THE SEPTEMBER 1982 RADIO OUTBURST OF CYG X-3

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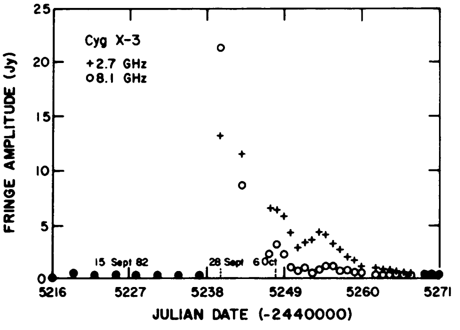
Cyg X-3 underwent a series of giant radio outbursts beginning on September 28, 1982 (Geldzahler et al. 1983). The flux densities at 2.7 and 8.1 GHz (11.1, 3.71 cm respectively, see Figure 1) were measured with the 2.4 km baseline of the Green Bank interferometer once every three days before October 5, 1982 (= JD 244 5248) and three times daily thereafter.



Date	Measured Size arc seconds	Frequency GHz	Comments
Oct 10.04	0.32 x 0.22 pa 9° ±0.10 0.07	1.660	VLBI
Oct 9.20	0.10 x 0.03 4° ±0.02 ± 0.02 ±4°	average of 22 and 15	VLA
	0.33 x 0.24 0° ±0.10 0.20 ±20°	1.465	VLA
Oct 20.02	0.25 x 0.06 178° ±0.02 0.04 2°	average of 22 and 15	VLA
	0.40 x 0.23 23° ±0.10 0.14 ±34°	1.465	VLA

The maximum flux density of Cyg X-3 during the outburst was at least 22 Jy. We can only set a lower limit on the maximum because of our three day sampling interval before October 5. The September 1982 outburst was not a single, unique event, but on ∿ Oct. 5 and again on Oct. 9 there is clear evidence other outbursts began. This is similar to the mid-September 1972 outburst (c.f. Hjellming 1973). The 1982 event sequence ended on about Nov. 4, again comparable to the mid-September 1972 events as to duration.

Cyg X-3 was observed at 20, 6, 2, and 1.3 cm with the B configuration of the VLA on 7, 8, 9, and 20 Oct. 1982. Spectra were obtained on all four days. For 9 and 20 Oct. 1982, we had a sufficient number of VLA antennas to make maps. In Table 1, we present the results of source

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size measurements derived from VLA data. The results from the 1.3 and 2 cm data are presented because they were obtained with the highest angular resolution (∿ 0.2 arcsec). Assuming that the outburst began on Sept. 27.5, which is accurate to a day, we infer from the Oct. 9 and 20 VLA result that the linear expansion proceeded at a rate of 0".010 ± 0".002/day. This is a minimum expansion rate derived from Gaussian source sizes (Case 1) and the knowledge of the date of the outburst. Had we modeled the data as a uniform sphere (Case 2), for example, the expansion rate would be almost twice as great. Dickey's (1983) lower limit of 11.6 kpc to Cyg X-3 coupled with the angular expansion rate yields an apparent linear expansion speed of $\gtrsim$ 0.7 c (Case 1) or $\gtrsim$ 1.3 c (Case 2). The radio emission seems to be beamed since at 1.3 and 2 cm the axial ratio of the source is 4:1.

If the energy transport mechanisms in Cyg X-3 and SS433 (Hjellming and Johnston 1981) are similar and if both beams in Cyg X-3 are observable, then the beam velocity is $\gtrsim$ 0.35 c (0.63 c) relative to the central source. We favor a model for Cyg X-3 describing a two-sided emission because of analogies with Sco X-1 and SS433 and because of the lack of motion of the brightness centroid ($\Delta\theta$ < 0".05).

At a distance of 12 kpc, the radio luminosity, on September 27.5- the peak of the outburst, was $\gtrsim 10^{34}$ erg sec^{-1}. The total radio energy involved in the event sequence was then $\gtrsim 10^{40}$ erg. These values are quite similar to those derived for the 1972 outbursts. As Gregory et al. (1972) point out for the 1972 events, the total energy is substantially less than that involved in a supernova.

Cyg X-3 joins the ranks of SS433 (c.f. Hjellming and Johnston 1981) and Sco X-1 (Fomalont et al. 1983) as a galactic source whose expansion has been measured. Cyg X-3 is clearly more similar to SS433 where v_{exp} = 0.26 c rather than Sco X-1 where v_{exp} < 0.0001 c. However, in SS433, the expansion velocity and jet collimation arises from radiation pressure and line locking due to absorption of photons below the Lyman edge by L α transitions (Milgrom 1979) whereas in Cyg X-3 the expansion results from an explosive event. The same is true when comparing the ratio of luminosity to the Eddington luminosity in that for Cyg X-3 and SS433 L/LE $\simeq$ 1 whereas for Sco X-1, $L/L_E \ll 1$. As Rees et al. (1982) point out, the stellar scale objects may be scaled down versions of active galactic nuclei and quasars.

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