Suzaku Observation of the Radio Galaxy 4C 50.55 (IGR J 21247+5058)

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Abstract

We present preliminary results from a 100 ksec *Suzaku* observation of 4C 50.55 (IGR J 21247+5058). 4C 50.55 is the brightest broad line radio galaxy in the hard X-ray (> 10 keV) band detected with *INTEGRAL* and *Swift*, which is located close to the Galactic plane. From a combination of the XIS and HXD, we are for the first time able to obtain simultaneous broad-band spectra of this source. A rapid flux increase by $\sim 20\%$ is found in the XIS light curve in the last 20 ksec exposure. The spectra before the flux rise can be well represented by a partially absorbed cutoff power law with a reflection component. The cutoff energy is found to be 46^{+3}_{-6} keV (with a photon index of $1.60^{+0.04}_{-0.08}$), which is lower than that observed in normal AGNs. The variable component shows a softer spectrum than the averaged spectrum, which may contain the jet emission.

Key words: galaxies: active — galaxies: individual (4C 50.55) — X-rays: galaxies

1. Observations

Since 4C 50.55 ($z = 0.02$) lies in the Galactic plane, this radio galaxy has not been recognized to be a bright hard X-ray emitter until its discovery with *INTEGRAL* and *Swift*. The hard X-ray luminosity is found to be $L = 10^{44.1}$erg s^{-1} in the $14 - 195$ keV band (Tueller et al. 2008). By assuming that it does not exceed the Eddington luminosity, the black hole mass is estimated to be more than $10^7 M_\odot$.

We observed 4C 50.55 with *Suzaku* in 2007 April for a net exposure of 100 ksec. This provides us with the best opportunity to investigate its simultaneous broad band spectra. Since the detection significance with the HXD/GSO was found to be marginal, we only utilize the data of the XIS and HXD/PIN in this paper. An analysis of the *XMM* and *INTEGRAL* data is reported by Molina et al. (2007).

2. Light Curve

Figure 1 shows the light curve of XIS-0 in the 2–10 keV band. The flux increases rapidly by $\sim 20\%$ in the last 20 ksec exposure. The time scale of variability is found to be $\sim 10^3$ sec, indicating that the emission region is within $\sim 10\ r_{\rm g}$ ($r_{\rm g} \equiv \frac{GM}{c^2}$ is the gravitational radius) for a black hole mass of $M > 10^7 M_\odot$ if relativistic beaming is not important. We separate the observation period into two, epoch 1 ($0-1.4\times10^5$ sec) and epoch 2 ($1.4\times10^5-1.7\times10^5$ sec), for the following spectral analysis.

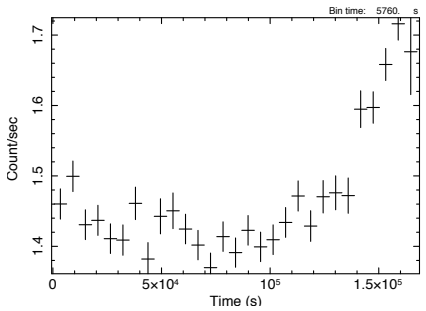

Fig. 1. The light curve in the 2–10 keV band obtained with XIS-0. We define epoch 1 as the period before the flux rise ($0-1.4\times10^5$ sec), and epoch 2 after it ($1.4\times10^5-1.7\times10^5$ sec).

3. Spectral Analysis

We firstly apply a standard model consisting of a direct component, a reflection component, and an iron-K emission line, modified by the Galactic absorption and intrinsic absorption(s). The direct component is represented by a cutoff power law, in the form of $E^{-\Gamma} \times \exp(-E/E_{\rm fold})$, where $E_{\rm fold}$ is a cut off energy and Γ is a photon index. We use the PEXRAV model for a reflection component from cold matter (Magdziarz &

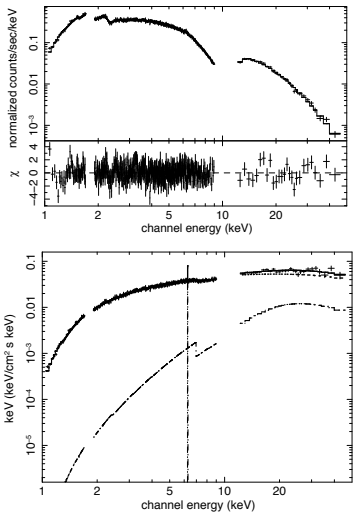

Fig. 2. *(Upper)* The folded spectra of 4C 50.55 observed with the XISs (1–9 keV) and HXD/PIN (12–50 keV). *(Lower)* The unfolded spectra in units of $EI(E)$. The cross points represent the observed data. The dotted line corresponds to a cutoff power-law component, the dash-dot lines are the reflection component with an iron-K emission line, and the solid line is the total. The best-fit parameters are summarized in Table 1.

Zdziarski 1995).

We finally adopt a partial covering model, where $100f\%$ of the total continuum is absorbed with $N_{\rm H}^1$ and the rest is absorbed with $N_{\rm H}^2$, since a significant improvement is found from a single absorber model. The best-fit parameters for epoch 1 are summarized in Table 1 and the unfolded spectra are plotted in Figure 2. The contour plots between Γ and $E_{\rm fold}$ are shown in Figure 3.

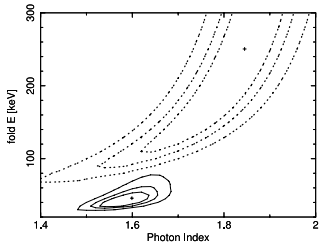

Fig. 3. The error contours between Γ and $E_{\rm fold}$ at $\Delta\chi^2$ of 2.3, 4.61, and 9.21. The solid lines represent the constraint from the *Suzaku* data in epoch 1, and the dotted lines that from *Swift*/BAT.

In the same figure, we also plot the same result obtained from the *Swift*/BAT spectrum in the $14-195$ keV band averaged over 2 years; the *Suzaku* spectrum of epoch 1 prefers a significantly lower cutoff energy than the BAT data.

The difference spectrum of XIS between epochs 1 and 2 is plotted in Figure 4. It has a photon index of $1.84^{+0.28}_{-0.26}$, slightly softer than the averaged spectrum of epoch 1.

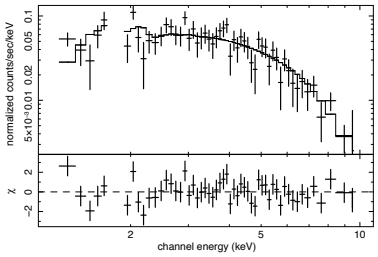

Fig. 4. The difference spectrum of XISs (FI) between epochs 1 and 2. The photon index is found to be ≈ 1.8.

The variable component may contain a contribution from the jet emission as suggested for the radio galaxy 3C 120 (Kataoka et al. 2007).

Table 1.

	Epoch 1
Γ	$1.60^{+0.04}_{-0.08}$
$E_{\rm fold}$ [keV]	46^{+3}_{-6}
R	$0.28^{+0.04}_{-0.05}$
f	0.20 ± 0.01
$N_{\rm H}^1$ [cm^{-2}]	$(8.5^{+1.1}_{-0.9}) \times 10^{22}$
$N_{\rm H}^2$ [cm^{-2}]	$(0.74 \pm 0.01) \times 10^{22}$
$N_{\rm H}^{\rm gal}$ [cm^{-2}]	1.0×10^{22} (fixed)
EW [eV]	22 ± 5
χ^2/ d.o.f.	928.2/802

(*Errors are 90% confidence level for a single parameter.)
Γ; photon index: $E_{\rm fold}$; cutoff energy
$R(=\Omega/2\pi)$; reflection strength: f; covering fraction
$N_{\rm H}^1, N_{\rm H}^2$; intrinsic absorption: $N_{\rm H}^{\rm gal}$; Galactic absorption
EW; equivalent width of iron-K line (6.4 keV)

4. Summary

We have presented the broad band spectra of the brightest broad-line radio galaxy 4C 50.55 by simultaneously covering the 1–50 keV band for the first time. We find that the spectrum prefers a lower cutoff energy compared with normal AGNs. We may see a transient phase of its spectral evolution, with variable components including the jet emission. The reflection intensity is found to be weak, $R = 0.28^{+0.04}_{-0.05}$ in epoch 1, consistent with a truncated disk geometry.

References

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