FIRST VLBI OBSERVATIONS OF 6.3 cm OH MASERS IN COMPACT HII REGIONS

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ABSTRACT. VLBI synthesis observations of the $^2\Pi_{1/2}$, J = 1/2 excited-state of OH at 6.3 cm ($\Delta F = 1-0 = 4765.562$ MHz) have been made towards four compact HII regions. Detailed maps have been produced for W3(OH) where three groups of sources are distributed over a region $\sim$ 0.01 pc in size. The brightest sources are shown to be saturated masers with $T_B \gtrsim 10^9$ K. In ON1 a weak feature gives fringes with a $\sim$ 0.05" lobe spacing.

1. INTRODUCTION

Synthesis maps of the ground- and excited-state OH sources associated with compact HII regions provide, together with model calculations, a unique mean to understand the physical conditions prevailing in cosmic masers. Detailed maps also probe the spatial distribution and the excitation mechanisms of the OH gas.

The only VLBI observations of excited-states of OH that have been published so far concern the 6035 MHz line, 84 cm^{-1} above the ground-level (Moran et al., 1978) and the 4765 MHz line, 126 cm^{-1} above the ground-level (Baudry et al., 1987).

2. OBSERVATIONS

The $^2\Pi_{1/2}$, J = 1/2 line of OH at 4765.562 MHz was observed with 4 or 3 telescopes of the European VLBI Network (EVN) and with transatlantic baselines to Owens Valley, in October 1984 and 1985 and in November 1986. The lobe spacings with the EVN were $\sim$ 0.018 to 0.050" and the spectral resolution in the line maps was $\sim$ 0.2 km/s. The type I OH sources associated with compact HII regions which were searched for 6.3 cm OH emission are given in Table I. These regions are known to be sites of active stellar formation.

3. W3(OH)

Our VLBI maps are extensively discussed in Baudry et al. (1987). The 6.3 cm emission consists of 3 groups of sources distributed over a region $\sim$ 1" in size. They lie on the edge of the associated continuum

M. J. Reid and J. M. Moran (eds.), The Impact of VLBI on Astrophysics and Geophysics, 235–236.

https://doi.org/10.1017/S0074180900134552 Published online by Cambridge University Press

TABLE I

Sources	RA (1950)	DEC	Detection	Year of observations (EVN)
W3	$02^h21^m53^s.35$	$61°52'23''.50$	No(a)	1984
W3(OH)	02 23 16.32	61 38 57.78	Fringes	1984, 1985, 1986
ON1	20 08 09.80	31 22 41.00	Fringes	1986
DR21(OH)	20 37 24.70	42 12 09.00	(b)	1986

(a) W3 is very time variable. No fringes at the time of the observations.
(b) Data not yet processed.

source. Some sources are unresolved with the EVN and have sizes $\lesssim$ 15-25 milli arc sec implying $T_B \gtrsim 10^9$ K. All sources are resolved with the Effelsberg-Owens Valley baselines. The strongest masers in W3(OH) appear to be saturated. In addition the cross-correlated spectra obtained in 1984, 1985 and 1986 with the Effelsberg-Westerbork baseline are fairly similar. The total power spectrum remains also unchanged. The observations show that there is a good spatial coincidence of the 4765 MHz masers with the 6035 MHz and the 1665-1667 MHz masers in comparable velocity ranges. This suggests similar pumping conditions for $^2\Pi_{1/2}$ and $^2\Pi_{3/2}$ OH although theory and experiment predict that collisions have opposite effects on the two OH energy ladders. However model calculations (Guilloteau et al., 1985) prove that the 4765 and 1665-1667 MHz transitions can be inverted simultaneously.

4. ON1 (OH 69.5 - 1.0)

ON1 is an isolated compact HII region with strong type I OH emission. Weak fringes were detected with the Effelsberg-Westerbork baseline near 14.9 km/s where 6035 MHz OH emission is also present (Rickard et al., 1975). Inspection of our cross-correlated spectra obtained with a lobe spacing of 0.05" suggests that the spatial structure across the spectral feature is complex. Detection of this feature with longer, less sensitive baselines is difficult because it is weak. Although final calibration of the data is not yet available we deduce, by comparison with the unresolved feature in W3(OH), that the peak flux is $\sim$ 0.45 Jy.

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