Detection of Intrahour Variabilities in Quasar 3c273?

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Abstract We detected a kind of intrahour variations in the blazar 3c273 both at 6 and 3.6cm. We explain that the variability is most likely due to shocked relativistic jet or instabilities of matter orbiting near the horizon of central black hole.

Key words blazar, 3c273, variability

1 Observations and Results

A long term monitoring campaign was carried out for a set of strong radio active galactic nuclei at 18, 6 and 3.6cm wavelength using Urumqi 25 meter radio telescope during 2000, to detect possible intraday variations in these sources. The observations were scheduled month by month at one or two frequencies when the antenna is free. The observing is using a source on-off technique and standard noise calibration. The signal is digitized and sampled in the MKIV total power device, and recorded in log file. A calibrator source is observed when time is available.

At the end of 2000, the data set of sources 3c273, 3c454.3, 3c279, 3c84 and 3c345 were analyzed. The data at 18 cm, were experienced even for calibrator e.g. 3c123, had to be rejected because of strong interference. At 6 and 3.6 cm no interference, but we found that receiver instability sometimes occurs. Most of our data can be analyzed properly. We found no intraday variations for majority sources except 3c273. Figure 1 and Figure 2 show the light curves of 3c273 at 6cm and 3.6 cm respectively; Figure 3 and Figure 4 show that of the calibrator 3c123 and 0836+710 in the 2 bands.

2 Analysis and Discussion

The source 3C273 is the first quasar ($z = 0.158$, $m = 13$), due to rapid multifrequency variability has led to its classification as a blazar. The source clearly shows a radio and

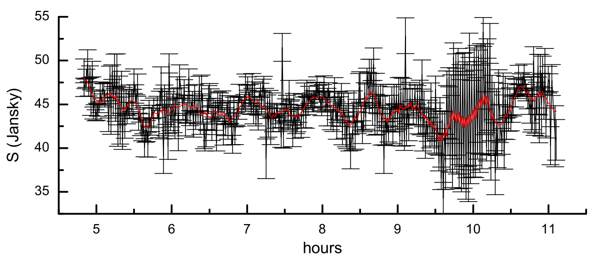

Fig. 1 6 cm light curve of 3c273 on day Sep. 18, 2000

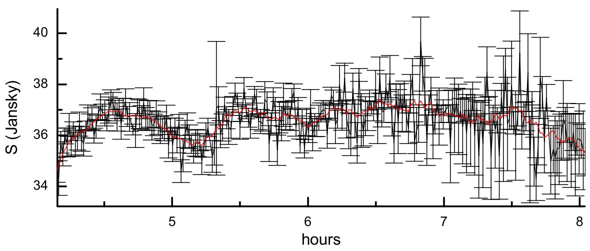

Fig. 2 3.6 cm light curve of 3c273 on day Oct. 24, 2000

optical jetlike feature extending to the southwest from nucleus. It is very bright across

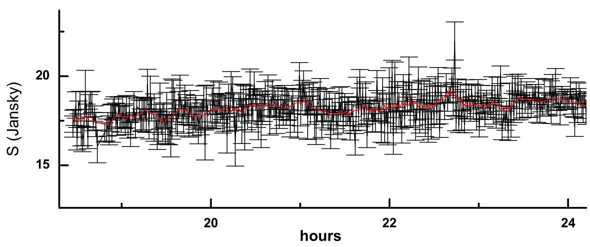

Fig. 3 6 cm light curve of calibrator 3c123 on day Aug. 25, 2000

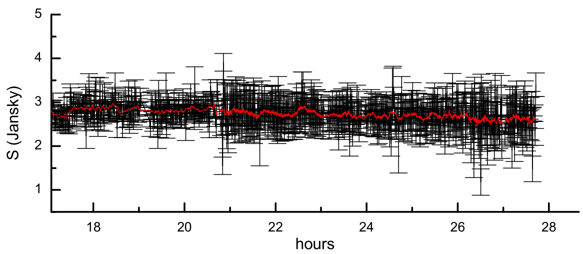

Fig. 4 3.6 cm light curve of calibrator 0836+710 on day Oct. 24, 2000

the wave bands from radio to gamma-rays. The large-scale structure from the VLA and MERLIN shows a compact flat-spectrum core and a single jet extending about 23″. Multi-frequency VLBI observations show a bright core and a number of jet components extending toward the southwest. The strong component at the eastern end is identified as the core, no counterjet is visible. The source is a classical superluminal source and a low polarization quasar (LPQ), although it does not show a high optical activity (optical variation is less than 1 mag). Optical and radio connections in this source have shown a clear correlation between the optical and radio events at least during some flares (e.g. Roland et al. 1994).

If the detected variability is source intrinsic, it will lead to the Compton catastrophe, i.e. the brightness temperature exceeds the upper limit of 10^{12} K. This is an open question for most intraday AGN sources, though some alternative mechanisms have been proposed to avoid the problem, e.g. the coherent radiation and the non-spherical geometry at the base of the jet (Krichbaum et al. 2001). It is believed in general that intraday variability is due to interstellar scintillation, especially at lower frequencies. At 6cm could be a critical wavelength at which both the interstellar scintillation and the intrinsic variation could occur, while at 3.6cm and higher frequencies the intraday variability could not be interstellar scintillation (Qian 1994). We consider the intrinsic explanation for our findings because similar variations were detected at both 6 and 3.6 cm.

A Shocked relativistic jet model is successful in reproducing the qualitative evolution of some flares in 3c273 (Stevens et al. 1998). The hourscale variations that we found could occur at the base of a conical jet near the accretion disk for the transverse shock wave. Alternatively, such short time variability probably is due to Rayleigh-Taylor instability and/or Kelvin-Helmholtz instability of matter orbiting near the horizon of central black hole. The variability time scales (nearly one hour) imply an upper limit on the mass of the central black hole by requiring that the time scale be longer than the light travel time across 6 Rs (this is the innermost stable orbit of a Schwarzschild black hole), it gives a black hole mass of $< 6 \times 10^7$ solar mass.

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