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GPS Sources with High Peak Frequencies

A. C. Edge
Institute of Astronomy, Cambridge, UK

Guy Pooley, Mike Jones, Keith Grainge, & Richard Saunders
MRAO, Cambridge, UK

Abstract. We have found two extreme GPS sources with peak frequencies of 20 and 30 GHz. The sources are both associated with X-ray bright, low redshift ($z < 1$) quasars. We have undertaken a search for similar sources using the Green Bank 5 GHz, NVSS 1.4 GHz surveys and follow-up observations with the Ryle Telescope at 15 GHz and the VLA up to 43 GHz.

1. Introduction

The selection of giga-hertz peaked spectrum (GPS) sources has been a somewhat haphazard process. For a source to be recognized as GPS the characteristic turnover must lie within the spectral range sampled in the surveys used. This constraint results in very few sources having peak frequencies above 5 GHz, i.e. the highest frequency survey available. This does not preclude the existence of sources with high peak frequencies, it just makes their discovery unlikely.

In the course of a completely independent study of ROSAT-selected clusters at 5 and 15 GHz we have serendipitously found a source with a highly inverted radio spectrum that, on more detailed inspection, has a peak frequency of 20 GHz. To this source we have been able to add one other source that has a peak frequency of 30 GHz (Figure 1). Both sources show significant variation at lower frequencies over the past decade indicating a change in the magnitude of the self-absorption present. As yet we have not obtained enough higher frequency data to test if the "optically-thin" emission varies as well. We have obtained VLBA data and an X-ray spectrum from ASCA for our brightest source, RXJ 1459.9+3337, which indicate a very compact source with an X-ray spectral index consistent with other radio-loud quasars.

2. A Systematic Search

In an attempt to make a uniform selection of highly inverted sources using just two frequencies as a method of GPS identification we have taken the Green Bank GB6 survey at 5 GHz (Gregory et al. 1996) and cross-correlated it with the NVSS 1.4 GHz survey (Condon et al., in prep.). This method works surprisingly well (it selects RXJ 1459.9+3337) but is swamped by variable sources. Therefore we selected all the sources with $\alpha_{1.4-5} > +0.5$ and brighter than 50 mJy at 5 GHz and observed them with the Ryle Telescope at 15 GHz (a total of 180 sources). We have obtained multi-frequency VLA follow-up for the 55 best candidates and the data are currently being reduced.

One important point to note is that the underlying power of these extreme GPS sources is high compared to most radio sources *once the effects of the self-absorption are removed.* For instance RXJ 1459.9+3337 peaks at a flux density of 1 Jy and would have a flux density of around 20 Jy at 1.4 GHz if it were not self-absorbed. This means that these sources, although faint in conventional observing bands, are "radio icebergs" in terms of their true power. It is only when we can compare the GPS sources with other CSO and CSS sources in an optically-thin part of the spectrum that a fair comparison of these sources can be made.

The existence of GPS sources with peak frequencies above 10 GHz is expected from all models of GPS sources. It is only observational limitations that have prevented their selection. The statistics and their milli-arcsec morphologies may place stringent constraints on models that include GPS sources as the precursors to CSO and CSS sources. The timescales of evolution of these sources appears to be of the order of decades making it possible that the study of one source over a number of years could provide the data required to constrain the "infancy" of a GPS source.

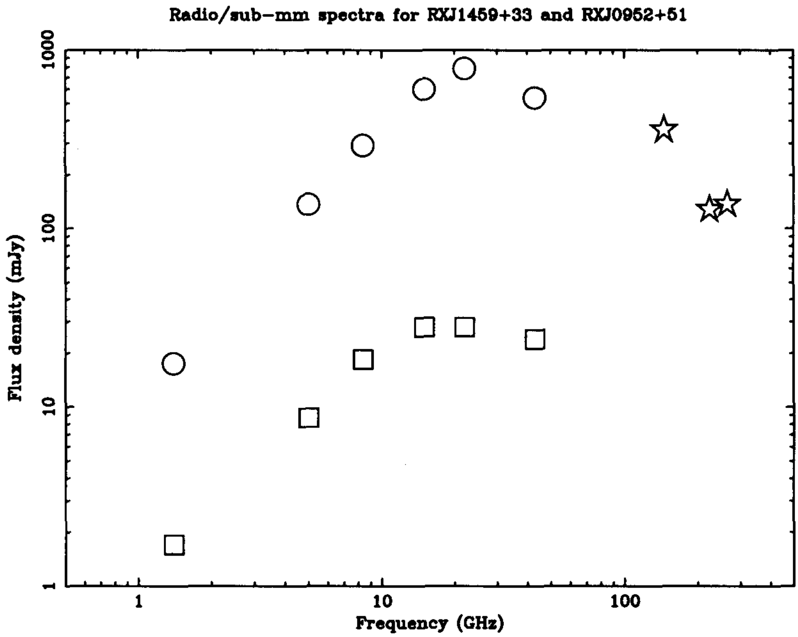

Figure 1. The radio/sub-mm spectrum of the two sources. The circles and stars are for the VLA and JCMT data for RXJ 1459.9+3337 and the squares are for RXJ 0952.7+5151.

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References

Gregory, P.C., et al. 1996. *ApJS*, **103**, 427–432.