ROSAT/ASCA OBSERVATIONS OF A SERENDIPITOUS BL LACERTAE OBJECT PKS 2316$-$423: 
THE VARIABLE HIGH-ENERGY TAIL OF SYNCHROTRON RADIATION

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ABSTRACT

We present the analysis of archival data from ROSAT and ASCA of a serendipitous BL Lac object PKS 2316$-$423. Because of its featureless nonthermal radio/optical continuum, PKS 2316$-$423 has been called a BL Lac candidate in the literature. PKS 2316$-$423 was evidently variable over the multiple X-ray observations; in particular, a variable high-energy tail of the synchrotron radiation is revealed. The X-ray spectral analysis provides further evidence of the synchrotron nature of its broadband spectrum: a steep and downward-curving spectrum between 0.1 and 10 keV, typical of high-energy peaked BL Lac objects (HBLs). The spectral energy distribution (SED) through radio to X-ray yields the synchrotron radiation peak at frequency $\nu_p = 7.3 \times 10^{15}$ Hz, with integrated luminosity of $L_{\text{syn}} = 2.1 \times 10^{44}$ ergs s$^{-1}$. The averaged SED properties of PKS 2316$-$423 are very similar to those “intermediate” BL Lac objects (IBLs) found recently in several deep surveys, such as Deep X-ray Radio Blazar, Radio-Emitting X-ray, and ROSAT-Green Bank surveys. We suggest that PKS 2316$-$423 is an IBL though it also shows some general features of an HBL. Actually, this double attribute of PKS 2316$-$423 provides a good test of the prediction that an IBL object can show either synchrotron or inverse Compton characteristics in different variability states.

Subject headings: BL Lacertae objects: individual (PKS 2316$-$423) — X-rays: galaxies

1. INTRODUCTION

BL Lac objects—a subclass of active galactic nuclei (AGNs)—show variable nonthermal emissions from radio to UV/X-rays and even to $\gamma$-rays over different timescales (e.g., Urry & Padovani 1995; Kollgaard 1994), which are commonly attributed to be synchrotron and inverse Compton radiation from plasma in a relativistic jet oriented at a small angle with our line of sight. As such, they represent a fortuitous natural laboratory to study the physics of jets and, ultimately, the mechanisms of energy extraction from the central black holes, a fundamental goal of extragalactic astrophysics.

Earlier studies of BL Lac objects have shown that the systematic differences between radio- and X-ray-selected BL Lac objects (RBLs vs. XBLs) are consistent with orientation differences (Kollgaard et al. 1996; Ghisellini et al. 1993). Meanwhile, BL Lac objects have been reclassified in a more physical way as “low-energy” and “high-energy” peaked BL Lac objects (LBLs vs. HBLs) based on the peak frequency of synchrotron radiation (e.g., Giommi & Padovani 1994) rather than just observational selection. In general, RBLs and XBLs tend to be LBLs and HBLs, respectively. However, recent evidence has shown that some of the differences between HBLs and LBLs cannot be accounted for by differences in orientation alone (Sambruna, Maraschi, & Urry 1996). The alternate explanation, that these classes are merely opposite extremes of the source’s spectral energy distribution (SED), also fails to explain some HBL-LBL differences (Kollgaard et al. 1996; Stocke 1996). Instead, the modern thinking is that the HBL-LBL dichotomy represents two extremes of a continuum in either luminosity and viewing angle (Georganopoulos & Marscher 1998) or luminosity and peak frequency (Fossati et al. 1998). Recent studies from deeper and larger X-ray surveys have indeed shown that BL Lac objects tend to exhibit more continuous distributions of properties (Sambruna et al. 1996; Scarpa & Falomo 1997; Perlman, Padovani, & Giommi 1998; Laurent-Muehleisen et al. 1999) rather than disparate ones. This has resulted in an important role for those objects with intermediate SEDs between HBL and LBL, namely, intermediate BL Lac objects (IBLs), in revealing BL Lac mysteries.

In this paper, we present the X-ray spectral analysis (ROSAT and ASCA archival data) and the SED of a serendipitous BL Lac object, PKS 2316$-$423. It is a southern radio source at $z = 0.0549$ and was formerly classified as a BL Lac candidate on the basis of its featureless nonthermal radio/optical continuum (Crawford & Fabian 1994; Padovani & Giommi 1996). We noticed this object as it has been the brightest contaminating source to the nearby narrow-line X-ray galaxy NGC 7582 (Xue et al. 1998; Schachter et al. 1998) in most of its historical X-ray records.

The ROSAT (PSPC) and ASCA satellites observed this object as a serendipitous source in 1993 April and 1994 November, respectively. These observations, though non-simultaneous, extend our knowledge of the source’s SED properties to the X-ray domain (0.1–10 keV) but also provide a good opportunity for X-ray spectroscopic studies, which turn out to be very important for its classification.

In § 2 we describe the observations and data reduction, then we present the spectral analysis in § 3. We construct the source SED in § 4 on the basis of our new X-ray flux measurements as well as the published photometry data. The results are summarized and discussed in § 5. Throughout this paper, $H_0 = 50$ km s$^{-1}$ Mpc$^{-1}$ and $q_0 = 0.5$ are
TABLE 1

| Instrument | Date       | Exposure (ks) | Count Rate (count s⁻¹) |
|------------|------------|---------------|------------------------|
| ROSAT PSPC ... | 1993 May 4 | 7.2           | 0.228 ± 0.006          |
| ROSAT HR1    | 1992 Jun 7 | 7.5           | 0.065 ± 0.003          |
| ROSAT HR1    | 1993 May 17| 4.2           | 0.067 ± 0.004          |
| ASCA SIS0    | 1994 Nov 14| 16.4          | 0.047 ± 0.002          |
| ASCA SIS1    | 16.4       | 0.034 ± 0.002 |
| ASCA GIS2    | 18.8       | 0.024 ± 0.002 |
| ASCA GIS3    | 18.8       | 0.026 ± 0.002 |

The model gives acceptable fit to the data with an absorption in good agreement with the Galactic value N_H,gal = 2.0 × 10²⁰ cm⁻² (Stark et al. 1992). This model describes the data reasonably well (Table 2). The fluxes corrected for the Galactic absorption are 4.20 ± 0.25 × 10⁻¹² ergs cm⁻² s⁻¹ in the 0.1–2.4 keV band and 1.83 ± 0.11 × 10⁻¹² ergs cm⁻² s⁻¹ in the 0.5–2 keV band, estimated from the best-fit power-law model. The inferred intrinsic luminosity is 5.7 × 10⁴³ ergs s⁻¹ in the 0.1–2.4 keV band, which is similar to that of other nonquasar AGNs. The source was observed twice with ROSAT HR1 in 1992 June and 1993 May, respectively; the obtained count rates correspond to fluxes of (5.9 ± 0.3) × 10⁻¹³ ergs cm⁻² s⁻¹ and (6.1 ± 0.3) × 10⁻¹² ergs cm⁻² s⁻¹ in the observed energy range 0.1–2.4 keV, assuming a power-law spectrum identical to that of PSPC. The PSPC observation was made between the two HR1 observations (Table 1) and recorded a relatively lower flux level. These factors suggest the source is variable, and thus there might be a nonthermal origin for the X-ray flux.

3. SPECTRAL ANALYSIS

Since no evident variations in the source count rate were detected during either observation, the time-averaged spectra from both satellites were used for spectral analysis. The spectra of both ROSAT PSPC and ASCA were grouped so that each energy channel contains at least 20 counts allowing χ² minimization techniques. Spectral analyses have been performed using XSPEC(V10) program.³

3.1. The ROSAT Data

A simple power-law fit to the ROSAT PSPC data in the range of 0.1–2 keV gives photon index Γ = 2.0 ± 0.2 and absorption column density of (1.41 ± 0.5) × 10²⁰ cm⁻² (Fig. 1), which is consistent with the Galactic value N_H,gal = 2.0 × 10²⁰ cm⁻² (Stark et al. 1992). This model describes the data reasonably well (Table 2). The fluxes corrected for the Galactic absorption are 4.20 ± 0.25 × 10⁻¹² ergs cm⁻² s⁻¹ in the 0.1–2.4 keV band and 1.83 ± 0.11 × 10⁻¹² ergs cm⁻² s⁻¹ in the 0.5–2 keV band, estimated from the best-fit power-law model. The inferred intrinsic luminosity is 5.7 × 10⁴³ ergs s⁻¹ in the 0.1–2.4 keV band, which is similar to that of other nonquasar AGNs. The source was observed twice with ROSAT HR1 in 1992 June and 1993 May, respectively; the obtained count rates correspond to fluxes of (5.9 ± 0.3) × 10⁻¹³ ergs cm⁻² s⁻¹ and (6.1 ± 0.3) × 10⁻¹² ergs cm⁻² s⁻¹ in the observed energy range 0.1–2.4 keV, assuming a power-law spectrum identical to that of PSPC. The PSPC observation was made between the two HR1 observations (Table 1) and recorded a relatively lower flux level. These factors suggest the source is variable, and thus there might be a nonthermal origin for the X-ray flux.

3.2. The ASCA Data

The spectra of the four ASCA instruments were fitted simultaneously in the range of 0.5–10 keV for SIS0/1 and

³ http://legacy.gsfc.nasa.gov/docs/xanadu/xspec/u_manual.html.

![Fig. 1.—Folded ROSAT PSPC spectrum of PKS 2316–423 in 1993 May. A single power-law fit to the observation and residuals are shown. The model gives acceptable fit to the data with an absorption in good agreement with the Galactic value.](http://example.com/image.png)
index of spectra suggest that the source spectral slope with photon the results with the ROSAT data, the ASCA spectra suggest that the source spectral slope with photon index of $\Gamma = 2.4 \pm 0.2$ in the 0.5–10 keV band is significantly steeper than that of the ROSAT PSPC spectrum in the 0.1–2 keV band. In addition, the ASCA data requires an absorption column density of $8.8_{-5.3}^{+5.9} \times 10^{20}$ cm$^{-2}$, which is significantly in excess of the Galactic value. This is clear evidence of spectral variability since the two observations were made 1.5 yr apart. There are two possible explanations for this result: either a variable absorbing column (which, as described below, we believe to be unlikely) or a spectral flattening at soft energies due to a convex continuum. However, the first case seems unlikely since very few BL Lac objects show evidence of significant cold absorbing gas in excess of line-of-sight Galactic column density (Perlman et al. 1996b; Urry et al. 1996). The recent detections of several BL Lac objects by the Extreme Ultraviolet Explorer (EUVE) (Marshall, Fruscione, & Carone 1995; Fruscione 1996) is further evidence that these objects do not have significant intrinsic absorption.

For the latter case, the “excess” absorption seen in the ASCA spectrum might be an artifact falsely introduced in the fitting process. To test this idea, we next fitted the ASCA data using a broken power law with a bound absorption at the Galactic value. Fitting with this model is notably improved ($\Delta \chi^2 = 6.8$ for two additional parameters, $P_F > 95\%$) compared to the fit of the single power-law model with the same bound absorption (Fig. 2). The final fit yields two power-law components with a break point at $\sim 2.1_{-0.7}^{+0.9}$ keV. The lower energy component is flatter with a photon index of $\Gamma = 2.0_{-0.4}^{+0.3}$; the higher energy component is steeper with $\Gamma = 2.6_{-0.3}^{+0.3}$. Thawing the absorption parameter in the broken power-law model produces little change of the $\chi^2$ value, and the resulting absorption column density is still consistent with the Galactic value (Table 3).

It should be noted that although the above two models cannot be statistically discriminated, consider that the spectral-flattening effect is by far the more likely physical explanation of the “excess” absorption seen in the ASCA spectra; hereafter, we will refer to the broken power-law model as the best fit to the ASCA data.

Figure 3 shows confidence plots of the power-law spectral components versus the corresponding absorption column density for both the ASCA and ROSAT data. The ASCA

### Table 2

| Data     | $\Gamma_1$ | $N_H$ (10$^{20}$ cm$^{-2}$) | $\chi^2$/dof | $F_{0.1-2\text{keV}}$ (10$^{-12}$ ergs cm$^{-2}$ s$^{-1}$) | $F_{0.1-2\text{keV}}$ (10$^{-12}$ ergs cm$^{-2}$ s$^{-1}$) |
|----------|------------|-----------------------------|----------------|-------------------------------------------------|-------------------------------------------------|
| ROSAT PSPC | 2.0_{-0.2}^{+0.2} | 1.41_{-0.43}^{+0.49} | 1.1/17 | 1.32_{-0.09}^{+0.08} | 2.63_{-0.18}^{+0.15} |
| ASCA      | 2.4_{-0.2}^{+0.2} | 8.78_{-3.37}^{+5.97} | 0.96/133 | 1.10_{-0.18}^{+0.16} | 1.35_{-0.23}^{+0.33} |

* Observed fluxes (not corrected for absorption).

0.7–10 keV for GIS(2,3). A simple power-law model gives an acceptable fit to the whole data set (Table 2). However, comparing the results with the ROSAT data, the ASCA spectra suggest that the source spectral slope with photon index of $\Gamma = 2.4 \pm 0.2$ in the 0.5–10 keV broad band is significantly steeper than that of the ROSAT PSPC spectrum in the 0.1–2 keV band. In addition, the ASCA data requires an absorption column density of $8.8_{-5.3}^{+5.9} \times 10^{20}$ cm$^{-2}$, which is significantly in excess of the Galactic value. This is clear evidence of spectral variability since the two observations were made 1.5 yr apart. There are two possible explanations for this result: either a variable absorbing column (which, as described below, we believe to be unlikely) or a spectral flattening at soft energies due to a convex continuum. However, the first case seems unlikely since very few BL Lac objects show evidence of significant cold absorbing gas in excess of line-of-sight Galactic column density (Perlman et al. 1996b; Urry et al. 1996). The recent detections of several BL Lac objects by the Extreme Ultraviolet Explorer (EUV) (Marshall, Fruscione, & Carone 1995; Fruscione 1996) is further evidence that these objects do not have significant intrinsic absorption.

For the latter case, the “excess” absorption seen in the ASCA spectrum might be an artifact falsely introduced in the fitting process. To test this idea, we next fitted the ASCA data using a broken power law with a bound absorption at the Galactic value. Fitting with this model is notably improved ($\Delta \chi^2 = 6.8$ for two additional parameters, $P_F > 95\%$) compared to the fit of the single power-law model with the same bound absorption (Fig. 2). The final fit yields two power-law components with a break point at $\sim 2.1_{-0.7}^{+0.9}$ keV. The lower energy component is flatter with a photon index of $\Gamma = 2.0_{-0.4}^{+0.3}$; the higher energy component is steeper with $\Gamma = 2.6_{-0.3}^{+0.3}$. Thawing the absorption parameter in the broken power-law model produces little change of the $\chi^2$ value, and the resulting absorption column density is still consistent with the Galactic value (Table 3).

It should be noted that although the above two models cannot be statistically discriminated, consider that the spectral-flattening effect is by far the more likely physical explanation of the “excess” absorption seen in the ASCA spectra; hereafter, we will refer to the broken power-law model as the best fit to the ASCA data.

Figure 3 shows confidence plots of the power-law spectral components versus the corresponding absorption column density for both the ASCA and ROSAT data. The ASCA

### Table 3

| $N_H$ (10$^{20}$ cm$^{-2}$) | $\Gamma_1$ | $E_{\text{break}}$ (keV) | $\Gamma_2$ | $\chi^2$/dof | $F_{0.1-2\text{keV}}$ (10$^{-12}$ ergs cm$^{-2}$ s$^{-1}$) | $F_{0.1-10\text{keV}}$ (10$^{-12}$ ergs cm$^{-2}$ s$^{-1}$) |
|---------------------------|------------|--------------------------|------------|--------------|-------------------------------------------------|-------------------------------------------------|
| 2.4_{-0.2}^{+0.2} ......... | 2.0_{-0.4}^{+0.4} | 2.1_{-0.9}^{+0.9} | 2.6_{-0.3}^{+0.3} | 0.95/133 | 1.13_{-0.16}^{+0.34} | 0.92_{-0.14}^{+0.28} |

* Observed fluxes (not corrected for absorption).
observations actually revealed a variable high-energy tail of the source brightness decreased by 33% in the 0.1–2.4 keV range compared with ROSAT PSPC data.

In summary, the ASCA observation of PKS 2316–423 in 1994 November is best fit by a broken power-law model, in which a relatively flatter component at lower energies below ~2.1 keV is very consistent with the shape of the ROSAT PSPC spectrum observed in 1993 May. This indicates that the broadband X-ray spectral slope remained constant at lower energies, even though the source brightness evidently decreased; however, the steeper component above ~2.1 keV does suggest that the X-ray spectrum became softer at higher energies with the decreasing of the source brightness. As shown in the next section, the ROSAT and ASCA observations actually revealed a variable high-energy tail of the source synchrotron radiation.

4. SPECTRAL ENERGY DISTRIBUTION

The X-ray spectral analysis of PKS 2316–423 in the last section has shown its HBL-type properties. Moreover, even though nonsimultaneous the composite SED from the literature could present more insights on this object through comparison with the properties of the most recent complete BL Lac object samples. We plot in Figure 4 nonsimultaneous radio, optical, UV, and X-ray data from both the space and ground-based observations, assuming an “average” SED of the source. It is clear that the composite SED from radio to X-ray is likely from only one radiation component (i.e., synchrotron emission). Its optical and ultraviolet radiation appear to be a continuation of the radio synchrotron spectrum; the X-ray data are likely from a common emission origin as the lower energy parts and represent a high-energy tail of the synchrotron spectrum.

First, we derive some spectral parameters from the SED of PKS 2316–423. Following the general definition, we get the K-corrected two-point spectral indices: radio-optical spectral index $\alpha_{r-o} = 0.56$, optical–X-ray $\alpha_{o-x} = 1.18/1.26$, and radio–X-ray $\alpha_{r-x} = 0.78/0.82$ (note that hereafter having two values for one parameter is due to the different X-ray fluxes discussed in the last section). Because of the spectral variability shown evidently in the hard X-ray band (>2 keV), the composite X-ray/optical spectral indices $\alpha_{o-x} = \alpha_{o} - \alpha_{x}$ also varied, with a value of 0.18/0.26 for $\alpha_{o} = 1.0$ and $\alpha_{x} = -0.42/-0.34$ for $\alpha_{x} = 1.6$, respectively.

Another important spectral parameter is the X-ray–to–radio logarithmic flux density ratio, and we get $\log S_x/S_r \sim -6.36/-6.29$.

Furthermore, it is clearly seen from Figure 4 that the radio to X-ray SED of PKS 2316–423 likely peaks in the EUV/soft X-ray band. Following Sambruna et al. (1996), we performed a parabolic fit to the radio through optical/UV/X-ray SED of the source to determine the value of the peak frequency. We obtain $v_p = 7.3 \times 10^{15}$ Hz. The same fit yields an estimate of the luminosity at the peak frequency $L_p = 1.5 \times 10^{43}$ erg s$^{-1}$ and of the integrated radio to X-ray synchrotron luminosity of $L_{\mathrm{X-ray}} = 2.1 \times 10^{44}$ ergs s$^{-1}$.

In the next section, we will discuss the general SED properties of BL Lac objects and the attributes of PKS 2316–423.

For comparison, we plotted in Figure 4 the EGRET sensitivity threshold as an upper limit to the GeV flux (marked by an arrow) since the source was never detected at $\gamma$-rays. It is shown that the source is dominated by a synchrotron process in the broad energy range below 10 keV, above which we know nothing about the inverse Compton emission that would undoubtedly dominate the source emission.

5. DISCUSSIONS

PKS 2316–423 was first serendipitously detected as a marginally extended (15') X-ray source in the Einstein Medium-Sensitivity Survey (Gioia et al. 1984; Stocke et al. 1991). The ROSAT HRI observation made by Crawford & Fabian (1994) in 1992 June confirmed the result of Einstein and further revealed a second weak X-ray source 10'' (15 kpc) south of the galaxy which may be related to the central source. They suggested that PKS 2316–423 is a BL Lac object based on its probably nonthermal radio/optical/X-ray radiation and the fact that it has an “off-sight” jet component. If this is verified, then it will provide an interesting test case for both the host galaxies of BL Lac objects and their environment. Unfortunately, the later ROSAT HRI observation made in 1993 May did not go deep enough compared to the former observation; thus, the misaligned scenario of this BL Lac object can hardly be further confirmed or constrained.

The multiple X-ray observations show that PKS 2316–423 was variable on timescales of weeks to years. The flux in the 0.1–2.4 keV band increased by ~50% from ROSAT PSPC to HRI observations in a 13 day interval in 1993 May and dropped ~73% 1.5 yr later when observed with ASCA in 1994 November. These factors suggest that the source is variable and thus consistent with the expected characteristics of a high-energy tail from a dominant synchrotron emission. The source, however, did not show any short-term variability during both ROSAT PSPC and ASCA observations spanned over ~1 day. More X-ray observations will be necessary.

Note that the parameter used here refers to the energy spectral index, which is related to the photon spectral index with $\alpha_{x} = \Gamma - 1$. 
X-ray spectral analysis provides more insights into the nature of the source's emission. A single power-law model fit to the ROSAT PSPC and ASCA data shows significant discrepancies. However, the two data sets can be reconciled if the ASCA spectrum is fit with a broken power-law model. This model indicates that, below an energy break point, ~2.1 keV, there is a relatively flatter component ($\Gamma = 2.0^{+0.2}_{-0.3}$) to be consistent with the PSPC spectrum and a steeper component with $\Gamma = 2.6^{+0.3}_{-0.6}$ above the energy break point—this is one of the general X-ray spectral properties of an HBL (Sambruna et al. 1996). This kind of intrinsically downward-curved X-ray spectrum can be easily interpreted as due to synchrotron losses from a relativistic plasma. The high-energy peaked SED of the source indicates that PKS 2316–423 is an HBL-type BL Lac object, with the X-ray spectrum being the high-energy tail of synchrotron emission over a wide wavelength range, with correlated flux and spectral variability. With the decrease in source brightness from ROSAT PSPC to ASCA observations, the X-ray spectrum in the 0.1–10 keV band became softer in the harder X-ray band.

The recent studies have greatly modified our view of BL Lac objects. Deep X-ray Radio Blazar (DXRBS) (Perlman et al. 1998), Radio-Emitting X-ray (REX) (Caccianiga et al. 1999), and ROSAT–Green Bank (RGB) (Laurent-Muehleisen et al. 1999) surveys have shown that BL Lac objects exhibit a continuous distribution of properties rather than two distinct classes: HBLs versus LBLs (or XBLs vs. RBLs). These findings show that the distribution of the SED parameters of BL Lac objects peaks where the empty region between the two extreme subclasses was previously seen. Therefore, most BL Lac objects should exhibit intermediate SED properties. The previously observed bimodal distribution is primarily due to observational selection effects (e.g., Laurent-Muehleisen et al. 1999).

Here we compare the SED properties of PKS 2316–423 with the general properties of BL Lac objects found recently. When we put PKS 2316–423 ($\alpha_{18} = 0.56$ and $\alpha_{2.6} = 1.18/1.26$) on the $\alpha_{18}$ versus $\alpha_{2.6}$ color-color diagram, we find that it is a somewhat intermediate BL Lac object. As we know, $\alpha_{18}$ can more precisely measure spectral changes from optical to soft X-ray bands. If $\alpha_{18} \lesssim 0$, then the X-rays lie along a power law or steepening synchrotron continuum. A positive value of $\alpha_{18}$ represents a concave spectrum and is likely caused by a hard inverse Compton component. The values of $\alpha_{18}$ for PKS 2316–423 depend on the X-ray spectral slopes in different variability states, being 0.18/0.26 and $-0.42/-0.34$ for $\alpha_{e} = 1.0$ in the high state of the ROSAT PSPC observation and 1.6 in the low state of the ASCA observation, respectively. We find these values should just locate in the intermediate range of the $\alpha_{18}$ distribution of recent BL Lac samples (e.g., Perlman et al. 1998; Caccianiga et al. 1999; Laurent-Muehleisen et al. 1999). Interestingly, the value of $\alpha_{18}$ at different epochs was of opposite sign; this might indicate that in the different variability states of PKS 2316–423 the spectral change from optical to X-ray could show either synchrotron or inverse Compton characteristics, just as would be expected for an IBL.

Previous studies show a clear bimodality in the ratio of the X-ray to radio flux densities of HBLs and LBLs at $\log S_{x}/S_{r} \sim -5.5$ (e.g., Padovani & Giommi 1995; Perlman et al. 1996a; Brinkmann, Siebert, & Kollgaard 1996). The value of $\log S_{x}/S_{r}$ for PKS 2316–423 is $-6.36/-6.29$, smaller than this sharp division value, seemingly in contradiction with its non-LBL attribute; however, the value is consistent with the distribution of the flux ratios of the intermediate BL Lacs found in DXRBS and RGB samples, which show no such dichotomy between HBL- and LBL-like SEDs (Perlman et al. 1998; Laurent-Muehleisen et al. 1999).

The importance of the frequency at which the synchrotron radiation peaks is that it provides a powerful diagnostic for the physical condition of the emitting region. Recent studies showed that among BL Lac objects the synchrotron peak frequencies are inversely correlated with their luminosities (Fossati et al. 1998). Due to its low peak luminosity, PKS 2316–423 could be located near the bottom right end of Figure 7c of Fossati et al. (1998), with a peak frequency of $\sim 10^{18}$ Hz. However, the parabolic fit to the SED of PKS 2316–423 just gives $\nu_{p} \sim 10^{16}$ Hz. Consider the given ROSAT photon index of 2.0 (see § 3), which equates to a flat spectrum in $\nu F_{\nu}$ versus $\nu$ space within the soft X-ray range, suggesting that the peak frequency of PKS 2316–423 might be underestimated. This could be caused by imposing that the X-ray point smoothly connects to the lower energy data, as would happen in a parabolic fit. If a cubic fit is adopted, the synchrotron peak of PKS 2316–423 could be shifted toward a value of $\sim 10^{17}$ Hz, which basically follows the general trend of inverse correlation of the synchrotron peak frequency versus the luminosity among blazars (Fossati et al. 1998). In this sense, however, the source also behaves like a typical HBL.

In summary, the averaged SED properties of PKS 2316–423 indicate that it is an IBL, like those many objects found in DXRBS (Perlman et al. 1998), REX (Caccianiga et al. 1999), and RGB surveys (Laurent-Muehleisen et al. 1999). However, the source also shows some typical X-ray spectral properties of an HBL. This in fact supports a people's general idea—that in X-rays, an intermediate BL Lac object can show either synchrotron or inverse Compton characteristics in different variability states, though the most compelling test of the idea awaits a large sample of such studies.

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