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"Red Blazars": Evidence Against A Synchrotron Origin

Frank J. Masci and Rachel L. Webster
School of Physics, University of Melbourne, Parkville, Victoria, Australia, 3052

Abstract. Recently, a substantial population of Blazar-like sources exhibiting sharp near-infrared cutoffs and hence exceedingly reddened optical to near-infrared colours ($B_J - K \gtrsim 6$) have been discovered in a complete sample of flat spectrum radio sources (Drinkwater et al. 1996). We argue that such "red " colours cannot be due to a synchrotron radiation mechanism alone.

1. Introduction

More than $\sim 30\%$ of the 330 sources in this sample exhibit an abrupt spectral turnover in the near infrared (see eg. Fig. 1). The currently most favoured explanation is that such turnovers are a feature characteristic to such sources that may be due to a "red" dominant synchrotron component associated with a relativistic jet (eg. Serjeant & Rawlings 1996).

On the assumption that the near-IR to optical emission is purely dominated by synchrotron, we show that the abrupt spectral cutoffs have to be as extreme as possible, in most cases violating the limits imposed by existing models of particle acceleration.

2. Theoretical limits

It has been shown that sharp high frequency spectral turnovers can be explained by a particle energy distribution exhibiting an ideal step-like cutoff. There is a limit however, to how steep such a cutoff can be. Fritz (1989) has modeled these cutoffs assuming a particle energy distribution described by a power law below some maximum energy E_{max} and an exponential type cutoff above E_{max}, ie.

$$N(E)dE \propto \begin{cases} E^{-s}dE & \text{for } E < E_{max} \\ \exp[-AE^n]dE & \text{for } E > E_{max} \end{cases} \quad (1)$$

where A, n and s are constants to be determined from the data. This has been shown to lead to the following synchrotron radiation spectrum (Masci & Webster 1996):

$$P(\nu) \propto \begin{cases} \nu^{-\alpha} & \text{for } \nu < \nu_T \\ \nu^{-1/2}\exp[-C\nu^{n/n+2}] & \text{for } \nu > \nu_T \end{cases} \quad (2)$$

where ν_T is the observed turnover frequency corresponding to E_{max}. By modifying the diffusion properties of particles across shock fronts, Fritz (1989) has

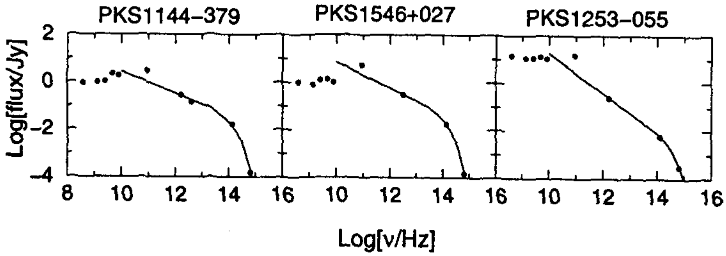

Figure 1. Multifreqeuency data for three "red" sources in the Drinkwater et al. 1996 sample with model fits as defined by Eqn. 2.

shown that it is only possible to generate particle distributions with

$$n < 2 \tag{3}$$

3. Comparison With Data

We have fit the multifreqency spectra of some of the reddest sources according to Eqn. 2 (see Fig. 1). We have analysed eight sources and five sources appear to be best described by fits with

$$n \gtrsim 6. \tag{4}$$

The values of n required are much greater than the theoretical limit in Eqn. 3. A detailed analysis of all fitted parameters can be found in Masci & Webster (1996).

4. Conclusions

We conclude that if the spectral turnovers are to be explained via a synchrotron mechanism alone, then we require a particle energy distribution that exhibits a nearly step-like cutoff or one that is nearly monoenergetic in nature. These distributions are not possible under any stochastic particle acceleration process.

We argue in favour of an alternative mechanism which states that opacity effects in the optical such as reddening of an underlying QSO continuum by dust may play a role (Webster et al. 1995). This hypothesis is currently being investigated.

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