VLBI SYNTHESIS OBSERVATIONS OF CIRCUMSTELLAR OH MASERS +

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ABSTRACT

A technique for mapping spectral line sources using closure phase VLBI techniques is described, and some initial results on circumstellar shell sources are presented. The maps show an unresolved point source on the nearside of the shell, but no corresponding source on the far-side of the shell. This is interpreted in terms of amplification of the stellar thermal emission. Preliminary results are also presented on another source, OH17.7, which show correlated flux outside the velocity range of the known OH masers, and it is suggested that this represents high velocity ($\sim$600 km s^{-1}) violent motions around the central star. If confirmed, this may represent a new class of source, representing violent phenomena associated with red giant stars.

INTRODUCTION

The OH maser emission from OH/IR stars is characterised by a double peaked spectrum which has been shown by MERLIN and VLA observations to emanate from an expanding shell surrounding a late type star (usually presumed to be an M giant or supergiant). A review of these observations is given by R.S. Booth elsewhere in these proceedings and so will not be duplicated here. Instead, we present the results of VLBI observations, which are designed to investigate the compact structure of these sources and we consider a mechanism which may produce the observed structure.

TECHNIQUES AND OBSERVATIONS

The technique, which is described in detail by Norris (1982) includes corrections for correlator-dependent phase offsets including a retarded-baseline effect and digitisation errors. The amplitudes are then calibrated using simultaneous autocorrelation spectra. One strong spectral feature, which need not be unresolved, is mapped using the closure phase technique (Cornwell & Wilkinson 1981). Other spectral

+ Discussion on page 461

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channels are then phase referenced to this feature, and their phases corrected for the structure of the reference. The data in these channels are then CLEANed to produce maps of the brightness distribution integrated over suitable velocity intervals. The observations presented here were made in February 1981 (OH127.8 and OH104.9) and March 1983 (OH17.7) using 4 telescopes of the European VLBI network (EVN): Jodrell Bank, Effelsberg, Dwingeloo and Onsala.

RESULTS AND DISCUSSION

Fig.1 shows a closure phase map of the sharp blue shifted feature at -66 km s^{-1} in the source OH127.8. The emission from this feature appears substantially unresolved on even the longest EVN baselines. In contrast, all other components are found to be resolved by the EVN with a characteristic size ∿0.1 arcsec, as shown in Fig.2. We suggest this represents the size of a turbulent cell.

A similar result has been obtained for the more complicated source OH104.9. In this case, there are three compact features at the blue-shifted end, but all features elsewhere in the spectrum are resolved. Preliminary processing on other sources indicates similar results.

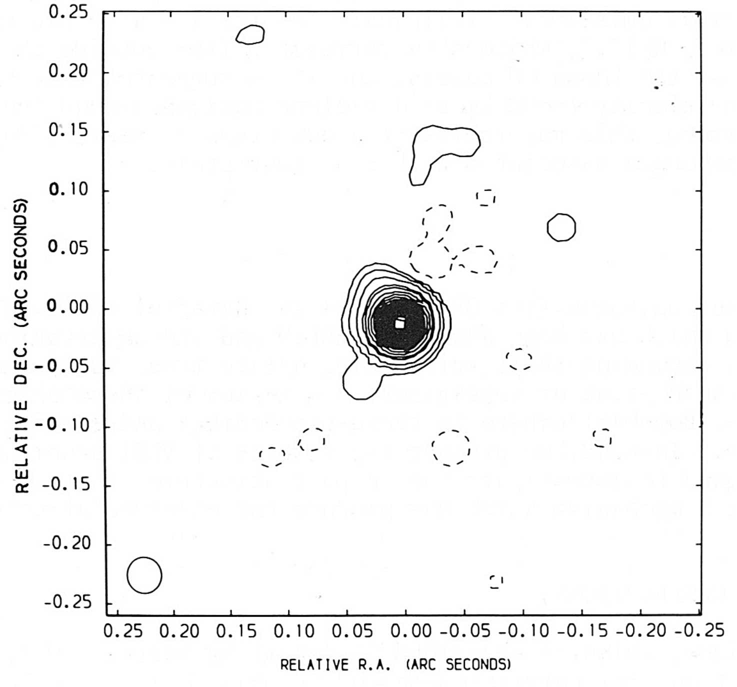

Fig.1 Closure-phase map of the -66 km/s feature of OH127.8, using Jodrell Bank, Effelsberg, Dwingeloo and Onsala. Lowest contour is 1%.

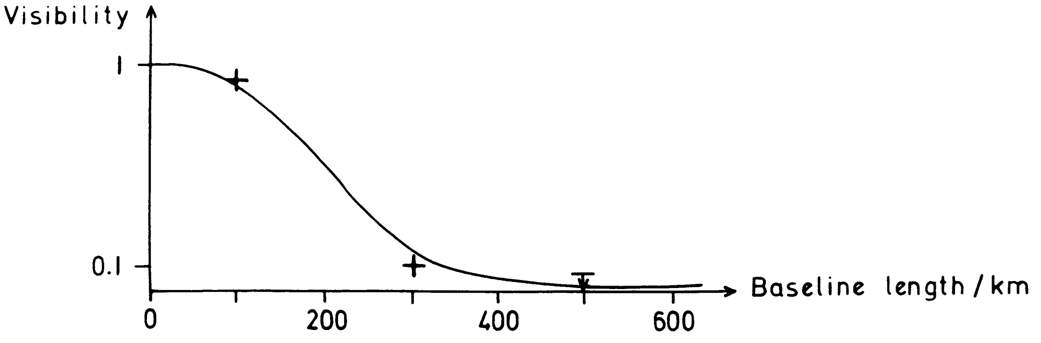

Fig.2 Typical visibility curve of a feature at the red-shifted end of the spectrum of OH127.8. The curve drawn represents a gaussian of width ∿0.1 arcsec.

MERLIN maps of OH127.8 and OH104.9 (Norris et al. 1982) show that the blue shifted peak of emission emanates from a compact component which is spatially coincident with the star. Fig.1 shows that this component is unresolved even on European VLBI baselines. The corresponding red-shifted emission appears resolved on the same baselines. We suggest that the compact blue-shifted component may represent the stellar thermal emission which is being amplified by the OH masers in the circumstellar shell. In this case, the OH compact component will remain exactly spatially coincident with the star, regardless of any inhomogeneities or disturbances in the circumstellar shell. That such amplification may occur, even if the maser is saturated, can be shown by considering the direction, as well as the intensity, of the saturating emission (Norris et al. 1983).

This hypothesis has two important consequences:

i) It provides a situation in which an easily observed radio emitter is known to be coincident with an optical emitter to an accuracy of a few milliarcsec. Several OH/IR stars have bright optical counterparts, and they should be invaluable in relating the optical and radio reference frames, and will be observed in conjunction with the HIPPARCOS project. In addition perhaps a similar result may be obtained for the H_2O and SiO masers around late type stars.

ii) The sizes (and spectral types) of the central stars of sources like OH127.8 and OH104.9 are unknown, although they are usually assumed to be M giants or supergiants. Since our hypothesis implies maser sizes equal to the stellar diameter, global VLBI measurements may be used to determine, or place limits upon, the stellar diameters of some of the nearest sources.

PROBABLE DISCOVERY OF BROADBAND EMISSION ASSOCIATED WITH AN OH/IR STAR

Recent EVN observations of the OH/IR star OH17.7 produced an

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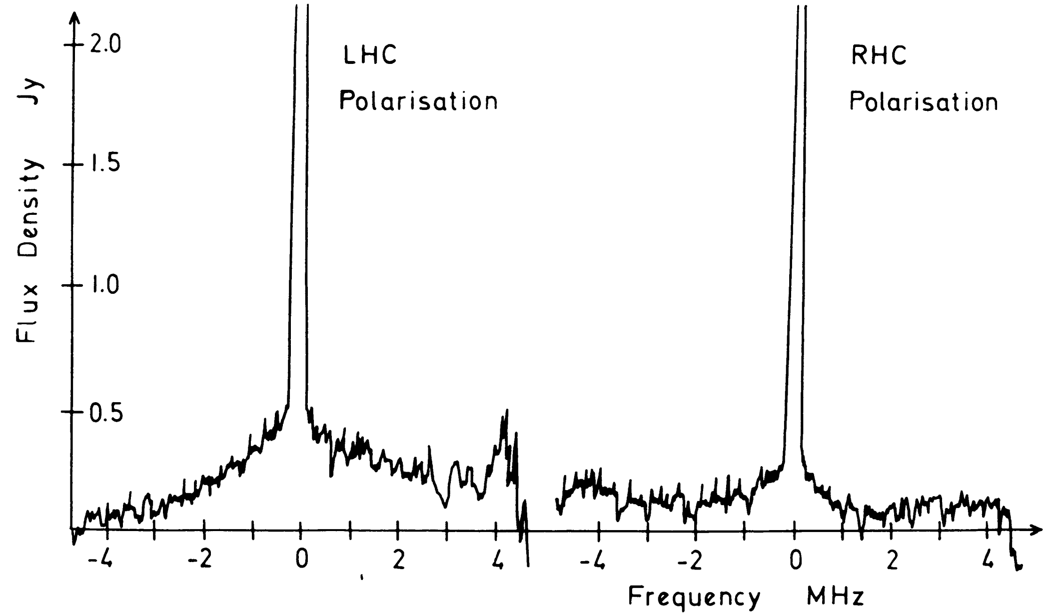

Fig.3 Autocorrelation spectra of OH17.7, measured in June 1983 with the Jodrell Bank MK IA telescope. Because of the wide bandwidth (10 MHz) the characteristic double peaked spectrum appears as a single spike in the centre of the band. No attempt has been made to remove a baseline from the spectrum. An indication of triangular wings may be seen in both spectra.

unexpected result in that correlated flux was detected not only within the OH lines but also across the entire bandwidth of 250 kHz. The data have not yet been completely analysed, but a flux density of the order of 0.5 Jy is implied. Subsequent spectra (Fig.3) imply that this emission is due to broad weak wings extending 600 km s^{-1} either side of the strong maser lines. Observations with the Effelsberg telescope allow an upper limit of $\sim$10 mJy to be placed on any 6 cm continuum flux from this source although the source was recently detected by IRAS as a strong far-IR emitter (IRAS working group, 1983).

We emphasize that the radio detections have yet to be confirmed by further observations. However, we speculate that, if they are confirmed, they represent a new type of violent phenomenon associated with late type stars.

REFERENCES

Cornwell,T.J. & Wilkinson,P.N., 1981.Mon.Not.R.astr.Soc.,196,1067-1086.
IRAS Working Group 1983. Nature 303, 480.
Norris,R.P.,1982. in 'VLBI Techniques' pp341-345.ed.F.Biraud,CNES Toulouse
Norris,R.P.,Diamond,P.J. & Booth, R.S. 1982. Nature 299, 131-134.
Norris, R.P., Booth,R.S., Graham, D.A., Nyman, L-A., 1983. In preparation