Exploring (extremely) obscured accretion

Francisco J. Carrera
(IFCA, CSIC-UC, Spain)

S. Mateos (IFCA, CSIC-UC, Spain),
R. Della Ceca, A. Caccianiga, A. Corral, P. Severgnini (OAB-INAF, Italy),
A. del Moro (U. Durham, UK)

X-ray Universe, Berlin, 30-June- 2011
Outline

• Obscured accretion and high $F_X/F_{\text{Opt}}$
• Our parent samples
• Our selection of high $F_X/F_{\text{Opt}}$ sources
• Our subsamples
• X-ray spectral properties
• Highlights:
  – High Eddington ratios (inc. Xabs BLAGN !?: NLSy1)
  – Transition object...
• Summary
Obscured accretion and high $F_X/F_{Opt}$

• Most accretion in the Universe is thought to occur in obscured AGN
  – But perhaps not so much in CT (Gilli+07)

• Several methods to select obscured AGN:
  – [OIII],[NeV]...
  – MIR colours
  – ...

• Our method: high X-ray flux to optical flux ratio
  – based on much higher obscuration in rest-frame optical-UV with respecto to X-ray
$F_x/F_{Opt}$ ratio: XMS (Barcons+07)

- 18/315 sources \( -1 \leq \log(F_x/F_{Opt}) \leq 1.2 \)
- 4/315 sources \( \log(F_x/F_{Opt}) \geq 1.2 \)
- 257/315 sources \( -1 \leq \log(F_x/F_{Opt}) \leq 1 \)
Our parent samples

• Aim was to assemble a large number of identifications of sources with large $F_X/F_{Opt}$ ratio:
  – Objects rare ➔ need large sky areas
  – Looking for properties ➔ high fluxes

• Parent samples:
  – XBS (DellaCeca+04, Caccianiga+07): serendipitous XMM sources at bright fluxes
  – del Moro+09, (+11 in preparation): objects with extreme $F_X/F_{Opt}$ in 2XMMp vs. SDSS DR5
  – Della Ceca+11 (in preparation): objects with extreme $F_X/F_{Opt}$ in 2XMMiDR2 vs. SDSS
  – BUXS (Mateos+11 in preparation): 5-10keV survey from 2XMMi-DR3
Our selection of high $F_X/F_{\text{Opt}}$ sources

- 41 initial sources: $F_X \geq 10^{-13}\text{cgs}\ \log(F_X/F_{\text{Opt}}) \geq 1.2\ (r'/R\sim 21-25)$
Identifications

- Used GTC/OSIRIS (18), VLT/FORS2 (1), Subaru/MOIRCS (3)
- Identified 22+3: 10BLAGN, 11NELG, 1Gal, 3BLLacs
Our subsamples of high $F_x/F_{Opt}$

- 41 initial sources: $F_x \geq 10^{-13}\text{cgs} \log(F_x/F_{Opt}) \geq 1.2$:

  ~IDed all 17 in here: “complete sample”
  ($F_x \geq 10^{-13}\text{cgs} \log(F_x/F_{Opt}) \geq 1.2$):
  
  6 BLAGN
  7 NELG
  1 Gal
  3 BLLac (candidates)
Our subsamples of high $F_X/F_{\text{Opt}}$

- 41 initial sources: $F_X \geq 10^{-13}\text{cgs } \log(F_X/F_{\text{Opt}}) \geq 1.2$

statistically complete subsample: 7 sources ($F_X \geq 1.6 \times 10^{-13}\text{cgs } \log(F_X/F_{\text{Opt}}) \geq 1.7$):
  1. BLAGN
  4. NELG
  2. BLLac (candidates)
X-ray spectral properties

QSO2 zone: 1BLAGN, 10 NELGs (95% sig.)

• Fitted powerlaw and intrinsically absorbed powerlaw to 22 sources, signif. from F-test (all log(L_{X,2-10keV})>~44):
  – No signif. abs. 8 sources: 4BLAGN (2N_H<<), 1NELG, 1Gal, 2BLLac
  – Signif. abs.: 14 sources: 3BLAGN, 10NELGs, 1BLLac
• 3 sources log(N_H)<=22 95% signif.: 2BLAGN, 1BLLac
“Complete” sample: 15 sources (2 more no X-ray spec.):
- No signif. abs. 8 sources
- Signif. abs.: 7 sources: 1BLAGN, 5NELGs, 1BLLaec
  - 1 sources log($N_H$) <= 22 95% signif.: 1BLLaec
X-ray spectral properties

- Statistically complete sample: 7 sources:
  - No signif. abs. 1 source: 1BLLac
  - Signif. abs.: 6 sources: 1BLAGN, 4NELGs, 1BLLac
    - 1 sources log($N_H$) $\leq$ 22 95% signif.: 1BLLac
    - Only 1 source $\Gamma < 1.4$ (95% signif.): XMM J1232+2152 (delMoro+09, z=1.87 -0.76?)

QSO2 zone: 1BLAGN, 4 NELGs (95% sig.)
J12+39: BLAGN $z=2.694$

- **CIV** $\Delta \nu = 820 \text{km/s}$
- **CIII]** $\Delta \nu = 1070 \text{km/s}$

**AGN template** $N_H = 2 \times 10^{21} \text{cm}^{-2} \sim 11x\text{Gal}$

- From Opt. spec.:
  - $\log(M_{BH}/M_{\odot})=7.6$
  - $\log(L_{Edd}/\text{cgs})=45.7$
- From X-ray spec.:
  - $\log(L_{X,2-10\text{keV}}/\text{cgs})=46.8$
  - $\Gamma \sim 2.3$ (but no ion. abs.)
- **Edd. ratio $>100$** ($\kappa = 35$)

**Narrow Line Sy1**

$\chi^2/\nu = 191/169$

$N_{H,\text{int}} = (2.5^{+0.6}_{-0.7}) \times 10^{22} \text{cm}^{-2}$
J08+51: BLAGN $z=2.859$

CIV $\Delta \nu=2250\text{km/s}$

CIII$\beta$ $\Delta \nu=790\text{km/s}$

AGN template $N_H=3\times10^{21}\text{cm}^{-2}$ ($\sim9\times\text{Gal}$)

- From Opt. spec.:  
  - $\log(M_{BH}/M_{\odot})=7.5$
  - $\log(L_{Edd}/\text{cgs})=45.6$

- From X-ray spec.:  
  - $\log(L_{x,2-10\text{keV}}/\text{cgs})=46.0$
  - No signif. neutral of ion. abs.

- Edd. ratio $\approx100$ ($\kappa =35$)

$\chi^2/\nu=115/104$

$N_{H,\text{int}}=(1.1-1.1^{+1.3})\times10^{22}\text{ cm}^{-2}$
J09+29: BLAGN z=1.188

- From Opt. and X-ray spec.:  
  - Edd. ratio~0.05 (κ =35)
- Out of 200BLAGN in XBS:  
  - only 2 EW~50-60Å, most <10-20Å  
  - int. abs. opt. @[OII]~1/3
- In Sy2 EW~200Å:  
  ⇒ transition object?
Summary

• Looking for obscured AGN at high FX/FOpt values
  – Good quality X-ray spectra ➔ high FX values ➔ rare objects
  – Merging of objects from several large samples (XBS, BUXS...)
• Using OSIRIS on GTC (and others)

• Identified 22+3 sources (10 BLAGN, 11 NELG, 1 Gal, 3 BLLacs?):
  – All $F_X > 1.5 \times 10^{-13} \text{ cgs } \log(F_X/F_{Opt}) \geq 1.2$: 17 (6 BLAGN, 7 NELG, 1 Gal, 3 BLLacs)
  – Statistically complete sample: 7 (1 BLAGN, 4 NELGs, 2 BLLac)
• XMM-Newton X-ray spectra of 22 sources:
  – 14 significant absorption, 11 log(NH)>22 (95% signif.):
    • 1 BLAGN: J12+39 $z=2.694$ NLSy1
    • 10 NELGs: all QSO2s
      – including J1232+2152 (delMoro+09)
    • no evidence for Compton Thick absorption
  – Statistically complete sample:
    • 2 BLLacs no signif. abs. or log($N_H$)<22 (95% signif.)
    • signif. abs.: 1 BLAGN (J12+39), 4 NELGs (all QSO2s)
  – Many BLAGN:
    • Two highest $L_X$ BLAGN super-Eddington, next one down transition?...

⇒ Good method to select QSO2s but not CT