Spectral Energy Distributions of Luminous X-ray Selected AGN in Stripe 82X

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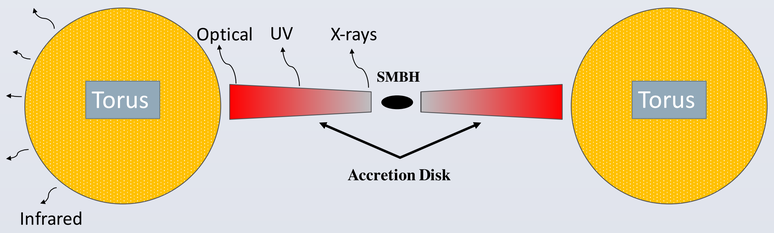
ABSTRACT

Multi-wavelength data (X-Ray–to–far-infrared: 0.5keV–250μm) from the Stripe 82X survey are used to compile the continuum spectral energy distributions (SEDs) of 1597 luminous ($L_X > 10^{43}$ erg/s) X-Ray selected (*Chandra, XMM*) sources with spectroscopically confirmed redshifts. All of these sources have X-Ray luminosities (0.5-10keV) normally associated with luminous active galactic nuclei (AGN) and quasi-stellar objects (QSOs). This is the largest statistically complete sample of luminous AGN with well-determined SEDs that has been studied to date. The full sample can be split into two luminosity groups: 1) sources (1206 = 75%) with higher X-Ray luminosity ($L_X \geq 10^{44}$ erg/s), which typically show broad emission lines characteristic of optically-selected QSOs, and 2) sources (391 = 25%) with lower X-Ray luminosity ($10^{43} < L_X < 10^{44}$ erg/s), which exhibit narrower emission lines more typical of narrow-line Seyferts and star-forming galaxies. The median and range of SED shapes of the higher luminosity X-Ray selected sources are similar to what is observed for UV-excess QSOs; both show characteristic features thought to be directly associated with the AGN accretion disk, e.g. a "big-blue-bump" (BBB) at UV–Visible wavelengths (0.1-0.4μm) and enhanced emission in the near/mid-infrared (2-5μm). However, in the lower X-Ray luminosity sources, these "AGN-like" features are less prominent, and there is a larger percentage of strongly-reddened sources that lack any evidence for excess UV and near/mid-infrared emission. The most surprising finding of our study is evidence for strong mid/far-infrared emission (8-250μm) *in the majority* of all X-Ray-luminous AGN; such emission is rarely observed in previous studies of UV-selected QSOs. Further high-resolution imaging and spectroscopy of individual sources will be required to determine whether the strong mid/far-infrared emission is directly associated with the AGN or if it is primarily due to more widespread star formation in the host galaxy.

Active Galactic Nuclei

Active-Galactic-Nuclei (AGN) are supermassive black holes, on the range of 10^5 to 10^9 solar masses, at the centers of galaxies that are actively accreting material. As the material falls into the black hole, various emissions, spanning the majority of the electromagnetic spectrum, are released, as shown in the graphic below.



Sample Selection

1. Tested photometric redshifts for all sources
- Decided photometric redshifts not reliable for use (too few data points)

2. We only use sources with spectroscopic redshifts
- To ensure reliable luminosities

3. Finally, we select all luminous sources ($L_X > 10^{43}$ ergs/s)
- Guarantees bonafide AGN

Final Sample

We end up with 1597 Highly luminous sources

Conclusions

1. Template Issues:
- Not enough data points to get reliable photometric redshifts
- Only use sources with spectroscopic redshifts

2. We find two main types of sources in our sample
- High L_X (~75%):Broad-line; similar to optical QSOs
- Low L_X (~25%):Narrow-line; new class of sources?

3. Strong mid-IR emissions in *majority* of sources
- Not previously observed; suggests dust obscuration

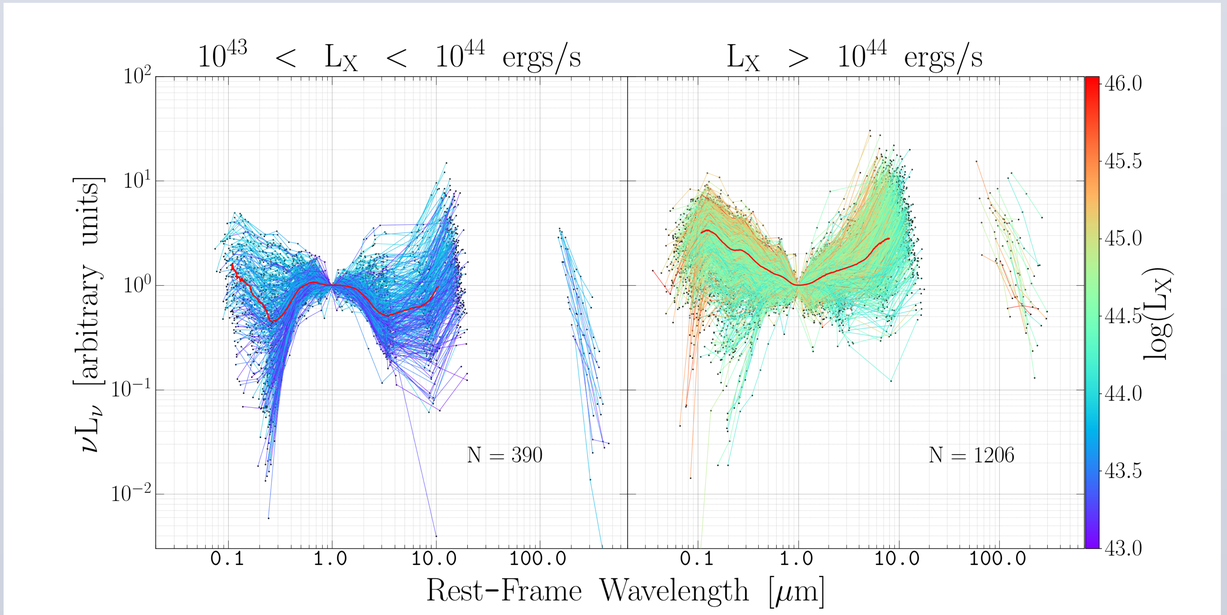
4. Median and range of SEDs show that:
- High L_X sources similar to previous UV-excess QSO populations: strong AGN features in UV-Visible (0.1-0.4 μm) and near/mid-IR (2-5 μm)
- Low L_X sources show weaker AGN features, and have a high fraction of strongly-reddened sources in UV

New Data: Stripe 82X

- Largest area Hard X-ray Survey: 31.3 deg^2 of sky-coverage
  - Designed to find representative population of luminous AGN
- Extensive multi-wavelength coverage from previous surveys across Stripe 82:
  - Data from:
    - FIRST, VLA, *GALEX*, SDSS, VHS, UKIDSS, *WISE*, *Spitzer*, *Herschel*
- In total: 6181 X-ray detected sources

Spectral Energy Distributions

- We present here SEDs, binned by L_X for the 1597 sources in our sample, normalized at 1 μm
  - We found that L_X was the only way to separate out the types of sources in our sample
  - Normalized to easily see relative variations in SED shape
- Color-coded by L_X, as shown by color-bar on the right
- Median line shown in red for each bin
  - Allows easy comparison between L_X bins



Importance

- Multi-wavelength coverage allows detailed study of these sources
- X-ray data (Chandra, XMM) allows easy and reliable AGN selection
- Wide coverage finds a large amount of luminous sources
  - X-ray surveys are usually narrow and deep
    - ➢ Only find low-luminosity sources

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