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Structure changes in two BL Lac Objects: ON 231 and OQ 530

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Abstract. Results from follow up observations are presented for two BL Lac objects, namely ON 231 and OQ 530. Previous EVN images of ON 231 at 1.6 GHz and 5 GHz showed new relevant features: a two-sided jet structure and a low brightness extension South-East of the main jet. The new EVN image obtained from observations done 2.3 years later at 5 GHz confirms the previous finding and, moreover, shows significant changes in the structure of the jet. Images obtained with the EVN at 5 GHz at two epochs separated by 2.3 years are also analysed for OQ 530. The comparison shows large changes in the flux density of the core component and suggests an apparent superluminal motion of the components along the straight jet. The BL Lac objects ON 231 and OQ 530 were selected because of their long term optical trends. Their optical behaviour will be briefly discussed in connection with the changes in the radio structure.

1. Introduction

We present recent EVN images at 5 GHz of the two BL Lac objects ON 231 ($z = 0.102$) and OQ 530 ($z = 0.152$), whose historical optical light curves are characterized by secular trends (Tosti et al. 1999; Nesci & Massaro 1999). The mean optical brightness of ON 231 increased during the last 20-25 years reaching a maximum level in Spring 1998 (Massaro et al. 1999), and then decreased as shown by Tosti et al. (2002) and by most recent observations. The luminosity of OQ 530 was fading since the first years of the past century, when it was very bright. In Summer 2000, however, a new active phase in the optical has been observed, suggesting that the decreasing trend is no longer continuing. Our scientific program is focused on the search of structural changes in the VLBI images of these BL Lac objects and on the possible relations of those changes with the optical variability.

EVN observations of both sources were performed in February 1999 and June 2001 at 5 GHz. The images obtained allow us to study the development and motion of the components in the inner parts of the jets.

2. Results

The analysis of our first image of ON 231 (Massaro et al. 2001) showed the presence of a new component emerging from the core in the direction opposite to that of the jet. This component was also detected in the second image we made, as discussed below. A comparison between the two epochs of OQ 530 and a previous image from VLBA observations made in June 1996 by Fomalont et al. (2000) shows some structural changes along the straight jet. We adopt $H_\circ = 100$ km sec^{-1} Mpc^{-1}; $q_\circ = 0.5$.

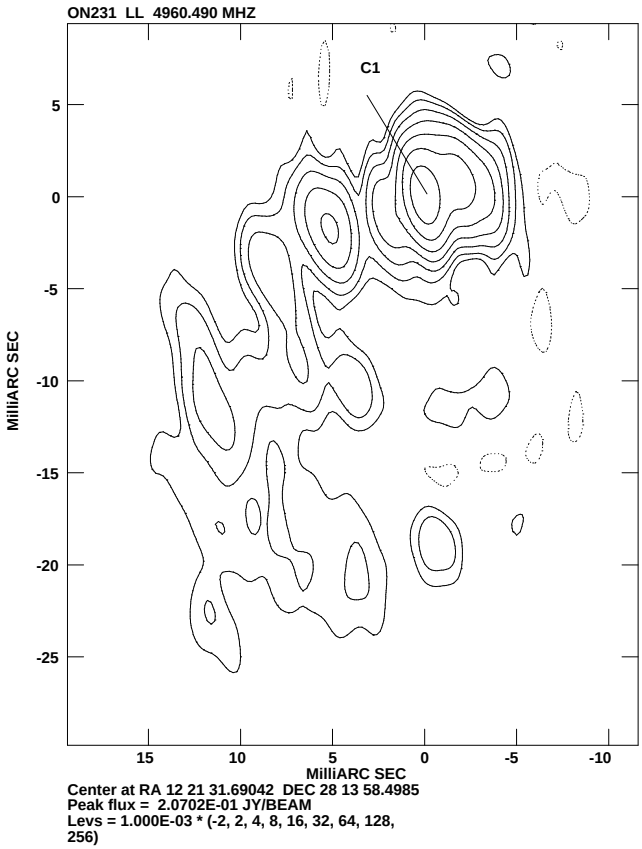

Fig. 1. EVN image at 5 GHz of ON 231 from the June 5th 2001 observations. The beam is 3.8×1.4 (mas) at 13°.

2.1. ON 231

The present 5 GHz EVN observations of ON 231 were made during a minimum in the short-term oscillation of

its optical brightness, which is superposed on a slowly decreasing mean of the long-term optical brightness. The source was observed in June 2001, 2.3 years after the observations presented in Massaro et al. (2001). The new image (Fig. 1) confirms the presence of a 'counter-jet' component on the West side of the core and of a large extension South-East of the main jet. Moreover, it shows significant changes in the position of the components along the jet. Their positions have been derived with respect to the brightest component C1 (see Massaro et al. 2001), considered to be the core. Taking C1 as the reference point, we derive a proper motion of ~ 0.9 mas yr^{-1} for the components along the jet, which corresponds to an apparent speed of $\sim 4\,c$. The two images were convolved with the same beam before the comparison. The peak flux density of component C1 slightly increased in the 2.3 year period. It looks more compact and we see a new component emerging from it on the jet side. The resolution achieved by these observations does not allow the detection of motion for the counter-jet component, if any. The assumption of C1 as the core will possibly be confirmed by the results of recent EVN (plus Wettzell and Matera) observations at 8.4 GHz, currently under analysis.

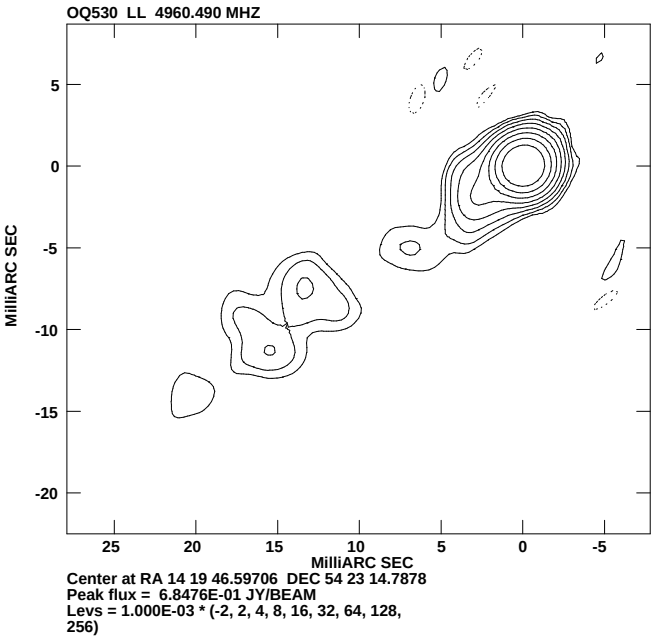

Fig. 2. EVN image at 5 GHz of OQ 530 from the June 5th 2001 observations. The beam is 2×2 (mas) at 0°.

2.2. OQ 530

Our high sensitivity 5 GHz EVN image of OQ 530 of June 2001 shows a core-jet structure (Fig. 2). The jet consists of a number of components, and this makes it possible to recognise them at different epochs, and to measure their relative displacement.

In the late Spring-Summer 2000 we observed an increase in brightness of about one magnitude in the optical luminosity of OQ 530. This activity, still continuing, may indicate that the long fading secular trend is finished and that a new brightening phase has started. In the radio band, we observed an increase by a factor of ∼3 in the core flux density between the two epochs. The measured peak brightness was 440 mJy/beam in June 1996 (Fomalont et al. 2000), decreasing to 204 mJy/beam in February 1999, and rising again up to 685 mJy/beam in June 2001. Furthermore, the elongation of the core in the jet direction noted in the first epoch, suggests that a new component is emerging. In order to test this hypothesis we made a comparison between the two EVN observations at 5 GHz with that by Fomalont et al. (2000) after convolving them with the same beam. The VLBA observations at 5 GHz by Fomalont et al. were made in June 1996. The component identification is ambiguous and two scenarios are possible: a) a stationary structure; b) very high proper motion with $\beta_{app} \sim 11\,c$.

3. Conclusions

We presented EVN 5 GHz second epoch observations of the BL Lac objects ON 231 and OQ 530. The previous structure of ON 231, in particular the counter-jet emerging West of C1 is confirmed by these observations. The superluminal character of ON 231 is also confirmed . This behaviour was already reported by Gabuzda & Cawthorne (1996). The situation is less clear for OQ 530. A stationary jet and a superluminal jet are both plausible interpretations. We note that the flare of this source in the radio and optical bands makes it a very promising candidate for structural changes and superluminal motion.

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References

Fomalont E.B., Frey S., Paragi Z. et al. 2000, ApJS 131, 95
Gabuzda D.C. & Cawthorne T.V. 1996, MNRAS 283, 759
Massaro E. et al. 1999, A&A 342, L59
Massaro E., Mantovani F. et al. 2001, A&A 374, 435
Nesci R., Massaro E. 1999 Proc. "Treasure-Hunting in Astronomical Plate Archives", (P. Kroll, C. La Dous, H.-J. Brauer eds.), Sonneberg,p. 111
Tosti G. et al. 1999, 'BL Lac phenomenon' PASP Conf. Ser. 159,149
Tosti G. et al. 2002, A&A, submitted