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CTD 93—The Not-So-Simple Double

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Abstract. A VLBA map of CTD 93 at 2 cm shows the morphology to be better described as a core-jet configuration than as a symmetric compact double structure.

Since its earliest VLBI observations (Shaffer & Kellermann, unpublished; Phillips & Mutel 1980), CTD 93 (1607+26; $z = 0.473$) has been called a "compact double" source. In fact, it has been championed as a defining object for a compact double (CD) category of radio sources. The CDs were proposed to be the formative stage of the much more extended classical double sources (Phillips & Mutel 1982). The small size ($\sim$ 100 pc) of the compact doubles was thought to be due either to their relative youth or because older components were slowed while forcing their way out through relatively dense material. If the CD model is correct, then there should be a nuclear source somewhere between the prominent double components. At low frequencies, the nucleus would be self-absorbed, but it should become more prominent at higher frequencies. In the case of the compact symmetric objects (CSOs; Taylor, Readhead, & Pearson 1996), possibly related to the CDs, observations at frequencies of 8 or 15 GHz revealed directly the core components. We have mapped CTD 93 at 15 GHz (2 cm) to better define the structure of the components and to look for the nucleus.

We observed CTD 93 for 13 hours with the VLBA on 23/24 July 1995 at 2, 3.5, 13, 18, and 50 cm. Images were made at all wavelengths using the standard NRAO AIPS package.

We find that CTD 93 is *not* a simple, compact double after all, as the two components appear markedly different. Figure 1 shows our 15 GHz map. CTD 93 appears to be an extended core-jet source, with a wide separation between the nuclear core-jet and a secondary, highly bent jet.

We believe that the northern component of CTD 93 is probably the core. Although this component does not have a flat spectrum, it does appear to be the origin of a short, wide opening angle jet which reappears some 100–150 pc away as the southern component. We can not rule out a CSO nature for CTD 93, but we find no central component as strong as those found by Taylor, Readhead, & Pearson (1996).

The southern component appears as a long, narrow jet, with a sharp bend near the end. The new maps at 6 (T. Cornwell, private communication), 3.5, and 2 cm all show the same features in the southern jet. The 50, 18, 13, and 6 cm maps indicate that the inward-pointing part of the southern component has a normal (steep, optically-thin) spectral index, unlike a flat-spectrum nucleus which would have to be located in this vicinity if CTD 93 is a CSO.

Although CTD 93 now appears to be ruled out as a compact double (and perhaps as a CSO as well), there are still some puzzling aspects about the components: the northern component does not look as "core-like" as most cores. Even at our highest frequency, this component is appreciably resolved. It also has significant structure other than the jet. It is extended transverse to the axis

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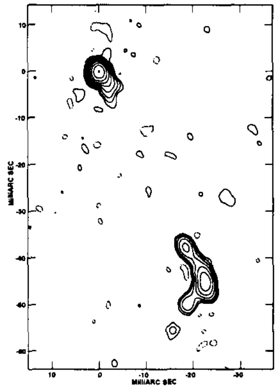

Figure 1. CTD 93 at 15 GHz. Contours are $0.6 \times (-1, 1, 2, 4, 8, 16, 32, 64, 120, 256)$ mJy/beam.

of separation between the northern and southern components. At 6 cm, there is low level emission surrounding the core.

The emission to the southeast of the southern component is also strangely placed. It does not appear to come from a beam which has simply "turned the corner" through a moderate angle, since it appears well north of the southernmost end of the jet, almost as if it has sprouted from the side of the jet, rather than being the end of a bent jet. Projection effects for a jet pointing nearly towards us could possibly give this appearance.

Direct comparison between our new 18 cm visibility data and data from 1976 on the Fort Davis-Owens Valley baseline indicates that any change in component separation is less than about 0.5 mas, so that any motion is $\lesssim 0.025$ mas/yr, or $v/c \lesssim 0.35$. We find a similar limit to any relative component motion from comparison of our new 13 cm image with that of Phillips & Shaffer (1983).

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References

Phillips, R. B., & Mutel, R. L. 1980. *ApJ*, **236**, 89–98.
Phillips, R. B., & Mutel, R. L. 1981. *A&A*, **106**, 21–24.
Phillips, R. B., & Shaffer, D. B. 1983. *ApJ*, **271**, 32–43.
Taylor, G. B., Readhead, A. C. S., & Pearson, T. J. 1996. *ApJ*, **463**, 95–104.