II. RADIO ASTRONOMY*

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A. POLARIZATION MEASUREMENTS ON THE CLOUD 2 OH SOURCE

OH emission was detected from interstellar dust clouds in 1967 (Heiles[1]). From the measurement of the ratio of the 1667-MHz to the 1665-MHz line strengths, it was believed that this emission was due to "normal" thermal emission (Heiles[2]). If this OH emission were due to thermal emission, it should also be unpolarized. Since many of the OH emission sources are nonthermal and have significant amounts of circular polarization, we decided to measure the circular polarization of one normal OH emission source to see if it was, in fact, unpolarized.

Observations of the normal OH emission were made during March 1969, using the Harvard College Observatory's 84-ft (26-m) Agassiz Radio Telescope. Because the dust-cloud OH emission is an extended source, and the polarization properties are also believed to be extended, the size of the antenna is unimportant. The data were taken in 30-min intervals, alternating between right and left circular polarization in successive intervals. A load-switching mode, switching against a sky horn, was used. The first stage of the receiver was an uncooled parametric amplifier which gave a system noise temperature of 150°K. The spectral-line processing was done using a 50-channel 1.5-kHz filter receiver. The total integration time was 10 h with right circular and 10 h with left circular polarization.

Data processing was carried out with the SLReduce program at the Haystack Lincoln Laboratory Facility (Ball[3]). With this program, the data were averaged together, baseline corrections made, and the sum S_0(RC+LC) spectrum and the difference S_3(RC-LC) spectrum plotted.

The circular polarization of the normal OH source Cloud 2 (1950: $\alpha = 4^h\, 38^m\, 30^s$, $\delta = 25°\ 38'$) was measured because this is the strongest of the normal OH sources

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(Cudaback and Heiles[4]). Heiles[2] has summarized the Cloud 2 parameters. The results of the Agassiz measurements are shown in Fig. II-1 where the S_o and S_3 1667-MHz spectra are plotted.

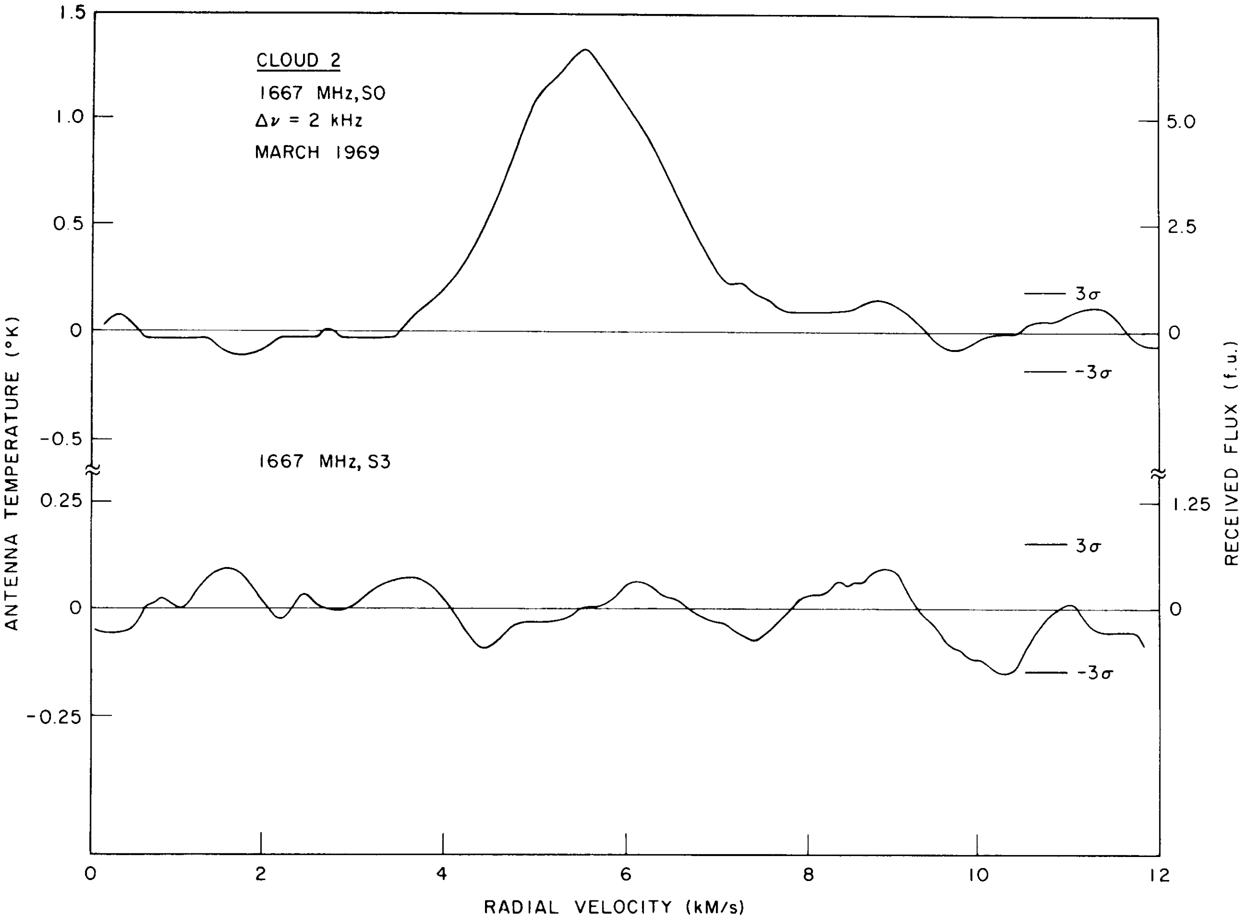

Fig. II-1. The 1667-MHz OH emission spectrum of the interstellar dust cloud, Cloud 2. The unpolarized, S_o(RC+LC), and the difference, S_3(RC-LC), spectra are plotted. Integration times were 10^h with RC, and 10^h with LC polarization. Observations were made using the Harvard College Observatory's 84-ft Agassiz Radio Telescope.

The 1667-MHz emission from Cloud 2 has less than 8 ± 2% circular polarization at the peak velocity of 5.5 km sec^{-1}, and less than 15 ± 2% circular polarization over the 3-dB width of the line. Therefore, this measurement supports the conclusion that the 1667-MHz emission is thermal.

It was also found that the Zeeman splitting is less than 1.1 kHz, which makes the magnetic field in Cloud 2 less than 10^{-3} G. It should be noted that this is not a very good upper limit, since magnetic fields in interstellar dust clouds are probably 1-2 orders of magnitude less than this value (Verschuur[5]).

A recent measurement of the 1720-MHz emission from dust clouds shows that the 1720-MHz signal is much stronger than expected for thermal emission (Turner[6]). Thus it appears that the dust cloud OH emission is not normal in every respect.

We would like to thank Dr. J. A. Ball and the staff of the Agassiz Station of Harvard College Observatory for the use of their facilities and technical support. We would also like to thank the staff of the Haystack Microwave Research Facility, Lincoln Laboratory, M. I. T., for support in the data reduction.

W. J. Wilson, A. H. Barrett

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B. VERY LONG BASELINE INTERFEROMETRY

A successful Very Long Baseline Interferometer experiment was concluded between the Haystack Microwave Research Facility, of Lincoln Laboratory, M. I. T., the National Radio Astronomy Observatory, and the Maryland Point telescope of the Naval Research Laboratory, at a frequency of 22.235 GHz, the water-line frequency. The interstellar masers associated with W49, W3 OH, the Orion Nebula, and VY Canis Majoris were all observed successfully, and upper limits were placed upon the angular size of a number of the observed features. The results of the experiment are summarized in Table II-1. It is shown that (i) the typical linear sizes of H_2O masers are of stellar dimensions; (ii) the atmosphere is sufficiently stable to permit VLBI observations at considerably shorter wavelengths; and (iii) there are no fundamental barriers to building phase-stable equipment for these frequencies. The observed phase stability, 2π rad/min, is attributable entirely to the frequency stability of the Rubidium standards that were used in the experiment.

We are now preparing a three-station experiment utilizing the Haystack telescope, the 140-ft Greenbank telescope, and the 36-ft Kitt Peak telescope of the National

Table II-1. Experimental results.

Source	V_R^* (km/s)	Fringe Spacing (sec of arc)	Fringe Amplitude	Angular Size (sec of arc)	Distance (kparsec)	Linear Feature Size (A. U.)	Size of OH Features (sec of arc)
W3 (OH)[†]	-49	0.012	0.3	<0.01	2.4	<24	.005-.02
Orion A	3.5	.005	0.6	$<.003$	0.5	<1.5	<10
	9	.005	0.6	$<.003$		<1.5	
VY CMa	18	.006	0.9	$<.004$	0.5	<2.0	<10
W49 (OH-1)	-8	.005	0.7	$<.003$	15	<40	~.05
	-6	.006	0.9	$<.003$		<40	
	-2	.004	0.7	$<.003$		<40	
	5	.005	0.9	$<.003$		<40	
	7	.005	0.7	$<.003$		<40	

[*] Rest Frequency = 22235.08 MHz.

[†] NRAO-NRL Baseline.

Radio Astronomy Observatory. Three observing sessions will be carried out at these stations during the month of June 1970.

B. F. Burke, D. C. Papa, G. Papadopoulos, P. R. Schwartz

C. PULSAR FACILITY

During the past quarter, work continued on improving the performance of the receiver to be used on the Pulsar Facility. This has included testing the use of a broadband RF preamplifier in conjunction with various filters to accept the desired band of frequencies (approximately 1 MHz centered on 148 MHz) and provide adequate image rejection.

In May 1970, maintenance was performed on the array of 16 antennas to repair damage caused by the effects of the winter weather. This included replacing some feed-element damage when high winds knocked over several feed tripods. The array has since been rephased and its impedance checked. The receiver will be tested on the array early in the summer.

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D. PULSAR OBSERVATIONS WITH A SWEPT-FREQUENCY LOCAL OSCILLATOR

Observations of pulsars have continued using the swept-frequency local-oscillator (SLO) techniques described previously (Sutton et al.[1]). Observations have been made near 120, 160, and 230 MHz on a number (approximately 15) of pulsars available to the 300-ft telescope of the National Radio Astronomy Observatory.

We have noted in MP0031 and AP2015, two pulsars with well-known "marching" characteristics, that there are times when the apparent P_3 or rate of marching varies by as much as a factor of two. This effect is particularly noticeable in MP0031, as is shown in Fig. II-2. Note that the changes sometimes occur while the pulses are strong, and

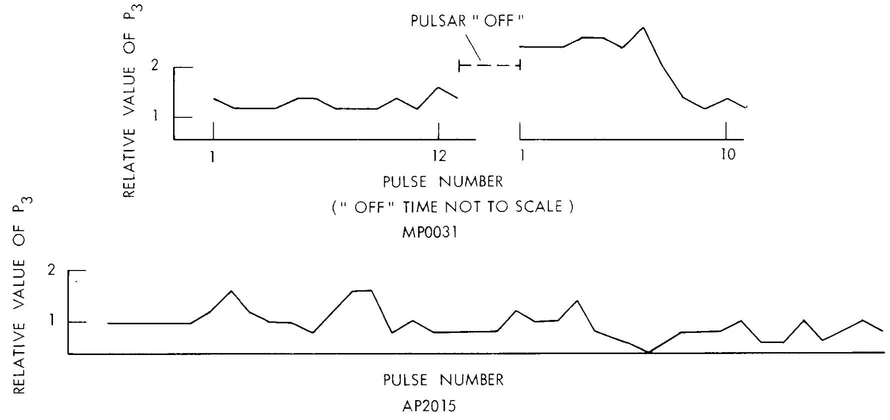

Fig. II-2. P_3 as a function of time for MP0031 and AP2015.

at other times while the pulses are weak or "off". It has been suggested (Huguenin and Taylor[2]) that this change occurs in a way related to the P_4 phenomena reported by Staelin et al.[3] Our present data are not extensive enough to support or contradict that suggestion. Studies of this phenomenon will continue.

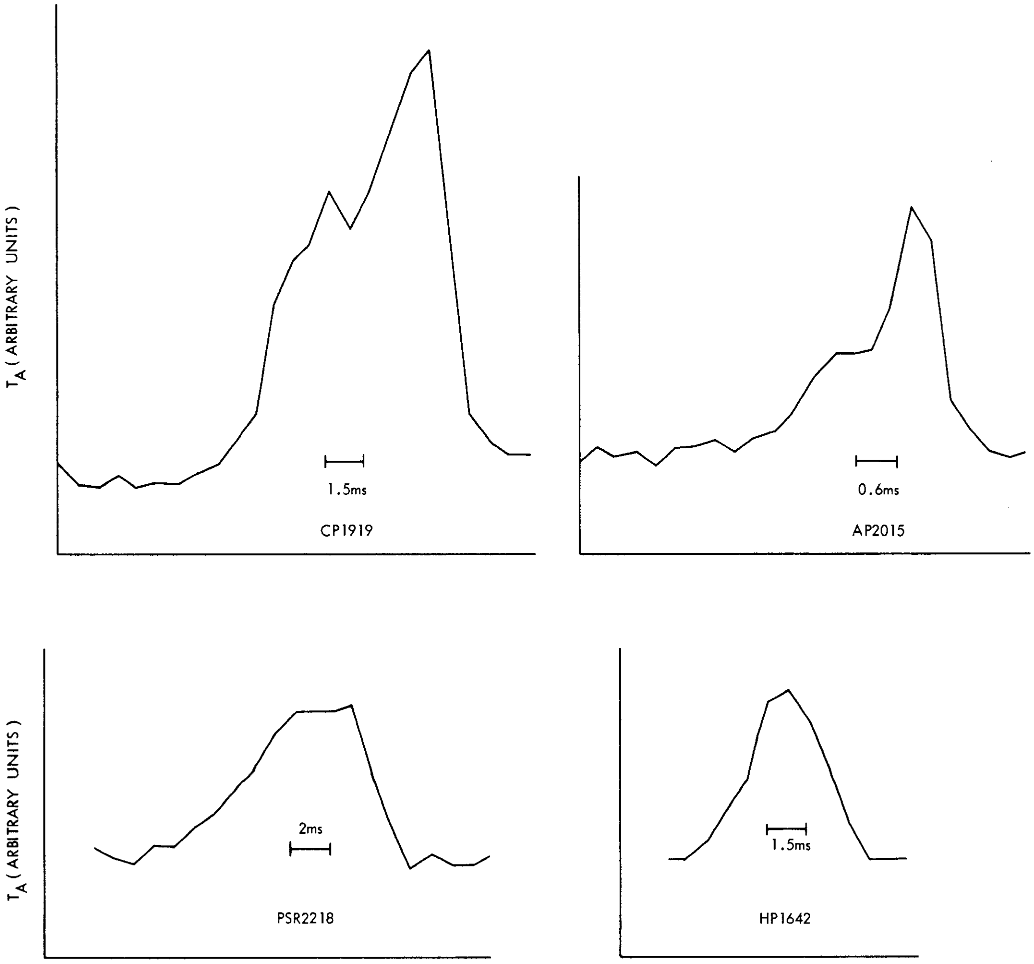

Fig. II-3. Average pulse shapes (5 min) at 160 MHz for 4 pulsars. Amplitudes are not to the same scale.

Average pulse shapes of a number of pulsars are being accumulated. Figure II-3 shows the 5-min average of pulsars CP1919, AP2015, HP1642, and PSR2218. Note that 1919 and 2015 have similar shapes as do 1642 and 2218. A study is under way to correlate the average pulse shapes with other pulsar characteristics.

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(Dr. John M. Sutton is at the National Radio Astronomy Observatory, Greenbank, West Virginia.)

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