Radio and Optical Observations of "Optically Quiet Quasars"

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1. Introduction

In recent years a number of very steep spectrum, compact radio sources have been discovered (e.g. Cotton 1983, Cotton and Owen 1985, Ulvestad 1985) which have no optical counterpart to the limit of the Palomar Sky Survey. VLBI observations of a number of these have confirmed the very compact (<10 mas) nature of several of these sources. Analysis of the available data in terms of the standard synchrotron model suggest that they contain very weak magnetic fields, large particle densities and may emit detectable infrared and optical emission by inverse Compton scattering in the compact radio source (Cotton 1983). This paper will report on an analysis including new VLBI observations, infrared and optical imaging at KPNO and low frequency radio observations at CLRO of a number of these objects.

2. Analysis

Important physical parameters can be derived for a synchrotron emitting source from observations of the spectrum and size of the source. In particular, the magnetic field strength and relativistic electron densities derived for the sources under consideration (see Marscher 1983) indicate weak magnetic fields and large relativistic electron densities. Under these conditions inverse Compton scattering of the radio photons off the relativistic electrons becomes important. Table 1 shows the observed and derived parameters for several objects; minimum gamma is the minimum bulk relativistic factor for which the model does not violate the data and B corresponds to this model.

Table 1
Observed and derived source parameters

Source	Size mas	Max. freq. MHz	Max flux mJy	Min gamma (z=0)	B mgauss
0752+342	11.	<100	>2000	4.6	<3.3E-3
1015+345	6.	<100	>400	2.9	<4.8E-3
1621+347	17.2	100	2000	2.5	1.1E-2
2147+145	5.8	150	3200	24.	1.2E-3

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Figure 1 shows the observed spectrum of 2147+145 and several synchtron model computations intended to reproduce the observed spectrum and size. The dotted line is a model including only synchrotron processes; the dashed line is the same model but including the effects of Compton scattering. This latter model shows that most of the radio photons have been scattered to higher frequencies. The solid line shows a model including relativistic beaming with a bulk relativistic factor of 24 (assuming z=0; 48 if z=1) which is in reasonable agreement with the data. Clearly, the only realistic synchrotron model which adequately reproduces the observations is the relativistic beaming case. There is, however, no direct evidence that the emission is from the synchrotron process.

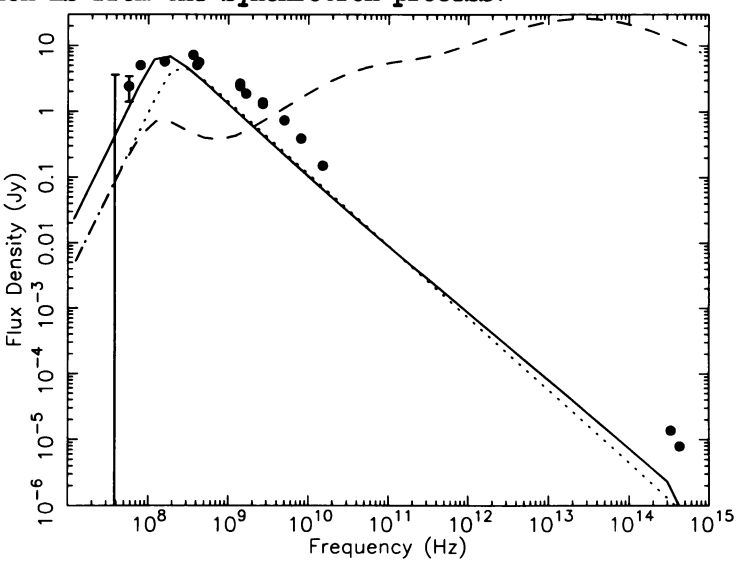

Figure 1 - Observed spectrum and synchrotron models for 2147+145.

3. Conclusions

A number of steep spectrum, compact, optically weak radio sources have been observed which cannot be modeled by synchrotron emission from a non-moving source. The sources can be adequately modeled by a synchrotron emitting source moving towards us at highly relativistic velocities. Another possibility requiring serious attention is that the emission may not be produced by the synchrotron process.

REFERENCES

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DISCUSSION

Burbidge : Are they galactic stars ?

Cotton : Probably not; several of the objects have only a stellar like component but several also have significant levels of fuzz. The one object with a good VLBI image, 2147+145, has a core - "jet" structure similar to quasars. There is no direct evidence that these are not stars.

Coleman : Could you say what Lorentz factor is required when fitting a synchrotron self-compton model to the low optical flux.

Cotton : If the object is at $z \simeq 0$, $\gamma = 25$ is required, but for $z \simeq 1$ it is $\gamma = 50$.

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