MARKARIAN 1239: A HIGHLY POLARIZED NARROW-LINE SEYFERT 1 GALAXY WITH A STEEP X-RAY SPECTRUM AND STRONG Ne IX EMISSION

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ABSTRACT

We report the results of an XMM-Newton observation of the narrow-line Seyfert 1 galaxy Mrk 1239. This optically highly polarized AGN has one of the steepest X-ray spectra found in AGNs, with $\alpha_X = +3.0$ based on ROSAT PSPC data. The XMM-Newton EPIC pn and MOS data confirm this steep X-ray spectrum. The pn data are best fitted by a power law with a partial-covering absorption model suggesting two light paths between the continuum source and the observer, one indirect scattered one, which is less absorbed, and a highly absorbed direct light path. This result agrees with the wavelength-dependent degree of polarization in the optical/UV band. Residuals in the X-ray spectra of all three XMM-Newton EPIC detectors around 0.9 keV suggest the presence of an emission-line feature, most likely the Ne ix triplet. The detection of Ne ix and the nondetection of O vii/O viii suggest a supersolar Ne/O ratio.

Key word: galaxies: active — quasars: general — quasars: individual (Markarian 1239)

1. INTRODUCTION

With the launch of the X-ray satellite ROSAT (Trümper 1982) the X-ray energy range down to 0.1 keV became accessible for the first time. During the half-year ROSAT All-Sky Survey (RASS; Voges et al. 1999) a large number of sources with steep X-ray spectra were detected (Thomas et al. 1998; Beuermann et al. 1999; Schwope et al. 2000). About one-third to one-half of these sources are AGNs. Grupe (1996) and Grupe et al. (1999a, 2004) found that about 50% of bright, soft X-ray–selected AGNs are narrow-line Seyfert 1 (NLS1) galaxies (Osterbrock & Pogge 1985; Goodrich 1989). They turned out to be the class of AGNs with the steepest X-ray spectra (e.g., Boller et al. 1996; Grupe 1996; Grupe et al. 1999a, 2001, 2004; Vaughan et al. 2001; Williams et al. 2002). NLS1 galaxies are AGNs with extreme properties that seem to be linked to each other: an increase in their X-ray spectral index $\alpha_X$ correlates with the strength of the optical Fe ii emission and anticorrelates with the widths of the broad-line region (BLR) Balmer lines and the strength of the narrow-line region (NLR) forbidden lines (e.g., Grupe 1996, 2004; Grupe et al. 1999; Laor et al. 1994, 1997; Sulentic et al. 2000). All these relationships are governed by one fundamental underlying parameter, usually called the Boroson & Green (1992) “eigenvector-1” relation in AGNs. The most accepted explanation for eigenvector 1 is the Eddington ratio $L/L_{\text{Edd}}$ (Boroson 2002; Sulentic et al. 2000; Grupe 2004; Yuan & Wills 2003), in which NLS1 galaxies are AGNs with the highest Eddington ratios.

In a spectropolarimetry study of 18 NLS1 galaxies Goodrich (1989) found three sources that show significant polarization allowing a detailed spectropolarimetric analysis: Mrk 766, Mrk 1239, and IRAS 1509–211. All these sources show an increase of the degree of polarization toward the blue. In the BLR Balmer lines the degree of polarization is larger than in the continuum, while it is less in the NLR forbidden lines, suggesting that the scattering medium is located somewhere between the BLR and NLR (e.g., Wills et al. 1992). All three sources were observed with the Position Sensitive Proportional Counter (PSPC; Pfeffermann et al. 1987) on board ROSAT (Rush et al. 1996a; Grupe et al. 1998b; Pfefferkorn et al. 2001). The NLS1 galaxy Mrk 1239 ($\alpha = 09^h52^m91^s; \delta = -01^\circ36'43''$ [J2000]; $z = 0.019$) had an unusually steep X-ray spectral index $\alpha_X = 2.9$ (Boller et al. 1996) during the ROSAT pointed observation. Here we present the results of a serendipitous observation of Mrk 1239 with XMM-Newton (Jansen et al. 2001).

The outline of this paper is as follows: in § 2 we describe the XMM and ROSAT observations and the data reduction, in § 3 we present the results of the ROSAT and XMM data analysis, and in § 4 we discuss these results. Throughout the paper spectral indexes are denoted as energy spectral indexes with $F_{\nu} \propto \nu^{-\alpha}$. Luminosities are calculated assuming a Hubble constant of $H_0 = 75$ km s$^{-1}$ Mpc$^{-1}$ and a deceleration parameter of $q_0 = 0.0$.

2. OBSERVATIONS

2.1. XMM-Newton Observations

Mrk 1239 was observed by XMM-Newton during orbit 353 on 2001 November 12 from UT 20:04 to 22:57 for 5 ks with the EPIC pn (Strüder et al. 2001) and 9.4 ks with the EPIC MOS (Turner et al. 2001) with the thin filters in full-frame mode. The background during the observation was low so all of the observing times were used.

Source photons were collected in a circle with a radius of 25″. The background photons of the pn observation were collected in a close-by circular region with a radius of 50″ and...
in the MOS observation of an annulus with an inner radius of 30" and an outer radius of 75". Only events with PATTERN ≤4 for the pn and ≤12 for the MOS were selected for spectral analysis with quality parameter FLAG = 0. The count rates in all three EPIC detectors were low enough (see §3.1) that the observations were not affected by pileups. Because it was a serendipitous observation, the source was not observed on CCD 1 in the MOS cameras, but instead on CCDs 4 and 6 on MOS-1 and MOS-2, respectively. The position on the EPIC pn was on CCD 4 close to the CAMEX.

The XMM data were reduced by using the XMM-Newton Science Analysis Software (XMMSAS) version 5.4.1, and the X-ray spectra were analyzed by XSPEC 11.2.0. The spectra were grouped by GRPPHA 3.0.0 in bins of at least 15 counts per bin. The response matrices and auxiliary response files were created for the XMM observations by the XMMSAS tasks RMFGEN and ARFGEN.

For the sake of completeness and comparison with the XMM data, we retrieved and reanalyzed the ROSAT PSPC data as well. Details of the ROSAT observations are given below.

2.2. ROSAT PSPC Observations

Mrk 1239 was observed twice by ROSAT, first during the RASS (Rush et al. 1996a) and second in a pointed PSPC observation (Boller et al. 1996; Grupe et al. 1998b; Pfefferkorn et al. 2001). During the RASS coverage on 1990 November 13–14 the source was observed for a total of 418 s and the pointed ROSAT PSPC observation was performed on 1992 November 08 between UT 05:53 and 15:58 for a total of 9043 s (ROR 700908p; Pfefferkorn et al. 2001). The source was on-axis. Source photons were collected in a circle with a radius of 100" and the background photons in a close-by circular region with a radius of 200".

The ROSAT data were analyzed by both the Extended X-Ray Scientific Analysis System (EXSAS; Zimmermann et al. 1998) version 01APR and XSPEC version 11.2.0. For the count-rate conversions between different X-ray missions, PIMMS version 3.2 was used.

3. RESULTS

3.1. X-Ray Variability

During the RASS and pointed ROSAT PSPC observations Mrk 1239 had mean count rates of 0.054 ± 0.014 and 0.069 ± 0.003 counts s⁻¹, respectively (Pfefferkorn et al. 2001), suggesting no significant variability in the 2 yr between the two ROSAT observations. On the other hand, the light curve of the pointed PSPC observation (Fig. 1) suggests some variability by ≈25% during the 10 hr coverage. The PSPC hardness ratios were 0.81 ± 0.18 and 0.29 ± 0.10 during the RASS and pointed PSPC observations, suggesting a change in the X-ray spectrum. The bottom panel of Figure 1 displays the hardness ratio light curve of the pointed PSPC observation. It suggests some spectral variability, with the spectrum becoming softer with increasing count rate.

The mean count rates measured from the EPIC pn, MOS-1, and MOS-2 observations were 0.21 ± 0.01, 0.053 ± 0.003 and 0.057 ± 0.003 counts s⁻¹, respectively. No significant variability was detected during the 5 and 9.4 ks pn and MOS coverages. Using PIMMS and the best-fit single power law in the 0.2–2.0 keV range with Galactic absorption as given in Table 1 (§3.2) the pn and MOS count rates convert into 0.016 and 0.019 PSPC counts s⁻¹, suggesting a long-term variability by factors of 3–4 in the 9 and 11 yr between the XMM observation and the pointed ROSAT and RASS observations.

Converting the single power-law spectrum with Galactic absorption to the pn data as given in Table 1 into a PSPC hardness ratio results in HR = 0.58, suggesting that the source has become harder compared with the pointed ROSAT PSPC observation. It agrees with the findings for the pointed PSPC light curve (Fig. 1) that the hardness ratio increases with decreasing count rate.

3.2. Spectral Analysis

The number of photons collected during the RASS coverage was only 22, not sufficient to perform spectral fits to the data. However, the 9 ks pointed PSPC observation was long enough to collect 625 source photons that allow a spectral analysis. Figure 2 displays a single power-law fit with neutral absorption at z = 0 to the PSPC data of Mrk 1239. Table 1 lists the results of spectral fits to the ROSAT PSPC. The data are well-fitted by a single power law with Galactic and intrinsic absorption. The X-ray spectral index is $\alpha_X = 1.74 \pm 0.27$. This slope agrees in the 0.1–1.8 keV energy range, with EXSAS results of $\alpha_X = 2.79 \pm 0.30$ with $N_{H} = 7.76 \times 10^{20}$ cm⁻². EXSAS has been used for the analysis of the soft X-ray–selected AGN sample of Grupe et al. (2001, 2004). The fit to the PSPC data also shows that there is excess absorption above the Galactic value ($N_{H} = 4.03 \times 10^{20}$ cm⁻²; Dickey & Lockman 1990). For consistency (see discussion in §4.1) we also fitted an absorbed power law to the ROSAT PSPC data in the 0.1–2.4 keV range, which results in an X-ray index $\alpha_X = 2.97 \pm 0.30$.

A single power law fitted to the XMM EPIC pn and MOS data in the 0.2–2.0 keV ROSAT PSPC energy range confirms the steep X-ray spectrum with $\alpha_X = 2.95 \pm 0.24$ (Table 1). The fit shows strong residuals around 0.9 keV. This spectral

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3 See http://wave.xray.mpe.mpg.de/exsas/users-guide.

4 $HR = (H - S)/(H + S)$ with $S$ counts in the 0.1–0.4 keV range and $H = 0.5–2.0$ keV.
feature can be fitted by a single Gaussian emission line with an equivalent width of \( EW = 120 \text{ eV} \), which significantly improves the fit. Figure 3 displays this fit to the \( XMM \) pn and MOS data. Even though the pn has the best energy resolution close to the CAMEX at 0.9 keV (cf. Ehle et al. 2003) the line is not resolved. The fit to the MOS data results in equivalent widths of 150 and 110 eV for the MOS-1 and MOS-2, respectively. Theoretically, the energy resolution of the MOS cameras is better than the pn. However, because the source is rather faint, the MOS data had to be rebinned, which reduces the resolution and the line is not resolved either. The line seems to be real and not an effect of the detectors or a result of miscalibration, because (1) no features in the EPIC detectors around this energy are known, (2) it can be seen in all three \( XMM \) detectors, (3) it can also be seen in the residuals of the \( ROSAT \) PSPC spectrum (Fig. 2), and (4) there are emission lines around this energy that have been found in the X-ray spectral of several AGNs (see discussion § 4.3).

Even though the 0.2–2.0 keV range seems to be well-fitted by an absorbed power law model with a Gaussian emission line, the spectrum becomes more complicated when seen in the 0.2–12 keV range as displayed in Figure 4. A simple absorbed power-law model fails to fit the data above 2 keV. The spectral fit still results in a steep X-ray spectral index \( \alpha_X \approx 2.7 \), but the fit is not acceptable (Table 2). Even though it results in an acceptable fit, an approach with a broken power-law model fails because it needs an unphysically flat hard X-ray component with \( \alpha_X = -2.1 \). The high degree of optical polarization in Mrk 1239 (Goodrich 1989; Brindle et al. 1990) suggests that part of the observed emission is scattered, while another part of the direct light path is highly absorbed. Having this in mind, we fitted a power-law model with two absorbers to the data. The result of this fit is shown in Figure 5.

### Table 1

Spectral Fit Parameters to the EPIC pn and MOS and ROSAT PSPC Data of Mrk 1239 in the ROSAT PSPC 0.1–2.0 keV Energy Range.

| Detector          | XSPEC Model          | \( N_{H,gal} \) (\( 10^{20} \text{ cm}^{-2} \)) | \( N_{H,\text{intr}} \) (\( 10^{20} \text{ cm}^{-2} \)) | \( \alpha_X \) | \( \text{EW(Ne} \text{ix)} \) (Å) | \( \chi^2 \) (DOF) |
|-------------------|----------------------|---------------------------------------------|-------------------------------------------------|----------------|-----------------|----------------|
| PSCP              | WA PO\(^{b}\)        | 7.77 ± 0.95                                | ...                                             | 2.73 ± 0.27    | ...             | 23.0 (28)      |
|                   | WA ZWA PO\(^{c}\)    | 4.03 (fix)                                  | 3.91 ± 1.00                                    | 2.74 ± 0.29    | ...             | 23.0 (28)      |
|                   | WA PO\(^{b}\)        | 10.94 ± 2.07                                | ...                                             | 2.95 ± 0.24    | ...             | 47.7 (45)      |
|                   | WA ZWA PO\(^{c}\)    | 4.03 (fix)                                  | 7.47 ± 2.21                                    | 2.97 ± 0.25    | ...             | 47.5 (45)      |
|                   | WA PO GAUS\(^{e}\)   | 9.75 ± 1.95                                 | ...                                             | 2.94 ± 0.24    | 120             | 34.7 (42)      |
| MOS-1 + MOS-2\(^{d}\) | WA ZWA PO\(^{c}\) | 16.50 ± 3.99                                | ...                                             | 3.34 ± 0.36    | ...             | 53.0 (42)      |
|                   | WA ZWA PO\(^{c}\)    | 12.02 ± 3.87                                | 14.15 ± 4.45                                   | 3.44 ± 0.38    | ...             | 52.6 (42)      |
|                   | WA PO GAUS\(^{e}\)   | 13.60 ± 2.15                                | ...                                             | 3.14 ± 0.21    | ...             | 98.2 (86)      |
|                   | WA ZWA PO\(^{c}\)    | 10.41 ± 1.59                                | 10.07 ± 2.41                                   | 3.21 ± 0.23    | ...             | 97.5 (86)      |
|                   | WA PO GAUS\(^{e}\)   | 4.03 (fix)                                  | ...                                             | 2.94 ± 0.18    | 120, 150, 110   | 74.4 (84)      |

\(^{a} \) ROSAT PSPC, observed energy range 0.1–1.8 keV.

\(^{b} \) Galactic absorption and power-law model.

\(^{c} \) Galactic absorption, redshifted neutral absorption at \( z = 0.02 \), and power law.

\(^{d} \) EPIC pn, MOS-1, and MOS-2, observed energy range 0.2–2.0 keV.

\(^{e} \) Power law with Galactic absorption and Gaussian line at \( \approx 0.92 \text{ keV} \).
improves the fit to $\chi^2/\nu = 38.3/50$. Figure 6 displays the unfolded spectrum of this fit showing the soft and hard X-ray continuum components and the Gaussian line at 0.91 keV. This result is somewhat similar to what has been seen in the Seyfert 1.5 galaxy Mrk 6 (Feldmeier et al. 1999; Immler et al. 2003). The two-absorber model is identical to a partial-covering model in which the partially covered continuum component passes a second absorber. It can be interpreted either as a leaky absorber or an additional line of sight through a scattering medium (see § 4.2). Partial-covering models have been successfully fitted to the $XMM$ data of NLS1 galaxies, such as 1H 0707−495 (Boller et al. 2002) and IRAS 13224−3809 (Boller et al. 2003).

As shown in Figure 5 there are still some residuals around 6.5 keV, suggesting the presence of an Fe Kα–line complex. Adding an additional Gaussian to the data results in a line with an equivalent width $EW = 1.3$ keV, but the quality of the data does not allow one to constrain any of the line parameters.

3.3. Spectral Energy Distribution

Figure 7 displays the spectral energy distribution (SED) of Mrk 1239. Radio observations of Mrk 1239 have been published by Ulvestad et al. (1995), Rush et al. (1996b), and Thean et al. (2000) showing a compact radio source. In the plot we used the values of Ulvestad et al. (1995). The far-infrared luminosities were derived from the IRAS Point Source Catalog and the near-infrared data were taken from the Two Micron All Sky Survey (2MASS). The optical spectrum was observed in 1997 at McDonald Observatory (Grupe et al. 1998b) and the UV spectrum was from an $IUE$ observation of Mrk 1239 (SWP 33659) derived from the $IUE$ archive at the Villafranca Satellite Tracking Station. The X-ray data are represented by the unabsorbed power law model that was fitted to the EPIC pn data in the 0.2–2.0 keV energy range (Table 1).

One of the crucial points in determining the SED of this highly reddened AGN is dereddening. For the optical and UV data we used the values given in Table 1 of Gaskell et al. (2003). For the UV we used a fixed ratio $A_λ/A_V = 1.44$, and for the optical wavelength range we determined $A_λ/A_V = 1.9762−1.7724 \times 10^{-4} \times \lambda$, with $\lambda$ in units of angstroms. For the 2MASS data we used $A_λ/A_V = 0.68 \times (1/\lambda − 0.35)$, with $\lambda$ in units of microns (Ward et al. 1980).

The 6 cm radio flux density that is used for the definition of radio loudness (Kellermann et al. 1989) is $19.49 \pm 1.05$ and $25.9 \pm 1.3$ mJy (Ulvestad et al. 1995 and Rush et al. 1996b, respectively). Using the definition of Kellermann et al. (1989) with $R^5$ for radio-loud sources and the dereddened flux density

![Fig. 4.—Power-law fit with Galactic and intrinsic absorption fitted to the $XMM$ EPIC pn and MOS data of Mrk 1239. The plot shows that the simple power law that fits the soft energy range does not fit the entire spectrum.](image1)

![Fig. 5.—Spectral fit with a power-law model and two intrinsic absorbers and a Gaussian line to the pn data of Mrk 1239 (see Table 2).](image2)

### TABLE 2

**Spectral Fit Parameters to the EPIC pn 0.2–12 keV Data of Mrk 1239**

| Parameter | ZWA PO | ZWA (PO + GA) | ZWA(PO + GA) + ZWA (PO) |
|-----------|--------|---------------|-------------------------|
| Absorber 1, $N_H (10^{20} \text{ cm}^{-2})$ | 5.76 ± 1.82 | 5.06 ± 1.81 | 6.21 ± 2.01 |
| Absorber 2, $N_H (10^{22} \text{ cm}^{-2})$ | … | … | 33.24 ± 13.46 |
| Spectral index $\alpha_X$ | 2.75 ± 0.20 | 2.75 ± 0.20 | 2.92 ± 0.23 |
| Gauss line, $E$ (keV) | … | 0.913 ± 0.022 | 0.913 (fix) |
| Gauss line, $\sigma$ (eV) | … | 32.4 ± 32.4 | 32.4 (fix) |
| Gauss line, EW (eV) | … | 110 | 110 (fix) |
| $\chi^2/\nu$ | 111.9 (53) | 99.6 (50) | 38.3 (50) |

*Note.—* The Galactic $N_H$ is fixed for all models to $4.03 \times 10^{20} \text{ cm}^{-2}$.

* The XSPEC model ZWA PO, intrinsic absorption by neutral elements and power law.

* The XSPEC model ZWA (PO + GAUS), intrinsic absorption with power law and Gaussian emission line.

* The XSPEC model ZWA (PO + GAUS) + ZWA (PO), two-component intrinsic absorption with power law and Gaussian line.
at 4400 Å, the radio loudness becomes \( R = 5.3 \) and 7.0, respectively. This would make Mrk 1239 a radio-quiet source. Nevertheless, it is a borderline object between radio-loud and radio-quiet.

We determined the X-ray loudness \( \alpha_{\text{ox}} \) using the unabsorbed monochromatic luminosities \( L_{2500} \) and \( L_{2\text{keV}} \), which were measured directly from the SED given in Figure 7. This results in \( \alpha_{\text{ox}} = 1.50 \). This agrees almost perfectly with the value of \( \alpha_{\text{ox}} \) given by Yuan et al. (1998) for a source of a redshift \( z < 2 \) and an optical luminosity density \( L_{\text{opt}} \) such that

\[
\log_{10} L_{\text{opt}} = 23 \text{ W Hz}^{-1} (30 \text{ ergs s}^{-1} \text{ Hz}^{-1}).
\]

From the best-fit two-absorber power-law model given in Table 2, we estimated the unabsorbed 0.2–2.0 rest-frame X-ray luminosity \( \log L_{0.2-2.0\text{keV}} = 37.27 \text{ W} \) and the 0.2–12 keV rest-frame luminosity \( \log L_{0.2-12\text{keV}} = 37.29 \text{ W} \), which makes Mrk 1239 one of the highest luminosity NLS1 galaxies compared with the sample of Grupe et al. (2004). The contribution of the soft, scattered component is \( \log L_{0.2-12\text{keV}(\text{soft})} = 35.00 \text{ W} \) by using a power law with an exponential cutoff plus a soft X-ray power-law with neutral absorption to model the big blue bump emission as described by Grupe et al. (2004). This suggests that Mrk 1239 has an Eddington ratio \( \lambda \) of about 2.

4. DISCUSSION

4.1. The Steep X-Ray Slope \( \alpha_X \)

The soft X-ray spectrum with \( \alpha_X \approx 3.0 \) is unusually steep even for an NLS1 galaxy, but not uncommon (e.g., Boller et al. 1996; Grupe et al. 2001). Its black hole mass of \( 5 \times 10^6 \text{ M}_\odot \) and Eddington accretion ratio \( L/L_{\text{Edd}} \) of about 2–3 are similar to what has been found for other NLS1 galaxies (e.g., Grupe et al. 2004; Grupe 2004). With an \( \alpha_X = 2.97 \) and a FWHM(H\(\beta\)) = 1050 ± 150 km s\(^{-1}\) (Grupe et al. 1998b), Mrk 1239 is one of the extreme sources in a FWHM(H\(\beta\))–\( \alpha_X \) diagram (cf., e.g., Boller et al. 1996; Grupe et al. 1999; Grupe 2004; Williams et al. 2002). Figure 8 displays the position of Mrk 1239 (marked as the large star) in the FWHM(H\(\beta\))–\( \alpha_X \) diagram of the complete soft X-ray–selected sample of Grupe et al. (2004) and Grupe (2004). The value taken for this plot was \( \alpha_X = 2.97 \), to be consistent with the other objects for which EXSAS had been used for the ROSAT data analysis. Please note that Mrk 1239 is the only NLS1 in this plot that was not selected by X-rays.

4.2. Partial-Covering and Its Relation to Optical Polarization

The degree of optical polarization is wavelength dependent and increases with decreasing wavelength (Goodrich 1989; Brindle et al. 1990), suggesting two main light paths between
the continuum source and the observer, one a direct, highly reddened, absorbed light path and one an indirect, scattered, and less-absorbed light path. The XMM data seem to confirm this model. The best-fit model to the pn data contains a power law with two absorbers (Table 2). We interpret the soft component not as direct light from a leaky absorber situation, but rather as a scattered component. This interpretation is motivated by the high degree of optical polarization. This picture is somewhat similar to the model proposed by Feldmeier et al. (1999) based on ASCA observations of Mrk 6, which was confirmed by the XMM observation (Immler et al. 2003).

Smith et al. (2004) have noticed that the polarization in the Hα line shows a minimum of polarization in the blue wing, while the polarization in the red wing shows a peak. Therefore, Smith et al. (2004) concluded that the scattering medium is part of the nuclear outflow. A strong outflow is expected in sources with high L/L_{Edd} (e.g., King & Pounds 2003) like Mrk 1239.

### 4.3. The Strong Ne ix Emission Line

One of our main findings in the X-ray spectrum of Mrk 1239 is a strong emission feature around 0.9 keV. Given the energy of the feature, the most obvious identifications would be the Ne ix triplet. However, the strength of the line, and the lack of any other detectable emission features, is surprising. In the first case, the absence of the oxygen triplet is unexpected. For solar metal abundances those lines are expected to be stronger than the neon features. Taking the line parameters of the 0.91 keV feature, we found an upper limit for the 22 Å O vii triplet of an equivalent width EW = 34 Å. An identification of the line with neon would thus lead us back to speculations about a neon/oxygen overabundance first discussed in the context of PG 1404+226 (Komossa & Fink 1998; Ulrich et al. 1999). In the latter case, features were seen in absorption, while we detect an emission line in Mrk 1239. Note that Ne and/or Fe L lines are relatively stronger as compared with oxygen lines in AGNs with steep X-ray spectra (cf. Nicastro, Fiore, & Matt 1999). A possible origin of that line then is the ionized medium not located along the line of sight, thus seen in emission.

The presence of He-like ions, such as Ne ix in emission suggests a hot plasma with a temperature of several million K (e.g., Pradhan 1982; Porquet & Dubau 2000; Porquet et al. 2001; Ness et al. 2003 and references therein). These types of emission lines have been found in the X-ray spectra of hot stars (e.g., Audard et al. 2001; Stelzer et al. 2002; Ness et al. 2003) and have also been reported for a few AGNs, e.g., NGC 3783 (Kaspi et al. 2002; Krongold et al. 2003), NGC 1068 (Kinkhabwala et al. 2002), NGC 5548 (Kastra et al. 2000), and NGC 4151 (Ogle et al. 2000). The 0.91 keV line found in Mrk 1239 from the XMM data shows an EW ≈ 120 eV. Comastri et al. (1998) reported a strong Ne ix line in the ASCA spectrum of the Seyfert 2 galaxy NGC 4507, with an equivalent width similar to that found in Mrk 1239. The continuum spectrum of NGC 4507 is somewhat similar to Mrk 1239 in showing a highly absorbed hard X-ray component and a less absorbed soft component. In both cases, emission lines are strongly detected because the direct light is suppressed. Theoretically the presence of an He-like ion triplet provides a powerful tool to determine parameters of the plasma, such as electron temperature and density (e.g., Netzer 1996). Unfortunately, in the case of Mrk 1239 the source is too faint to be explored by XMM’s reflection grating spectrometer. Much more powerful observatories such as XEUS and Constellation-X have to be used to observe this source with high-resolution X-ray spectrometers.

#### 4.4. X-Ray Variability

The variability of a factor of about 4 between the pointed ROSAT PSPC and the XMM observation about 9 yr later cannot be explained only by a change in the intrinsic absorption column. Using the changes in the absorption columns of the ROSAT PSPC and XMM observations as given in Table 1 would cause a variability by only a factor of about 2. This means that the source has to be intrinsically variable. Changes in the observed X-ray flux by factors of 3–4 are not uncommon among AGNs (e.g., Leighly 1999; Grupe et al. 2001 and references therein), especially NLS1 galaxies (e.g., Boller et al. 1996). The fits to the PSPC and XMM data in the 0.2–2.0 keV energy range do not suggest any significant change in the soft X-ray slope (Table 1). From the current data sets, the fits are consistent with a spectrum that just goes up and down without any significant changes of its spectral slope $\alpha_X$.

#### 5. CONCLUSIONS

We have studied the X-ray spectra of Mrk 1239 in a serendipitous observation by XMM-Newton and our main results are as follows:

1. The 0.2–2.0 keV soft X-ray spectrum of the source is very steep with $\alpha_X \approx 3.0$, confirming previous results from ROSAT.

2. The 0.2–12 keV EPIC pn X-ray continuum spectrum is best fitted by a power law with $\alpha_X = 2.92$ and two intrinsic absorbers with $N_H = 6 \times 10^{20}$ cm$^{-2}$ and $3 \times 10^{23}$ cm$^{-2}$, supporting the optical spectropolarimetry results by Goodrich (1989) of having a direct highly absorbed light path and an indirect scattered light path, which is less absorbed.

3. The X-ray spectrum shows an emission-line feature around 0.91 keV (observed frame), which is most likely the Ne ix triplet.

4. The nondetection of the O vii triplet suggests a supersolar Ne/O ratio.

5. To finally resolve the 0.91 keV feature, longer observations with XMM or even more powerful future X-ray missions are needed.

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