The WISSH Quasars Project:
X-raying the most luminous quasars at cosmic noon

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Sample of ~90 WISE/SDSS Selected Hyper-luminous (WISSH) Quasars
- SDSS DR7 broad-line quasars at \( z > 1.5 \) with WISE(22\( \mu \)m) $> 3$ mJy
- Bolometric Luminosity $\log(L_{\text{bol}}/\text{erg/s}) > 47.2$

**GOAL: Observing the AGN-driven feedback at its extreme**
Models & Obs. $\rightarrow$ the most luminous QSOs are the best targets to hunt for maximum feedback (huge radiative output, powerful AGN-driven outflows)
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Extensive multi-band coverage from sub-mm to X-ray based on proprietary & archival data (i.e. ALMA, HERSCHEL, ESO/VLT, LBT/LUCI, SDSS, CHANDRA, XMM)

On-going follow-up: NOEMA, MUSE, X-shooter, HST .. ..
MULTIBAND FOLLOW-UP OF WISSH

WISSH Tasks:
✓ Probing widespread presence of outflows from different gas phases/distances
✓ Constraining the properties of the central engine
✓ Studying the ISM and SFR of quasars host galaxies
MULTIBAND FOLLOW-UP OF WISSH: First Results

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A taste of WISSH...

• Largest ever luminosity of Broad [OIII] lines
• Powerful (~1% Lbol) kpc-scale outflows

![Graph showing relationship between kinetic energy and bolometric luminosity]
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• Ultra-massive BH with 1e9-1e10 M☉
• High-velocity BLR winds
• BLR (CIV) – kpc-scale [OIII] winds dichotomy
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• Broad-band SED (UV-FIR)
• Giant star nurseries with SFR >1000 M☉/yr

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X-ray Universe 2017 ★
X-WISSH: X-raying the poorly explored bright end of the AGN LF

- X-ray coverage for 41 quasars (~50% of WISSH)
- Bulk of quasars (70%) with \( N_h < 1 \times 10^{22} \text{ cm}^{-2} \) (as expected for Type 1)
- X-ray Luminosities \( \log (\text{Lum}[2-10]/\text{erg/s}) \sim 45-46 \)
X-RAY VIEW OF WISSH QUASARS

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Typical AGN region
(COSMOS, CDFS, PG)

0.1 < Flux ratio X/O < 10

WISSH QSOs show X/O < 0.1
Unexplored region of the X/O vs Lx plane

X-ray spectral slope vs. SMBH Mass

From the Jin+12 sample of nearby Type1 with SDSS+OM+XMM data
• Improved the sampling at the largest $M_{BH} \gg 10^9 \, M_\odot$ thanks to WISSH
• Added two samples of AGN with $M_{BH} < 10^6 \, M_\odot$ Ludlam+15 Miniutti+09
• Fits accounting for the soft excess or limited to the hard X-ray band

Flatter dependence than previously found over the broad $5 < \log M/M_\odot < 11$ range
WISSH QSOs: VERY STEEP AlphaOX

Steep ionizing continuum

→ Weak UV lines

→ NO overionization

→ OK for radiation line driving force

→ Hi-ionization CIV Winds

$\alpha_{\text{OX}} < 1.8$
typical threshold of “X-ray weakness” for typical AGN

WISSH QSOs are “intrinsically” X-ray weak
Ideal sources for driving high-ionization broad-line winds
Combination of AGN samples selected by different criteria:
- better sampling of the plane
- mitigate bias

OFFSET from LOCAL RELATION
LARGE SCATTER

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HIGH-LUM QUASARS HAVE WEAKER X-RAY EMISSION

At odds with the scenario of a torus with a lum-dependent covering factor

WISSH QSOs with $L_{\text{bol}} \gg 1 \times 10^{47}$ erg/s allows to sample a poorly explored region of the $K_{\text{X,Bol}} - L_{\text{bol}}$ plane

Large $L_{\text{bol}} \rightarrow$ Large $K_{\text{X,Bol}}$

- Extrapolated Lusso+12 relation well fits also Hyper-Lum quasars
- X-ray corona in Hy-Lum QSOs provides a smaller contribution to $L_{\text{bol}}$ than in “standard” AGN
Relative X-ray weakness of Hy-Lum quasars compared to less luminous AGN

- Lower X/O, steeper alphaOX, lower MIR/X, larger KX,Bol
- cannot be explained by obscuration (WISSH are unobscured sources)
- Mean SED of high-L AGN is characterized by a softer (= redder) far-UV spectral slope, a bluer optical continuum and a stronger hot dust emission

(a) Luminosity SEDs normalized at 1.3\(\mu\)m

(b) Luminosity SEDs normalized at 1450\(\AA\)
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X-ray weakness is a key feature to produce line-driven winds

Proga (2005) luminous AGN can launch UV radiation-driven accretion-disk winds being able to weakening/destroying the X-ray corona
15 ks X-IFU simulated spectrum for a WISSH-like quasar at $z=3.4$ with a PDS456-like UFO

$[v=0.15c, N_h=23.4 \text{ cm}^{-2}, \log U=2.3$ and $v=5000 \text{ km/s}]$

Cheap ATHENA Program: Sizable fraction of WISSH ($\sim25\%$) can be targeted with a total exp. of 300 ks
The WISE/SDSS selected Hyper-Luminous (WISSH) Quasars Project aims to offer a panchromatic view of nuclear, outflows and host galaxy properties (Bischetti et al. 2017; Duras et al. 2017)

X-WISSH: X-ray properties for 35 hyper-luminous, broad-line quasars (Martocchia et al. 2017, sub.)

Opportunity to significantly extend & validate relations involving X-ray Lum.

Γ-M(BH): Flatter dependence than previously found over $5 < \log M/M_\odot < 11$

X-ray emission of hyper-luminous quasars is relatively weaker compared to lower-luminosity AGN (low X/O, X/MIR and largest X-ray Bol corrections)

Hy-Lum QSOs to complete the view of the accretion disk-corona system (i.e. X-ray vs. broad-band SED properties)

X-ray weakness as a key ingredient for nuclear winds acceleration
X-RAYING LUMINOUS QUASARS

Hyper-Luminous QSOs → Bolometric luminosity $>> 10^{47}$ erg/s  
→ X-ray luminosity $> 10^{45}$ erg/s

VERY RARE → Sampling of large sky area required

VERY FAINT → Cosmic downsizing, peak of density at high $z$

★ Systematic study of the X-ray spectral properties of quasars available only for $z < 0.1$ QSOs (i.e. PG QSOs; Piconcelli+05)

★ Chandra snapshots eg Vignali+03 Just+07 Shemmer+08
★ Few targeted obs. of (mostly lensed) luminous QSOs Chartas+02,07 Lanzuisi+12,16 Banerji+14

★ Deep fields only cover sky fields of $\leq$ few deg$^2$

X-raying the unexplored brightest end of the LF
✓ Spectral features
✓ X-ray bolometric correction
✓ Extending correlations involving LX