Partial Covering and Reflection in Narrow-Line Seyfert 1 Galaxies

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Th. Boller, Y. Tanaka, A. Fabian,
N. Brandt, S. Vaughan
Discovery of sharp spectral drops at $E > 7$ keV

- width is $< 160 – 300$ eV
- no detection of accompanying Fe emission
- drop energy changes with time

Similar features in e.g.: PG 1211+143 (Pounds et al.), NGC 4051 (Pounds et al.; Uttley et al.), IRAS 13349+2438 (Longinotti et al.), PG 1402+261 (Reeves et al.)
2 XMM observations separated by 2 years

- source flux increases by a factor of \( \sim 5 \)
- harder spectrum during GT
- drop energy increases
- drop depth decreases
- soft-excess shifted to higher energies
- emergence of an absorption/emission type feature at \( \sim 1 \) keV
Photoionisation?

Probably not.

Edge energies correspond to:
FeVII-X (1H0707-495)
FeXVIII-XX (IRAS13224-3809)
requiring a high photoionisation parameter (\(\xi\)).
Palmeri et al. (2002) predict:
• broad edge
• K\(\beta\) UTA
Partial Covering


„lumpy accretion“
„patch absorber“

fluorescent yield discrepancy

no fluorescent yield discrepancy necessarily

„slab-type absorber“

polarized light
Neutral absorber

AO2
3x solar Fe
\( \nu = 0.05c \)
\( \text{edge } E = 7.5 \text{ keV} \)
\( \Gamma = 2 \)

GT
3x solar Fe
\( \nu = 0.0 \)
\( \text{edge } E = 7.1 \text{ keV} \)
\( \Gamma = 2 \)
Reflection and Light Bending

Reflection dominated spectrum

Continuum dominated spectrum
Is there a line in 1H0707-495?

\[ \Gamma = 2.8 \]

Laor line:
\[ E = 6.7 \text{ keV} \]
\[ EW = 1.8 \text{ keV} \]
Ionised reflector in 1H0707-495

AO2
q = 5.1
r = 2.5-100 Rg
i = 50 deg, 3x solar Fe
log $\xi$ = 2.8

GT
q = 7
r = 2.5-100 Rg
i = 50 deg, 3x solar Fe
log $\xi$ = 2
no power-law present

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Short term flux & spectral variability

GT

no significant spectral variability

AO2

strong spectral variability
Two component variability model

Following Taylor et al. (2003)
One variable component (power-law) plus one less variable component (reflection)

power-law is \(~1.6x\) more variable than the reflection
Double partial covering

difference between low- and high-flux state
can be described by changes in only the covering
fraction of the absorbers
Chandra observation of 1H0707-495
Leighly et al. (2002)

• observed 2 months after first (GT) XMM observation
• flux was ~ 10x the GT observation and 2x the AO2

similar emission/absorption feature as seen in AO2

similar spectral variability as seen during AO2

usual flux variability
Comparison between the two observations of 1H0707-495

<table>
<thead>
<tr>
<th></th>
<th>Reflection</th>
<th>Part. Covering</th>
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</thead>
<tbody>
<tr>
<td>Harder spectrum</td>
<td>Y</td>
<td>Y</td>
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<tr>
<td>during low-luminosity</td>
<td></td>
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<tr>
<td>Nature of soft-excess</td>
<td>Y</td>
<td>Y</td>
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<tr>
<td>Nature of warm emission/absorption</td>
<td>Y</td>
<td>Y</td>
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<tr>
<td>Edge sharpness</td>
<td>N</td>
<td>Y</td>
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<td>Shift in drop energy</td>
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<td>~</td>
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<tr>
<td>Flux variability</td>
<td>Y</td>
<td>Y</td>
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<tr>
<td>Spectral variability</td>
<td>Y</td>
<td>Y</td>
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</tbody>
</table>

but see IRAS13224-3809 (Gallo et al. 2004)

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Conclusions

• two XMM observations of the NLS1 1H0707-495 separated by two years
• spectral and short-term timing properties can be explained by either partial covering or reflection
• partial covering requires an outflow of $\sim 0.05c$
• reflection dominated spectrum requires light bending considerations very close to black hole
• partial covering and reflection appear very different in a high-flux state
• detection of 1H0707-495 in various (and a high-flux) state can reveal the correct model
• or a very high signal-to-noise spectrum to examine the spectrum above the edge

Thank you!