Multi-wavelength analysis of Active Galactic Nuclei

Nuria Fonseca Bonilla
Matteo Guainazzi
Stefano Bianchi
OUTLINE

- Introduction to AGN: characteristics ↔ multi-wavelength analysis
- Projects: description & results
  - XMM-Newton catalogue of radio-quiet AGN
  - Classification of an individual source: Spectral Energy Distribution (SED)
- Conclusions
- Further analysis

Multi-wavelength analysis of AGN

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INTRODUCTION

a few galaxies present non stellar emission in inner regions extreme luminosities: $L \sim 10^{42} - 10^{46}$ erg s$^{-1}$

• luminosity comes from a compact region: SUPERMASSIVE BLACK HOLE (SMBH)
• energy is produced by accretion: ACCRETION DISK

CHARACTERISTICS

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Nuria.Fonseca@sciops.esa.int
INTRODUCTION

Emissions

Jet → Radio emission

Accretion disk

Torus (dust)

Optical / UV emission

IR emission

X-ray emission

Comptonization
INTRODUCTION

MULTI-WAVELENGTH ANALYSIS

- Useful to understand the physics of AGN ⇒ better knowledge of their properties
- Examples:
  - Study of possible correlations in different bands with data from the XMM-Newton catalogue of radio quiet AGN
  - Study of the Spectral Energy Distribution (SED) of an individual source
XMM-NEWTON CATALOGUE OF RADIO QUIET AGN

- **X-ray**: 157 unobscured AGN targeted by XMM-Newton
  - Luminosities in both bands:
    - Soft: 0.5-2 keV
    - Hard: 2-10 keV
  - Main spectral properties (Fe line, spectral index...)

- **Optical**:
  - $M_{\text{ABS}}$ to distinguish between:
    - Quasars: $M_{\text{ABS}} < -23$
    - Seyfert: $M_{\text{ABS}} > -23$
  - BH masses
  - H$\beta$ FWHM to classify sources:
    - Narrow line: < 2000 km/s
    - Broad line: > 2000 km/s

- **Radio**: Flux in 6 cm (5GHz) and 20 cm (1.4GHz)

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## XMM-NEWTON CATALOGUE: DATA

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Entire catalogue</strong></td>
<td>157 sources</td>
</tr>
<tr>
<td><strong>Seyfert</strong></td>
<td>79</td>
</tr>
<tr>
<td><strong>Quasars</strong></td>
<td>78</td>
</tr>
<tr>
<td><strong>BL objects</strong></td>
<td>64</td>
</tr>
<tr>
<td><strong>NL objects</strong></td>
<td>38</td>
</tr>
<tr>
<td>( M_{\text{ABS}} )</td>
<td></td>
</tr>
<tr>
<td>( M_{\text{BH}} )</td>
<td></td>
</tr>
<tr>
<td><strong>Radio flux</strong></td>
<td></td>
</tr>
<tr>
<td>6cm</td>
<td>89</td>
</tr>
<tr>
<td>20cm</td>
<td>117 (29 upper limits)</td>
</tr>
</tbody>
</table>

**Multi-wavelength analysis of AGN**

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PROJECT 1: RESULTS

XMM-NEWTON CATALOGUE: IWASAWA-TANIGUCHI EFFECT

Highly significant anticorrelation!!

\[ \text{covering fraction of torus} \Rightarrow \text{opening angle of torus} \Rightarrow \text{L}_{\text{hard}} \]
\[ \Rightarrow \text{ionization} \Rightarrow \text{EW of neutral Fe line} \]

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Weaker anticorrelation with the Eddington luminosity and $M_{\text{BH}}$ mass than with X-ray luminosity ($L_{\text{hard}}$)

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XMM-NEWTON CATALOGUE: X-ray luminosity ratio vs Hβ FWHM

\[ \log\left(\frac{L_{0.5-2}}{L_{2-10}}\right) = (0.14 \pm 0.03) + (-0.60 \pm 0.08) \log(H\beta_{FWHM,2000}) \]

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PROJECT 1: RESULTS

XMM-NEWTON CATALOGUE: X-ray luminosity ratio vs Hβ FWHM

\[ \log\left(\frac{L_{3.5}}{L_{2.16}}\right) = (0.14 \pm 0.03) + (-0.60 \pm 0.08) \log(\text{Hβ FWHM, 2000}) \]

E ↓ → soft X-ray

NL objects

Multi-wavelength analysis of AGN
XMM-NEWTON CATALOGUE: X-ray luminosity ratio vs Hβ FWHM

\[
\log \left( \frac{L_{0.5}}{L_{2-10}} \right) = (0.14 \pm 0.03) + (0.60 \pm 0.08) \log (H\beta \text{ FWHM})
\]

BL objects

E ↑ → hard X-ray

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CLASSIFICATION OF AN INDIVIDUAL AGN

SOURCE: XMMU J002200.8+000655

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CLASSIFICATION OF XMMU J002200.8+000655: spectrum

- Spectrum of the EPIC cameras: MOS 1 and 2, PN
- Simultaneous fitting of the three spectra

![Simultaneous fit](image-url)
CLASSIFICATION OF XMMU J002200.8+000655: spectrum

<table>
<thead>
<tr>
<th>model</th>
<th>$N_H$ [$10^{20}\text{cm}^{-2}$]</th>
<th>$\Gamma$</th>
<th>$N$ [$10^{-4}$]</th>
<th>$E_X$ [keV]</th>
<th>$L_X$ [$10^{-5}\text{phcm}^{-2}\text{s}^{-1}$]</th>
<th>EW [eV]</th>
<th>$\text{Red}_{\chi^2}$/ d.o.f.</th>
</tr>
</thead>
<tbody>
<tr>
<td>po+zga</td>
<td>$4.69^{+1.53}_{-1.56}$</td>
<td>$2.29^{+0.049}_{-0.065}$</td>
<td>$7.43^{+0.44}_{-0.44}$</td>
<td>6.4</td>
<td>$&lt;4.60$</td>
<td>$&lt;428$</td>
<td>1.002/350</td>
</tr>
</tbody>
</table>

![Simultaneous fit](image)
PROJECT 2: RESULTS

CLASSIFICATION OF XMMU J002200.8+000655: SED

More data needed to fill the SED

X-ray band
0.5-10keV

Radio band
1 point: 1.4GHz

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CLASSIFICATION OF XMMU J002200.8+000655: SED

It seems to be a radio-quiet source.
CONCLUSIONS

1. XMM-Newton catalogue of radio-quiet AGN
   • IT effect: anticorrelation between EW Fe and $L_{\text{hard}}$, $M_{\text{BH}}$ and $L_{\text{BOL}}/L_{\text{Edd}}$
   (more details in Bianchi et al. 2007)
   • Anticorrelation between the X-ray luminosity ratio and H\textbeta FWHM

2. Classification of XMMU J002200.8+000655
   • The source seems to be a radio quiet AGN
1. XMM-Newton catalogue of radio-quiet AGN
   - IT effect: more details in Bianchi et al. 2007
   - Entire catalogue is nearly to be published

2. Classification of XMMU J002200.8+000655
   - More data needed in radio and other bands to fill the SED
   - Comparison with standard SED in order to classify the source
Thanks a lot for your attention!!