The wide band X-ray spectral and timing analysis of AGN

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Abstract

We report the spectral and timing analysis of 14 Seyfert galaxies observed with Suzaku, in order to decompose X-ray spectral components. The reflection component via a torus is considered to be less variable, while the varible component is considered to come from the central engine directly. Using this consideration, we tried to decompose a direct component and a reflection component. We compared the spectral parameters obtained by spectral fitting with direct nuclear component plus reflection with those obtained from the difference spectra between high and low state. In particular, we focus attention on the power-law photon index and the Fe-Ka line. As a result, the photon index, the Fe line intensity, and the reflection fraction is almost the same between high and low state. However, some of them are not the case, and the equivalent width of Fe-Ka line against the best-fit reflection component is unreasonable for some objects. These indicate that two-component model is valid for most of Seyfert galaxies, but the behavior of some Seyfert galaxies cannot be explained by two-conmponent model.

Key words:

1. Introduction

AGN X-ray spectra generally consist of the direct nuclear component, emission line, absorption, reflection component, and high energy cut-off. These components are thought to reflect the material structure around AGNs, and the detailed analysis of AGN in the X-ray band can clarify physical geometry of the AGN. Understanding such a complex X-ray spectral feature needs observation above 10 keV to decompose the spectral components. As far, such hard X-ray observations of many AGNs has not ever performed due to high instrumental background. Suzaku archieves the highest S/N ratio by the lowest instrumental background than ever. Wide-band X-ray observation of AGNs is extremely effective to understand the spectral properties of AGNs.

But it is difficult to decompose the spectral component from only X-ray spectral analysis because direct component cannot be expressed with only power-law. Therefore, we need to confirm whether the spectral modeling is correct by an independent analysis. We used the timing analysis for this. In the past studies of X-ray time variability, it is proposed that the X-ray spectrum of Seyfert galaxy is reproduced by a direct component and a reflection component (Miniutti et al. 2007). The direct component from the central engine is considered to be variable, while the reflection component via a torus is considered to be less variable.

So in this study, by spectral and timing analysis with Suzaku data in wide energy band and good S/N, we tried to decompose a direct component and a reflection component.

2. Observation

Object	Date	Flux
NGC3516	2005-10-12	7.04
3C120	2006-02-23	6.11
MCG-5-23-16	2005-12-07	15.14
MCG-6-30-15	2006-01-27	4.82
Mrk335	2006-06-21	1.50
NGC3783	2006-06-24	9.28
Mrk509	-	6.80
Ark120	2007-04-01	3.48
Mrk79	2007-04-03	1.57
NGC4388	2005-12-24	11.18
NGC5506	2007-01-31	16.28
1H0417-577	2007-07-25	2.63
NGC5548	2007-07-29	4.50
IC4329A	2007-08-01	16.20

Table 1. Targets list. Flux in unit of 10^{-11} erg/cm^2/s (15-50 keV)

Table 1 is a list of targets which we used for this analysis. The column 2 is a observation date, and the column 3 is a flux in 15-50 keV. The selection criteria of these objects is based on two points. First, the target is bright above 10 keV to be detected with HXD-PIN. Second, it is time-variable enough to divide data into high and low state.

3. Analysis and result

We fit average spectra using two-component model for each object. The model consists of power-law with absorption, Fe-Kα line and reflection component (pexrav). At first, we fit spectra by only power-law model. Second, absorption, Fe-Kα line, and reflection component are added step by step, considering the goodness of fits.

We made high and low state spectra, based on the light curve. At first, the average of the count rate of the light curve is taken. We defined that the time region above the average is the high state and the region below the average is the low state. Second, spectra in the high and low state were derived.

For spectral fitting, power-law photon index and line enegy of Fe-Kα are set to be common between high and low states.

After fitting, we compare the photon index between the average-spectral analysis and high/low-spectral analysis.

If the reflection component is constant, we can obtain the variable power-law component by taking the difference spectra between high and low states. Therefore we subtracted the low state spectra from the high state one. We fit the thus-obtained difference spectra with a power-law model, and compare the photon index with that of other analysis.

First, we compare the photon index between the average spectrum and the difference spectrum.

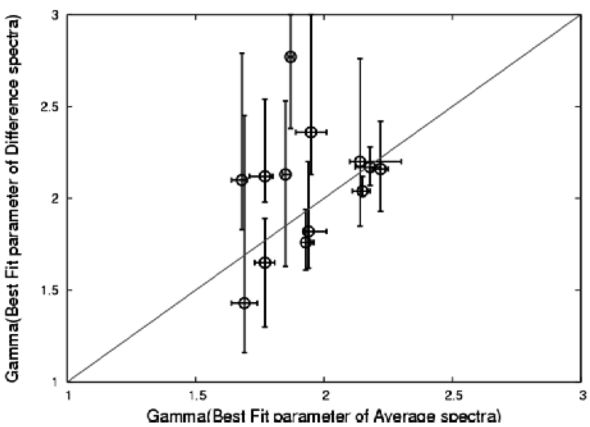

Fig. 1. Comparison of photon index between average spectra and difference spectra.

As shown in fig.1, most objects exhibit a good agreement, indicating that X-ray spectrum of most objects is represented by two-component model. But some objects do not show a good agreement, indicating that estimation of the reflection component is not accurate.

Therefore, we analyzed the Fe-Kα emission line. The Fe-Kα line is a part of reflection component, and thus thought to be less variable.

Fig.2 is a comparison of the normaliztion of Fe-Kα between low state and high state. All objects exhibit a good agreement, indicating that the Fe-Kα line does not vary significantly and the reflection component is less variable.

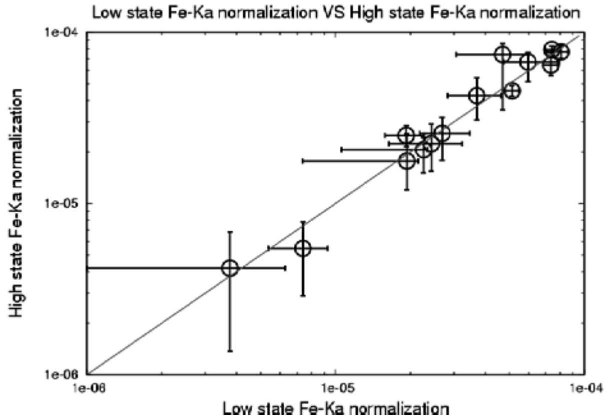

Fig. 2. comparison of normalization of Fe-Kα between low state and high state

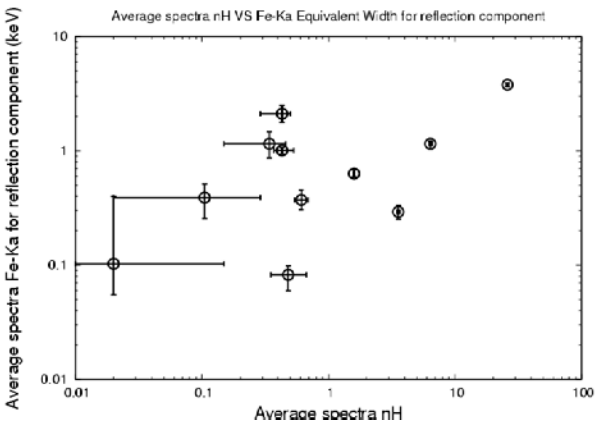

Fig. 3. Relation between the absorption of average spectra and equivalent width of Fe-Kα against the reflection component

In order to check that the obtained reflection continuum intensity is valid, we looked at the equivalent width (EW) of fluorescent Fe-Kα line against the obtained reflection model. As Ikeda et al.(2009) reported, the EW is around 1 keV for 1 solar abundance. Even considering the abundance scatter of 0.5-2.0 solar, some objects show an unusual EW. This indicates that the obtained reflection continuum level is not valid in some case, and the X-ray spectra might be complex due to partial covering absorption, broad Fe-K line, and so on.

References

Ikeda S. et al. 2009, ApJ, 692, 608
Miniutti et al. 2007 PASJ, 59, S315