RevMexAA (Serie de Conferencias), **44**, 96–96 (2014)

PARSEC-SCALE ACTIVITY IN BL LACERTAE: SIGNATURE OF RELATIVISTIC JET PRECESSION

A. Caproni[1], Z. Abraham[2], and H. Monteiro[3]

In this work, we present the precession model parameters for the relativistic parsec-scale jet of BL Lacertae obtained from the cross-entropy global optimization method.

BL Lacertae ($z = 0.0686$; Vermeulen et al. 1995) is the prototype of the BL Lac class of active galactic nuclei. High-resolution interferometric images at radio wavelengths show the presence of a compact core and a diffuse halo-like source at arc-second scales (Antonucci 1986), while at an intermediate resolution, BL Lacertae shows a core-jet structure (Polatidis et al. 1995). At parsec scales, BL Lacertae exhibits multiple ejections of superluminal jet components, with components following different trajectories on the plane of the sky (e.g., Mutel et al. 1990; Gabuzda & Cawtorne 1996; Stirling et al. 2003; Lister et al. 2009; Tateyama 2009).

In this work we analyzed temporal changes of the observed right ascension and declination core-component offsets in BL Lacertae in terms of our relativistic jet-precession model (Abraham & Carrara 1998; Abraham & Romero 1999; Abraham 2000; Caproni & Abraham 2004a,b; Caproni, Abraham & Monteiro 2013). The seven free parameters of our precession model are the jet bulk Lorentz factor, semi-aperture precession cone angle, viewing angle of the precession cone axis, position angle of the precession cone axis on the plane of the sky, the precession period, precession phase and sense of precession (clockwise or counterclockwise). The model parameters were optimized via a heuristic cross-entropy global optimization method (Rubinstein 1999; Caproni et al. (2009), Monteiro, Dias & Caetano 2010; Caproni et al. 2011; Monteiro & Dias 2011), comparing the projected precession helix with the positions of the jet components on the plane of the sky and imposing constraints on their maximum and minimum superluminal velocities (Caproni, Abraham & Monteiro 2013).

[1]Núcleo de Astrofísica Teórica, Universidade Cruzeiro do Sul, R. Galvão Bueno 868, Liberdade, 01506-000, São Paulo, SP, Brazil.

[2]Instituto de Astronomia, Geofísica e Ciências Atmosféricas, Universidade de São Paulo, R. do Matão 1226, Cidade Universitária,05508-900, São Paulo, SP, Brazil.

[3]Departamento de Física, Universidade Federal de Itajubá, Av. BPS 1303-Pinheirinho, 37500-903, Itajubá, Brazil.

The merit function used to measure the quality of fit has a minimum at a precession period of about 12.1 years (measured at the observer's reference frame), independently of the sense of precession. This degeneracy is broken looking at the values of the jet-counterjet intensity ratio and the relativistic Doppler boosting factor, which ruled out the clockwise sense of precession (see Caproni, Abraham & Monteiro 2013 for further details).

In summary, our optimized best precession model is compatible with jet bulk speed of $0.9824c$, where c is the speed of light, precessing in a counterclockwise sense with a period of about 12.1 yr in the observers reference frame ($\sim$550 yr in the sources reference frame), and changing its viewing angle between 4 and 5 degrees. The position angle of the precession cone axis on the plane of the sky is about -166 degrees. In addition, our jet precession model produces residuals significantly lower than the values obtained for a non-precessing jet and the previously published precession models.

REFERENCES

Abraham Z., 2000, A&A, 355, 915
Abraham Z., Carrara E. A., 1998, ApJ, 496, 172
Abraham Z., Romero G. E., 1999, A&A, 344, 61
Antonucci R. R. J., 1986, ApJ, 304, 634
Caproni A., Abraham Z., 2004a, ApJ, 602, 625
Caproni A., Abraham Z., 2004b, MNRAS, 349, 1218
Caproni A., Monteiro H., Abraham Z., 2009, MNRAS, 399, 1415
Caproni A., Monteiro H., Abraham Z., Teixeira D. M., Toffoli R. T., 2011, ApJ, 736, 68
Caproni A., Abraham Z., Monteiro H., 2013, MNRAS, 428, 280
Gabuzda D. C., Cawthorne T. V., 1996, MNRAS, 283, 759
Lister M. L. et al., 2009, AJ, 138, 1874
Monteiro H., Dias W. S., Caetano T. C., 2010, A&A, 516, 2
Monteiro H., Dias W. S., 2011, A&A, 530, 91
Mutel R. L., Phillips R. B., Su B., Bucciferro R. R., 1990, ApJ, 352, 81
Polatidis A. G.,et al., 1995, ApJS, 98, 1
Rubinstein R.Y., 1999, Methodol. Comput. Appl. Probab., 2, 127
Tateyama C. E., 2009, ApJ, 705, 877
Vermeulen R. C., et al., 1995, ApJ, 452, L5

XIV Latin American Regional IAU Meeting (Florianópolis/SC, Brazil, 25-30 November 2013)
Editors: A. Mateus, J. Gregorio-Hetem & R. Cid Fernandes