UFOs in (all?) high-z QSOs

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Outline

i. Motivation(s)

ii. UFOs in (all?) high-z QSOs

Framework (i/iv): Co-evolution of galaxies

First unexpected “revolution” in extragal. astrophysics: not only most (all?) galaxies have SMBHs (MDOs) in their centers, these also correlate with bulge properties.

Kormendy & Richstone, 1995, ARA&A
Framework (ii/iv): Feedback in the co-evolution of galaxies

⇒ evidence for feedback mechanism between SMBH(AGN) and its’ host galaxy?

Magorrian et al. '98
Tremaine '02; Gebhardt '02...etc
(see e.g. King and Pounds '03, Crenshaw, Kraemer & George '03, ARA&A)

\[ M_{bh} \sim 6^4 \]
Second unexpected “revolution” in extragal. astrophysics:
need preheating to recover L-T relations & cooling flows extra-heating
⇒ Energy feedback from AGNs/QSOs in groups&clusters?

Grav. scaling

With SN preheating

With AGN pre-heating

With QSO ejection/outflows

Lapi, Cavaliere & Menci, '05

Perseus Cluster
Fabian et al. '05
Framework (iv/iv): MBH vs SFR, which arrived first at z~2-3?

QSO space density

SFR space density

Wall et al. ‘05
Madau et al. ‘96

BUT HOW?

Jet, Winds/UFOs, $L_{AGN}$, mix?

$M_{bh}-\sigma$ relation, AGN-gal coevolution, L-Tx relations, Heating cooling flow, Galaxies colors & sizes

AGN Feedback!
At low-z: A possible (unifying) X-ray view of UFOs and non-UFOs (WAs)

- UFOs kinetic energy >1% of Lbol
- Feedback (potentially) effective!

Tombesi, MC et al., ‘12b, ‘13
At high-z: UFOs and/or FeK complex features seen in lensed high-z QSOs

APM 08279+5255 (z=3.91)
$V_{\text{out}} \sim 0.2-0.76 \, c$

HS0810+554 (z=1.5)
$V_{\text{out}} \sim 0.1-0.4 \, c$

Chartas et al. 2002, 2009

→ Ubiquitous complex (i.e. ionized and/or partially covering), and massive absorption in high-z QSOs?

At high-z: UFOs and complex absorbers measured in lensed high-z QSOs

**PG1115+080 (z=1.7)**

$V_{\text{out}} \sim 0.1-0.34 \ c$

**B1422+231 (z=3.6)**

Ionized absorber, $V_{\text{out}} = ?$

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**Chartas et al., '07**

**Dadina, MC, et al., '16**
The new X-ray view: UFOs and complex absorbers measured in lensed high-z QSOs

MG J0414+0534 (z=2.6) p ≈ 0.32 c

Dadina, MC, et al., see poster
The new X-ray view: UFOs seen also in non-lensed high-z QSOs

(z=2.73) high-z RQ (NAL) QSO HS1700+6416,
$V_{\text{out}} \sim 0.12\text{-}0.6c$

PID352 (z=1.6)
$V_{\text{out}} \sim 0.15c$

→ Ubiquitous complex (i.e. ionized and/or partially covering) absorption?

Lanzuisi et al., ’12

Vignali et al., ’15
UFOs seen also in non-lensed high-z QSOs

(z=2) PG1247+268
$V_{\text{out}} \sim 0.15c$

Another high-z UFO candidate...

Lanzuisi et al., '16

→ Ubiquitous complex (i.e. ionized and/or partially covering) absorption?
→ Desperately need more and longer XMM observations on high-z QSOs

Just were approved a $\sim 450$ ks of XMM time to observe 4 non-lensed QSOs at $z \sim 2$ (PI: MC)
Remarkable correlation between wind mass outflow rate and AGN bolometric luminosity: 

$$M_{\text{out}} \sim L_{\text{bol}}^{0.5}$$ for molecular winds

$$M_{\text{out}} \sim L_{\text{bol}}$$ for ionized winds

$$E_{\text{kin}}(\text{out}) = 1-10\% \ L_{\text{bol}}$$ (molecular)

$$E_{\text{kin}}(\text{out}) = 0.1-10\% \ L_{\text{bol}}$$ (UFOs, BALs)

$$E_{\text{kin}}(\text{out}) = 0.1-1\%$$ (ionized low $L_{\text{bol}}$) = 1-10 % (ionized high $L_{\text{bol}}$)

Fiore et al., ’15
Summary:

- **Science Case (outflows)**
  - Recognized importance, and “pathfinder” to future missions/observatories (from ground based Obs. ALMA, MUSE, SINFONI to Athena).
  - Important implications for both astrophysics of winds/outflows formation and acceleration, and the cosmological impact/feedback of AGN winds.

- **Cosmological impact/feedback:**
  - Few decent high-z QSOs spectra available, ALL show UFO-like features in their X-ray spectra
  - Need to have good quality (>10000 cts) X-ray spectra for a representative sample of (30-40) high-z QSOs to characterize and measure the frequency of massive and energetic outflows in high-z QSOs (for z~0-2, L~0.1-Ledd). Need multi-ni coverage to obtain full outflow energetics. Multi-ni would also “guarantee” more publications per XMM-ks, like experience in low-z AGNs.
  - The future: from XMM (LPs and VLPs) to Athena (core science)
Thank you very much for your attention