

# XWAS: XMM-2dF Wide Angle Survey

Jonathan Tedds (Leicester) and the



The XMM-Newton Survey Science Centre (SSC) is carrying out an identification and follow-up programme (XID) of serendipitous sources discovered in XMM-Newton observations. The goals of this survey include the detailed characterisation of the dominant X-ray source populations (e.g. AGN luminosity functions, absorption distribution and evolution, and the relationship between optical emission line and X-ray spectral properties) and the discovery of new, rare classes of sources. In addition to our ongoing core XID spectroscopic identification programme, we have now targeted over 3000 sources, spread evenly over 3 decades in X-ray flux, with the **2df optical multi fibre spectroscope on the AAT** in 27 pointings including the LSS survey fields. Critically we have now identified **1000 sources** with  $F_{0.5-4.5\text{keV}} > 10^{-14} \text{ ergs}^{-1}\text{cm}^2$  which is an unsurpassed resource with which to investigate the AGN population around the break in the X-ray source counts. We also demonstrate the potential of such a large, wide area survey in identifying significant numbers of unique and **rare objects** such as the **Broad Absorption Line QSOs**, not detected in pencil beam surveys.

## SSC XID programme (PI M.G. Watson)

Statistical identifications for the whole XMM-Newton serendipitous catalogue

Core programme: **spectroscopic IDs** (1000 sources/sample):

High b faint sample ( $\sim 10^{-15} \text{ erg cm}^{-2} \text{ s}^{-1}$ )

High b medium sample ( $\sim 10^{-14} \text{ erg cm}^{-2} \text{ s}^{-1}$ )

=> **AXIS** in North (Barcons+07) + **XWAS** in South (Tedds+07)

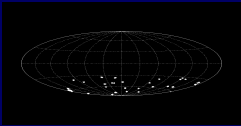
-> **bulk of objects contributing to X-ray background are at fluxes  $\sim 10^{-14}$ : depth of XMM serendipitous survey**

High b bright sample ( $\sim 10^{-13} \text{ erg cm}^{-2} \text{ s}^{-1}$ ) => Della Ceca et al 04

Galactic Plane Sample ( $\sim 7 \cdot 10^{-15} \text{ erg cm}^{-2} \text{ s}^{-1}$ ) => PI Motch

Imaging programme (u,g',r',i',Z,H): a large number of XMM-Newton fields

## 2dF observations



2dF optical multi-fibre spectroscopy on the AAT for 68 XMM-Newton fields (tepx ~ few tens of ksec) over a **total area >11 deg<sup>2</sup>**

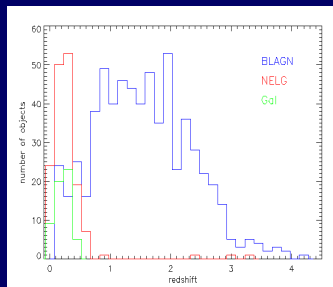
>3000 sources with X-ray fluxes above  $\sim 10^{-14} \text{ cgs}$  and optical counterparts brighter than V=21 observed

**978 serendipitous X-ray sources with 0.5-4.5 keV flux >10<sup>-14</sup> erg cm<sup>-2</sup> s<sup>-1</sup> spectroscopically identified**

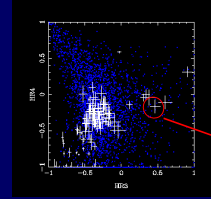
## XWAS ID statistics

Type	Number
BLAGN	641 (65.5%)
NELG	157 (16%)
Gal	57 (5.8%)
Stars	123 (12.6%)

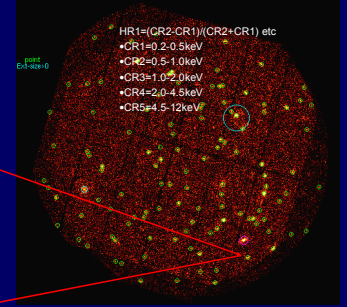
Catalogue paper Tedds+ 07



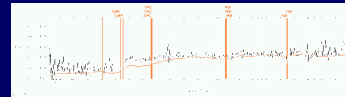
## Extreme HR objects



X-ray colour selection -> obscured source -> ID with NELG z=0.23



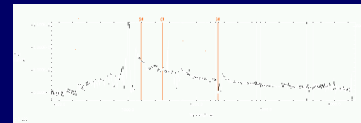
with Silvia Mateos, Mike Watson



## Serendipitous BAL QSOs (M. Page+ 08)

- Virtually absent in previous X-ray surveys because of absorption
- None in ROSAT surveys!

2dF: 10-20 BALQSOs found cf. ~1000 QSOs



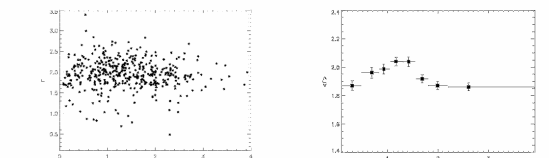
- 1-2% of the X-ray QSO population
- 1/3 the fraction found in past optical surveys
- this is surprisingly large... but agrees with new SDSS result ~15% optical QSO population,  $1.7 < z < 3.5$  (Reichard et al 03)
- X-ray selected will have the lowest X-ray absorption of the BALQSO population
- Are their optical absorption lines typical of the optically selected population?
- What are their X-ray column densities?

## Type-1 AGN X-ray Spectral Analysis (Mateos+ 07)

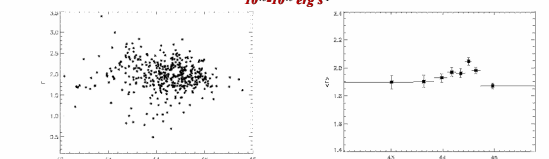
496 type-1 AGN with  $\geq 75$  EPIC counts selected for X-ray spectral analysis

- Power law and abs power law (both absorbed by the Galaxy) models fitted (0.2-12 keV)
- $\chi^2$ -test significance  $\geq 95\%$  to accept additional spectral components
- Overall results of spectral fits:
  - 37 (~7.5%) objects with detected absorption
  - 381 (~77%) best fitted with a power law
  - 78 (~15.7%) objects with detected soft excess emission

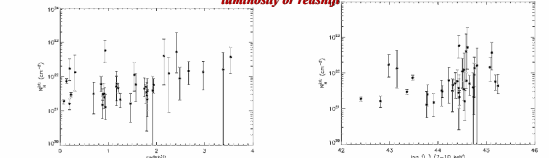
**No clear cosmic evolution of the mean continuum shape of type-1 AGN up to z~3**



The 0.2-12 keV continuum shape does not show obvious dependence with X-ray luminosity from  $10^{43}$ - $10^{45} \text{ erg s}^{-1}$



No evident dependence of X-ray absorbing column densities detected in type-1 AGN with luminosity or redshift

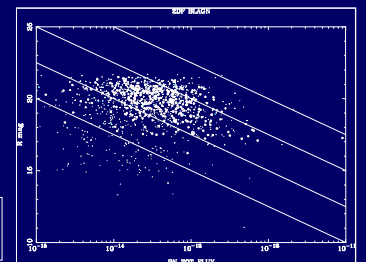


## $F_x - F_{opt}$ correlations

- correlate to Supercosmos R,B mags
- WFC/WFI u,g',r',i',Z mags for 1/3 of XWAS fields
- 2 mags deeper than SDSS

with Mike Watson, R. McMahon, A. Schwobe, F. Carrera

white dots - all 2dF objects  
filled red circles - BLAGN  
orange crosses - XMM separation > 7''  
grey boxes - Supercosmos separation > 1''



## Summary

**XWAS = 1000 sources brighter than  $F_{0.5-4.5} > 10^{-14} \text{ erg cm}^{-2} \text{ s}^{-1}$**

- Homogeneous 2XMM X-ray data reprocessing
- Characterise XRB, Tyl,II AGN source population
- Spectral stacking of AGN (Corral+ 07)
- Optical multiband imaging complete for 1/3 fields (WFC,ESO...)
  - opt mag dropouts (Astrogrid VO tools)
- **Excellent statistical ID training sample for future, larger XMM surveys**

XMM serendipitous survey = **WIDE coverage!**

- Larger no of **rare** objects than deep, narrow surveys to date, e.g.
  - X-ray selected **BAL QSOs** => SDSS agreement
- Large statistically significant samples of optically "normal" & starburst galaxies (Xu+ 07)