X-ray Spectral Modelling of newly identified AGNs in Chandra Source Catalog

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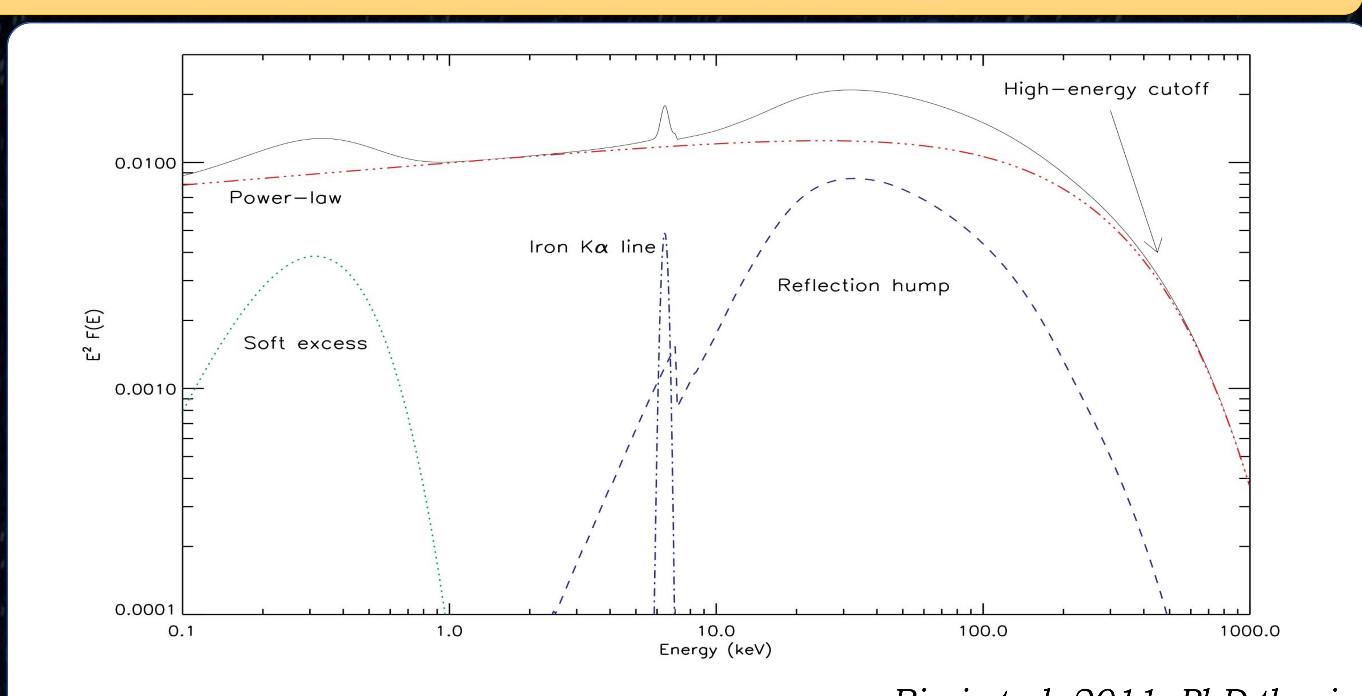
Introduction

AGNs' X-ray Spectral Features

X-ray spectrum of typical AGNs have several components as follows **a) Powerlaw component**, produced in hot electron corona by inverse comptonization of optical/UV photons from accretion disc. It is the dominant and main source behind X-ray emission in AGNs; **b) Soft Excess** – an additional thermal emission at low energy (~0.5 keV) from the very inner part of the accretion disc; **c)** some of the X-ray emission from corona come back and reflect on the accretion disc resulting a **Reflection Hump** and a characteristic **FeKα** line emission at ~ **6.4keV**; **d) High-energy cut-off** of powerlaw typically at >100keV denoting the temperature of the corona, beyond which inverse comptonization no longer occurs.

In our project, we wanted to probe the spectral feature of some newly identified AGNs using Chandra X-ray Observatory's data and check how the AGN population behaves as a whole. In our sample, only a simple absorbed powerlaw model suffices the fitting requirements for all the sources. Hence, we fitted all the spectra using power law and calculated luminosities in different bands of energy. Hardness ratios between them have also been calculated.



Ricci et al. 2011, PhD thesis

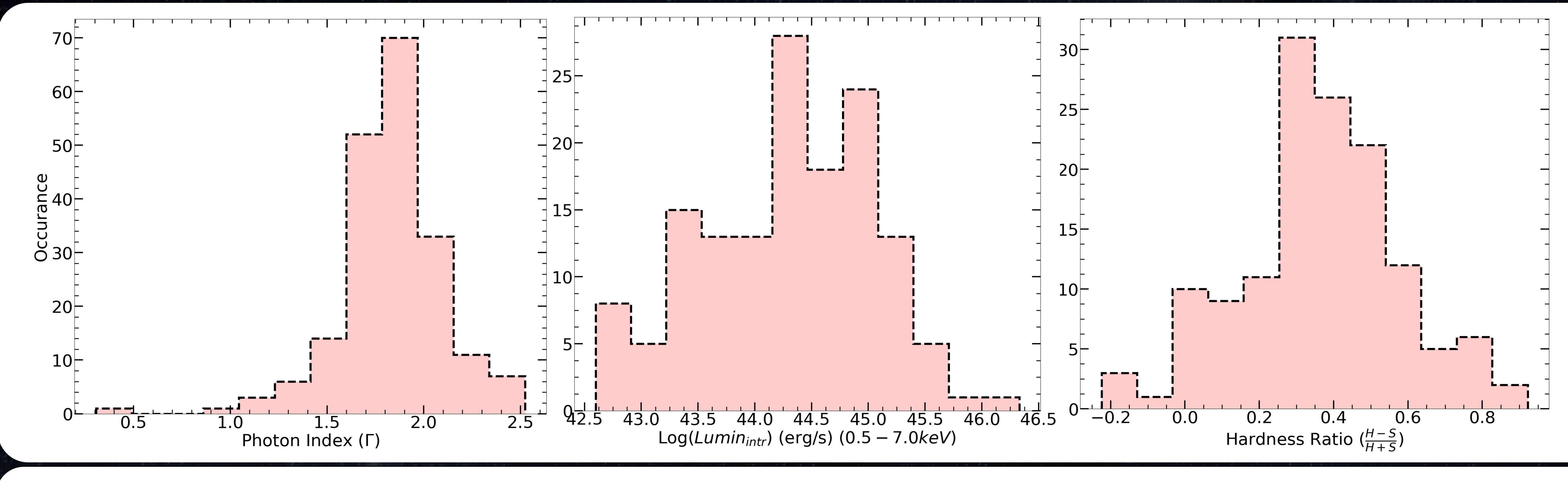
Sample Selection

31824 AGNs $\sigma_{conf} > 99.73\%$ From Kumaran et.al. 2023 → (400 counts in Source aperture enclosing 90% of total energy of PSF) → 233 AGNs → (Removing sources with Distorted PSF in the field) → 198 AGNs

In broad energy band (0.5-7.0keV observed) we wanted atleast 20 bins in the spectra with at-least 20 counts in each bin for a statistically significant spectrum. Hence we decided the threshold total counts based on which the sources were selected.

Results

The powerlaw fit has yielded the following results. The left panel shows the **distribution of Photon Index Γ**. We found redshifts from observations in other wavelengths for 145 AGNs . Luminosities were calculated after correction for the absorption, contributed by both the Galactic and local column density. **The Broad Band luminosity distribution** is shown in the middle panel. Based on Luminosity in Hard and Soft Band we have calculated Hardness ratios. The **distribution of Hardness ratios** is presented in the right figure.



Energy Bands

Broad Band : 0.5 – 7.0 keV

Soft Band : 0.5 – 1.2 keV

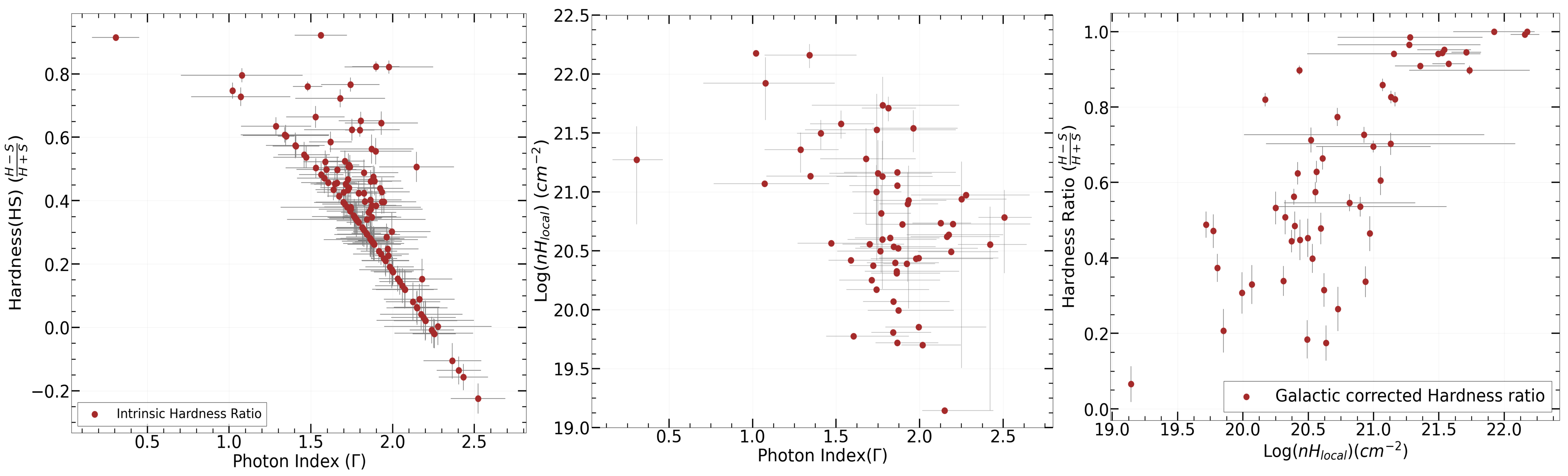
Hard Band : 2.0 – 7.0 keV

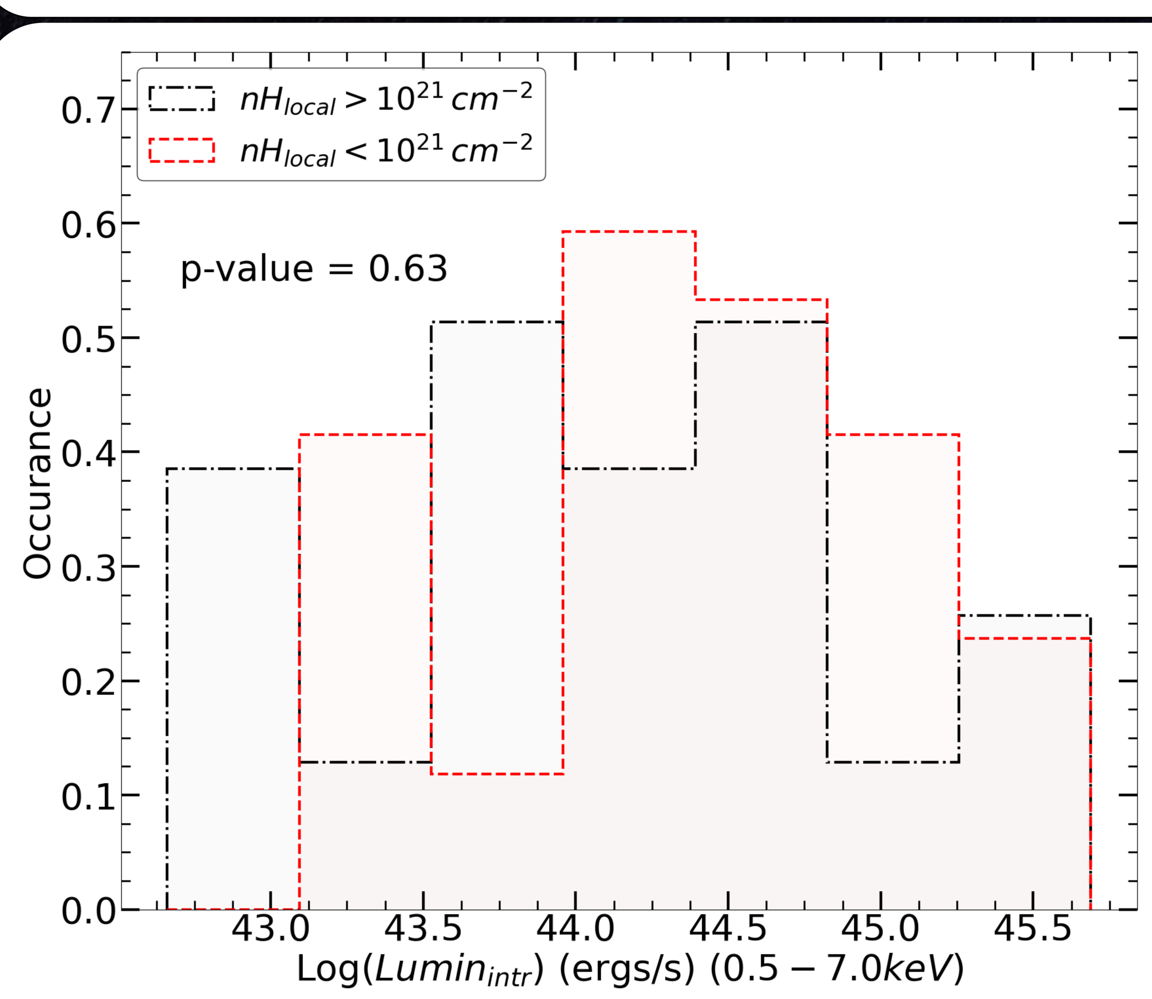
Hardness Ratio

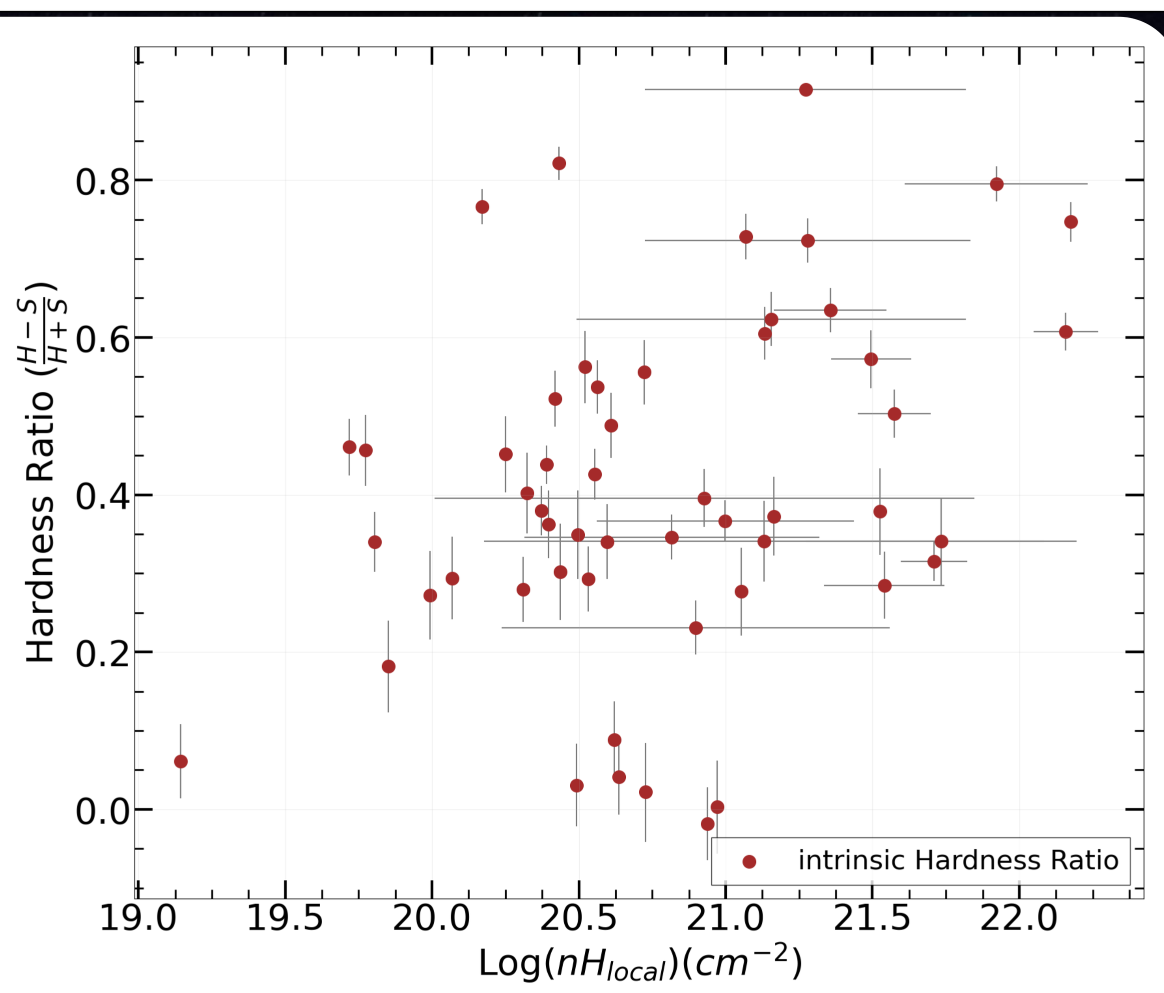
$$\frac{Lumin_{Hard} - Lumin_{Soft}}{Lumin_{Hard} + Lumin_{Soft}}$$

The **left panel** shows that harder spectra correspond to lower **Γ**. Steeper spectra are softer than shallower ones, because of low amount of high energy emission. **Middle panel** shows anticorrelation between nH_{local} and **Γ** which tells us hardening of spectra with higher obscuration. Similar thing can be seen from the **right panel** where also higher nH_{local} shows higher hardness ratio.

Local obscuring material absorbs photons of low energy and makes the spectrum harder which is evident from the plots.







Although, local obscuring material affects the observed spectra, the intrinsic properties are independent of the column density. We have subdivided the total set of sources into two parts, one with high nH_{local} and another with low nH_{local}. The distribution of intrinsic broad band luminosities for these two different cases are plotted in the left panel above. KS-Test on the two samples yields a p-value that indicates that they are similar.

Apart from that, plot of intrinsic hardness ratios with respect to nH_{local} (right panel) shows a significant scatter unlike the correlation found earlier with galactic corrected hardness ratios.

These two plots collectively show strong evidences on the Unification model of AGNs that whether the obscuration is, intrinsically they are same objects.

Conclusions and Future Plans

Conclusions

- Broad Band Intrinsic Luminosity and Intrinsic Hardness ratio provide some evidence for unification model.
- Photon indices of the powerlaw model and Galactic corrected Hardness Ratios show hardening of spectra with increasing obscuration.
- Local obscuring material absorbs more low energy photons as compared to high energy, making the spectra harder.

Future Plans

- Several AGNs in our sample has multiwavelength data, which we can use for studying the spectral energy distribution and understand these AGNs better.

References

I. ***Active Galactic Nuclei at hard X-ray energies: absorption, reflection and the unified model***; *Ricci, C; Courvoisier, T; 2011, (Ph.D. Thesis)*

II. ***Automated classification of Chandra X-ray point sources using machine learning methods***; *Kumaran, S; et. al. 2023; MNRAS*