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A SEARCH FOR WATER MASERS ASSOCIATED WITH HERBIG-HARO OBJECTS

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RESUMO: Procuramos emissão maser de H_2O em 66 objetos Herbig-Haro; detetamos emissão em uma fonte (objeto 19 de Gyul'budgyan, 1982), e provável emissão variável em 4 outros objetos.

ABSTRACT: We searched for H_2O maser emission in 66 Herbig-Haro objects; we detected maser emission in 1 object (number 19 of Gyul'budgyan,1982), and possible variable emission in 4 other objetcs.

Key words: HERBIG-HARO OBJECTS — MASERS

1. INTRODUCTION

Herbig-Haro (HH) objects are tiny and clumpy nebulosities found in dark clouds, which seem to be excited by shocks resulting from the encounter of matter ejected in bipolar flow from recently formed stars, with the surrounding medium. The optical spectrum of these objects presents Balmer emission and usually strong [S II] and [O III] lines, with intensities which are in agreement with shock excitation (Dopita, 1978).

H_2O maser emission at 22 GHz has been searched in the direction of HH objects by several authors (Dickinson et al., 1974, Rodriguez et al., 1980, Haschick et al., 1983), resulting in about ten detections. The detection of H_2O masers provide usefull informations on the velocities, kinematics, and physical conditions in the environment of young stars still embedded in molecular clouds.

In the present work we report the results of a search for H_2O emission in 66 Herbig-Haro objects, which yielded only one clear detection, and possible detections in other objects.

2. OBSERVATIONS

The observations were made with the 13.7m Itapetinga radiotelescope, using a room temperature Shottky barrier diode mixer with about 1200 K system temperature, and an acousto-optical spectrometer with 70 KHz resolution and about +/-200 kms^{-1} velocity coverage. The observing periods were in 1988 July, September and October, and 1989 March, May and July. Several half-hour integrations were made for each object, resulting in a detection limit of about 20 Jy. The velocity scale of the spectrometer was checked by observations of known source Due to instabilities in the system, the velocities of the detected sources can be in error by a most 2 kms^{-1}. The search list, given in table 1, was mostly taken from Reipurth an Graham(1988) and from Gyul'budgyan (1982).

TABLE 1. Negative Results

Nº HH	R.A. (1950)			DEC. (1950)			Nº HH	R.A. (1950)			DEC. (1950)		
G3	2	55	56	17	4	0	46	8	24	17.1	-50	50	34
G6	3	44	31	32	50	0	73	9	0	26.6	-44	39	25
G11	4	23	58	23	53	0	75	9	9	50.7	-45	30	7
102	4	28	25.3	18	0	57	48	11	3	1.9	-77	1	55
G12	4	59	8	-8	57	0	49	11	4	37.4	-77	17	21
G13	5	17	15	-5	56	0	50	11	4	39.7	-77	16	44
58	5	28	22.7	-4	11	44	51	11	8	21.5	-76	8	1
59	5	29	52	-6	31	9	52	12	51	27.3	-76	41	40
G14	5	29	36	12	49	0	53	12	51	34.6	-76	41	17
60	5	30	11.4	-6	28	50	54E	12	52	12.6	-76	40	11
44	5	32	48.5	-5	12	19	54C	12	52	10.1	-76	39	50
62	5	33	47.5	-7	12	51	54D	12	52	10.8	-76	40	16
45	5	33	6.3	-4	52	43	54A	12	52	8.2	-76	40	18
42	5	33	37.4	-5	6	31	54B	12	52	10	-76	40	8
41	5	33	34.2	-5	4	39	77	14	56	42.9	-62	55	53
63	5	34	21	-4	27	45	76	14	56	32.9	-62	52	20
64	5	35	22.3	-7	7	12	78	16	5	51.3	-38	57	10
43/38	5	35	45.4	-7	11	4	79	16	23	45.1	-24	13	42
G15	5	35	34	30	34	0	57	16	28	56.8	-44	49	17
65	5	37	53.8	-7	26	36	56	16	28	54.1	-44	47	37
66	5	37	55	-2	4	4	80	18	16	6.9	-20	53	6
G16	5	38	41	-8	6	0	81	18	16	7.5	-20	52	23
67	5	38	32.6	-1	48	6	82	18	57	53.6	-37	1	36
68	5	39	8.7	-6	27	20	96	18	58	18.8	-37	5	10.5
69	5	39	15.6	-6	31	18	101	18	58	12.3	-37	7	17
70	5	43	28.7	-0	6	43	99A	18	58	42.18	-36	59	13.7
G17	5	44	0	30	34	0	100	18	58	29.4	-37	2	49
71	5	44	46.1	+0	39	43	99B	18	58	43.31	-36	58	56.2
G18	6	5	34	-6	25	0	98	18	58	30.4	-37	1	56.5
72	7	18	4.5	-23	56	45	97	18	58	23.3	-37	4	21.3
47	8	24	22.8	-50	50	0							

. RESULTS

The only clear detection is G19 (figure 1); this emission was observed in several bserving periods. For some other sources we obtained about 2 sigma detections (of the order of .3 K or 12 Jy) in some, but not in all the observational periods, so that we consider these as robable detections. The results are summarized in Table 2.

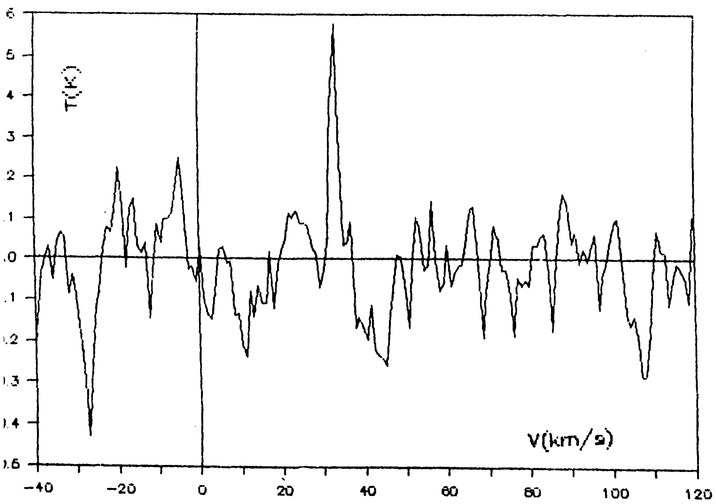

Figure 1: The H_2O spectrum of G19.

The object G19 is situated in a crowded area of the sky; there are several IRAS sources in the field so that no clear identification is possible.

TABLE 2. Possible detections and G19.

Name	R.A. h,m,s	Decl. deg,m,s	Velocity kms^{-1}
G10	4 23 40	25 56 00	48 ?
HH61	5 33 47	-07 08 51	59 ?
HH74	9 00 28	-44 37 59	42 ?
HH55	15 53 18	-37 42 12	49 ?
G19	17 55 27	-26 07 00	33

No emission greater than 0.6 k was observed in any of the 66 searched objects.Since the HH objects belong to nearby (nearer than 500 pc) molecular clouds, their emission is intrinsically weaker by about 3 orders of magnitudes than the emission from regions of massive star formation like Orion A. The low detection rate that we obtained is in agreement with the previous searches, and is attributed to the weakness and to the variability of these masers. The weak emission, the variability and the high velocities are consistent with the interpretation of the HH objects being associated with small clumps of gas moving at supersonic speed with respect to the surrounding medium. The resulting shock is probably the excitation mechanism of the masers.

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