A SUB-PARSEC ACCRETION DISK IN NGC 4261

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Abstract. We observed the nuclear region of NGC 4261 (3C270) with the VLA to determine the morphology of the \(3.6 \mu m\) radio source on parsec scales. Our highest angular resolution image at 8.4 GHz shows a very faint torus gap in emission just east of the radio core (on the counterjet side), which we interpret as an absorption feature cut off by a small, dense inner accretion disk whose width is less than 0.1 parsec. If the inclination of this inner disk is close to that of the much larger-scale disk imaged by 11 GHz, it becomes optically thin at 8.1 GHz radiation at a deprojected radius of about 0.1 pc.

September 1997 VLA observations at higher frequencies should allow us to determine the radial electron density distribution of the inner disk.

1. Introduction

The FR I radio source 3C270 associated with NGC 4261 has symmetric kpc-scale jets extending along position angle 88.4 \(^\circ\) (Birkinshaw & Davis 1985). The optical nucleus of NGC 4261 is surrounded by a large disk of gas and dust with a projected rotation axis which is several degrees away from the radio jet axis (Ferrarese, Ford, & Jaffe 1996). Our initial motivation for observing NGC 4261 with VLBI was to see if the parsec-scale radio structure was aligned with the kpc-scale jets or with the rotation axis of the large disk imaged by HST. These two possibilities could be interpreted
as requiring either a change in rotation axis between the HST disk and the
(much smaller) accretion disk feeding the presumed central black hole or a
head in the radio jet during its first few parsecs of travel.

2. Observations and Results

We observed NGC 4261 with the VLBA in April 1995 at both 1.6 and 8.4
GHz. The observations revealed highly symmetric radio structures at both
1.6 and 8.4 GHz. At both frequencies the parsec-scale jets are aligned with
the kpc-scale jets images by the VLA. This implies that the plane of the
innermost accretion disk II the base of 11′ radio jets differs from the plane
of the 100- pc-scale 11 ST disk.

Surprisingly, there is little evidence for free-free absorption in the inner
few pc, despite the fact that the HST disk appears to be within 20-30°
of edge on. The implied electron density over the inner 1.0 pc, assuming
a temperature of $\sim 10^{4}$ K, is less than $10^{5}$ cm$^{-3}$.

However, our highest resolution images (8.4 GHz with uniform weighting)
show a very narrow gap in emission just east of the brightest peak
(Jones & Wehrle 1997). The spectral index distribution between 1.6 and
8.4 GHz indicates that the brightest peak corresponds to the core of the
radio source. Based on the relative brightness of the VLA jets and the ori-
entation of the HST disk, the eastern jet is the receding jet (the counterjet).
Thus, the gap in emission appears to be located at the base of the counter-
jet. This is the expected signature of absorption by a thin inner accretion
disk seen nearly edge-on. The thickness of the inner disk must be less than
0.1 pc. If the inclination of this inner disk is close to that of the larger scale
11 ST disk, it becomes optically thin to 8.4 GHz radiation at a deprojected
radius of 0.5 pc. The much lower angular resolution at 1.6 GHz prevents
this feature from being detectable, but higher frequency VLBA observa-
tions in September 1995 should allow us to determine the radial electron
density distribution in the disk (e.g., Walker et al. 1997).

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References