SCATTERED X-RAY RADIATION IN ACTIVE GALACTIC NUCLEI

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Active Galactic Nuclei in X-Rays

- Active galactic nuclei (AGN) are accreting supermassive black holes, virtually present at the center of all massive galaxies and play an important role in the evolution of their host galaxies.
- AGNs are surrounded by large amounts of gas and dust and based on the column density of the material in the line of sight, they are classified as obscured or unobscured.
- AGNs are also characterized by strong emissions in the X-rays produced by the Comptonization of optical and UV photons in a hot corona close to the central black hole.
- Primary X-ray radiation is reprocessed by the circumnuclear material via processes like reflection, absorption and scattering. This reprocessed radiation can help us shed light on the structure of the inner regions of AGN.
- In the case of obscured AGNs, a component due to the Thomson scattering of the X-ray continuum in a region above the accretion disk is also visible.
- X-rays are an efficient way to study the accreting system and to find obscured AGNs, as they are not absorption biased and can penetrate large column densities (N_H), up to Compton-thick values.

Objectives:

The aim of this work is to study:

I. The properties of the scattered X-ray radiation in obscured AGNs in the local universe $(z < 0.1)$.

II. The relation between the fraction of scattered radiation (f_{scatt}) and the physical properties of the black hole like luminosity, black hole mass and Eddington ratio.

Sample and Data

- Our sample of study consists of 838 hard-X-ray-selected AGNs detected by the 70-month *Swift*/BAT all-sky survey.
- By combining the observations from *XMM-Newton*, *Swift*/XRT, *ASCA*, *Chandra*, and *Suzaku* in the soft X-ray band (< 10 keV) with the 70-month *Swift*/BAT data in the 14-195 keV energy range, the broadband X-ray spectra of 836 AGNs were fitted using 24 different models. (Ricci et al. 2017)
- X-ray spectral parameters like photon index, column density, high energy cutoff, reflection parameter, scattered fraction and flux in different bands were obtained from this fitting analysis.
- In another work (Koss et al. 2017) as part of the same collaboration, the optical spectra of 642 AGNs were analyzed and their black hole mass (M_{BH}) was calculated based on the relation between M_{BH} and velocity dispersion.

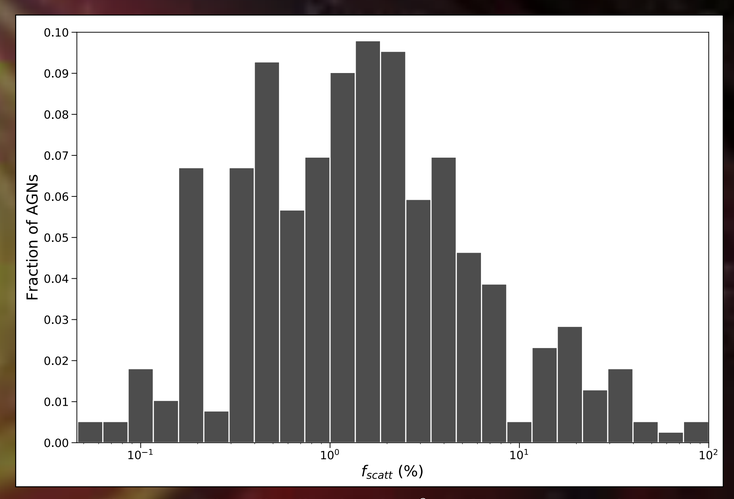


Figure 1: The distribution in f_{scatt} for our sample.

Results

- Out of the 838 AGNs in our sample, the value of f_{scatt} was obtained for 388 sources.
- In Figures 2 & 3, we show the relation between the scattered fraction and different parameters. The mean and error in different bins of column density were calculated using two methods:
  I. Survival Analysis
  II. Monet Carlo Simulations
- The correlation in Figure 2 was calculated using linear regression for the actual as well as the simulated.

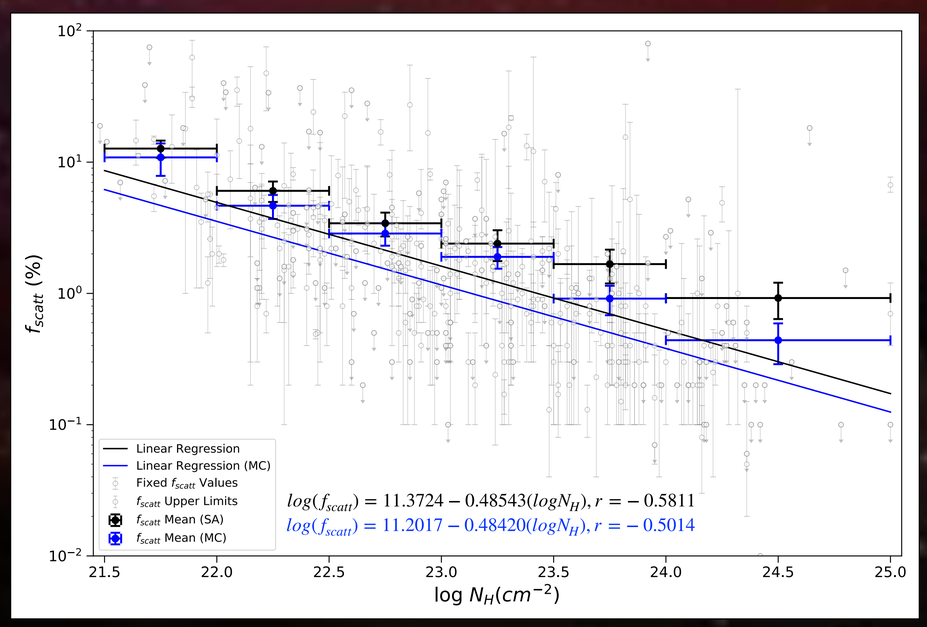
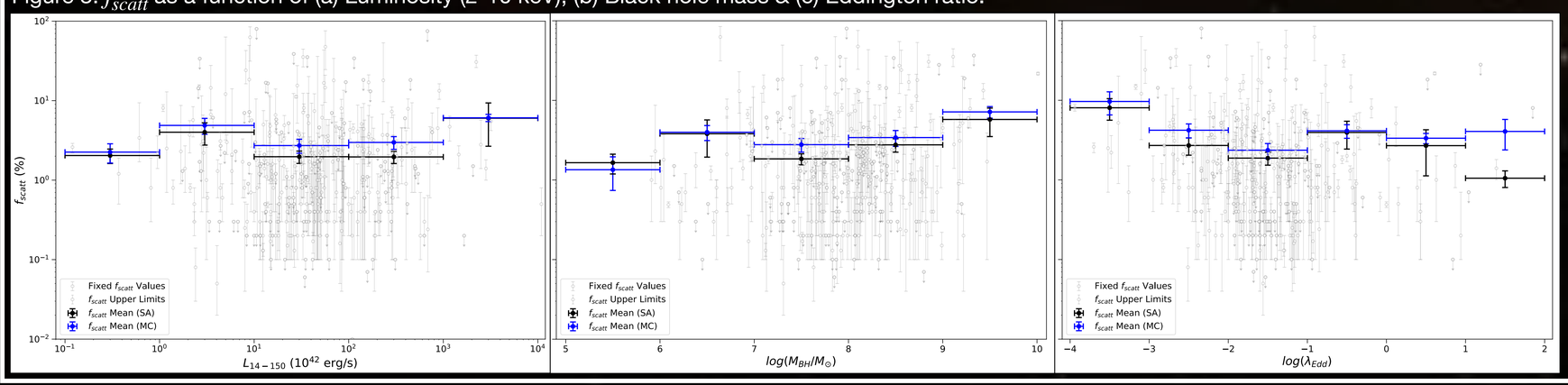


Figure 2: The f_{scatt} vs column density plot shows a strong negative correlation.

- Our analysis showed that the fraction of scattered X-ray radiation is inversely correlated to the column density.
- This can be interpreted as follows: higher column density means higher covering factor of the torus, which in turn blocks the radiation from the central black hole and hence, a lower fraction of scattered radiation is able escape.
- We did not find any dependance of scattered fraction on other physical properties of the black hole.
- The next step in this analysis is to check for parameter degeneracy.

Figure 3: f_{scatt} as a function of (a) Luminosity (2-10 keV), (b) Black hole mass & (c) Eddington ratio.



References:

- www.bass-survey.com
- Ricci, C., Trakhtenbrot, B., Koss, M. J., et al. 2017, ApJ, 233, 17
- Koss, M., Trakhtenbrot, B., Ricci, C., et al. 2017, ApJ, 850, 74