IAU Colloquium 164: Radio Emission from Galactic and Extragalactic Compact Sources
ASP Conference Series, Vol. 144, 1998
J. A. Zensus, G. B. Taylor, & J. M. Wrobel (eds.)

The Rosat-Green Bank Sample of Intermediate BL Lac Objects

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Abstract. The Rosat-Green Bank BL Lac sample consists of 119 objects and smoothly bridges the gap between the previously disparate subclasses of radio- and X-ray-selected objects. Further study of this sample should provide useful constraints to the unified scheme and help determine if modifications are necessary.

Prior to the launch of the ROSAT observatory, approximately 200 BL Lacs were known, making them one of the rarest classes of AGN. The vast majority of these objects were discovered in either radio or X-ray surveys and belong to two distinct observational subclasses: X-ray- and radio-selected objects (XBLs and RBLs respectively). Of the two, RBLs exhibit more extreme properties (e. g., Laurent-Muehleisen 1996, and references therein). The data are largely consistent with a unified scheme which asserts that RBLs, XBLs and FR I radio galaxies represent objects that are intrinsically the same, but whose relativistic jets are oriented at increasingly larger angles to the line-of-sight (Urry & Padovani 1995; Kollgaard 1994). Few objects with *intermediate* properties between RBLs and XBLs are known, but their characterization is crucial for testing the unified scheme.

1. The RGB BL Lac Sample

We have created such a sample of intermediate objects from a correlation of the ROSAT All-Sky Survey (RASS) and the Green Bank 5 GHz radio (GB) survey. This correlation consists of 2,127 objects for which we obtained followup VLA observations which facilitated the unambiguous identification of optical counterparts (Laurent-Muehleisen et al. 1997; Brinkmann et al. 1997). Combining previously known BL Lacs with new objects we identified spectroscopically, we produced the ROSAT-Green Bank (RGB) catalog of 119 BL Lacs (Laurent-Muehleisen 1996). These BL Lacs span nearly three orders of magnitude in both X-ray and radio flux ($4\times10^{-13}<F_x<4\times10^{-10}\,\mathrm{erg\,s^{-1}cm^{-2}}$; $3<S_r<2160$ mJy), and have blue magnitudes which range from $13.3<B<21.2$ mag.

2. Discussion and Conclusions

The division between RBLs and XBLs is usually based on the ratio of the X-ray flux density to the radio flux density, where objects with $\log S_x/S_r<-5.5$ are considered RBL-like. The S_x/S_r distribution of the RGB BL Lacs shows this sample consists of both traditional XBL- and RBL-like objects in addition to many objects with flux ratios that smoothly bridge the gap between them (Fig. 1).

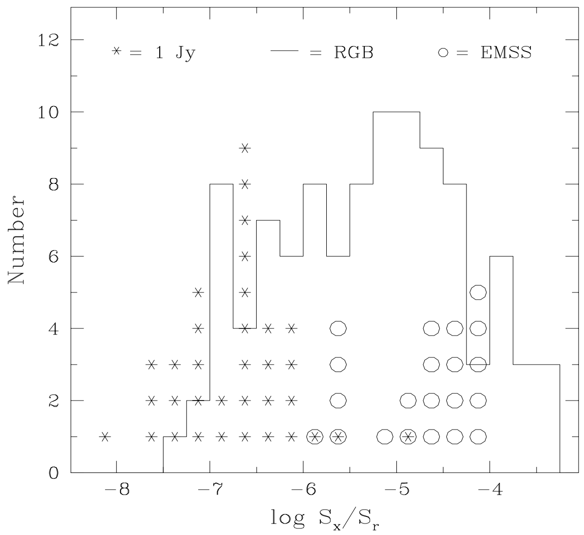

Figure 1. The ratio of the 2 keV X-ray and 5 GHz radio flux densities. RBLs are represented here by the 1 Jy sample (Stickel, Fried, & Kühr 1993) and XBLs by the EMSS sample (Morris et al. 1991). The RGB sample smoothly spans the range from $-7.5<\log S_x/S_r<-3.5$ and in particular shows many objects with $\log S_x/S_r$ between -6 and -5, a region which until now has been severely undersampled.

The RGB BL Lacs exhibit other properties which are consistent both with their classification as intermediate objects and with the predictions of the unified scheme. However, similar to trends seen in other samples (e. g., Sambruna, Maraschi, & Urry 1996), the RGB BL Lacs exhibit some properties, particularly in their high energy continuum, which indicate factors other than orientation may be important. Detailed study of a sample such as the RGB which contains transitional objects should prove invaluable for testing the unified scheme and characterizing any modifications that prove necessary.

Acknowledgments. This work was supported by NASA grant No. NAGW-2120 and the NASA Space Grant Consortium through their Space Grant Fellow program. The National Radio Astronomy Observatory is a facility of the National Science Foundation, operated under a cooperative agreement by Associated Universities, Inc.

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