Discovery of Compton reflection in NGC 4151

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Abstract

We study the γ-ray observation of NGC 4151 by *GRO*/OSSE contemporaneous with X-ray observations by *ROSAT* and *Ginga* in 1991 June. The spectrum is well modeled by thermal Comptonization and a dual neutral absorber. We also find, for the first time for NGC 4151, a Compton-reflection spectral component. When reflection is taken into account, the intrinsic X-ray energy spectral index is $\alpha \sim 0.8$ and the plasma temperature is ~ 60 keV. The X-ray spectral index is within the range, $\alpha \simeq 0.95 \pm 0.15$, observed from other Seyfert 1s. Also, the OSSE spectrum of NGC 4151 is statistically undistinguishable from the average OSSE spectrum of radio-quiet Seyfert 1s. Thus, NGC 4151 observed in 1991 June has the intrinsic X-ray/γ-ray spectrum typical for Seyfert 1s, and the main property distinguishing it from other Seyfert 1s is a large absorbing column of $\sim 10^{23}$ cm^{-2}.

1. Observations

NGC 4151 is a nearby Seyfert 1.5 galaxy at $z = 0.0033$. It was observed by OSSE 1991 June 29–July 12 (Maisack et al. 1993). Close in time to the OSSE observation, NGC 4151 was observed by *Ginga*, 1991 May 31–June 2 (Yaqoob et al. 1993), and by *ROSAT*, 1991 May 31–June 1. The *Ginga* (top-layer only) and *ROSAT* data have been analyzed by Warwick et al. (1995). Here we use both the mid-layer and top-layer *Ginga* data. Full description of our results is given in Zdziarski, Johnson and Magdziarz (1996).

2. Results

Our model contains a hard continuum due to thermal Comptonization, a Compton reflection component, a soft X-ray component, a dual absorber, and a Kα line with the energy and width of 6.4 keV and 0.1 keV, respectively. We study the presence of Compton reflection (Magdziarz and Zdziarski 1995). We assume the inclination of $i = 65°$, which is the minimum inclination allowed by *HST* observations of Evans et al. (1993). We find that adding a reflection component significantly improves our fit with respect to the model with no reflection, $\Delta\chi^2 = -10.5$, $\chi^2 = 88.6/124$ d.o.f. This corresponds to the probability of 0.02% that the fit improvement was by chance. The reflection fraction (in units of the 2π solid angle of the reflector) is $R = 0.43^{+0.23}_{-0.22}$. The X-ray energy spectral index is $\alpha = 0.80^{+0.03}_{-0.03}$, which is within the 1-$\sigma$ range observed in Seyferts, $\alpha = 0.95$ with $\sigma = 0.15$ (Nandra & Pounds 1994). The spectrum is shown in Fig. 1.

We also compare the OSSE spectrum to the average spectrum of all radio-quiet Seyfert 1s except for NGC 4151 observed by OSSE (Johnson et al. 1996). We find that both spectra

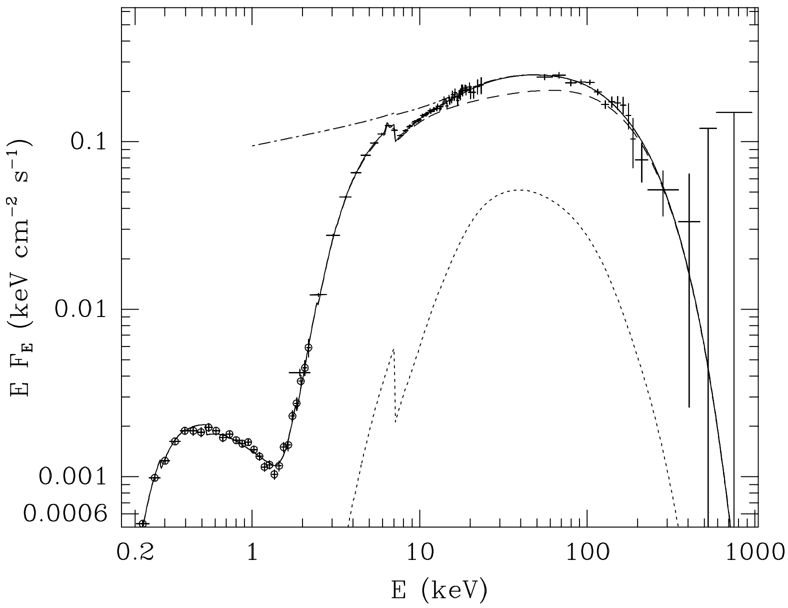

Fig. 1. The Xγ spectrum of NGC 4151 as observed in 1991 June/July by *ROSAT*, *Ginga* and OSSE. The dashed curve gives the absorbed thermal Comptonization spectrum, the dotted curve, the reflection component, and the solid curve gives the total model. The dot-dashed curve gives the unabsorbed continuum. The *ROSAT* data are marked with circles.

can be fitted with the same model parameters with no difference in χ^2 with respect to fits of the individual spectra. Thus, the OSSE spectrum of NGC 4151 is the same as the average Seyfert 1 spectrum within the statistical uncertainties.

Thus, NGC 4151 observed in 1991 June appears to be a typical radio-quiet Seyfert 1, with a rather average intrinsic X-ray spectrum, a Compton-reflection component, and an average γ-ray spectrum. This is a surprising result for NGC 4151, which has been considered so far to be an unusual Seyfert with a hard intrinsic spectrum and no Compton reflection (e.g., Yaqoob et al. 1993).

3. References

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