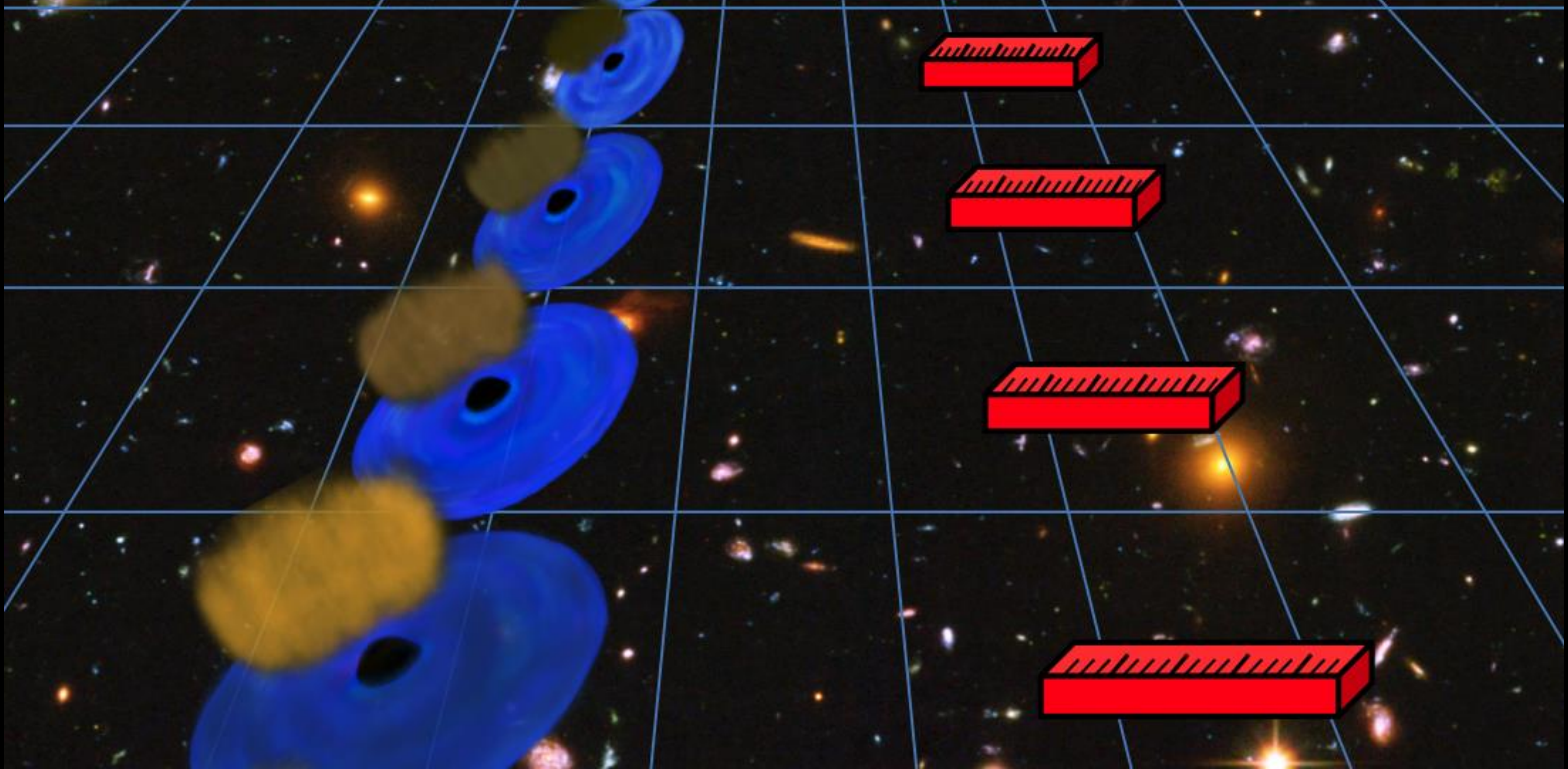
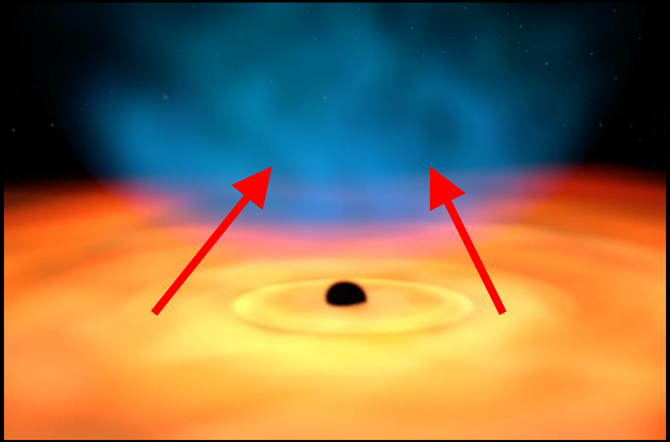
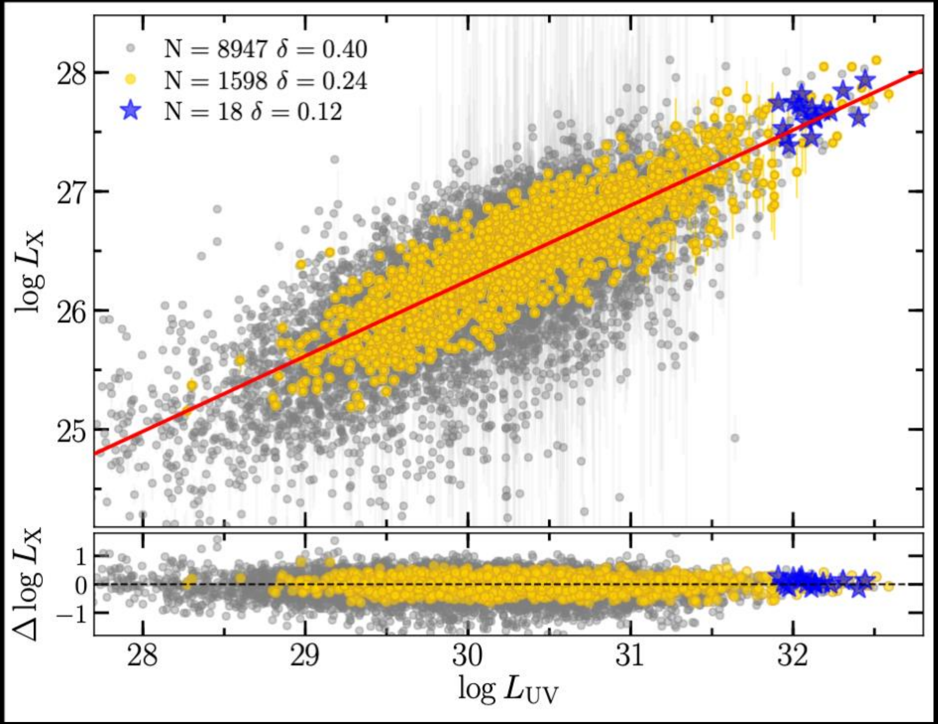
Quasars as high redshift standard candles

Guido Risaliti
University of Florence & INAF – Arcetri Observatory, ITALY
Elisabeta Lusso*, *G. Bargiacchi, S. Bisogni, E. Nardini, A. Sacchi, M. Signorini, B. Trefoloni



The non-linear relation between L_X and L_{UV} in quasars





$$\log(L_X) = \alpha \log(L_{UV}) + \beta$$

L_ν(2 keV)

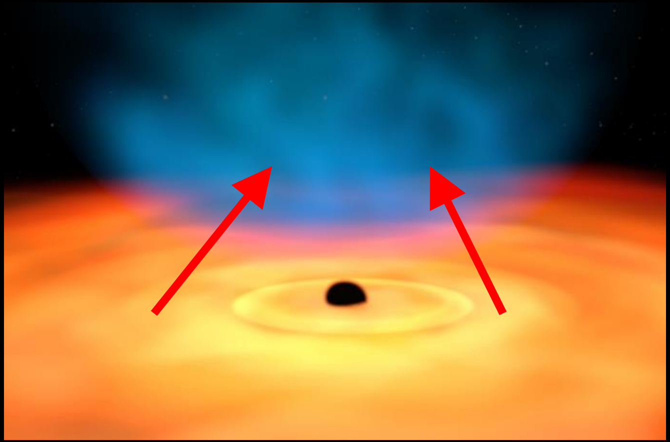
L_ν(2500 Å)

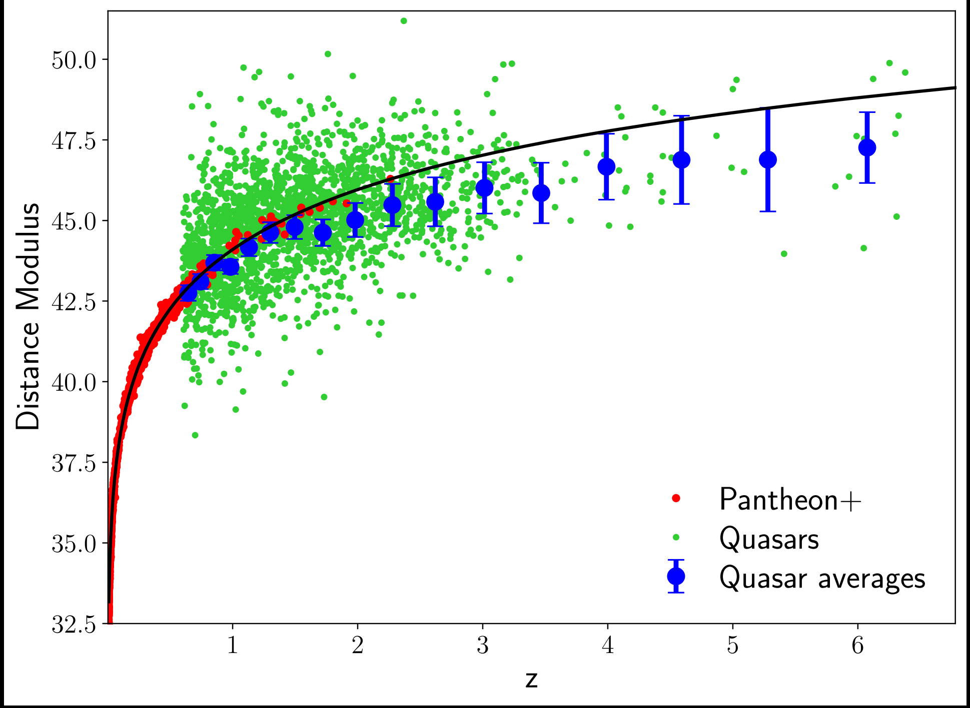
$\alpha = 0.6$

Risaliti & Lusso 2019, Lusso et al. 2020

The non-linear relation between L_X and L_{UV} in quasars

$$\log [D_L(z)] = \log(F_X) - \alpha \log (F_{UV}) + \beta'$$





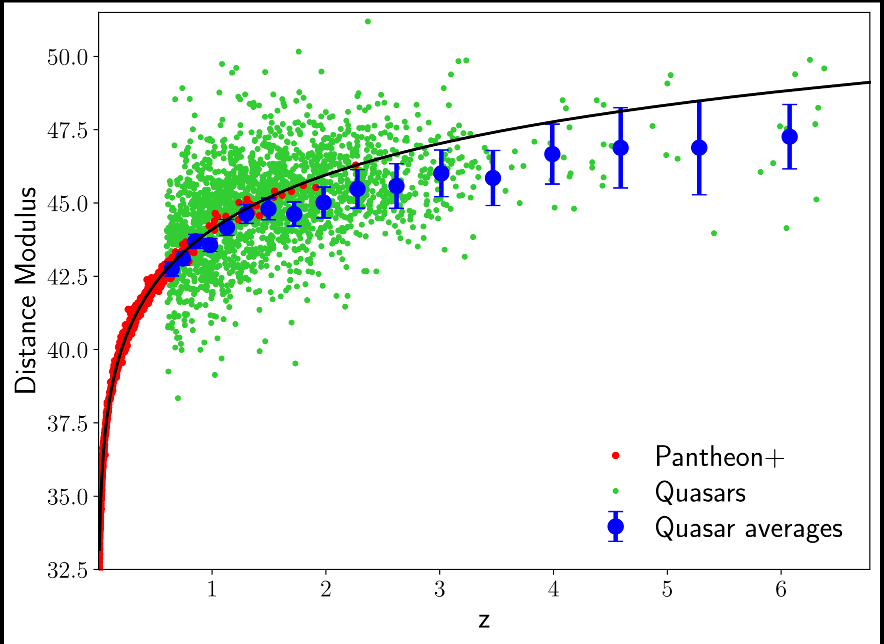
$$\log(L_X) = \alpha \log(L_{UV}) + \beta$$

L_ν(2 keV)

L_ν(2500 Å)

$$\alpha = 0.6$$

Quasars as Standard Candles: are they reliable ?



Is the X-ray to UV relation constant with redshift ?

Are there selection effects in the sample ?

Are the quasars in the cosmological sample really *average* quasars or are we "cherry-picking" the ones we like?

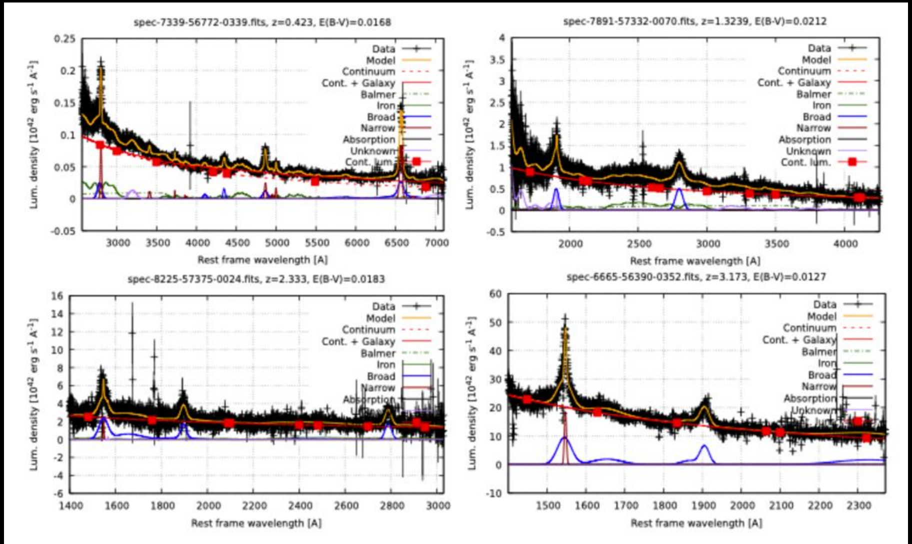
Are there systematic effects in the flux measurements ?

Can reddening (extinction, host galaxy contamination) affect our sample?

Quasars as Standard Candles: are they reliable ?

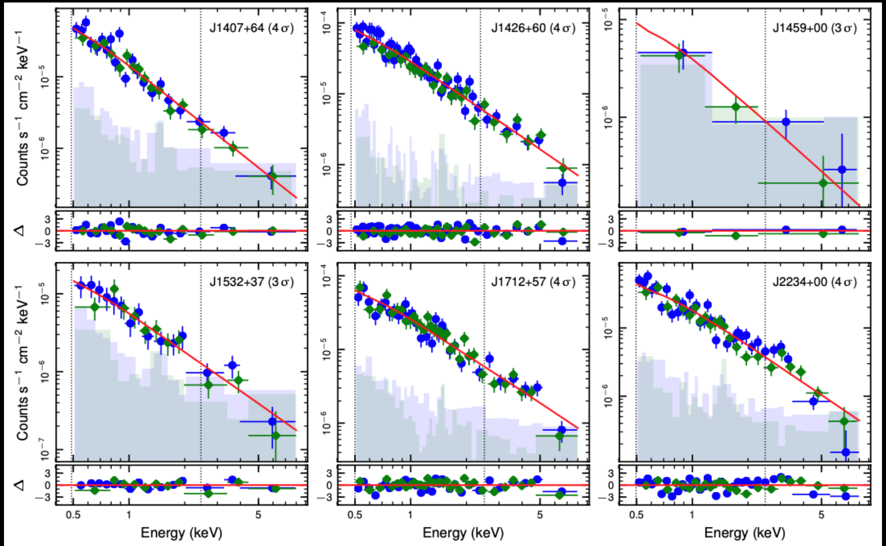
Detailed spectral analysis (dust reddening, etc…)

OPTCAL/UV



Signorini et al. 2023a

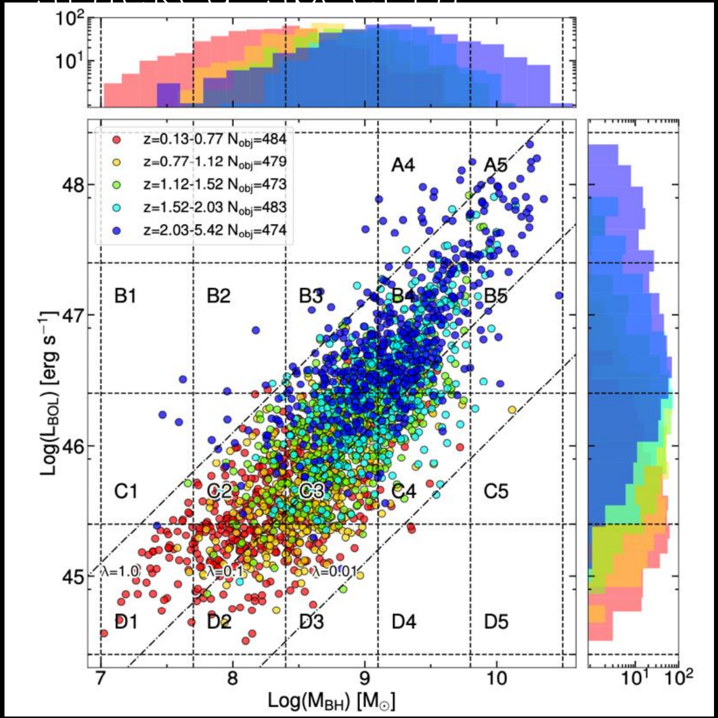
X-ray

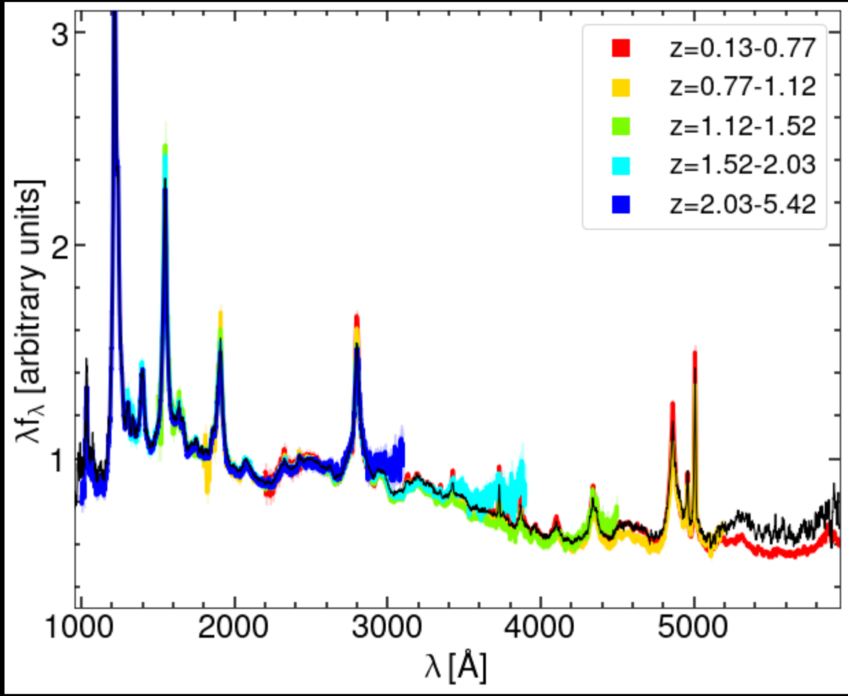


Nardini et al. 2019, Signorini et al. 2023

Quasars as Standard Candles: are they reliable ?

Quasar spectral properties as a function of redshift: analysis of stacked spectra

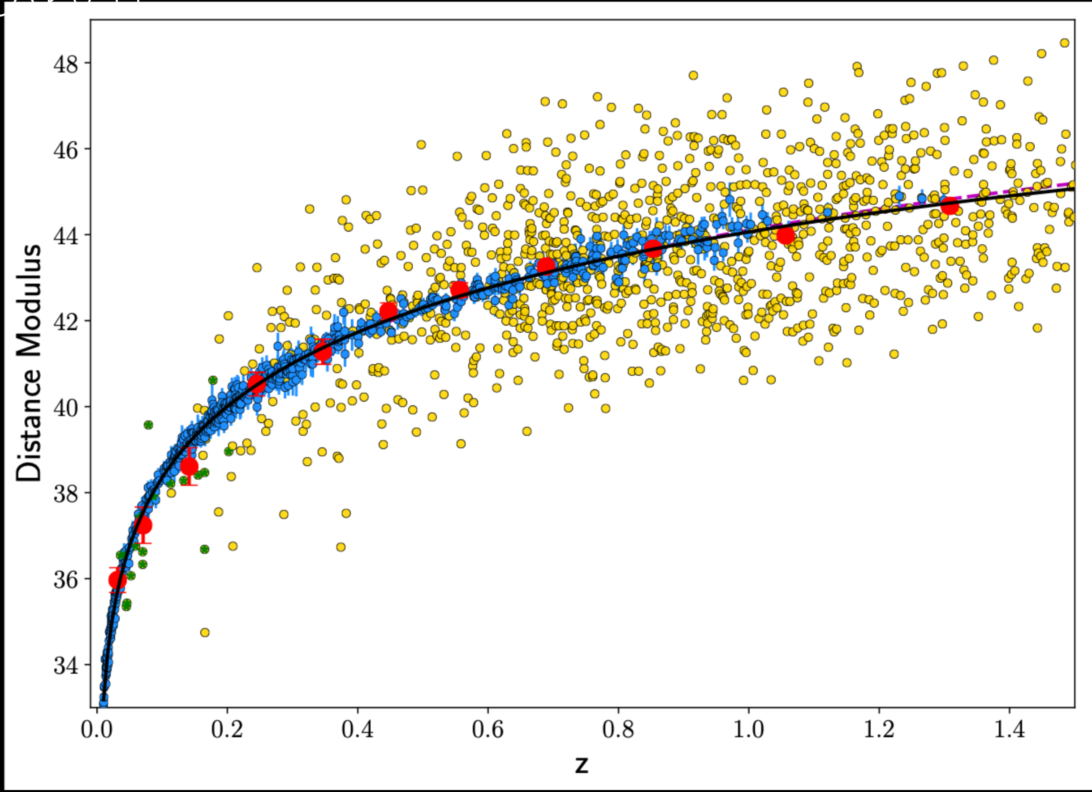




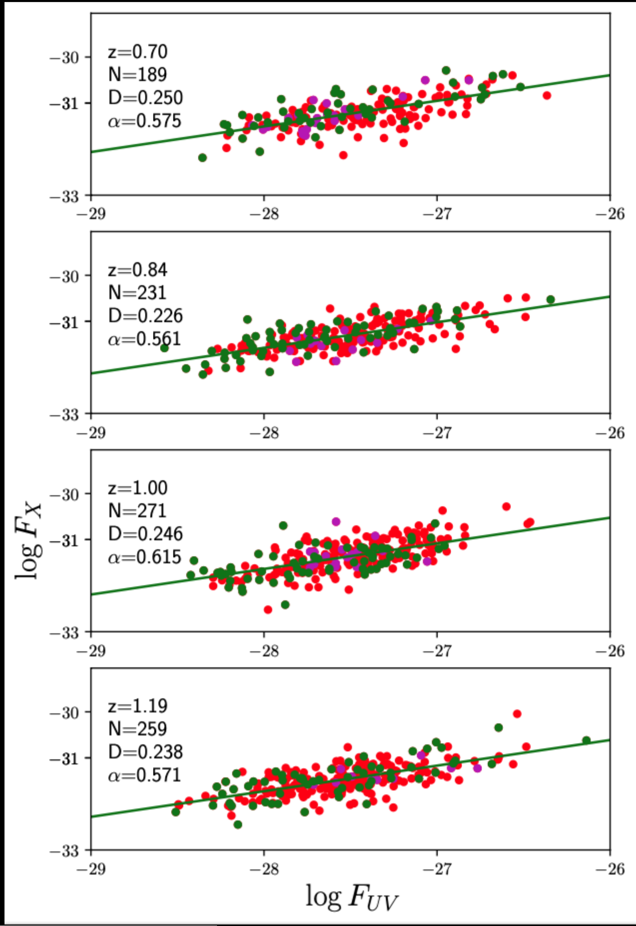
Trefoloni et al. 2024

Quasars as Standard Candles: are they reliable ?

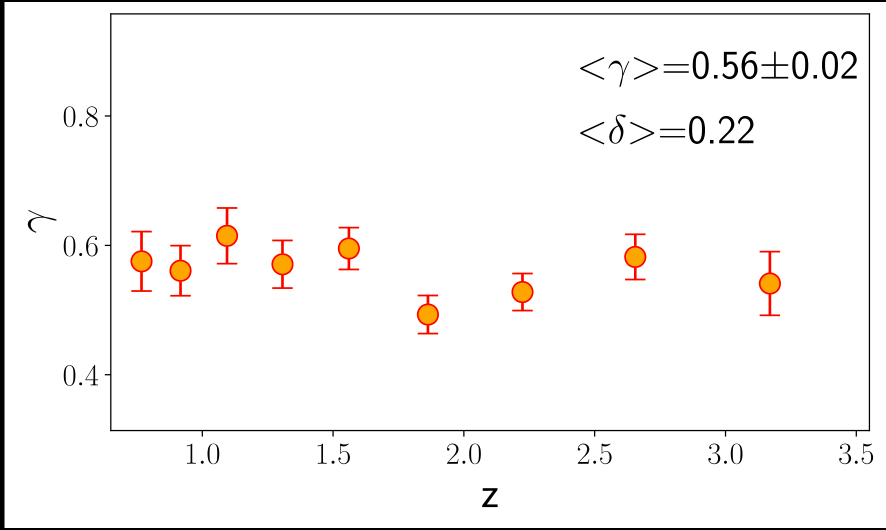
Comparison with SN Ia in the common redshift interval



Quasars as Standard Candles: are they reliable ?

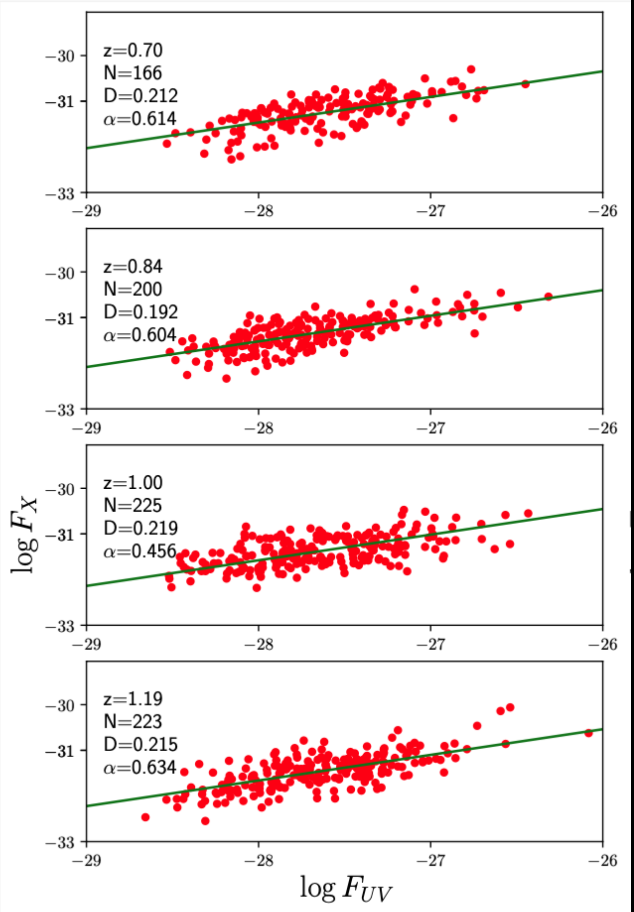


Relation slope vs. redshift

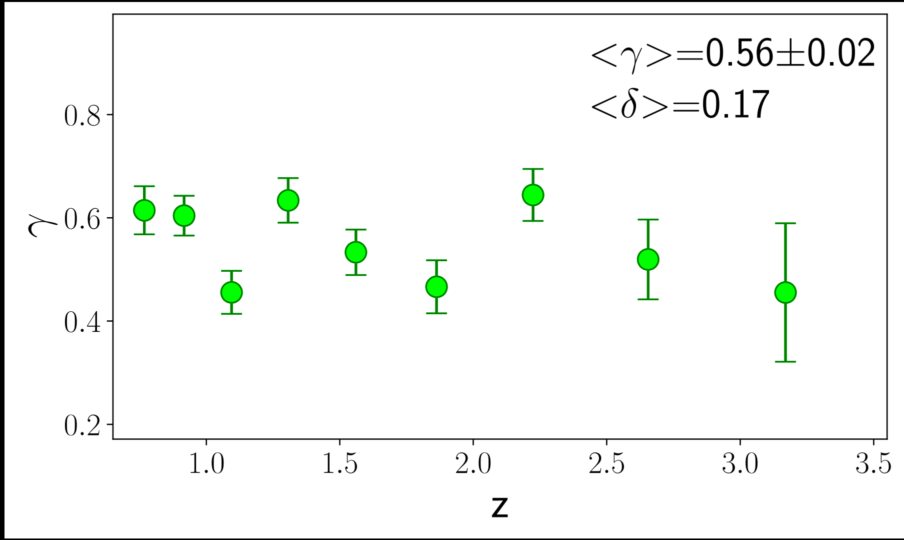


Lusso+20: 2,400 quasars:
1,600 XMM + 800 Chandra

Quasars as Standard Candles: are they reliable ?



Relation slope vs. redshift



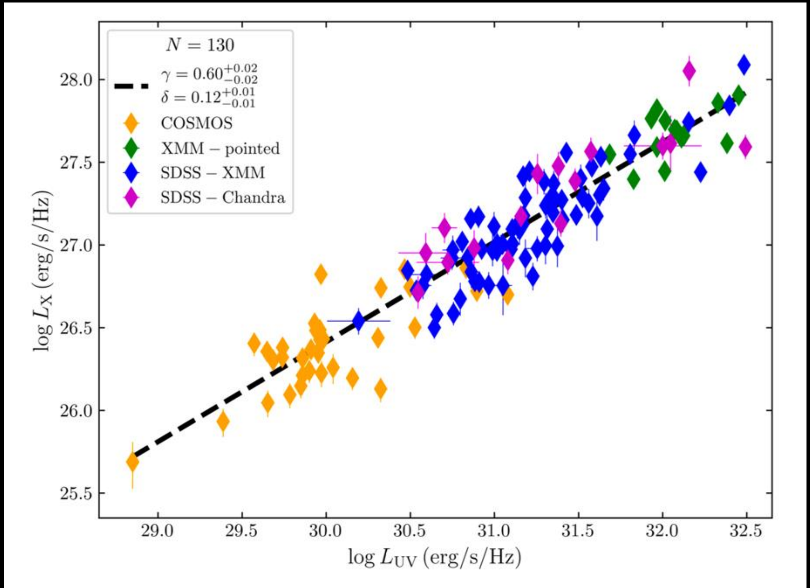
2024: 2,000 quasars:
All Chandra (from CSC 2.

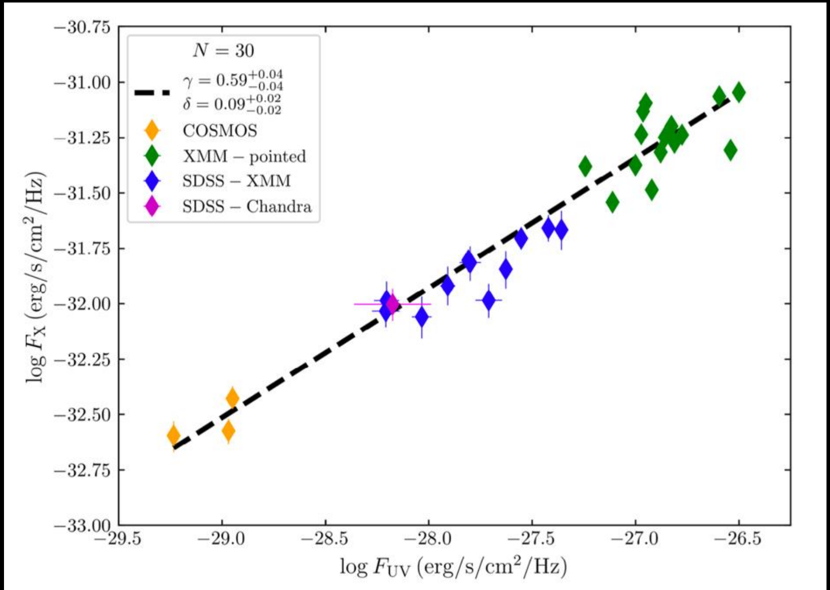
Quasars as Standard Candles: are they reliable ?

Lower dispersion with better data and better analysis

130 sources, δ = 0.12

30 sources, δ = 0.08





Sacchi et al. 2022

Quasars as standard candles:

- No satisfactory physical model for the disk-corona connection
- Dispersion still higher than that of supernovae

BUT

- Slope not evolving with redshift
- Spectral properties non evolving with redshift
- Perfect match with supernovae in the common redshift range
- Dispersion decreasing with better flux measurements
- Dispersion entirely explained with “external” effects (inclination, variability)