THE RATE OF COMPONENT SEPARATION IN SCO X-1 +

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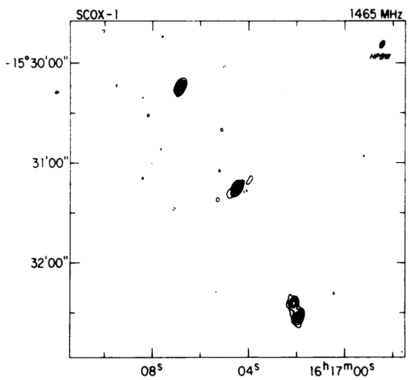
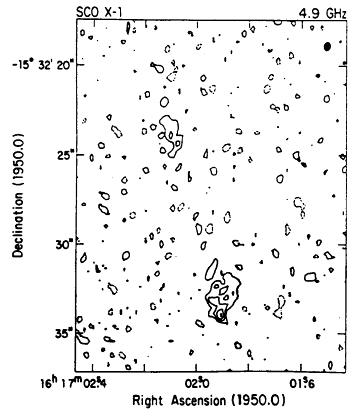
Sco X-1 was observed in the A configuration of the VLA on 4 Feb. 1981 and 18 Mar. 1982 (Fomalont et al. 1983). The radio map at 1.5 GHz, made with the 1982 data, is shown in Figure 1. The central component is nearly coincident with the binary and has an angular size of less than 0″.1. A 0″.5-resolution map of the SW component of Sco X-1, shown in Figure 2, displays only the brightest peaks in the two emission regions. The brightest part of the emission is located at the extreme edge of the component, and its location and shape are reminiscent of hot spots in radio lobes associated with luminous extragalactic radio sources. Although the NE component is only slightly resolved at this resolution, it is extended in approximately the same position angle as that of the entire source and that of the SW component.





The results of the component position analysis from the Gaussian fits can be summarized as:

1. No change in the separation of the central component from the NE component to a limit of 0″.015 (< 32 km s^{-1} at d = 500 pc).
2. No change in the separation of the central component from the bright peak in the SW component to a limit of 0″.13 (< 277 km s^{-1}).

+ Discussion on page 456

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3. No variability of intensity in the NE and SW components between 1981 and 1982. There may be some indication of variability on longer time scales.

The dual-opposing beam model has been used extensively for explaining jets and hot spots in extragalactic sources and this model has already been suggested as a good one for Sco X-1 (Blandford and Rees 1974). The major problem with the application of the beam model to Sco X-1 is the difficulty in transporting sufficient energy to supply the components with the observed radiative energy while not transporting excessive momentum consistent with the observed upper limit of 32 km s^{-1}. The lower limit of the external density, ρ_e, needed to keep the lobe from moving faster than 32 km s^{-1} is: $\rho_e > 3.2\ [c(\gamma^3+1)\ (\gamma+1)/(v_b\ \varepsilon\ \gamma^4)]\ cm^{-3}$ where v_b = particle velocity in beam at working surface, ε = conversion efficiency of kinetic energy in beam to radiative energy at the working surface. Even with a relativistic, efficient beam the lower limit to the external density needed to restrain the NE component is uncomfortably large.

The beam model can work if the flow velocity is relativistic, if the conversion of bulk kinetic energy into radiative energy at the working surface is efficient (> 10%) and if the density of material into which the beam impinges has a density of > 10 cm^{-3} which is much larger than that of the typical interstellar region (e.g. Turner 1979). Other models in which most of the energy of the component is contained internally are even less attractive.

The small linear size of the NE component cannot be maintained without confinement of the relativistic electrons generated at the working surface. The confinement could be inertial if the component contains a high density gas which may be needed to stop the beam. This region may also contain a magnetic field strength as large as 0.1 G; hence the radiative age of the electrons may be as short as several years and the confinement problem significantly reduced.

Generalization of these results to extragalactic, luminous radio sources is speculative. The possible high efficiency of the Sco X-1 beam may suggest that the typical conversion efficiency of bulk kinetic energy into relativistic electrons and magnetic field approaches 100%. The possible high density region at the termination of the beam in Sco X-1 may also suggest that entrainment of the thermal matter by the beam and the depositing of the material near the lobes can occur. Finally, the magnetic field near the working surface may be much larger than that calculated from the usual equipartition considerations.

REFERENCES

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