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# Recent ASCA and SAX observations of intermediate BL Lac objects

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## 1. Introduction

BL Lac objects detected in X-ray and radio surveys show markedly different properties and are clearly separate in terms of their spectral energy distributions (SEDs), parameterized by, e.g. $\alpha_{\rm rx}$, the ratio of the 5GHz radio to the 1 keV X-ray flux. The unification of BL Lac objects is a long-standing, but still unsolved issue. However, recent observational and theoretical progress indicates that all BL Lacs do indeed belong to one population. New samples derived from the ROSAT All-Sky Survey (RASS) and sensitive radio catalogs show a continuous distribution in $\alpha_{\rm rx}$ (e.g. Laurent-Muehleisen et al. 1999). Theoretical work indicates that variations in the peak energy of the synchrotron emitting electron population combined with orientation might be able to explain the range of properties among BL Lac objects (e.g. Celotti 1993; Padovani & Giommi 1994). In this contribution we present the broad band X-ray spectra of intermediate BL Lac objects (IBLs) discovered in our correlation of the RASS and the 5GHz 87GB radio survey (cf. Brinkmann et al. 1995, 1997). They show $\alpha_{\rm rx}$ values *intermediate* between the previously known classes of X-ray and radio selected BL Lacs.

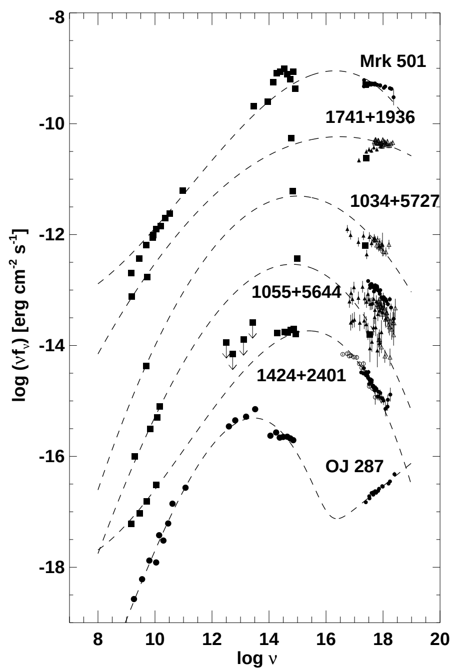


**Fig. 1.** The spectral energy distribution of various IBLs. The normalization is arbitrary.

## 2. Observations and results

In total we performed 6 observations of 4 IBLs with both ASCA and SAX. Table 1 summarizes the results from our spectral analysis. In general, the hard X-ray spectra of IBLs are very steep with photon indices ranging from 2.1 to 2.8. Furthermore, a broken power law provides a significantly better description of the X-ray spectra of IBLs than a simple power law. The X-ray spectra get flatter towards lower energies. In addition to that, the spectrum of 1424+2401 also seems to flatten above 5 keV. This may indicate that a flat inverse Compton component starts to dominate the X-ray spectrum. The X-ray flux from 1055+5644 varied by almost an order of magnitude between our three observations and the ASCA data show a 50% decrease within one day. Interestingly, no significant spectral changes are found, which might provide important constraints on electron injection and cooling processes.

**Table 1.** Results of the spectral analysis.

| Name | Obs. | $\Gamma_{\rm l}$ | $\Gamma_{\rm h}$ | $E_{\rm br}$ [keV] | $F_{2-10\rm keV}$ |
|---|---|---|---|---|---|
| 1034+5727 | SAX | $2.10^{+0.15}_{-0.16}$ | $2.42^{+0.26}_{-0.25}$ | 2.0 (fixed) | $0.8 \times 10^{-12}$ |
| 1055+5644 | SAX 1 | $2.34^{+0.20}_{-0.22}$ | $3.21^{+1.25}_{-0.92}$ | 1.75 (fixed) | $0.3 \times 10^{-12}$ |
| 1055+5644 | SAX 2 | $2.22^{+0.11}_{-0.13}$ | $2.78^{+0.25}_{-0.25}$ | 1.75 (fixed) | $1.4 \times 10^{-12}$ |
| 1055+5644 | ASCA | $2.23^{+0.11}_{-0.13}$ | $2.76^{+0.09}_{-0.07}$ | $1.75^{+0.21}_{-0.18}$ | $2.9 \times 10^{-12}$ |
| 1424+2401 | ASCA | $2.78^{+0.04}_{-0.04}$ | $1.22^{+0.90}_{-0.73}$ | 5.0 (fixed) | $1.9 \times 10^{-12}$ |
| 1741+1936 | SAX | $1.71^{+0.20}_{-0.15}$ | $2.10^{+0.08}_{-0.07}$ | $1.90^{+0.67}_{-0.69}$ | $5.4 \times 10^{-12}$ |

In Fig. 1 we present the SEDs of our IBLs and compare them to Mrk 501 and OJ 287, typical X-ray and radio selected BL lac objects, respectively. The steep and convex X-ray spectra as well as the SEDs of IBLs both confirm their intermediate nature. The SEDs are characterized by a synchrotron peak in the UV/soft X-ray band. In hard X-rays we obviously observe the steep tail of the synchrotron component. Variability and uncertainties in the absorption correction might explain the discontinuities between the X-ray and the optical band, in particular for 1741+1936. In one case (1424+2401) we might see the onset of the flat inverse-Compton component.

## References

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