Space VLBI observations reveal a parsec scale misalignment in the jet of 0458–020

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1. Introduction

The quasar 0458–020 (z=2.286) is a member of the variable source sample of Wehrle et al. (1992), which includes objects whose flux density has exceeded 4.5 Jy at 8 GHz at any epoch. The strong variability is coupled to gamma-ray activity, as the source is marginally detected by EGRET. The position angle (PA) of the mas-scale jet of 0458−020 is 305° Wehrle et al. (1992), while 608 MHz VLBI observations reveal a helically bent jet Briggs et al. (1989). There is a 71° misalignment between the inner radio jet and the kpc-scale structure Appl et al. (1996). The source has been observed in geodetic VLBI experiments at 2.3 and 8.4 GHz (Ma et al. 1998), and VLBI survey experiments at 5 GHz (VSOP-VLBA Pre-launch Survey – VLBApls, Fomalont et al. 2000) and 15 GHz (Kellermann et al. 1998).

2. Observations and data reduction

The source was observed at 5 GHz for three hours on 22 September 1999, in left circular polarization. The observing array was the Australia Telescope Compact Array (ATCA), Mopra, Kashima and the HALCA satellite. The data were recorded in the S2 system, and correlated in Penticton (Canada). The NRAO AIPS package was used for data processing. We used nominal system temperatures of the telescopes for amplitude calibration.

Imaging was attempted using DIFMAP. Due to the very poor (u,v) coverage, we could not make a reliable image of the source using the traditional hybrid mapping procedure, but we performed model-fitting. After a phase calibration using a 0.5 Jy point source model and one minute solution interval, two Gaussian components were fitted to the visibility data (Table 1.). The average antenna gains were consistent with this model within 4%.

TABLE 1. Fitted elliptical Gaussian model parameters of the source components. S: flux density, r: separation, Θ: position angle, a: major axis, b/a: ratio of minor and major axes, Φ: position angle of the major axis, T_{B}: brightness temperature. The size upper limit for component A is determined as described in Fomalont et al. (2000)

Component	S (mJy)	r (mas)	Θ (°)	a (mas)	b/a	Φ (°)	T_{B} (10^{12} K)
Core	443.3	0.00	–	0.82	0.26	−14	0.40
A	49.6	0.97	−28.9	0.31	<0.71	31	>0.12

3. Discussion

The orientation of the sub-mas scale structure of the source is misaligned with respect to the mas-scale jet. The position angle of the secondary component, located at 0.97 mas (~ 5 pc projected distance) to the core, is 331°, while components identified in VLBApls at 1.2, 3.9 and 11.9 mas from the centre were located at PA=319°, 306° and 303°, respectively. Recently several authors examined the correlation of gamma-ray activity with jet bending in different types of AGN. Hong et al. (1998) found that the distribution of pc to kpc jet misalignment angle is significantly different for the 42 EGRET detected BL Lacs and quasars, the former class being more misaligned. The $\Delta PA_{\rm kpc} = 71°$ reported in the literature for 0428–020 is the highest for EGRET detected quasars, but almost all BL Lacs have higher values (the only exception is 0537–441, with $\Delta PA_{\rm kpc} = 60°$).

Von Montigny et al. (1995) noticed that several of the non-EGRET blazars have large jet bends. They proposed that gamma-ray emission in gamma-ray quiet AGN could be beamed in a different direction or more narrowly than the radio emission. The role of jet bending was investigated further by Tingay et al. (1998). They found that the ΔPA distribution on kpc scales does not differ significantly for the EGRET detected and gamma-ray quiet AGN, but the parsec scale jets are more aligned in the former case. Our target source perfectly fits into this picture since it has $\Delta PA_{\rm kpc} = 71°$ while we measure $\Delta PA_{\rm pc} = 28°$ (with respect to the most distant component detected in VLBApls).

4. Conclusion

We conclude that the jet of 0428–020 slightly turns from North-West to West on parsec scales, which is expected in view of earlier observations. This bending is only modest, and not in contradiction with the suggestion that EGRET detected sources have more aligned jets than gamma-ray quiet AGN. We measure a brightness temperature of 4×10^{11} K in the radio core, which is at the inverse Compton limit. The relatively low $T_{\rm B}$ (compared to values reported in the literature) can be reconciled with the fact that the source was in a quiescent state during the observations, but the absolute amplitude calibration uncertainty might also be higher than in typical VSOP experiments.

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