BROADBAND STUDIES OF COMPACT SOURCES

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ABSTRACT

Progress is reported on a program to study the polarization, spectral and variability properties of compact sources at centimeter and millimeter wavelengths. Source characteristics divide according to the broadband shapes of their spectra.

We report here progress on an extensive program to study the physical properties of compact radio sources through their polarization, spectral and variation characteristics. The program includes simultaneous polarimetry at centimeter and millimeter wavelengths for a sample of 20 active sources. When possible, optical and infrared photometry and polarimetry have been obtained, as well. In addition, we have obtained VLA observations (at 2, 6 and 20cm) of an unbiased sample of 40 flat spectrum ($\alpha > -.5$, $S \sim \nu^{\alpha}$) sources in the S4 survey and a sample of 20 strong nuclear components of classical doubles. This observational work is supported by theoretical calculations of the appearance and evolution of compact sources. An analysis of the spectral and variability characteristics of the active sources has been reported elsewhere (Jones et al. 1981). A preliminary study of the S4 sources also has been reported (Rudnick and Jones 1982).

The study has shown a strong relationship between the polarization and variability of sources and their spectral shape. If we divide the S4 sources into groups with straight or power spectra (\, e.g., 0954+55), simple convex or "humped" spectra (⌒, e.g., 0923+39), and complex spectra (~, e.g., 1641+39), we find that only the complex sources commonly exhibit large amplitude variability on timescales of a few years. The simple convex and straight spectrum sources appear relatively constant, although they are mostly unresolved at 6cm on the VLA ($\lesssim$0".2) and, therefore, of kiloparsec or smaller dimensions. The straight spectrum sources have a median polarization ~3% at 2cm, but the value decreases to ~0.3% at 20cm indicating considerable Faraday depolarization. This can be explained if these sources have internal electron densities $\sim 10^{-2} cm^{-3}$ as if, for example, they are confined in the inner regions of

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their parent galaxies. In contrast, both sets of simple convex and complex spectrum sources show little, if any, wavelength dependence to their median polarizations (~1% and ~2% respectively). Individually the simple convex spectrum polarizations also show little wavelength dependence. VLBI observations will be especially helpful in determining if these sources are indeed a physically distinct class of object. Preliminary analysis of polarization data on double radio source nuclei shows them to be unpolarized at the 1% level. We have not yet investigated whether this is associated with their spectral properties, or requires different physical conditions than the other compact sources.

Individually, the complex spectrum sources show large polarization changes from one wavelength to another. Our observations of active sources at 9mm and 3mm using the NRAO 11m telescope indicate a continuation of this pattern to very high frequencies. On the other hand, the plane of polarization seems to vary only slowly with wavelength in these sources. We interpret these data as evidence for a composite source structure with distinct regions visible at different wavelengths. Although the magnetic field is apparently tangled by different degrees at different locations, there must be some large scale ordering to the field as well. Data are now being analyzed which should allow us to explore magnetic fields in the longer wavelength emitting regions by separating out effects of galactic Faraday rotation.

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TABLE 1

Source Characteristics Summary

Spectrum or class	10 year Variability	6cm Polarization	Wavelength Dependence of Polarization
⟍	$\lesssim$10%	~2%	Faraday depolarized
⌒	$\lesssim$10%	~1%	little
∼	$\gtrsim$50%	~2%	individually complex
nuclear comp.	small?	<1%	

REFERENCES

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