Coronal properties of luminous quasars at cosmological redshifts

Elias Kammoun (SISSA)

Main collaborators:
Guido Risaliti (U. of Florence)
Dan Stern (NASA/JPL)
Emanuele Nardini (INAF-Arcetri)
Annalisa Celotti (SISSA)
The X-ray emitting region (Corona)

Comptonization:

Relatively cold accretion disc emitting a BB spectrum ($kT \sim$ few eV)

Hot relativistic electrons ($kT_e \sim$100-300 keV)

Resulting spectrum $\approx$ Power-law $\times$ high energy cutoff

\[
\Gamma - 1 \approx \left[ \frac{9}{4} + \frac{m_e c^2}{kT_e \tau (1+\tau/3)} \right]^{1/2} - \frac{3}{2}
\]

\[
E_{\text{cut}} \sim 2 - 3kT_e
\]
General questions:

➢ How to heat the corona?

➢ Magnetic field reconnection (similar to solar flares)?


➢ Temperature? Importance of pair production? Dependence on luminosity?

➢ Corona - disc interaction?

➢ .....
Main Aim

Studying X-ray coronal properties of high-redshift quasars using joint XMM-Newton + NuSTAR spectra.
Objective

$E_{\text{cut}}$ has been recently determined for local bright AGNs. However, it is complicated because of the need of high quality spectra, the complexity of the spectra, and the cutoff might not be seen.

Considering:

1. The high luminosity and redshift of the source.

2. The high sensitivity of joint XMM-Newton & NuSTAR observations in the 0.5-80 keV band.
Objective

$z = 0$

$vF_\nu$ [a.u.]

XMM-Newton

NuSTAR

Energy (keV)
⇒ Redshift $E_{\text{cut}}$ closer to the observed range

⇒ Better constraints on the coronal parameters / geometry / dependence on luminosity
Why XMM+NuSTAR?

Simulated source @ z = 3.5

E. Kammoun - The X-ray Universe 2017
The case of QSO B2202-209

**Name:** QSO B2202-209 (aka PB 5062)

**Type:** Radio-Quiet Quasar

**Luminosity:** $L_{2-10} \sim 10^{46}$ erg/s

**Redshift:** $z = 1.77$
Back in 1987

Reboul et al. (1987):

2.4. P.B. 5062

This object is again a mixed pair from the Berger-Fringant catalogue (1980) where it is described as a 17.5 class II object with a faint companion (colour G, magnitude 19″, 3 southward).

A 60 minutes exposure has been made with the same equipment than for P.H.L. 6657–58. The spectrum of P.B. 5062 (Fig. 3) shows a broad emission feature. The most likely identification is C iv 1549 at a redshift of 1.77 which would affect to this quasar an absolute magnitude $M_B \sim -28.5$. 
Back in 1987

Back in 1987, Reboul et al. (1987) found that the redshift $z \approx 0.53$.
Palomar - 2016 ⇒ New redshift

$z = 0.532$
Spectral analysis

+ absorption line @ 1.8keV (instrumental)

χ^2/dof ~ 1.05

model(s):
- Galactic absorption (wabs)
- Neutral absorption (zwabs: N_H = 1.4E+21 cm^{-2})
- Ionized partially covering absorber (zxipcf: N_H = 2.3E+23 cm^{-2}; Log ξ = 0.4, CF = 30%)
- high-energy Cutoff PL (phenomenological)
- Comptonisation (compTT)
B2202-209 $(z=0.532)$
Conclusions

➢ **Optical spectrum**
- \( M_{BH} = 1.2 \times 10^9 \, M_\odot \Rightarrow L_{Edd} = 1.56 \times 10^{47} \, \text{erg/s} \)

- \( L_{bol} \approx 8 \nu_B L_B \Rightarrow L_{bol} \approx 0.04 \, L_{Edd} \) (Marconi+04)

- \( EW_{obs}([\text{O III}]\lambda5007) = 146 \, \text{Å} \Rightarrow \cos \theta = EW*/EW_{obs} \Rightarrow \theta \approx 85^\circ \)

➢ **X-ray spectrum**
- \( L_X = 1.9 \times 10^{45} \, \text{erg/s} \Rightarrow L_{bol} \approx 1.15 \, L_{Edd} \) (Marconi+04)

- Similar coronal properties compared to local AGNs: Relatively low KT, flat X-ray spectrum, low reflection fraction

  ⇒ universality in the X-ray emission, despite the high X-ray luminosity and mass.
Conclusions
Conclusions

Optical + X-ray spectra

- Optical-to-X-ray slope:
  \[ \alpha_{\text{OX}} = 1.0 < \langle \alpha_{\text{OX}} \rangle = 1.6 \] (Lusso & Risaliti, 2016)

✔ Agreement between the \([\text{O III}]\)λ5007 and X-ray:

\[ \log L_X = 1.22 \log L_{[\text{OIII}]} - 7.34 \] (Panessa+06)

✔ High inclination:

\[ \Rightarrow L_{B,\text{int}} = L_{B,\text{obs}} / \cos \theta \Rightarrow \alpha_{\text{OX, int}} = 1.43 \]

⇒ Explain the low reflection fraction

+ Low amount of absorption
  + low IR emission, compared to standard SED

⇒ Edge-on & Torus-free system