IAU Colloquium 164: Radio Emission from Galactic and Extragalactic Compact Sources
ASP Conference Series, Vol. 144, 1998
J. A. Zensus, G. B. Taylor, & J. M. Wrobel (eds.)

Model of a Precessing Jet in 3C 279

Z. Abraham
Instituto Astronômico e Geofísico, Universidade de São Paulo, Brazil

E. A. Carrara[1]
National Radio Astronomy Observatory, Socorro, NM 87801, U.S.A.

J. A. Zensus[2]
National Radio Astronomy Observatory, Charlottesville, VA 22903, U.S.A.

Abstract. The parsec scale radio jet of 3C 279 presents a number of superluminal features that move along straight trajectories with constant velocities. The position angles *P.A.* of these trajectories, projected in the plane of the sky, and the velocities β_{obs} of the individual components are different. We interpret the differences in the these velocities as differences in the angle between the jet and the line of sight and apply the model of a precessing beam to the data. All the geometrical parameters of the precessing jet and the Lorentz factor γ of the relativistic particles are determined. The model predicts the behavior of the Doppler factor δ as a function of time and we verify that its maximum value occurred at the epochs in which strong optical and X-ray flares were observed.

1. The Precessing Jet Model

We used the geometrical parameters of a precessing jet described in Carrara et al. (1993), noticing that the angle ϕ_0 between the axis of the precessing cone and the line of sight should be replaced by $90° - \phi_0$ in the equations that give the position angle of the jet, $\eta = -P.A. - 90°$, projected in the plane of the sky, and its angle with the line of sight ϕ, as a function of time. The other parameters of the model are the aperture of the precessing cone Ω and the precessing period T, measured in the observers reference frame; we assume the angular velocity of the precessing jet to be a constant in its own reference frame.

Table 1. Properties of the superluminal features in the jet of 3C 279.

Comp.	(1) $\beta_{\rm obs}$ [c]	(2) *P.A.* [deg]	η [deg]	(3) t_0 [year]	(4) Ref.
C1	9.0 ± 1.0	-142 ± 2	52 ± 2	1967.0 ± 1	a
C3	3.0 ± 0.3	-135 ± 3	45 ± 3	1976.2 ± 1	b, c, d
C4	2.8 ± 0.3	-115 ± 3	25 ± 3	1981.0 ± 1	b, c, d
C5	4.7 ± 0.9	-84 ± 10	-6 ± 10	1987.0 ± 1	e

Notes: (1): apparent speed; (2): position angle; (3): epoch of origin; (4) a: Cotton et al. (1979), b: Unwin et al. (1989), c: Carrara et al. (1993), d: Aller et al. (1991), e: this communication.

The data used to determine the parameters of the precessing jet are presented in Table 1. The references are shown in colum 6, the data for component

[1]Present Address: Instituto Astronômico e Geofísico, Universidade de São Paulo, Brazil.

[2]Present address: Max-Planck-Institut f. Radioastronomie, Bonn, Germany.

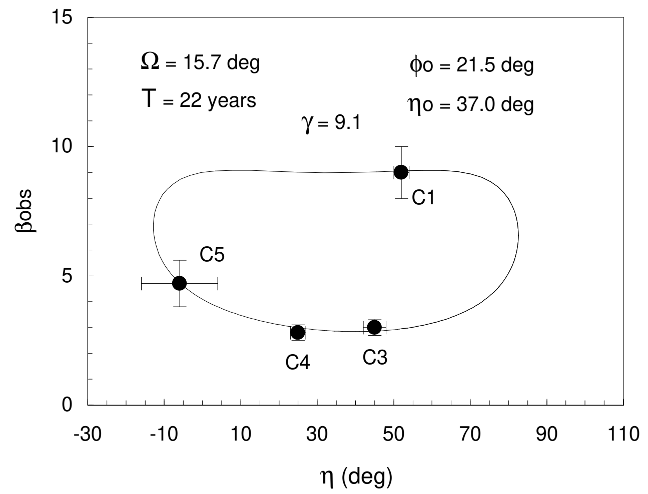

Figure 1. Fit of the precession model to the data in the β_{obs}, η space. The uncertainties in the parameters are: $\Delta\Omega = 1.5$ deg, $\Delta\phi_0 = 2$ deg, $\Delta\eta_0 = 1$ deg.

C5 are presented for the first time in this comunication, it was obtained from a 10.7 GHz, global VLBI map, for epoch 1991.14.

The best fit to the data in the β_{obs}, η space, that also fits β_{obs} and η vs time is shown in Figure 1, where the parameters of the jet and their uncertainties are also shown. The precession period T was obtained under the assumption that the time interval between the formation of C1 and C3 was 9.2 years, in the observers reference frame. Notice that the value of γ obtained in the fitting is the smallest possible, compatible with the observed superluminal velocities. The most important result of this model is the prediction of the behavior of the Doppler factor as a function of time, the maximum $\delta \sim 10$ occurred in 1988.5, when the extremely large optical and X-ray flares were observed (Webb et al. 1990).

Acknowledgments. This work was partially supported by the Brasilian Agencies CNPq and FAPESP.

References

Aller, H. D., Hughes, P. A., & Aller, M. F. 1991. in *Variability of active galactic nuclei* , eds. H. R. Miller & P. J. Wiita (Cambridge: Cambridge Univ. Press), 172–183.

Carrara, E. A., et al. 1993. *A&A*, **279**, 83–89.

Cotton, W. D., et al. 1979. *ApJ*, **229**, L115–117.

Unwin, S. C., et al. 1989. *ApJ*, **340**, 117–128.

Webb, J. R., et al. 1990. *AJ*, **100**, 1452–1456.