Quasars as high redshift standard candles

The $L_X - L_{UV}$ relation at high redshift

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The $L_X - L_{UV}$ relation: why?

1. Where does it come from?

$$L_X = KL_{UV}^\gamma$$
The $L_X-L_{UV}$ relation: why?

1. Constraints on the unknown physical mechanism
2. Quasars as Standard Candles
Hubble Diagram of SN1A

\[ D_L = \frac{-F_X + \gamma F_{UV} - \beta}{2(\gamma - 1)} \]

Distance Modulus

Redshift \( z \)

SN1A

SN1A averaged

\( \Omega_m = 0.295, \ \Omega_\Lambda = 1 - \Omega_m \)

Betoule et al. (2014)
The $L_X - L_{UV}$ relation

Avni and Tananbaum (1986)

$L_X - L_{UV}$ relation

$\delta_{\text{intr}} \sim 0.35-0.40$ dex

Lusso et al. (2010)
The $L_X-L_{UV}$ relation

- SDSS DR7 (Shen et al. 2011)
- 3XMM-DR5
- No BAL sources
- Radio Quiet
- $1.6 < \Gamma_X < 2.8$
- 2153 sources
- $0.065 < z < 4.925$

$Lusso and Risaliti (2016)$

$\gamma \sim 0.6 - 0.65$

$\delta_{intr} = 0.24$
The sample

- SDSS DR7 (Shen et al. 2011) & DR12 (for $z<5.3$)
- No BAL sources
- Radio Quiet
- Archival $\textit{Chandra}$ and $\textit{XMM-Newton}$ observations
- No X-ray flux upper limit
- $4.0 < z < 7.08$

Accurate selection
Accurate X-ray analysis
Evolution with redshift?

More details in: Salvestrini et al. in prep.
\[ \log(L_X) = \gamma \log(L_{UV}) + \beta \]

\[ \gamma = 0.51^{+0.12}_{-0.12} \]

\[ \delta = 0.22 \text{ dex} \]
Consistency with lower redshift results
Conclusions

1. $L_{UV} - L_x$ relation
   - Accurate sample selection
   - More reliable flux estimates
   - No evidence of evolution with redshift

2. Hubble Diagram of quasars
   - Test of the ΛCDM model
   - Test on possible extensions to standard model
Thank you!