X-ray spectral catalogue

Overview

• Something which has to be done …
• Legacy (?) value
• Parent sample for more interesting analyses … some interesting surprises are emerging  (Piero352)
• ...

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Spectral Analysis

2-10 keV, >10σ AND 1 Ms exposure -> 130 sources

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Absorption Distribution

Observed vs Predicted (GCH07)

Uncertainties associated to $N_H$ measurements at low column densities

Or revise model parameters

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Flat 5
64, 66, 324, (144,147 C11)

Flat 10
48, 214, 222, 245, 285
64, 66, 324, (144,147 C11)

Herschel sources $N_H$
Rovilos+12 & talk

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Stacking-XMM-CDFS

Type 1

Type 2

Falocco et al in preparation
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> 100,000 counts “Type1” un-obscured NOT BLAGN
>~ 60,000 counts “Type 2” obscured -NOT Type 1

6.4 & 6 keV lines
Photo-z unk?
Stacking-XMM-CDFS

Residuals wrt Power law fit $\Gamma \sim 1.7$
Line EQW $\sim 170$ eV

Power law plus $R=1$ reflection component plus disk line

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Phase 2 Spectral Analysis

Define a flux limited sample and perform “accurate” spectral fitting:

• $118 > 5.0 \times 10^{-15}$ cgs
• $137 > 4.0 \times 10^{-15}$ cgs, 2-10 keV
• $180 > 1.8 \times 10^{-15}$ cgs

Baseline model: $\text{po+zwa} \ast (\text{po+zgaus})$

plus Galactic absorption at $8 \times 10^{19}$ cm$^{-2}$

(Obviously not always the best fit)
Photo-z $\sim 1.5$

X-ray-z = 2.03$\pm$0.04
(1sigma-1 par)

Gamma$\sim$ 1.05
(reflection dom?)

Line EW $\sim$ 100 eV

Obs frame...

Gamma=1.9 fixed

$N_H \sim 4 \times 10^{23}$
Distant C-thick AGN in the XMM-CDFS

$z=1.53$

$z=0.51$

$z=0.68$

$z=0.7$
P311 X-ray $z = 0.90 \pm 0.02$
0.98 tentative Silverman - $z_{(spec)} = 2.09$?
Photo-z 1.45, Highly obscured $2 \times 10^{23}$
Excess (pn only) above 5 keV ??

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Single Power Law $\Gamma = 0.42$
Baseline plus narrow absorption line
Best fit Redshift $\sim 1.58 \pm 0.02$
Formal 1 sigma error

Residuals/Ratios wrt best fit “pure” baseline  
Deltachi $\sim 18$
Absorption feature is preferred to an edge
Narrow absorption line
Energy vs Flux
Need to freeze continuum parameters:
If resonant ionized iron line 
@ 6.96 keV then the
outflow velocity $< \sim 0.1 \, c$

Flattish Power law plus plus strong
absorption (again freezing the line
parameters)
EQW emission line $\sim 85$ eV
EQW absorption line $\sim -90$ eV

Unabsorbed luminosity (2-10 keV)
$3 \times 10^{44}$ erg s$^{-1}$ @ $z \sim 1.58$
$z_x \sim 1.67; [\text{Fe}] \sim 5; \chi^2 \sim 264/259$

More physical model
Absorbed power law plus ionized reflection
Both emission line feature and soft excess are accounted for

Fix Iron to Solar abundances and absorption line width to zero
$\chi^2 \sim 271$
Absorption line energy vs flux
Freezing power law parameters

E ~ 7.8 keV @ z ~ 1.66
Outflow if resonant iron
0.12 c
EQW ~ -95 eV observed frame
250 rest frame
Constrain the redshift from the continuum cold absorption and ionized reflection.
Very good constraint to the Cold absorption
CHANDRA Spectrum

Power law plus Ionized Reflection
not very different from baseline
\( \chi^2 \sim 14.4/18 \)

\( N_H \sim 3.5 \times 10^{23} \)

\( \text{Gamma} \sim 1.86 \)

\( \text{Csi} \sim 3000 \) (mimic a power law)

Redshift fixed @ the XMM value
\( \sim 1.66 \)
Summary

Baseline

Baseline + emission line $\chi^2 = 286/262$

Some obvious residuals

Improved by addition of:

1) Reflection Component $\Delta\chi^2 = 17.4/1$ dof PEXRAU norm.
   \[
   \chi^2 = 269/261
   \]

   BUT $P \sim 9$ Reflection dominated

2) Additional Abs Edge $E = 7.2$ keV (neutral) $\Delta\chi^2 = 18.7/2$
   $c = 0.48$

   Physical meaning of extra abs edge?
   \[
   \chi^2 = 267.3/260
   \]

3) Absorption line $E = 7.60$ $EW \sim 90$ eV (obs)
   $\Delta\chi^2 = 17.4/2$
   \[
   \chi^2 = 268.6/260
   \]

   $\Gamma_{H\alpha c} = 2.41 \pm 0.45$

   $N_H = 19 + 4$

   $\Gamma_2 = 1.49 \pm 0.13$

   $z = 1.58 \pm 0.01$

   $EW = 88 \pm 22$ (40) $EW = 91 \pm 21$

   Happens to be the best fit also in Chandra.
SUMMARY IONIZED REFLECTION

IRON ABUNDANCE = SOLAR

Absorption line improvement $290.7/263 \rightarrow 271.4/261$
$\Delta x^2 = 19/2$

IRON ABUND = SUPER SOLAR $\sim 2.5-5$

Absorption line improv. $282.2/262 \rightarrow 264.2/260$
$\Delta x^2 = 18/2$

<table>
<thead>
<tr>
<th>ION</th>
<th>$5.0 \pm 2.6$</th>
<th>$2.0 \pm 1.6$</th>
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<tbody>
<tr>
<td>$g$</td>
<td>$5.1 \pm 3.7$</td>
<td>$2.3 \pm 1.4$</td>
</tr>
<tr>
<td>$E$</td>
<td>$1.67 \pm 0.03$</td>
<td>$1.65 \pm 0.04$</td>
</tr>
<tr>
<td>$N_H$</td>
<td>$2.1 \pm 2$</td>
<td>$2.8 \pm 2$</td>
</tr>
<tr>
<td>$E$</td>
<td>$7.83 \pm 0.18$</td>
<td>$7.79 \pm 0.17$</td>
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<tr>
<td>$E_GW$</td>
<td>$-90 \pm 22$</td>
<td>$-94 \pm 22$</td>
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<tr>
<td>$\Gamma$</td>
<td>$1.42 \pm 0.02$</td>
<td>$1.8 \pm 0.02$</td>
</tr>
</tbody>
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$264.2/260 \chi^2 = 276.5/261
data and folded model

normalized counts s\(^{-1}\) keV\(^{-1}\)

Energy (keV)
Xue 571 = P34H_352, 4Ms CDFS (FB) + 240ks ECDFS data
Ionized Reflection plus absorbed power law

keV

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Summary

• Background subtraction/fit
• …