# THE RELATIVISTIC JET IN M84

J.M. WROBEL AND R.C. WALKER
*NRAO, Socorro, New Mexico 87801-0387, USA*

AND

A.H. BRIDLE
*NRAO, Charlottesville, Virginia 22903-2475, USA*

## 1. Introduction

The elliptical galaxy M84 (NGC 4374, UGC 07494) hosts an FR-I radio continuum source (Laing & Bridle 1987, MNRAS, 228, 557) and a dusty, warped optical emission line "disk" (Baum *et al.* 1988, ApJS, 68, 643; Goudfrooij *et al.* 1994, A&ApS, 105, 341). HST imaging shows that the inner dust distribution is not relaxed, but filamentary and complex (Jaffe *et al.* 1994, AJ, 108, 1567). M84 is a member of the Virgo Cluster, at which distance 1 arcsec = 73 pc independent of Hubble's constant (Jacoby *et al.* 1990, ApJ, 356, 332). Our VLA imaging, at 6 cm with a resolution of 500 mas (36 pc) FWHM, shows that the two large-scale jets in M84 are initially asymmetric: the ratio $R_I$ of the intensity of the northern main jet to the southern counterjet exceeds unity. However, these jets symmetrize ($R_I \sim 1$) by a projected nuclear offset $r_p \sim 13$ arcsec (950 pc). Is this VLA symmetrization trend consistent with Doppler boosting in a decelerating, but initially relativistic, jet? To test this, we obtained preliminary VLBA images of M84 at 18 cm and 4 cm, with resolutions of 11 mas (0.80 pc) and 1.9 mas (0.14 pc), respectively, and used them to evaluate $R_I$ on pc scales for comparison with $R_I$ on 100-pc (VLA) scales.

## 2. VLBA/VLA Symmetrization Trends: $R_I(r_p)$

Fig. 1 shows how $R_I$ in M84 depends on $r_p$, measured relative to the peaks of the bright VLBA or VLA "cores". On pc (VLBA) scales, $R_I$ is from peak intensities read directly from the digital images every 3 pixels N and S of the nucleus, starting at $r_p = 18$ mas (1.3 pc) at 18 cm and $r_p = 3$ mas (0.22 pc) at 4 cm. On 100-pc (VLA) scales, $R_I$ is the ratio of the areas



*R. Ekers et al. (eds.), Extragalactic Radio Sources*, 131–132.

under the transverse intensity profiles of the main jet and counterjet at matched distances N and S of the nucleus. Profile areas were derived from slices in the E-W direction spaced every 6 pixels (480 mas or 35 pc). These $R_I$ values (i) differ from on-axis ones because the main jet appears wider than the counterjet and (ii) are not sensitive to jet "wings".

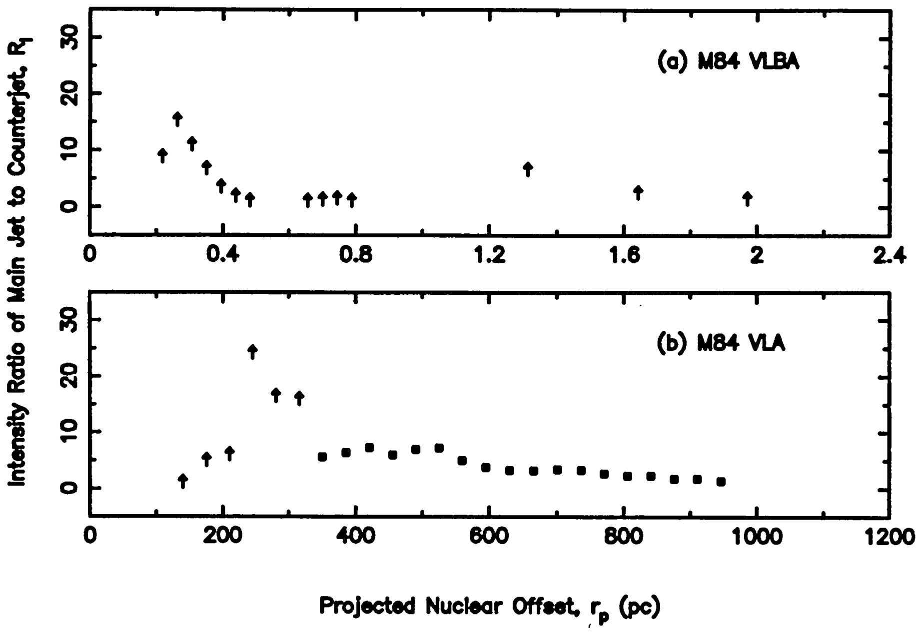


*Figure 1.* $R_I(r_p)$ in M84.

## 3. Interpretation: $R_I(\beta_{fluid})$

If $R_I$ differs from unity only through Doppler boosting in identical and opposed relativistic jets, then it will depend on the jet fluid velocity $\beta_{\rm fluid} = v_{\rm fluid}/c$ and on the line-of-sight viewing angle $\theta$. Although $\theta$ is unknown for M84 it should be approximately constant with $r_p$. Within this framework, Fig. 1 implies: (a) $R_I > 15$ at $r_p \sim 0.3$ pc and $r_p \sim 300$ pc, requiring $\beta_{\rm fluid} > 0.49$ and $\theta < 60°$ at these locations. (b) $R_I$ drops gradually between $r_p \sim 350$ pc and $r_p \sim 950$ pc, as expected if twin relativistic jets smoothly decelerate. (c) $R_I$ drops rapidly between $r_p \sim 300$ pc and $r_p \sim 350$ pc, suggesting an abrupt slowing of the jet at this distance. Indeed, the main jet morphology at $r_p \sim 300$ pc resembles an oblique shock. Furthermore, although the main jet is not initially perpendicular to the dust layer seen by HST, a clockwise deflection of the jet at $r_p \sim 300$ pc brings it into closer alignment with the normal to the layer. This hints that the optical line-emitting gas and the dust in M84 trace the medium initially entrained across the jet's boundary layer, both abruptly slowing the jet and deflecting it toward the normal to the gas/dust layer.