produced semi-analytically in the computer. In the latter case strong point sources within the field to be CLEANed can be used to determine mean values of the pointing offset and phase error (between east and west halves of the array), which can then be specified in the computation of the beam. In practice we compute the beam out to a radius of ~8 beamwidths.

The extent to which MOST maps can satisfactorily be CLEANed depends upon how well the ‘artificial beam’ represents the true point source response in the map and upon the extent to which this true response is constant over the field. As yet no account has been taken of possible changes in gain, pointing offsets, and phase errors during the 12 h of observation.

The sidelobe of the main beam is a direct consequence of the particular $u$, $v$ plane weighting shown in Figure 1(a). Hence it is possible to reduce its amplitude, and avoid the need to CLEAN, by merely Fourier-transforming the map and radially reweighting the visibilities to a shape (such as a truncated Gaussian) which would have a lower sidelobe level (Crawford 1984). Unfortunately this procedure reduces the resolution, and from some preliminary tests we have done it appears to enhance weak base-level variations to an unacceptable extent.

Grating Rings and Horizontal Bands
Weak grating rings from edge-of-field sources arise because of time-varying phase discontinuities at the junctions of modules of the cylindrical paraboloid. The rings are significant only for fan beams well removed from the field centre. Projected on to an equatorial plane, the rings have a single characteristic radius but an amplitude dependent upon the distance of the point source from the centre of the field. We remove the rings with a special AIPS task by: (a) specifying three points on each ring with the graphics display cursor; (b) fitting the position and amplitude of a ring of known radius to intensities in the neighbourhoods of the three points; (c) subtracting the calculated ring from the map. The removal of grating rings by this method is illustrated in Figure 2.

In some MOST maps the base level varies slowly in the north-south direction producing weak east-west bands. The cause of the effect is under investigation. These bands can usually be removed by subtracting from each east-west strip the average intensity in a region of the map centred at the declination of the strip and outside the extended source of interest. An AIPS task has been written to accomplish this in conjunction with the interactive graphics display.

Merging of Adjacent Maps
Merging of adjacent fields is accomplished with a new AIPS task which regrids the original maps into a new larger area with a newly defined field centre. Areas of overlap are blended with complementary linear weighting functions.

Remarks
The techniques we have described enable the observer to produce maps with the MOST which are of higher sensitivity and which more accurately represent the emission from extended sources. The software routines will be supplied to interested MOST observers upon request.* Other somewhat related aspects of the mapping of radio sources with the MOST have been described by Crawford (1984) and Kesteven (1984).

The Molonglo Observatory is operated by the School of Physics in the University of Sydney and funded by the ARGC, the Sydney University Research Committee and the Science Foundation for Physics within the University. We thank Professors B. Y. Mills and A. G. Little and Dr. J. M. Durdin for generous assistance in using the MOST.

Kesteven, M. J., ibid, p. 261.

*Requests for the software routines may be directed to Dr. M. J. Kesteven, Division of Radiophysics, CSIRO, P.O. Box 76, Epping, N.S.W. 2121.

A Search for OH Emission from Symbiotic Stars
R. P. Norris,1 David A. Allen,2 R. F. Haynes,1 and Alan E. Wright1
1 Division of Radiophysics, CSIRO, Sydney
2 Anglo-Australian Observatory

Summary
A sensitive search has been made for OH maser emission from a sample of 16 symbiotic stars. This sample has been selected on the basis of infrared optical depth and variability, so that the stars within it have circumstellar shells similar to those seen in the well-known OH/IR and OH/Mira stars. There were no significant detections, except for one unassociated background source, and we conclude that the presence of a hot binary companion inhibits any possible OH maser action.

Introduction
Symbiotic stars are characterized by their optical spectra, which show lines typical of both late M type stars and hot compact stars. Some of these objects are now popularly interpreted as binary systems comprising a Mira variable and a white hot dwarf (e.g. Allen 1984). The spectrum of the M type component resembles that of an isolated Mira star with a circumstellar dust shell, and such isolated stars commonly exhibit OH maser emission. In at least some symbiotic systems, the separation of the binary companions is believed to be of the order of 1000 AU,
which is comparable to or larger than the typical dimensions of maser shells around optically identified OH/Mira stars (e.g. Diamond et al. 1984). Therefore a Mira in a symbiotic system might be expected to show maser emission similar to that observed in isolated Miras.

Interest in maser emission from symbiotic stars is twofold. Masers would provide the most accurate monitors of orbital motion by the M star, whilst observations with synthesis techniques could reveal the dynamical influence on the Mira's envelope by its companion.

Previous searches for maser emission from symbiotic stars (e.g. Lépine and Nguyen-Quang-Rieu 1974; Broca 1979; Zuckerman 1979; Cohen and Ghigo 1980) have to date resulted in the discovery of only one such source: the SiO maser in R Aqr. However, the samples searched had not been chosen with regard to the properties of the stars. We have therefore selected 16 symbiotic stars which, on the basis of their optical and infrared properties, are likely to have circumstellar dust shells similar to those observed around the OH/IR and OH/Mira stars. The sample, which is listed in Table 1, is composed of symbiotic stars south of declination +20° which have K magnitudes brighter than ~8 and infrared colours dominated by dust emission. Known carbon-rich stars were excluded from the sample.

Observations
The observations were made in the period 1984 June 20 to 1984 July 4 using the Parkes 64-m telescope at 1612, 1665 and 1667 MHz. Parametric amplifiers gave system temperatures of about 80 K in each of the orthogonal linear polarizations. The 1024 channel Parkes digital autocorrelator was split into two 512 channel sections, each of which operated at a bandwidth of 2 MHz. Observations were made in a frequency switching mode, with the band centre shifted alternately 0.5 MHz lower and 0.5 MHz higher than the adopted stellar velocity. The difference between the alternate spectra was then folded, and the spectra in the two polarizations added, to give a 256-channel spectrum with a bandwidth of 1 MHz (~180 km s⁻¹). Any emission lines within a further 1 MHz of the edge of the band appear as absorption lines within the bandpass.

Table 1
Source List and Sensitivities

<table>
<thead>
<tr>
<th>Source name</th>
<th>Position (1950)</th>
<th>Adopted lsr vel.</th>
<th>Sensitivities*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R.A.</td>
<td>Dec.</td>
<td>1612 MHz</td>
</tr>
<tr>
<td></td>
<td>h m s</td>
<td>° ' &quot;</td>
<td>(km s⁻¹)</td>
</tr>
<tr>
<td>RX Pup</td>
<td>08 12 28.2</td>
<td>-41 33 18</td>
<td>0</td>
</tr>
<tr>
<td>He2-38</td>
<td>09 53 03.7</td>
<td>-57 04 39</td>
<td>120</td>
</tr>
<tr>
<td>BI Cru</td>
<td>12 20 40.3</td>
<td>-62 21 39</td>
<td>-100</td>
</tr>
<tr>
<td>He2-104</td>
<td>14 08 53.3</td>
<td>-51 12 18</td>
<td>0</td>
</tr>
<tr>
<td>He2-106</td>
<td>14 10 22.7</td>
<td>-63 11 45</td>
<td>-10</td>
</tr>
<tr>
<td>He2-127</td>
<td>15 21 10.4</td>
<td>-51 39 15</td>
<td>-30</td>
</tr>
<tr>
<td>He2-139</td>
<td>15 50 48.6</td>
<td>-55 20 48</td>
<td>0</td>
</tr>
<tr>
<td>He2-171</td>
<td>16 30 47.0</td>
<td>-34 59 12</td>
<td>-80</td>
</tr>
<tr>
<td>H1-36</td>
<td>17 46 24.1</td>
<td>-37 00 36</td>
<td>-130</td>
</tr>
<tr>
<td>W16-312</td>
<td>17 47 03.0</td>
<td>-30 56 45</td>
<td>0</td>
</tr>
<tr>
<td>H2-38</td>
<td>18 02 51.5</td>
<td>-28 17 23</td>
<td>-40</td>
</tr>
<tr>
<td>AS 289</td>
<td>18 09 34.7</td>
<td>-11 40 55</td>
<td>0</td>
</tr>
<tr>
<td>He2-390</td>
<td>18 17 51.4</td>
<td>-26 49 50</td>
<td>-20</td>
</tr>
<tr>
<td>HM Sge</td>
<td>19 39 41.4</td>
<td>16 57 33</td>
<td>-40</td>
</tr>
<tr>
<td>RR Tel1</td>
<td>20 00 20.1</td>
<td>-55 52 04</td>
<td>-60</td>
</tr>
<tr>
<td>R Aqr</td>
<td>23 41 14.3</td>
<td>-15 33 43</td>
<td>-25</td>
</tr>
</tbody>
</table>

*Detection sensitivities are r.m.s. noise temperatures, converted to millijanskys. In each case the quoted detection limit is for individual 4 kHz channels within a bandwidth of 1 MHz (~180 km s⁻¹) centred on the quoted velocity. In addition, a detection limit of 1.4 times the quoted limit applies to a further 1 MHz either side of this bandwidth. Limits in brackets refer to the sensitivities on sources where possible detections were made.
Table 2

Possible Detections

<table>
<thead>
<tr>
<th>Source name</th>
<th>Freq. (MHz)</th>
<th>Velocity (km s(^{-1}))</th>
<th>Flux density (Jy)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>BI Cru</td>
<td>1612</td>
<td>0, -30</td>
<td>0.3</td>
<td>Definite: probably confused with weak OH/IR star.</td>
</tr>
<tr>
<td>H1-36</td>
<td>1667</td>
<td>-55, -2</td>
<td>0.3</td>
<td>Marginal</td>
</tr>
<tr>
<td>H2-38</td>
<td>1612</td>
<td>+2</td>
<td>0.2</td>
<td>Marginal</td>
</tr>
</tbody>
</table>

Each field was observed initially for between 20 minutes and 1 hour in this mode; suspected detections were reobserved at a higher spectral resolution and with a longer integration time. The sensitivities of the searches on each field are given in Table 1.

Results

Of the 16 stars studied, only one gave a definite detection. In addition, we have possible detections on two other stars. The results are summarized in Tables 1 and 2. We do not discuss the two possible detections any further, since each is considered to be doubtful.

The one definite detection in the source BI Cru was confirmed by subsequent narrow band observations, resulting in the spectrum shown in Figure 1. An attempt was made to measure the position of this source, by observing a grid of positions around the star. The OH maser source appears to be offset from the stellar position by 2' ± 1' arc in right ascension, and 4' ± 1' arc in declination, where the uncertainties represent estimated 1σ standard errors.

The Nature of the Maser near BI Cru

Figure 1 shows the spectrum of the source detected near BI Cru. The double-peaked spectrum, and the velocity separation of the

Figure 1 The spectrum of the OH emission detected near BI Cru. The velocities are relative to the local standard of rest, assuming a rest frequency of 1612.231 MHz.

Figure 2 The profile of H\(\alpha\) emission in BI Cru. The lower ordinate shows the observed wavelength (Å) and the upper ordinate shows the radial velocity (km s\(^{-1}\)) relative to the local standard of rest. The two lines near 0 km s\(^{-1}\) indicate the location of the two OH peaks.
two peaks (~30 km s⁻¹), are characteristic of the well-known OH/IR stars, which are believed to represent late M stars surrounded by thick circumstellar shells. This is the type of spectrum we expect from a symbiotic system containing an M type variable star. However, we will now show that this OH maser source is probably not associated with the BI Cru symbiotic system.

The projected separation of the cool star (and hence maser) and its hot companion, which may dominate the visible appearance, cannot exceed a few seconds of arc. Thus the offset in position of 4' ± 1' arc (corresponding to 1000 AU at 16 pc) is too large for a positive identification.

The profile of the Hα emission line from BI Cru is shown in Figure 2. This was obtained on 1984 July 6 using the échelle spectrograph and PCA on the MSSSO 1-m telescope. The profile is very broad and of a P Cygni nature. The velocity of the centre of the broad wings appears to be about ~80 km s⁻¹. The difference (~100 km s⁻¹) in velocity between this and the centre of the maser spectrum implies an orbital velocity much larger than would be expected in a symbiotic system. Furthermore, such a high orbital velocity would place the binary companions only ~1 AU apart. Thus the hot companion would be within any putative maser shell, and would probably destroy it. It therefore appears unlikely that the maser is associated with BI Cru.

A survey of OH masers in the galactic plane near the star BI Cru (Caswell et al. 1981) shows a density of 1612 MHz masers with S≥0.5 Jy of ~6.5 per square degree. Therefore the probability of detecting a background source within 4' arc of a given position is ~0.1. Since we have observed 16 sources, some of which are in or near the galactic plane, we may expect ~1 to 2 chance detections similar to that of BI Cru. This figure is uncertain, because many of the 16 sources lie a few degrees from the galactic plane. On the other hand, at the flux density of the BI Cru maser (0.3 Jy) there is presumably a greater density of maser sources than at the 0.5 Jy limit of the survey by Caswell et al.

We conclude that the source detected is a background source which is not associated with BI Cru.

Discussion and Conclusion
Discounting the BI Cru detection, we find no evidence for OH emission from symbiotic stars, even when these are selected to have properties similar to those of the OH/IR and OH/Mira stars.

Isolated Mira and other M type variable stars commonly exhibit OH maser emission at a flux density of at least several janskies (e.g. Engels 1979). This emission has been observed in a wide variety of M type stars, including Mira variables, long-period variables, and M supergiants. It appears to occur quite generally wherever there is a loss of material from an M star, and is attributed to pumping of the OH in the circumstellar shell by far infrared from the star (Elitzur 1978).

The upper limit of ~0.2 Jy placed on any OH maser radiation from the symbiotic stars in our sample, which has been selected to maximize the probability of a detection, is therefore significant. This result argues for one of two conclusions:

1. The symbiotic systems do not contain a normal M type star with a circumstellar shell produced by mass loss. However, this argument ignores a great weight of accumulated evidence, and in particular the analysis of H1-36 (Allen 1983). We therefore discount it.

2. The OH in the circumstellar shell is disrupted by the hot companion so that maser emission cannot occur. Cohen and Ghigo (1980) suggested that heating by the companion might drive the regime of suitable temperature out to a radius where the density is too low for maser emission to occur. This is supported by the observations of Roche et al. (1983), who found that the dust associated with the Mira is unusually hot.

We suggest a further two possible mechanisms for the disruption of the maser shell. The dynamical influence of a companion could produce a velocity structure in the shell which would drastically reduce the coherent path length along which maser action may take place. Alternatively, ultraviolet radiation from the hot star might dissociate or depopulate the excited OH.

Although OH maser action in symbiotic systems seems to be inhibited by the presence of the hot star, molecules deeper within the atmosphere of the Mira companion may not be so affected. Since the majority of the stars studied here have not been examined for H₂O or SiO maser activity, it is not yet time to abandon the search for masers around symbiotic stars.