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GALACTIC CONFUSION AND THE DETECTION OF 1665 AND 1667 MHz OH LINES IN THE NEIGHBORHOOD OF PLANETARY NEBULAE

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RESUMEN. La radiación OH de 1665 y 1667 MHz se detectó asociada con la nebulosa planetaria VY 2-2. Las líneas de OH también fueron observadas en los campos de NGC 1514, M1-5, VV 42, K 3-3, He 2-459 y M3-35. Este gas parece estar más identificado con material en la vecindad solar. Una búsqueda breve, cercana al plano galáctico, muestra estadísticas de detección de gas similar a las de las nebulosas.

ABSTRACT. OH radiation at 1665 and 1667 MHz was detected in association with the planetary nebula VY 2-2. OH lines were also detected in the fields of NGC 1514, M1-5, VV 42, K 3-3, He 2-459, and M3-35. This gas, however, is more naturally identified with material in the solar neighborhood. A brief OH survey near the galactic plane shows similar gas detection statistics.

Key words: INTERSTELLAR-MOLECULES — NEBULAE-PLANETARY — RADIO LINES-MOLECULAR

I. INTRODUCTION

Recent OH observations of planetary nebulae (Payne, Phillips and Terzian, 1986 in press) made with the NRAO 14-ft telescope resulted in the detection of OH lines in the direction of ten planetary and protoplanetary nebulae. However, almost all of the detected lines were very weak, and some were spacially extended, indicating a high degree of OH confusion from the galactic plane. In order to investigate this situation we have observed 20 planetary nebulae in the declination range 0 degrees to 36 degrees North with the narrower (3.1 arcminute) beam of the Arecibo telescope. We have also observed the galactic plane visible at Arecibo with one degree (and in some cases half a degree) spacing, in order to study the confusion problems.

II. OBSERVATIONS

Observations were made with the 305-m Arecibo Radio Telescope in June, 1985 and May, 1986. The earlier observations were in the nature of a pilot project to determine feasibility. Points along the galactic plane in the anticenter region were measured for ten minutes each. A number of planetary nebulae were also examined in this fashion. The later observations were more systematic, with an allocation of 6 minutes of integration time per point. For the most part, each nebula was observed together with a grid of 4 points spaced north, south, east and west about the central object. This operation was carried out on three nights with grid spacings of 2, 4 and 6 arcminutes on successive nights. Figure 1 illustrates the observing pattern for the planetary nebulae.

Observations at galactic latitude zero were also made in systematic fashion, with one degree spacing. As time allowed, half degree spacings were added, as were observations

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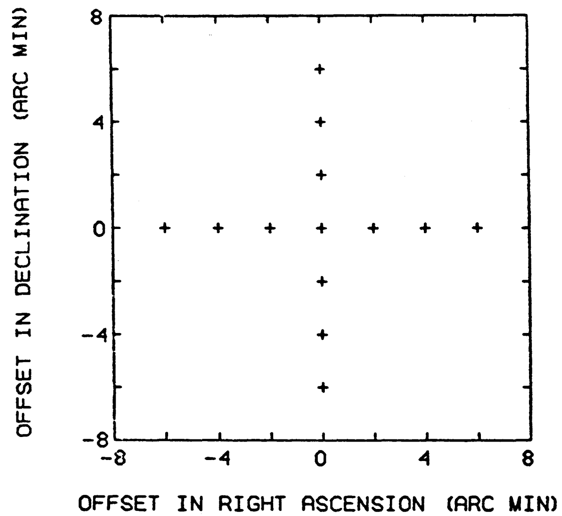

Fig. 1. Observing pattern (3 arcmin beam).

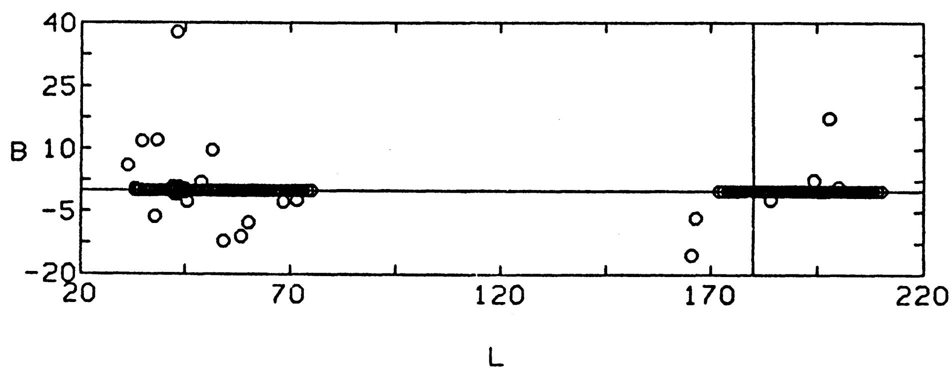

Fig. 2. Observed fields in planetary nebula OH survey.

above and below the plane to explore the extent of OH activity detected. Figure 2 presents schematically the distribution of points observed in the survey here reported. The cluster of detections near 44 degrees longitude may be associated with the Sagittarius spiral arm, which crosses the line of sight in this direction.

A small systematic correlation may be observed between the two polarizations. This is the result of a minor problem with the new Arecibo autocorrelator at the time of the observations, and in no way effects the detection of the reported lines.

III. RESULTS

Of twenty planetary nebula fields observed, OH lines were detected in seven. A summary of these results may be seen in Tables 1 and 2. The most interesting result is for VY 2-2. Figure 3 shows the on-source profiles, while Figure 4 shows the average of all the neighboring grid points. The peak at -63 km s^{-1} is clearly present on source and absent in the source neighborhood. It is also in good agreement with the optical velocity of -54 km s^{-1} (Schneider et al. 1984).

The case is much less convincing for the other detected fields. In all cases, the gas is present over an extended area, and near the local velocity. For NGC 1514, M1-5, and M3-35, the optical velocities do not agree with the velocity of the OH lines. This seems good evidence that we have not detected gas associated with the planetary nebulae themselves. The case is more ambiguous in the cases of VV 42, K 3-3, and He 2-459, since no optical velocities were available for these objects. However, the low velocity of the gas and its non-concentration on the nebulae suggest that it is local material.

TABLE 1. PLANETARY NEBULA FIELDS WITH OH DETECTIONS

NAME	R.A. (1950.0)			Dec.			l	b	V(opt)	V(OH)	Ta
	h	m	s	d	'	"	deg	deg	km/s	km/s	K
NGC 1514	4	6	8.0	30	38	42.0	165.53	-15.29	52	8	0.19
M1-5	5	43	46.0	24	20	59.0	184.05	-2.14	26	3	0.10
VV 42	6	15	54.3	15	18	13.0	195.65	-0.10		20	0.05
K3-3	18	24	38.1	1	12	59.0	31.27	5.97		9	0.20
VY2-2	19	21	59.0	9	48	0.0	45.50	-2.70	-54	-63	0.23
HE2-459	20	11	55.5	29	24	49.0	68.35	-2.74		8	0.13
M3-35	20	19	4.0	32	19	28.0	71.62	-2.36	-159	8	0.15

OH Radiation at 1665 and/or 1667 MHz was detected in these fields. Ta is peak line antenna temperature in degrees Kelvin. Optical and OH velocities are in km s^{-1}, in the Local Standard of Rest. Optical velocities are from the compilation of Schneider et al. (1983).

TABLE 2. PLANETARY NEBULA FIELDS WITHOUT OH DETECTIONS

NAME	R.A. (1950.0)			Dec.			l	b	U. L.
	h	m	s	d	'	"	deg	deg	K
CRL618	4	39	33.6	36	1	12.0	166.45	-6.53	0.10
J900,VV44	6	23	2.2	17	49	15.0	194.24	2.60	0.09
NGC 2392	7	26	13.3	21	0	56.7	197.88	17.40	0.06
IC4593	16	9	23.4	12	12	0.0	25.33	40.84	0.06
N6572	18	9	40.0	6	50	17.0	34.62	11.85	0.09
N6790	19	20	25.0	1	24	47.0	37.89	-6.31	0.26
CN3-1,VV391	18	15	13.0	10	7	47.0	38.26	12.08	0.09
N6210	16	42	23.7	23	53	29.1	43.11	37.76	0.05
HE2-429	19	11	21.6	14	53	57.0	48.77	1.99	0.06
HU2-1,VV458	18	47	38.3	20	47	7.0	51.48	9.69	0.08
N6891	20	12	47.1	12	32	41.0	54.19	-12.11	0.07
IC4997	20	17	51.5	16	34	12.0	58.33	-10.98	0.07
N6886	20	10	30.0	19	50	4.0	60.14	-7.74	0.09

Three sigma upper limit to OH in undetected fields in degrees K of antenna temperature. 0.06K correspond to $\sim$ 10 mJy.

The case of NGC 1514 is also an interesting one. Here we see OH with local velocity around the object, but absent on the object. (see Figure 5). The most plausible explanation may be that the continuum radiation from the planetary nebula is being absorbed by the local OH and so rendering the lines invisible in that direction.

In six of twenty fields (30%) we have detected gas believed to be local. We find very similar detection ratios in the observations made near the galactic plane. Here we have, in all, 31 detections in 119 fields (26%). Figure 6 shows the locations of these detections. However, to be fair, we should only count the fields selected according to our general survey, that is, at whole degrees of longitude, and not those chosen to be near detected fields. In that case, we detect OH in 15 out of 82 fields, (18%), still in reasonable agreement with the Planetary Nebula fields.

In general, the situation in the galactic plane is complex. There is wide variation in both intensity and velocity of the observed OH emission, and when the line intensities are high, there tend to be several components. Although emission dominates, absorption features are not uncommon.

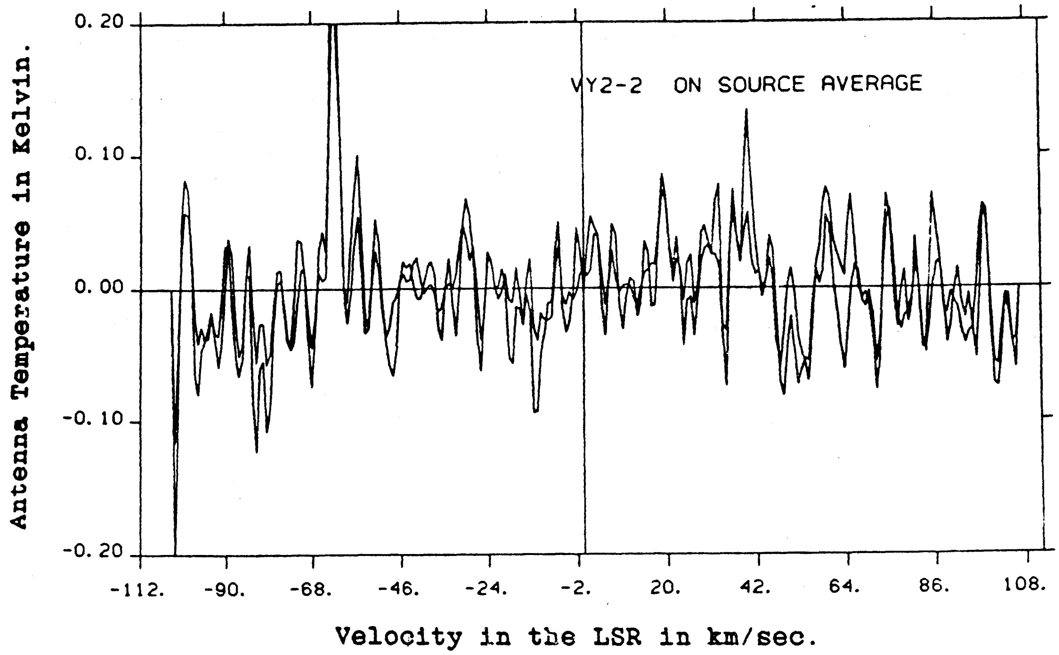

Fig. 3. VY 2-2, 1667.253 MHz. Both polarizations shown. 22 minutes total integration time, rms is .039 K.

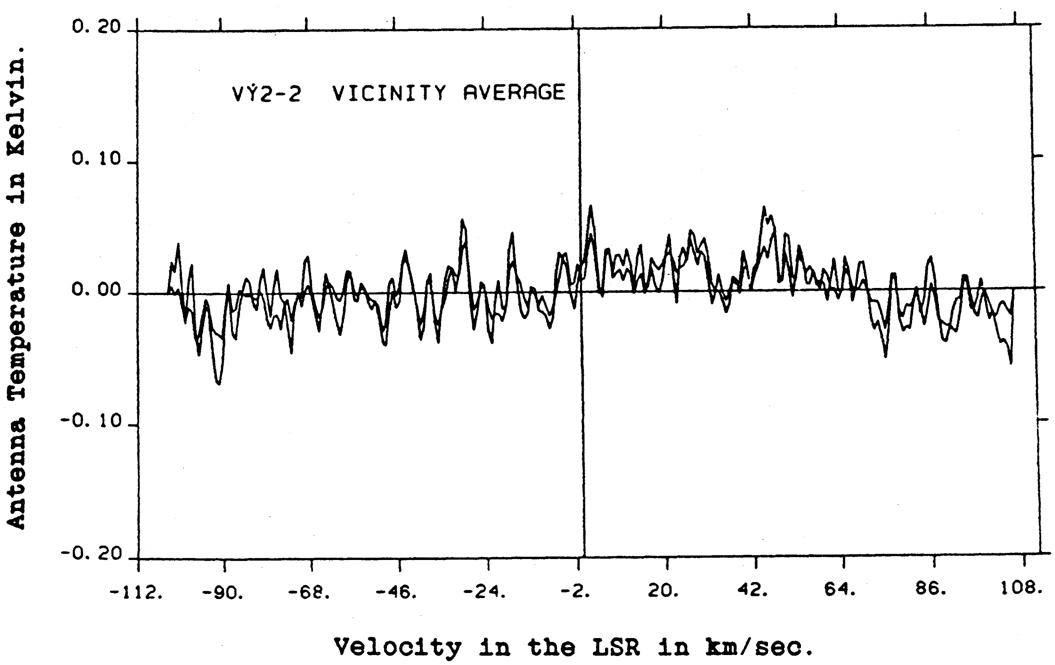

Fig. 4. Average of all off source grid points around VY 2-2 1667.253 MHz. Both polarizations shown. 72 minutes equivalent integration time, rms is .017K.

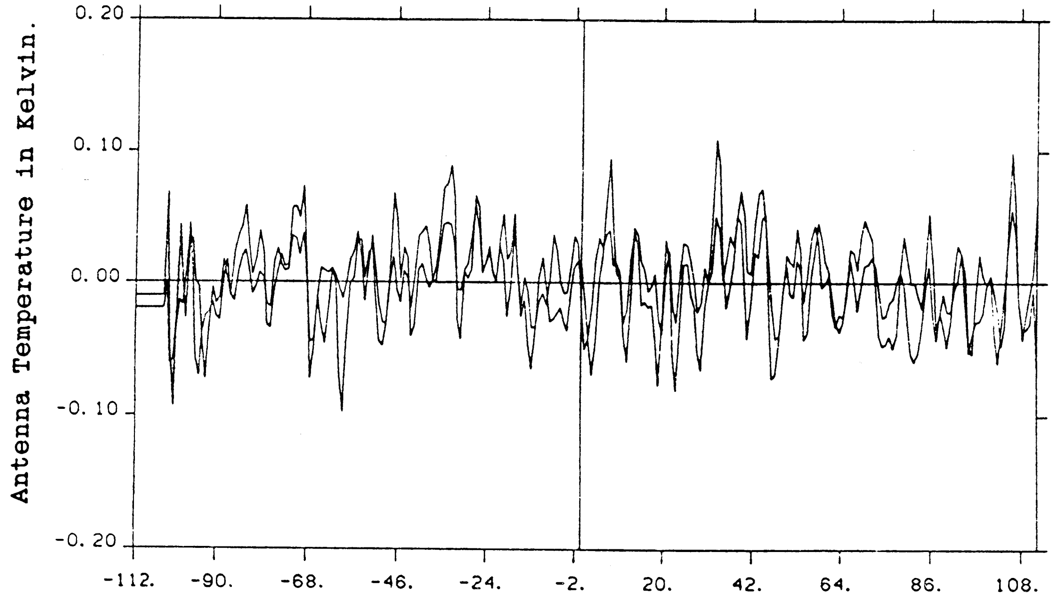

Fig. 5a. NGC 1514. 2667.253 MHz. Both polarizations shown. 24 minutes total integration time, rms is .028K.

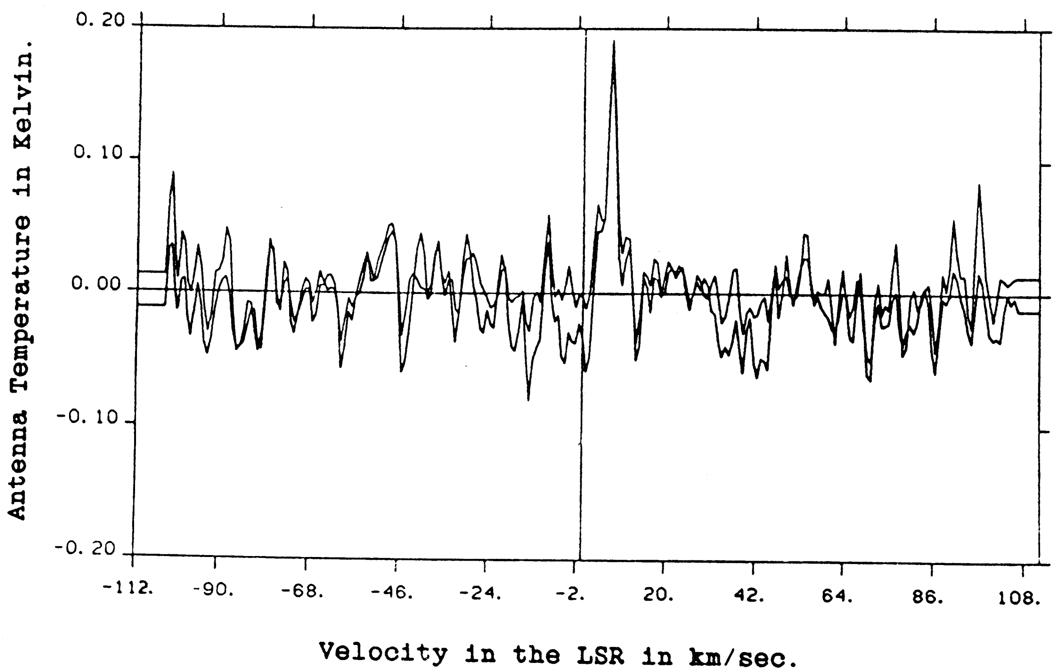

Fig. 5b. Average of all off source grid points around NGC 1514. 1667.253 MHz. Both polarizations shown. 72 minutes equivalent integration time, rms is 0.23K (No correlation for line).

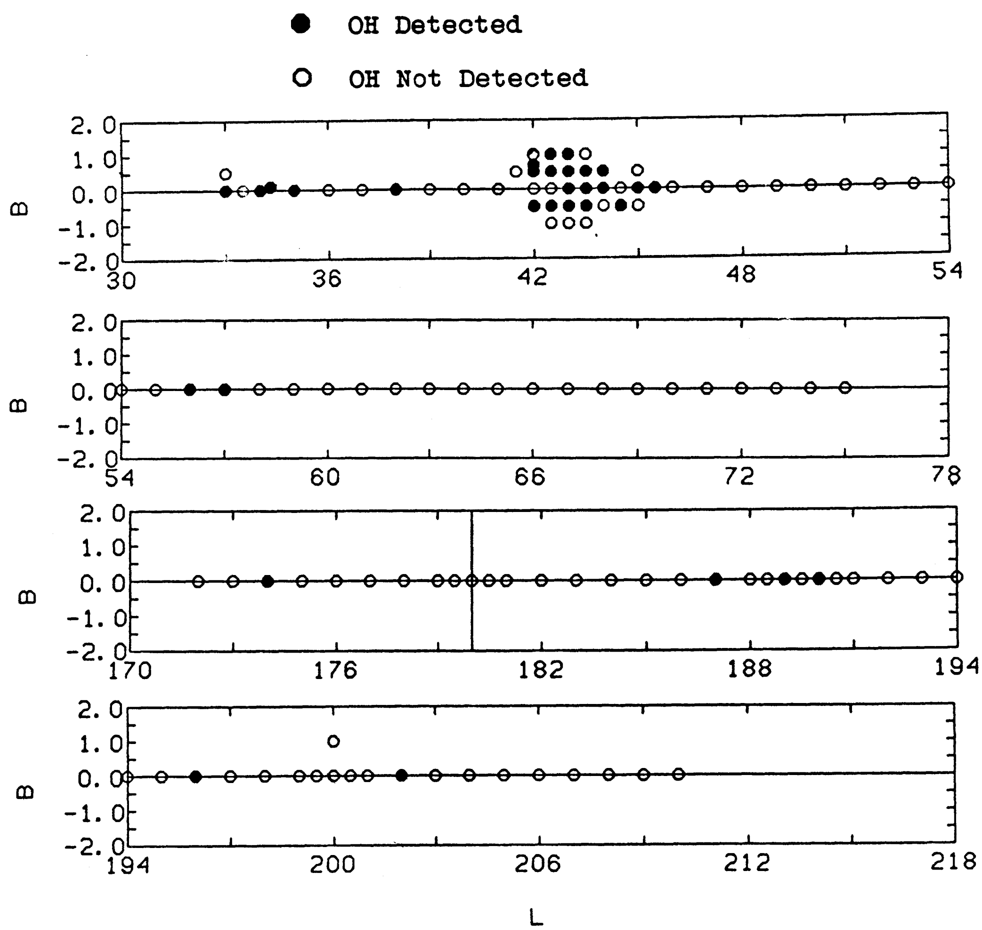

Fig. 6. OH detections near the plane.

IV. SUMMARY

Weak OH emission at 1665 and 1667 MHz is fairly common near the plane of the galaxy. Therefore caution must be exercised in searching for such emission from interesting objects. It is important to have sufficient resolution to be able to isolate the object in question from its nearby field. It is also very useful to have an independent velocity criterion for claiming detection.

Only one object in our present survey, VY 2-2 survives these tests, and hence is the only object which we can clearly associate with the OH emission we have detected in its direction.

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