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# VLBI Observations of Intraday Variability

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**Abstract.** Integrated VLA measurements during our 6 cm global VLBI polarization observations of the intraday variable sources 0716+714, 0917+624, and 0954+658 indicate that although there were no significant total intensity variations during the 24-hour VLBI experiment, the polarization for all three sources varied substantially. Independent polarization images made for 2–3 hour segments show that there were no variations on VLBI scales for 0716+714 or 0954+658, but that there were appreciable variations in the VLBI core of 0917+624, which correlate well with the integrated variations in the simultaneous VLA data.

## 1. Introduction

In recent years, rapid (intraday = IDV) variations at X-ray through radio wavelengths have been observed in a growing number of strong extragalactic radio sources (Wagner, these Proceedings, p. 257, for example). In many cases, the fractional variations in polarized flux density are substantially greater than those for total flux density. It is not entirely clear whether such variations are extrinsic, e.g., due to refractive scintillation in the interstellar medium (Rickett, these Proceedings, p. 269, for example), or intrinsic. If the variations are intrinsic, the brightness temperatures implied by the rapidity of the variability are very high—to $10^{19}$ K in 0917+624 (Quirrenbach et al. 1989). It is thus of crucial importance to determine whether IDV is a phenomenon intrinsic to the most compact AGN or if it can be explained by effects external to the source. One very natural "intrinsic" explanation is that two or more variable polarized components contribute to the integrated measurements. One component could be identified with a relativistic shock that varies as it propagates down a turbulent jet (Qian et al. 1991; Wagner et al. 1996): the rapidity of the variations corresponds to the thinness of the shock structure perpendicular to the direction of propagation.

## 2. Results of Our VLBI Polarization Observations of IDV Sources

We made 6 cm VLBI polarization observations of the three previously known IDV sources 0716+714, 0917+624, and 0954+658 over a 24-hour period in June 1991 using a global VLBI array of ten antennas, hoping that at least one of the sources would vary during our VLBI run. The VLA was used as one of the VLBI elements, and the VLA data provided simultaneous monitoring of the integrated total intensity $I$ and polarization $P$ of all three sources during nearly the entire VLBI run. In all cases, the total intensity did not show significant variability, allowing us to use the entire $I$ data sets to construct the $I$ images of these sources. In contrast, the VLA $P$ data for all three sources showed substantial swings in polarization position angle $\chi$ of from 10 to 50° on timescales of about fifteen hours. The VLBI $P$ data for each source were divided into groups in time according to the polarization variations indicated by our VLA data. Each data interval lasted 2–3 hours, during which time the VLA indicated the source polarization to be roughly constant. We then conducted independent $P$ imaging and model fitting for each group of scans for all three sources.

This analysis shows that there were no variations in the VLBI data of 0716+714 and 0954+658, so that if the integrated $\chi$ swings reflect real polarization variability, this occurred on scales larger than those sampled by our VLB array. On the contrary, we detected mas-scale variations in the VLBI core of 0917+624, which correlate well with the integrated polarization measurements, showing that the integrated variations occurred in the VLBI core.

## 3. Discussion

The VLA $\chi$ swings for each of the three sources are qualitatively somewhat similar, and it seems likely that they are at least partially instrumental in nature. This is consistent with the fact that no mas-scale variations were observed for 0716+714 and 0954+658, but makes it difficult to understand why the VLA $P$ variations for 0917+624 (in both $P$ amplitude and $\chi$) correspond so well to the simultaneous $P$ variations in the VLBI core. We believe that there may be some instrumental component to the observed variations for all three sources, and that this dominates the apparent $P$ variability in 0716+714 and 0954+658. We propose that there are in addition true intraday variations in 0917+624, which dominate the observed VLA $P$ variations for this source.

Monitoring changes in mas-scale polarization structure guided by integrated polarization measurements provides an effective means of studying intraday variability. It is clear, however, that that extreme care must be taken in taking these sorts of observations: it is essential to observe at least one source known *not* to be an intraday variable, as a control, and it is desirable to obtain data at at least two frequencies, in order to obtain more information about the origin of any polarization variations. We have in fact just made VLBA polarization observations of six IDV sources plus one control source quasi-simultaneously at 2 and 3.6 cm over 24 hours. A more detailed analysis of the data discussed here is in preparation for submission to *Astrophysical Journal*, together with analysis of the VLBI and VLA images in their own right (see also Gabuzda & Kochanev [1997] and Kochanev & Gabuzda, these Proceedings, p. 273).

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