If the propagation effects of the medium are important the spectrum will cut off near[6]

$$\nu_\mu = 20 N_e B^{-1} \text{ c.g.s.} \quad (3)$$

From the parallel exponential decay of the post maximum emission at 8.0 and 15.5 GHz it has been argued[1] that $B \leq 1$ Gauss. Thus from equation 3 an upper limit to the electron density in the emitting region is $N_e \leq 10^8$ cm^{-3}. This density does not necessarily preclude a model[1] in which a density of 6×10^9 cm^{-3} is required to explain the exponential decay by bremsstrahlung energy losses. It does require that the electrons radiate in a region different from where they are damped by bremsstrahlung collisions.

If the low frequency turnover in the spectrum is due to synchrotron self-absorption and if the source is not expanding as argued by Aller and Dent[1], then the increase in the 2.7 GHz emission observed by Hjellming and Balick[3] must be due to the emitting particles streaming into a region of decreasing magnetic field during the early stages of the outburst. If the magnetic field is decreasing, the source opacity is decreasing at a faster rate than the volume emissivity and an external observer would see (equation 1) a net increase in the emission at the lower frequencies where $\tau \gg 1$.

The 2.7 GHz flux density measurement and equation 1 with $\tau \gg 1$ and $B < 1$ Gauss can be used to place an upper limit to the angular diameter of the source of 0.008 arc s at 4 h UT on September 3, 1972. If Cygnus X-3 is at a distance of 2.1 kpc (ref. 5) then an upper limit to the size of the source is 3×10^{14} cm or 20 a.u. and is a factor of ten smaller than that inferred from the time scale of the variation in the radio emission. It is unfortunate that long-baseline interferometer observations were not made during this event. Such measurements would yield a more accurate estimate of the magnetic field and thus provide a crucial test to the possible source models.

An estimate of the radio luminosity of the outburst at maximum can be obtained by integrating the spectrum in Fig. 1 over frequencies below 10^{11} Hz. The integrated radio flux is 1×10^{-11} erg s^{-1} cm^{-2} and the corresponding luminosity is 6×10^{33} erg s^{-1} assuming a distance of 2.1 kpc.

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Absence of Linear Polarization in Cygnus X-3

HERE I describe the results of linear polarization measurements of the Cyg X-3 outburst[1,2] made with the University of Michigan 85-foot telescope at 8 GHz between 0 and 8 hours UT on September 3, 4, and 5. The equipment and observational technique used have been described elsewhere[3]. The standard error of the instrumental-polarization calibration of the telescope was less than 0.1%, and the radio source Cyg A was observed alternately with Cyg X-3 to verify that the instrumental parameters had not changed significantly during the observing period.

Linear polarization was not detected at any time during the three days and the scatter in the measurements was consistent with the measurement uncertainties. Using twice the standard error of the measurements as an upper limit places limits of <0.7, <0.5, and <1.1% on the degree of polarization on September 3, 4, and 5, respectively. The average of all the observations gave a degree of polarization of $P = 0.25 \pm 0.20$% at a position angle of $\chi = 40° \pm 21°$. This null result is consistent with the previously reported upper limit for Cyg X-3 of 2% (ref. 4).

Mechanisms which intrinsically produce unpolarized radiation (such as thermal bremsstrahlung) cannot produce the observed radio spectrum of the outburst; synchrotron radiation seems to be the most likely source of the emission[5,6]. A low degree of linear polarization could be produced by a highly disordered structure of the magnetic field in the emitting region[7], but such highly disordered fields are not typical of other known variable radio sources which are believed to radiate by the synchrotron process. Of the more than 20 such sources which have been observed frequently at 8 GHz, only one (NGC 1275) has exhibited an average degree of polarization of less than 0.5%. At present a clear choice cannot be made, but Faraday depolarization[7] seems to be the most likely cause of the low degree of linear polarization in Cyg X-3. The X-ray spectrum of this object indicates that $\gtrsim 10^{23}$ cm^{-2} atoms of gas may lie in the line of sight to the X-ray source[8]; and strong Faraday depolarization would be expected if the radio emitting region was situated in a high-density plasma, as has been proposed[5].

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Radio Observations of Cygnus X-3 and the Surrounding Region

ON September 7, 1972, Cygnus X-3 was observed with the Goldstone 64-m antenna at wavelengths of 13.1 cm, 3.55 cm, and 1.95 cm. At 13.1 cm a map of received flux density has been constructed for a region 0.5×0.6 arc degree with a resolution of 8.15 arc min. This map reveals the presence of several partially resolved features having integrated flux densities in excess of one flux unit (Fig. 1).