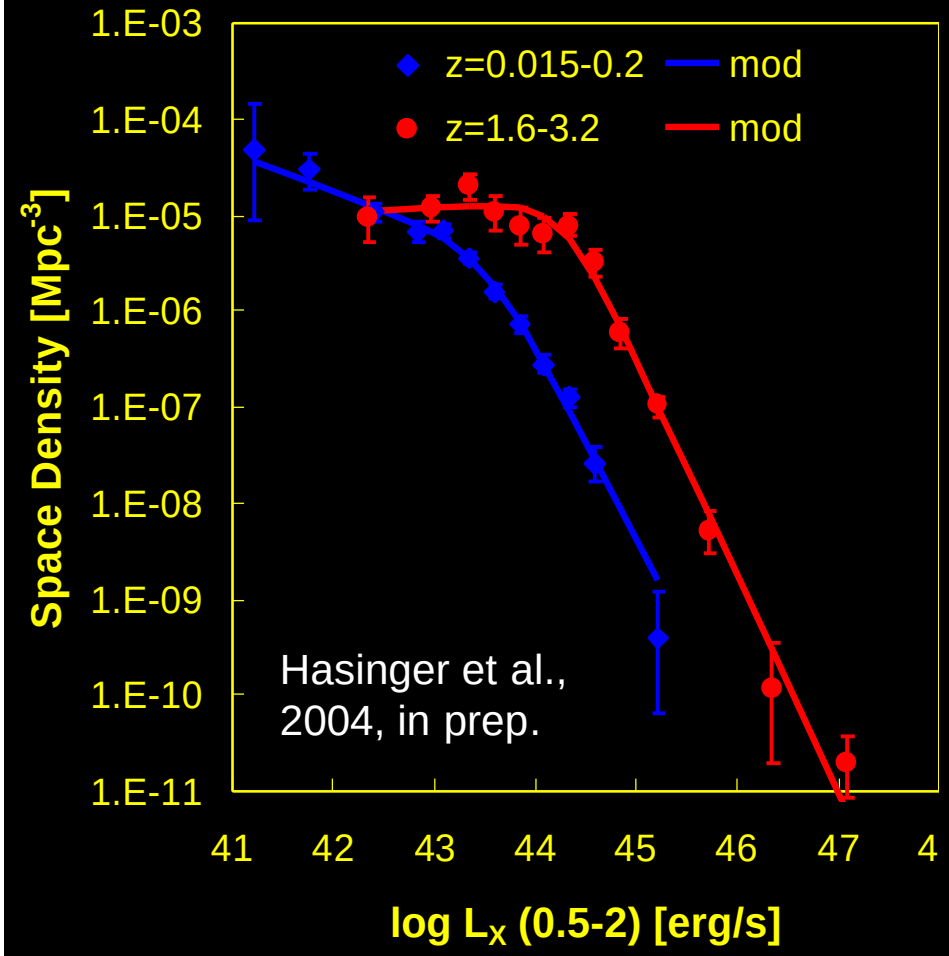


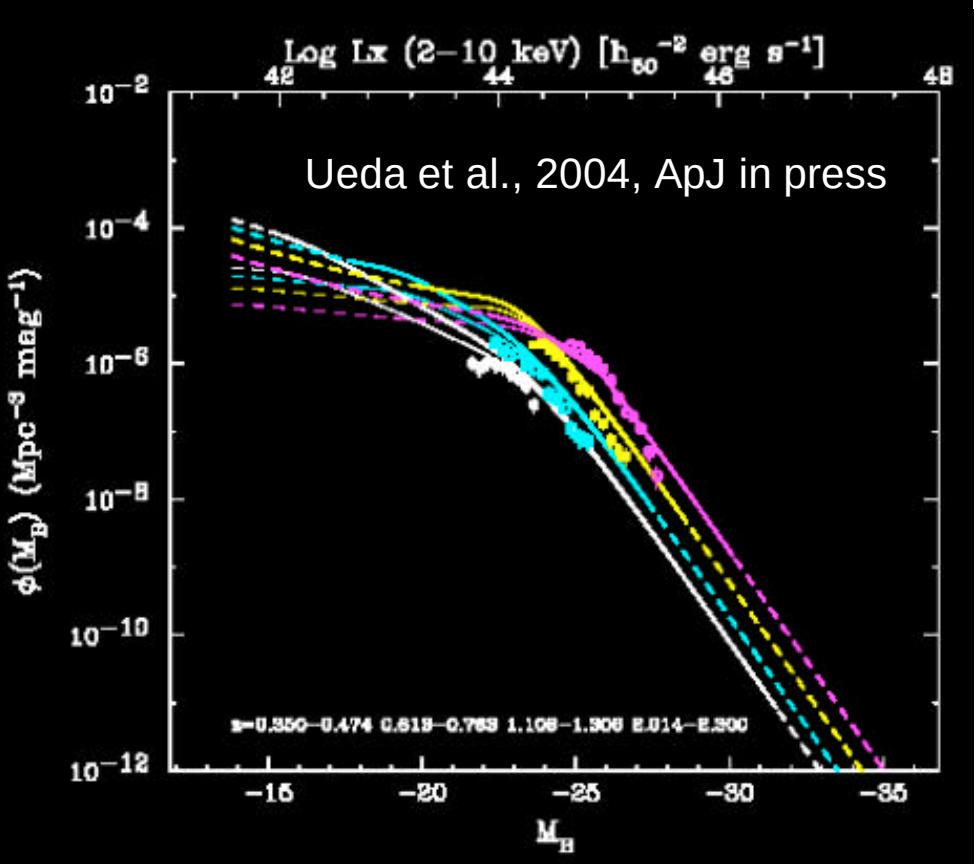
luminosity-luminosity

Evolution of log f_X / f_{opt}



Luminosity Functions X-ray/optical

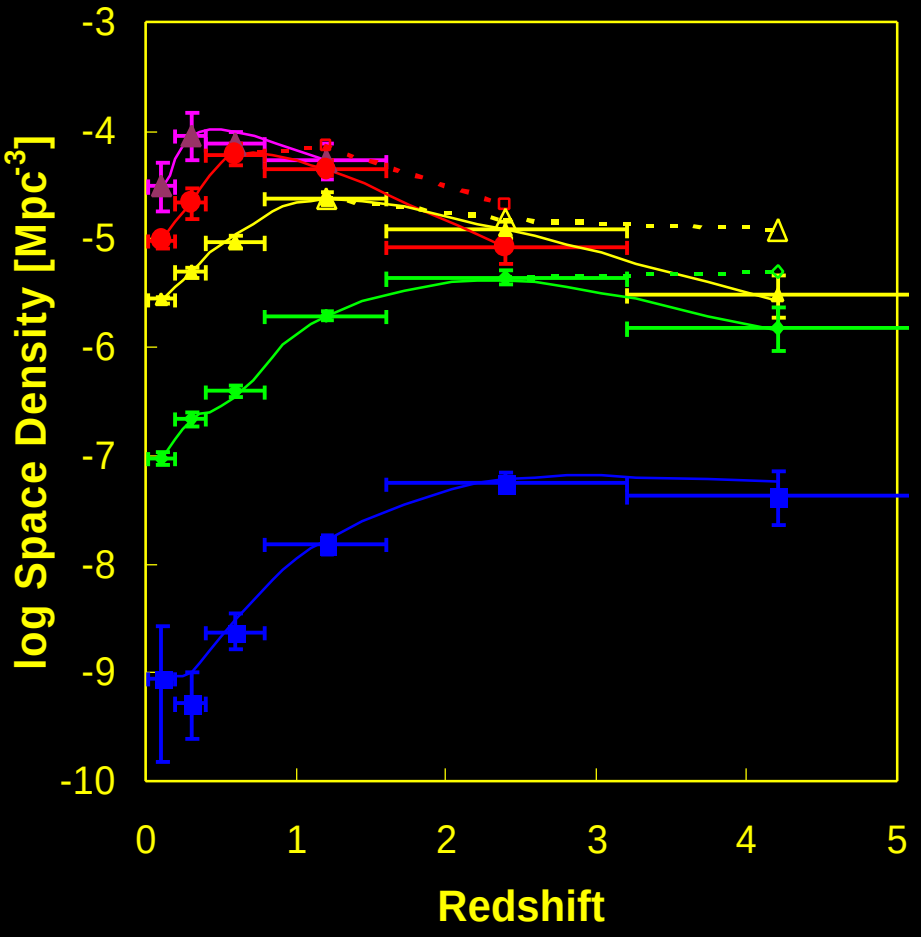


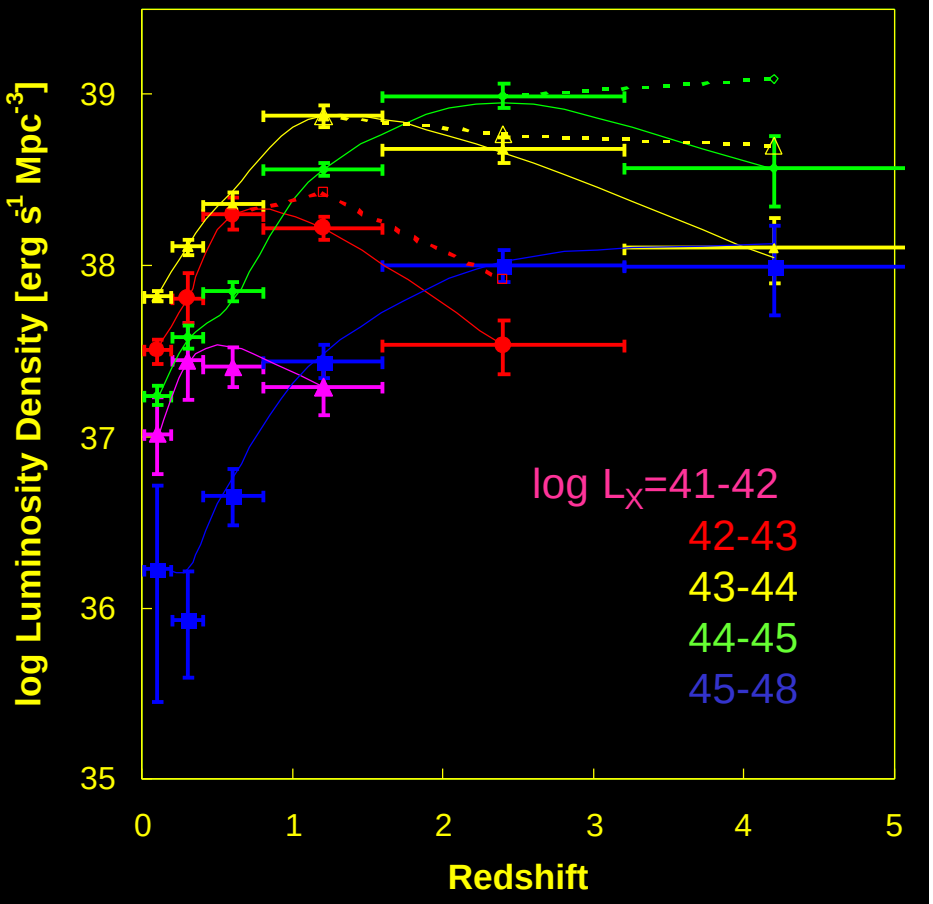


⇒ Change of XLF as a function of redshift

⇒ Luminosity-dependent density evolution

Space/Luminosity Density





Hasinger, Miyaji, Schmidt, 2004, in prep.; see Miyaji poster

Seyferts come significantly later than QSOs !

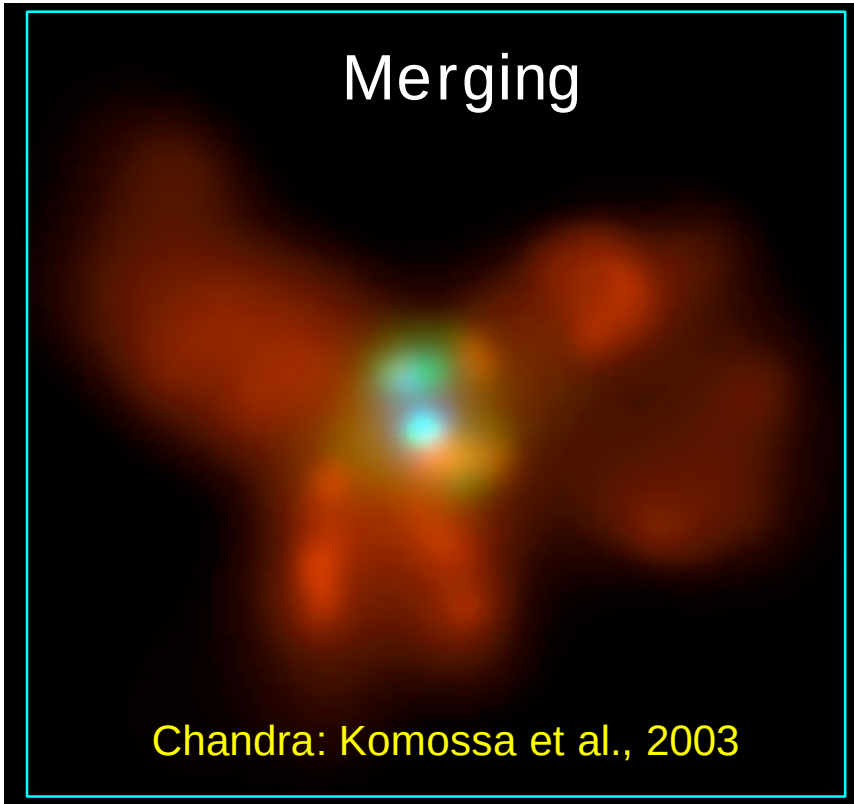
Summary

- Majority of AGN not detectable optically (1/10!)
- Type-2 QSOs found, type-2 fraction decreases with L_X
- Still large numbers of hard sources to resolve
- Evolution of optical/X-ray flux ratiostical evolution
- Seyferts peak much later than QSO and like to live in redshift spikes (sheets)

=> Need two modes of BH accretion

Major mergers and tidal capture?

Merging



Chandra: Komossa et al., 2003

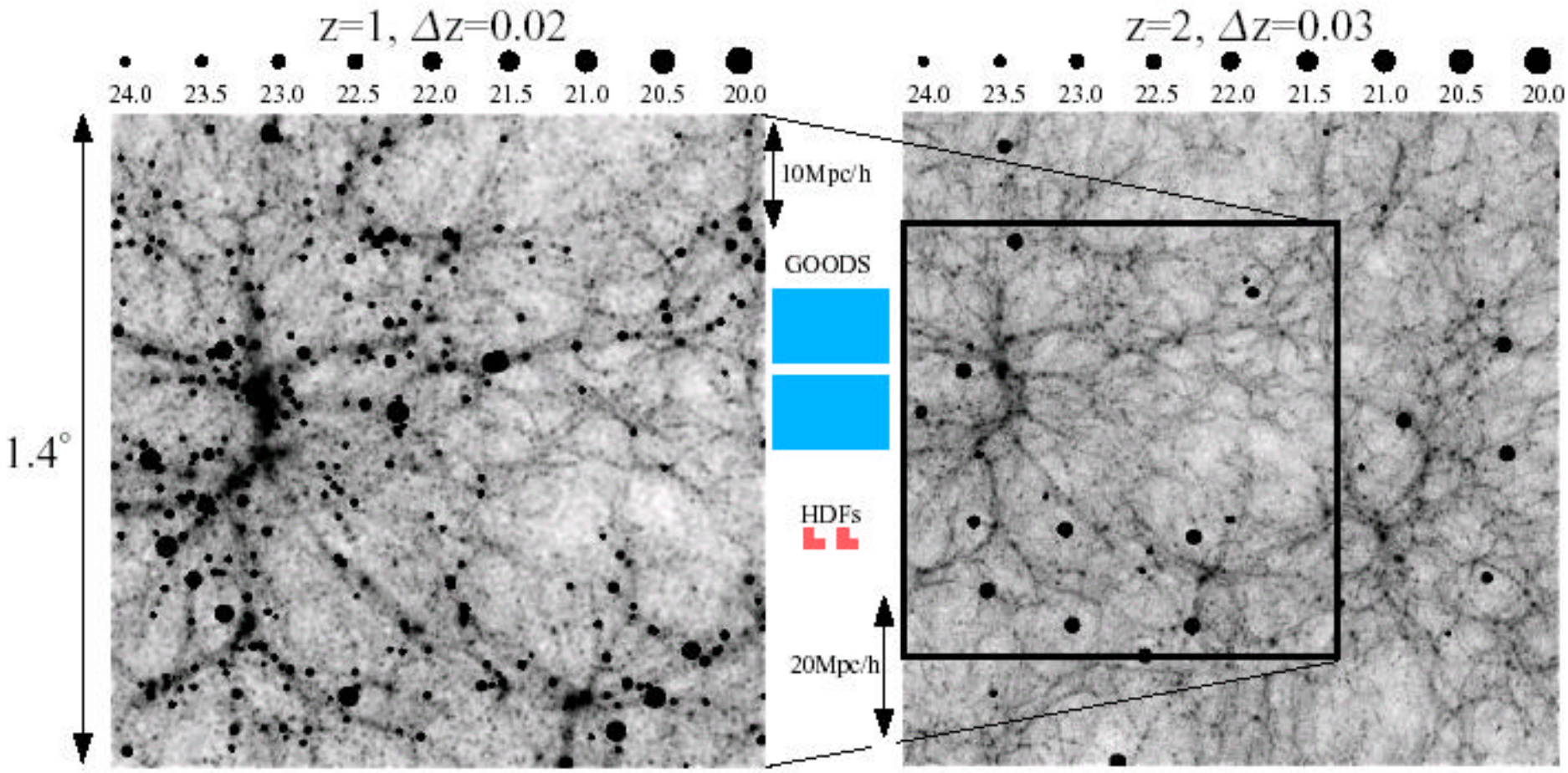
Tidal capture

ROSAT, Chandra, XMM: Komossa et al., 2004

Outlook:

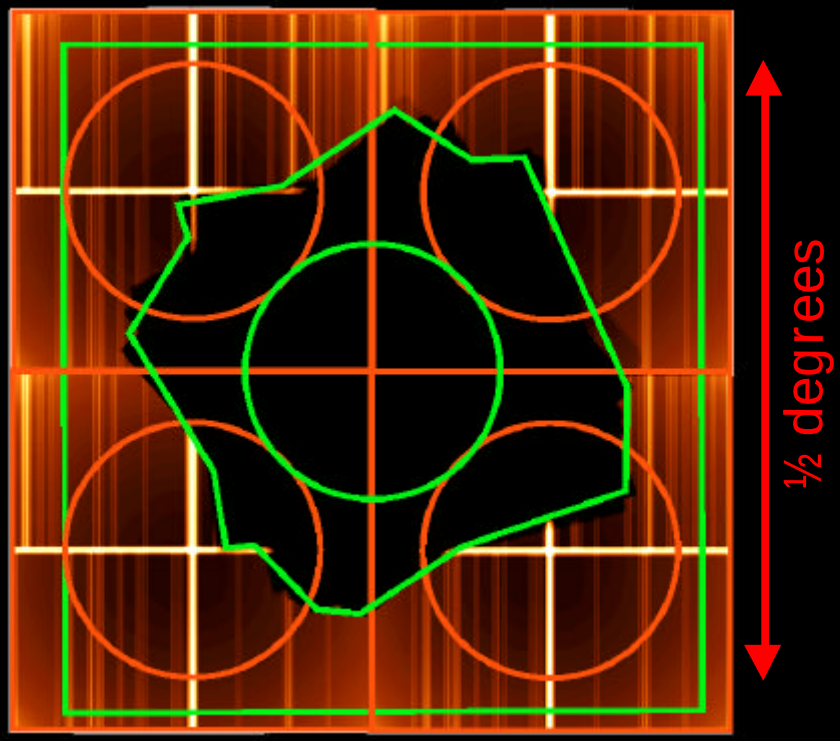
E-CDFS, COSMOS, DUO, ROSITA, XEUS

Need to go to larger scales and deeper



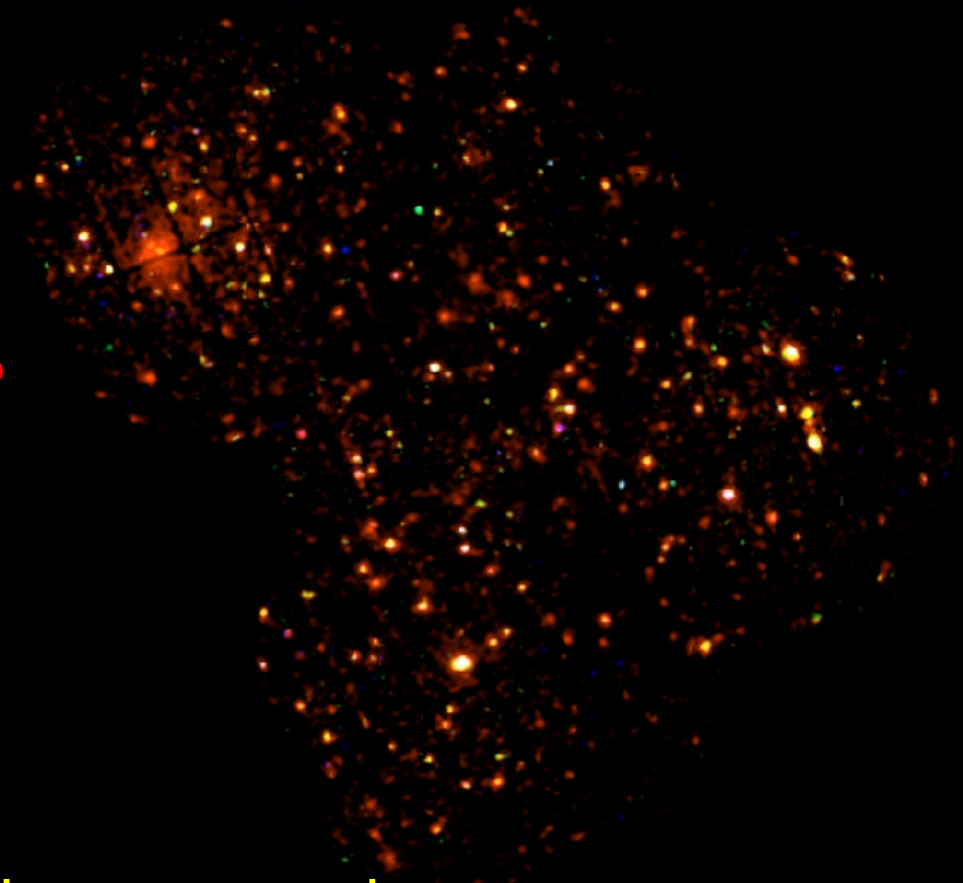
Wide & Deep Chandra and XMM surveys

Extended Chandra
Deep Field South



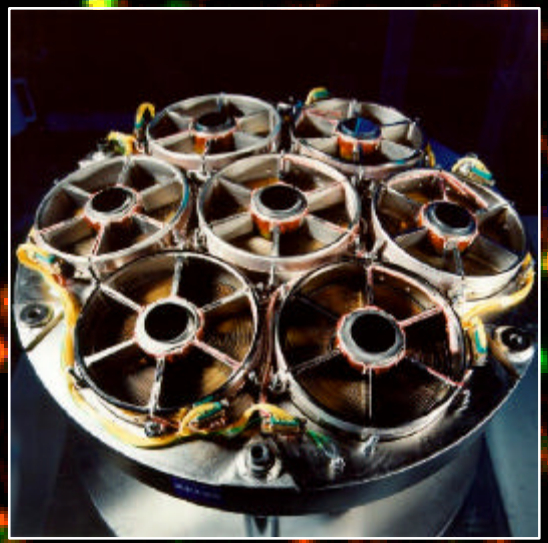
PI: N. Brandt (PSU); 4x250 ksec

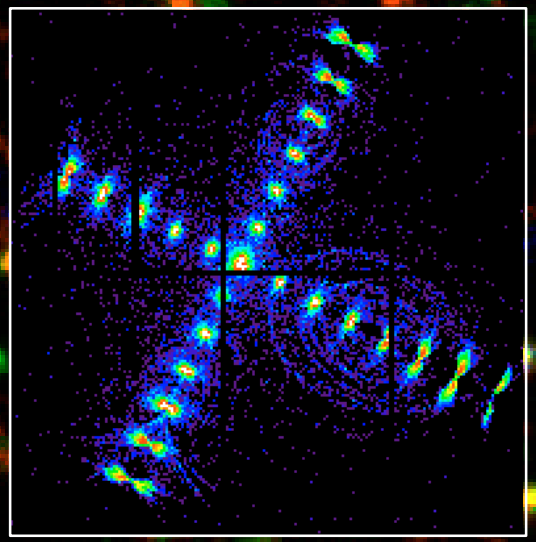
XMM-Newton/HST
COSMOS Field

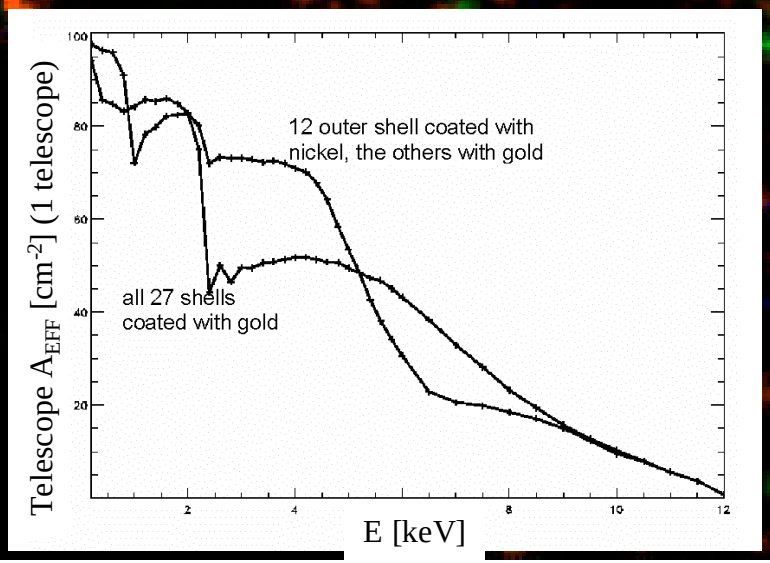


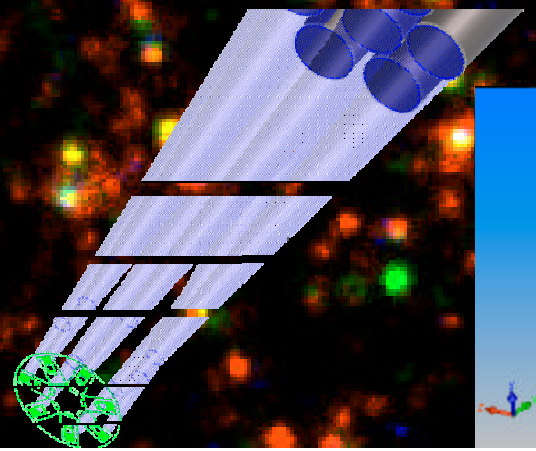
Observations have started

DUO Dark Universe Observatory

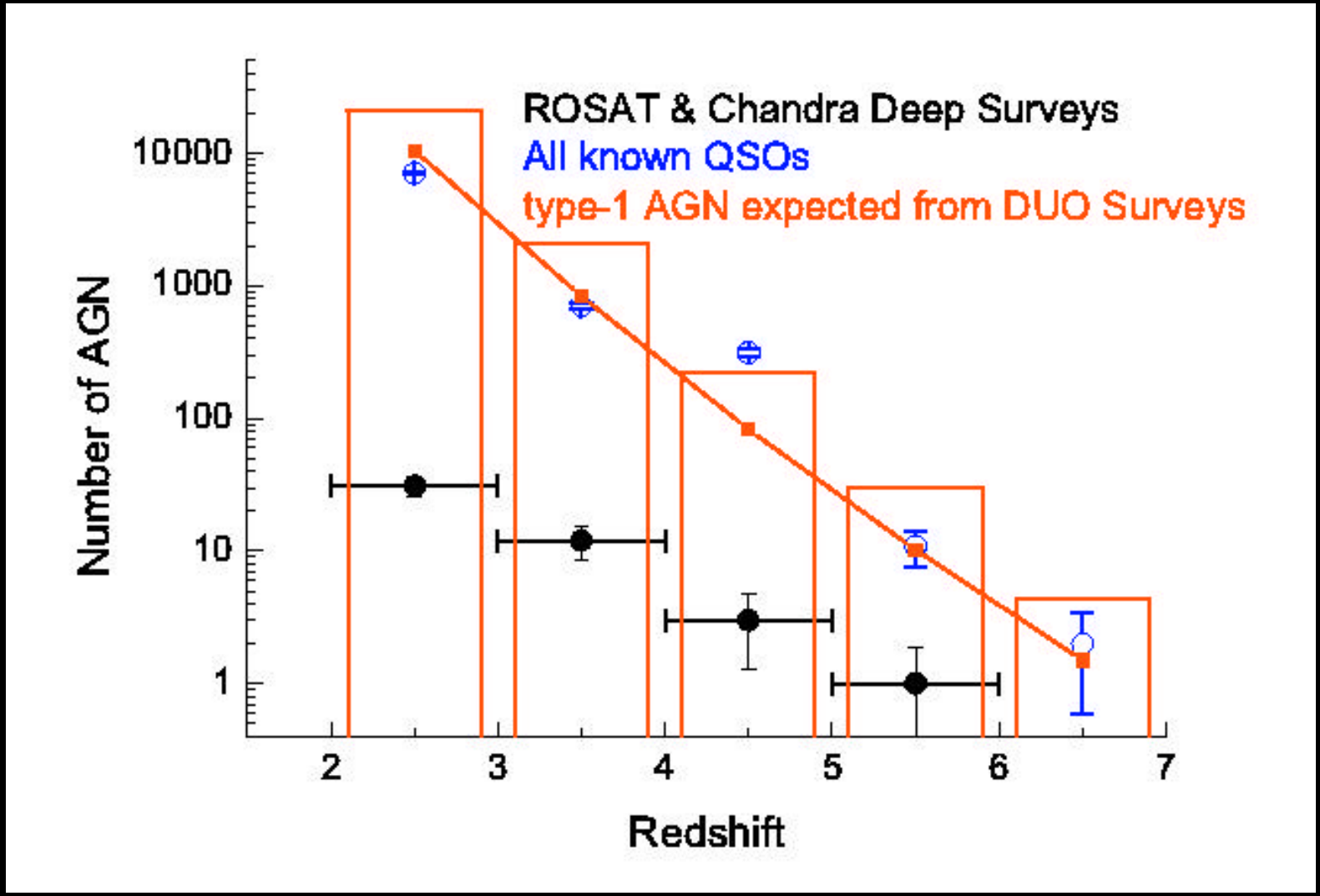




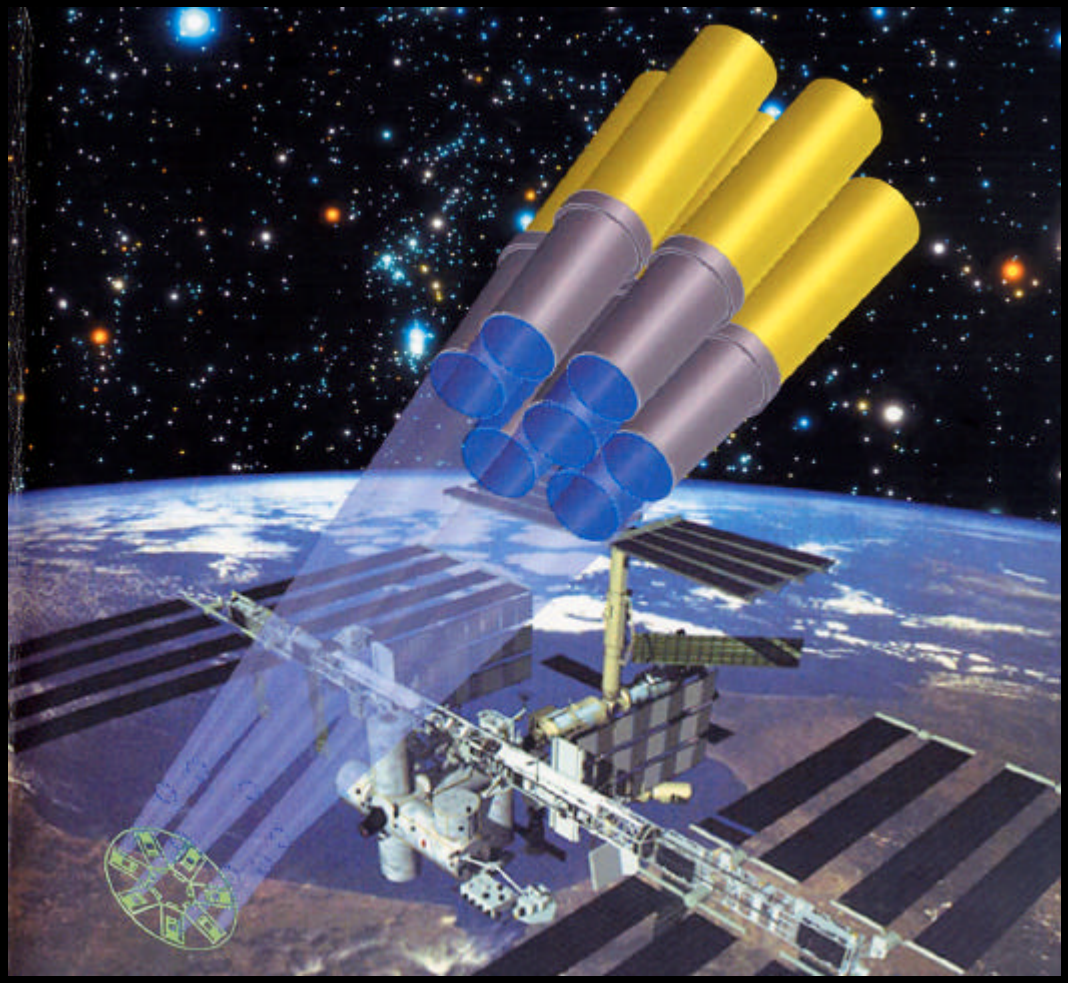




Expected QSO counts

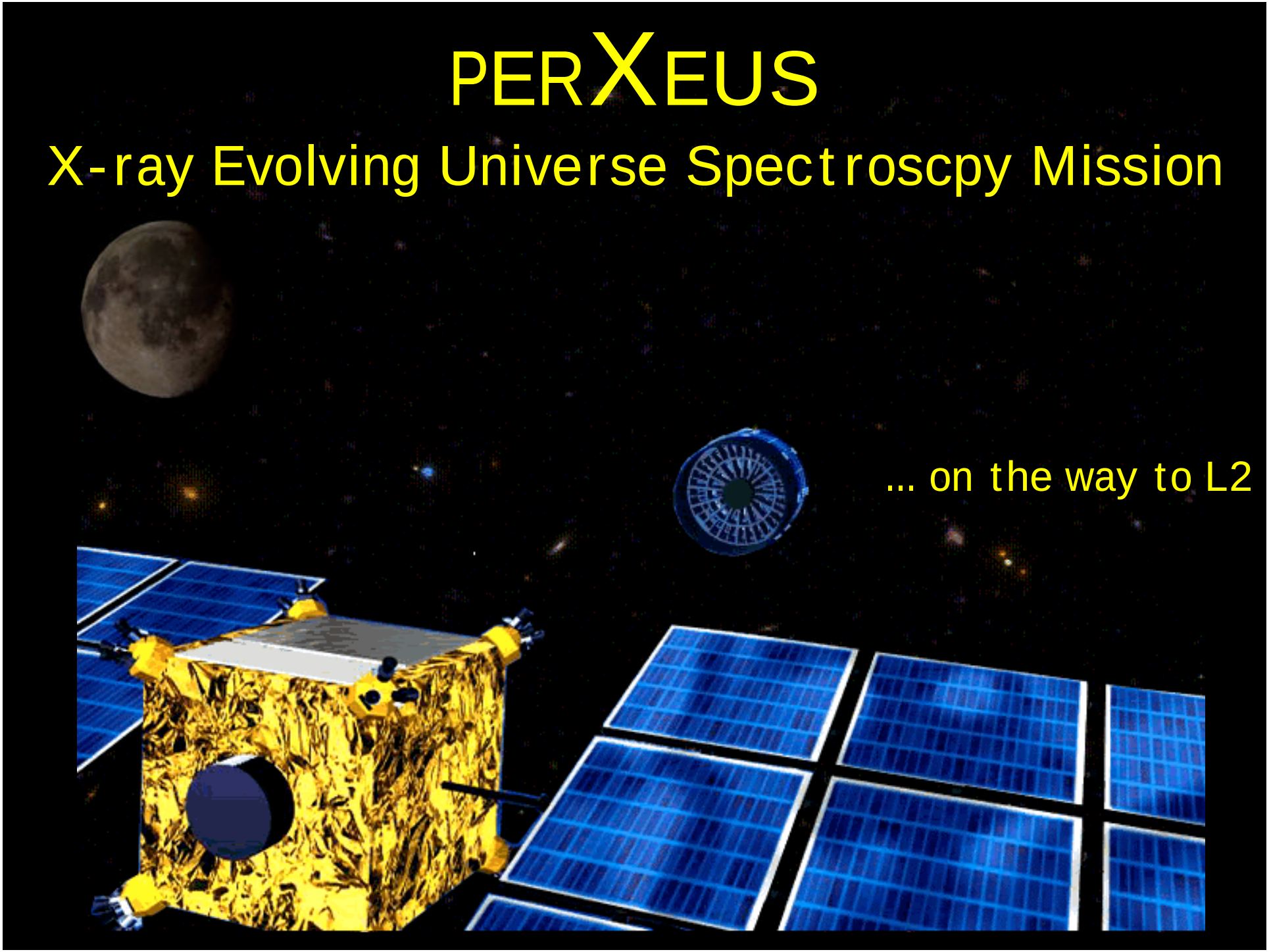


ROSITA All-Sky Survey



PERXEUS

X-ray Evolving Universe Spectroscpy Mission



Thank you very much !

My dream:

XEUS in Lagrange 2 ...
... and together with Constellation X