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Four Southern Intraday Variable Radio Sources

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Abstract. This is a progress report on the ATCA IDV survey of compact, flat or inverted spectrum radio sources. We found that four sources: PKS 0405–385, PKS 1034–293, PKS 1144–397, and PKS 1519–273 out of the sample of 125 show high flux density variability on the daily timescale. The characteristics of observed IDV are discussed and we reflect on its possible origin.

1. Survey Observations & Results

A sample of 125 compact, flat-spectrum Parkes sources was observed with the ATCA in four sessions between Nov 1993 and Aug 1994. Each source was observed every ~ 2 hours for 1 min, at four almost simultaneous frequencies (8.6, 4.8, 2.4, and 1.4 GHz). Full polarization information was recorded. PKS 1934–638, the standard ATCA flux calibrator was used. The pointing errors are less than 20 arcsec corresponding to 1% rms flux density error at 8.6 GHz, the most affected frequency. The estimated gain stability from observations of PKS 1934–638 is better than 0.5% at all frequencies.

One immediate result of the survey was the discovery of the four, rapid and high amplitude intraday variable radio sources: PKS 0405–385 (Kedziora-Chudczer et al., these Proceedings, p. 267), PKS 1034–293, PKS 1144–397, and PKS 1519–273. A special monitoring program was carried out for these sources in June 1996. The examples of lightcurves for PKS 1519–273 and PKS 0405–385 are presented in Figure 1 and Figure 1 in these Proceedings, p. 267).

PKS 1519–273 is a BL Lac with a VLBI brightness temperature $T_b = 2.9 \times 10^{12}$ K at 2.3 GHz (Linfield et al. 1989). The source appears to vary irregularly on an hourly timescale with high-amplitude flux changes at 8.6 and 4.8 GHz accompanied by an anticorrelated variability in polarized flux density. At 2.4 GHz it varied by 32% peak-to-peak over 50 hours in June 1996 (see Figure 1).

PKS 1144–379 and PKS 1034–293 are BL Lacs known to vary at optical wavelengths. We found remarkable hourly timescale variations for PKS 1144–379. The initial survey data showed a 33% change at 4.8 GHz over 2.5 days, with a correlated change at 8.6 GHz. The June 1996 data showed variations that were a maximum at 8.6 GHz, with a 20% irregular change over three hours that was strongly correlated with a 10% change at 4.8 GHz. However, as has been seen for our other IDV sources, the flux density changes at 2.4 and 1.4 GHz were smaller, slower, and completely uncorrelated with the higher frequencies.

The flux density changes of PKS 1034–293 are strongest at 4.8 GHz. In May 1994 the source showed 15% day-to-day variations at 4.8 GHz and about 10% at 8.6 GHz. In August 94 its flux changed over 33% within four days at 4.8 GHz. During the follow-up observations in June 1996 we found that PKS 1034–293

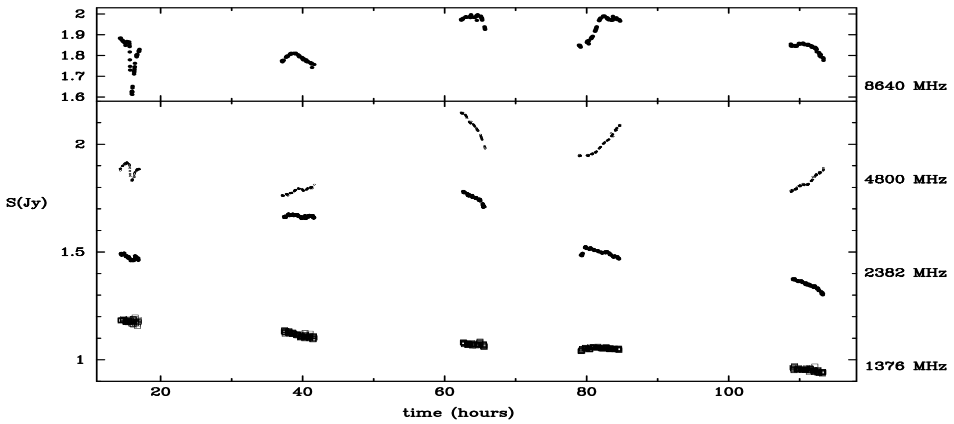

Figure 1. The example of flux density changes in the compact, inverted radio spectrum quasar PKS 1519–273 as observed between 10 and 14 June 1996.

seems to vary over two distinct timescales: hourly at 8.6 and 4.8 GHz and daily at 2.4 GHz.

2. Discussion

The brightness temperatures inferred from the fastest observed time scales of IDV are between $T_b \sim 10^{16}$ K and 10^{21} K (as for PKS 0405–385), far beyond the Compton limit for a static synchrotron source. The Doppler factors δ corresponding to this range of T_b are between 20 and 10^3. Doppler factors as high as 10^3 are not seen in VLBI superluminal sources, although factors of $\sim$ 20 are. Consequently, we suggest that the 10^{12} K inverse Compton limit may be at times violated in non-stationary conditions (Slysh 1992).

Line-of-sight effects such as interstellar scintillations or microlensing provide an alternative explanation of IDV (Wagner & Witzel 1995). We have successfully applied a simple model of interstellar medium (Taylor & Cordes 1993) for ISS induced variability of PKS 0405–385 (Kedziora-Chudczer et al. 1997). The radio variability of PKS 1144–379, PKS 1034–293 and PKS 1519–273 is less extreme than that for PKS 0405–385, and may contain both extrinsic and intrinsic components. To make conclusions about the importance of different mechanisms of IDV in these sources we will include detailed polarization information and multiwavelength observations in our future models.

References

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