EVIDENCE FOR A RADIO BRIGHTENING ZONE AROUND SS433

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SS433 is thought to be a binary system from which two antiparallel beams are ejected at 0.26c. An excellent review of this peculiar object has been given by Margon (1984). The so-called "kinematic model" describes the precessing motion of the beams. They can be observed over at least 8 orders of magnitude in distance: from 10^{12} cm to 10^{20} cm.

We have investigated the beams of SS433 on scales of 10^{15} cm. A series of 6 European VLBI Network observations at 5 GHz was made in May 1985 at two-day intervals, using Mark III recording in Mode E. In the 6 hybrid maps we have obtained, the dynamic range is typically 50 to 1. Maps 2 and 3 which are shown in Figure 1 display all the characteristic features of this series. We have drawn the projection on the sky of the beam trajectories as predicted by the 5-parameter kinematic model (Margon, 1984) by adopting a distance of 5 kpc. The predicted ejection angle was almost at right angles to the line of sight.

There is a strong (75 mJy), variable, unresolved core, which contains a large fraction of the total flux density. Sometimes the central structure is elongated along the precession locus; this may be related to subsequent unresolved ejection episodes. Additionally there are discrete emission patches (total flux density typically 20 mJy). They are unresolved perpendicular to the model trace, but much broader along it. In general, all maps are quite symmetric, which supports our choice of the brightest central knot as the core. There is no emission beyond 100 mas (500 AU) in any of our maps.

When the locus of the brightest points in each map is followed from map to map, the rate of divergence is found to be (at most) three quarters of that predicted. This is unlikely to be due to a low ejection velocity or a very deviant ejection angle: such large deviations have never been seen in earlier radio or optical data, and are not observed in simultaneous optical spectra (Vermeulen et al., in preparation). The symmetric flux density distribution is hard to reconcile with the differential Doppler boosting expected at deviant ejection angles. We believe it is much more plausible that we observe a series of blobs which pass through a zone where they brighten, after which they decay in flux density. We can decompose the emission patches along the model trace into substructures, which are unresolved, and which move in

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accordance with the kinematic model. The "brightening zone" is located at about 50 mas (4 x 10^{15} cm) from the centre. We do not observe the brightest spots of emission to be stationary in our series of maps since, when there is a succession of blobs rather than a continuous jet, each of these will dominate the appearance of the maps for some time.

The decay time by synchrotron radiation for the relativistic electrons in the observed blobs is some 10^6 years. Therefore, the observed flux density decay after the blobs have passed the brightening zone is probably due to adiabatic expansion. The stellar wind emanating from the normal star in the SS433 system, if moving at 2000 km/s, traverses 3 x 10^{15} cm in one precession period. This is therefore the largest distance at which any wind gas which may have been disturbed by a blob can be fully replenished before the next blob passes. Hence, expansion of the blobs beyond the brightening zone could be explained by the relative absence of confining material there.

The nature of the brightening zone is unclear. Because the beams are evidently composed of discrete clouds, a speculative explanation is available which needs no assumptions about the external medium. An ejected clump of gas develops a bow shock which points backward at the Mach angle. Because the ejection direction precesses, and since all blobs move at the same speed, each blob will overtake the bow shock of its precursor. When this happens, density enhancement, particle acceleration through turbulence, or compression of the magnetic field, could all lead to brightening.

Reference: Margon, B. Ann. Rev. Astr. Astrophys. 22, 507-536 (1984)

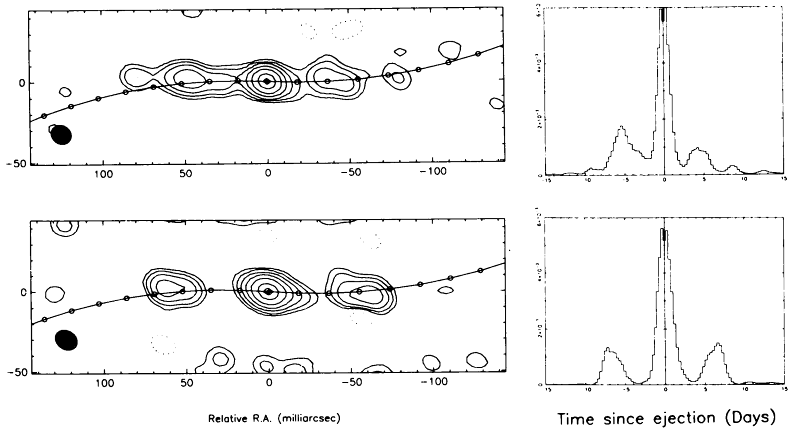

Figure 1: Maps 2 and 3 of the series of 6 EVN observations of SS433. The ellipse at lower left is the FWHM of the restoring beam. Contour levels are drawn at -2,2,4,8,16,32,64 and 90 percent of the peak flux level in each map. Marks along the kinematic model locus are present at two-day intervals. We display a crosscut of the maps along this locus, with the horizontal axis labelled in days since the assumed ejection.

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