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How Strong Should an Emission Line Be for BL Lac Classification?

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Abstract. An equivalent-width limit $EW < 5$ Å has been imposed as a selection criterion for BL Lac objects. However, such sharp cutoff has no physical meaning, and it is likely to be biasing BL Lac samples. This result is suggested by the analysis of a sample of low-luminosity, flat radio-spectrum sources selected for the purpose of investigating the limits of BL Lac phenomena. In this work it is proposed that, instead of imposing sharp limits on the quantities observed, we should look for clear breaks occurring in the distributions of the observed properties for each sample.

1. Introduction

BL Lac objects are active galactic nuclei (AGN) with flat radio spectra, and which display rapid optical variability, high and variable optical polarization, and weak or non-existent emission lines. The classification of a source showing all of these properties does not usually pose any problem. However, the matter is complicated when the source shows some, but not all of the above properties. This means that there are some observational properties which are considered to be essential for BL Lac classification, whereas others are thought of secondary importance. Deciding which properties belong to each of these categories may prove to be a difficult task, and not always one that reaches consensus.

2. Why is Equivalent Width a Bad Selection Criterion?

Of all the possible ambiguities in the classification of BL Lac objects, the most potentially misleading is probably the one involving the strength of the emission lines. Traditionally, BL Lac classification requires emission lines to be weaker than $EW \leq 5$ Å (Stickel et al. 1991; Stocke et al. 1991). This, however, is likely to bias the samples because (1) the 5 Å limit was imposed for practical reasons even though there is no physical meaning to such a cutoff, and (2) EW changes when the continuum changes. Since in the case of an AGN, the amount of continuum is the result of the sum of the galaxy continuum, plus the extra source of continuum due to the AGN, there are several reasons why changes can occur. In particular, they can occur because of the following:

Dilution: Different objects suffer different amounts of dilution by their host galaxy, which means that in some cases EW is smaller because there is more

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galaxy continuum, whereas in other cases EW can be stronger because the galaxy contribution is smaller.

Beaming: As a result of beaming, the observed continuum can be many times larger than the intrinsic continuum.

Variablity: If the continuum due to the AGN varies with time, then EW will also vary with time.

3. What Do the Data Tell Us?

To try and investigate the limits of the BL Lac phenomena, a new sample of bright, flat radio-spectrum sources was selected (Marchã et al. 1996). The sample contains 55 objects, 53 of which possess spectral information. The observations of this sample include not only spectroscopy, but also polarimetry, and radio-core polarization. The analysis of these data do not support a separation of objects based on a sharp cutoff of EW. In fact, to impose a limit $EW \leq 5\,\text{Å}$ for the selection of BL Lacs would be totally arbitrary, and it would leave out some good BL Lac candidates.

4. Conclusions

- Empirical limits on the strength of the emission lines can bias samples because they can leave out intrinsically similar objects.
- An alternative approach is to look for clear breaks in the distribution of EW for a given sample.
- The study of the strength of emission lines should be made uniform by calculating EW always relative to the same quantity. For example, to eliminate the effects of dilution, beaming, and variability, EW should be determined relative to the galaxy continuum.
- The problem with imposing limits on the emission-line EW for the purpose of selecting BL Lacs is just an example of introducing biases in the samples. The same type of reasoning can be used for other kinds of objects and observed properties.

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