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MONITORING OF WATER MASERS FROM IRAS SOURCES

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RESUMEN. Se hicieron observaciones sistemáticas de las intensidades de veintitrés máseres de vapor de agua en la dirección de las fuentes de IRAS en el hemisferio sur, desde el Radio observatorio de Itapetinga. Estos máseres fueron detectados en cuatro búsquedas en las cuales cada observación tiene diferente criterio de selección. El análisis de flujo IRAS y la forma del espectro de estos máseres sugiere que los objetos están asociados con estrellas pre-secuencia principal, todavía rodeadas por el polvo de su envoltura. Casi todas las fuentes presentaron cambios drásticos en la distribución de líneas espectrales en sus espectros.

ABSTRACT. Twenty three water vapour masers in the direction of IRAS sources in the southern hemisphere had their intensities monitored sistematically at Itapetinga Radio Observatory. These masers were detected in four surveys in which each run had different selection criteria. The IRAS fluxes analysis and the shape of the spectra of these masers suggest that the objects are associated with pre-main sequence stars, still surrounded by the dust cocoon. Almost all sources presented drastic changes in the overall spectral line distribution in their spectra.

Key words: INFRARED-SOURCES — MASERS

- INTRODUCTION

Infrared observations have been carried out over a range of about 1-'00 µm. The atmosphere of the Earth contains a number of transparent windows ı the range 1-40 µm namely J, H, K, L, M, N and Q (1.25, 1.65, 2.2, 3.5, 4.5, ' and 20 µm, respectively). Between 40 and 300 µm no observations from the ırth's surface can be made and airbone or space platforms must be used (Wynn-illiams, 1985).

Prior to IRAS there had been few attempts to make infrared surveys of ıe sky. The Caltech (IRC) survey (Neugebauer and Leighton, 1969) presented .ve thousand infrared sources brighter than 3rd magnitude north of :clination -40°. It was performed with a 1.5 m ground based telescope at 2.2 n. Most of the sources were identified with cool stars. The AFGL rocket ırvey (Kleinmann et al. 1981) found two thousand sources in the range 4-27 µm sing a 3'X10' beam. While most of the 4 µm sources were identified with cool ars, many of the 11 and 20 µm sources were thought to be associated with HII :gions or molecular clouds. The IRAS Point Source Catalogue 2.0 presents the bservations of more than two hundred thousand point sources in the infrared RAS 1985a,b).

The IRAS survey was a great improvement over AFGL in sensitivity 100 times better), spatial resolution (2-8 times better) and reliability ach source was observed about 6 times). These data consist of 2' spatial :solution photometry at four wavelenghts (12, 25, 60 and 100 µm) and some :ry low resolution ($\lambda/\Delta\lambda \sim 10$) spectroscopy of the brightest compact sources.

It's well known that, of the five types of molecular masers (OH, H_2O, CH_3OH, SiO and H_2CO) in regions of star formation, water vapour masers are the most powerful, may trace bipolar flows, have the widest spreads in velocity and produce the most variable spectral lines yet observed, varying from hours (Abraham et al., 1986) to months (e.g. Sullivan III, 1973; Sestokas Filho 1988).

Masers have been searched for in the direction of peaks in the radio continuum maps by several authors (Caswell et al. 1980, 1983a,b; Braz and Scalise, 1982). The detected masers have showed no correlation between the strength of the continuum peaks and the water lines, although some are seen in the direction of strong temperature gradients in the maps (Scalise and Schaal 1977). Others authors have showed that infrared point sources detected by IRAS in the direction of star formation regions with associated molecular maser emission have colour index (CI) in well defined intervals (Braz and Epchtein 1987; Braz and Sivagnanam, 1987).

The observations in the infrared have revealed the existence of objects at or near the maser positions. These objects are the best tracers for sites of massive star formation.

2 - OBSERVATIONS

The observations of the 6_{16} - 5_{23} rotational transition of the water maser at 22.23508 GHz were made with the 13.7 m enclosed antenna at Itapetinga Radio Observatory. The HPBW of the radiotelescope at this frequency is 3.7 arcmin. A room temperature mixer receiver operating at the K band was used with a 750 channel acousto-optical spectrometer. The configuration used has a resolution of 70 kHz representing a spectral resolution of 0.94 km s^{-1} (Scalise et al., 1986), covering an instantaneous velocity interval of the order of 600 km s^{-1}. The system temperature (SSB) was typically 800 K. The observations were made using the on-on beam switching which consists in commuting the position of the source from one horn to another every minute. The differential gain measured between the two horns was never larger than 9%. The antenna temperature obtained was corrected for optical depth, zenital gain and radome transmission. The radio galaxy Virgo A was used as a prime calibrator. The resulting aperture eficiency was 42% which gives a flux factor of 45 Jy/K.

3 - DISCUSSION

Twenty three water vapour masers in the direction of IRAS sources in the southern hemisphere had their intensities monitored sistematically at Itapetinga Radio Observatory. These masers sources were detected in four surveys. Each run had different IRAS sources selection criteria: *i)* sources placed in the vicinities of strong continuum peaks of galactic HII regions and molecular clouds that have CI values within the intervals found by Braz and Epchtein (1987) in the IRAS Point Source Catalogue 2.0 (Braz et al., 1989); *ii)* sources with no association reported in any of the 37 catalogs listed in the Table V.H.1 of the IRAS Explanatory Supplement that have flux larger than 1000 Jy at 60 or 100 µm (Scalise et al., 1989) and *iii)* sources usually placed at the periphery of ultra-compact HII regions which are invariably present in association with the OH masers (Caswell et al. 1980, 1983a). The selected water masers from IRAS sources are presented in Table 1, in which we show the IRAS and the maser position, and the velocity with respect to the local standard of rest of the most proeminent component.

Several authors have proposed criteria to classify sources on the basis of their IRAS colour index (Wouterloot and Walmsley, 1986; Emerson, 1987; Wood and Churchwell, 1989; Hughes and MacLeod, 1989; Scalise et al., 1989).

Table 1: Selected water masers from IRAS sources.

NAME	IRAS RA(1950) (h m s)	IRAS DEC(1950) (° ' ")	MASER RA(1950) (s)	MASER DEC(1950) (' ")	V_{LSR} (km s^{-1})
08303-4303	08 30 23.2	-43 03 31	23.2	03 31	8
09002-4732	09 00 12.1	-47 32 07	12.1	32 07	-58
09149-4743	09 14 57.9	-47 43 50	58.0	44 00	9
10295-5746	10 29 35.4	-57 46 40	36.8	46 40	3
11097-6102	11 09 44.7	-61 02 17	47.2	02 30	-123
11119-6052	11 12 58.7	-60 52 11	54.0	52 57	14
13092-6218	13 09 16.3	-62 18 36	21.2	18 02	-37
14416.5937	14 41 39.6	-59 36 21	36.4	36 53	-46
14498-5856	14 49 51.9	-58 56 40	51.9	56 40	-53
15278-5620	15 27 49.8	-56 20 15	49.8	20 15	-57
15492-5426	15 49 13.3	-54 28 26	12.5	28 12	-58
15579-5303	15 57 55.7	-53 03 19	58.1	03 38	-47
16065-5158	16 06 32.3	-51 58 15	30.0	58 14	-52
16162-4956	16 16 12.4	-50 07 33	02.0	07 50	-90
16183-4958	16 18 22.9	-49 59 57	24.5	59 08	-52
16487-4423	16 48 45.1	-44 22 04	40.6	22 07	-41
16547-4247	16 54 43.5	-42 47 33	43.5	47 33	-40
16594-4137	16 59 27.2	-41 37 38	28.5	37 47	-4
17130-3756	17 13 03.1	-37 56 57	00.0	56 21	-81
17233-3606	17 23 22.3	-36 06 55	20.9	06 53	-1
17278-3541	17 27 52.4	-35 41 57	52.4	41 57	-5
17402-2938	17 40 14.2	-29 38 01	15.5	38 08	-2
18507+0121	18 50 45.2	01 21 09	45.2	21 09	59

The CI [25-12], [60-25] and [100-60] were determined as the logarithm of the $\lambda * F(\lambda)$ ratios between the non corrected fluxes at 12, 25, 60 and 100 µm. The observed sources for the criteria above in the CI diagrams [25-12] vs [60-25], [60-25] vs [100-60] and [25-12] vs [100-60] are presented in Figure 1.

In this work we present the results of the selected sources that have CI [25-12], [60-25] and [100-60] out of the ranges 0.2 to 1.4, 0.4 to 1.3 and -0.2 to 0.5, respectively. The different distributions of the CI in Figure 1 may be attributed to the present evolution state of these sources. Figure 2

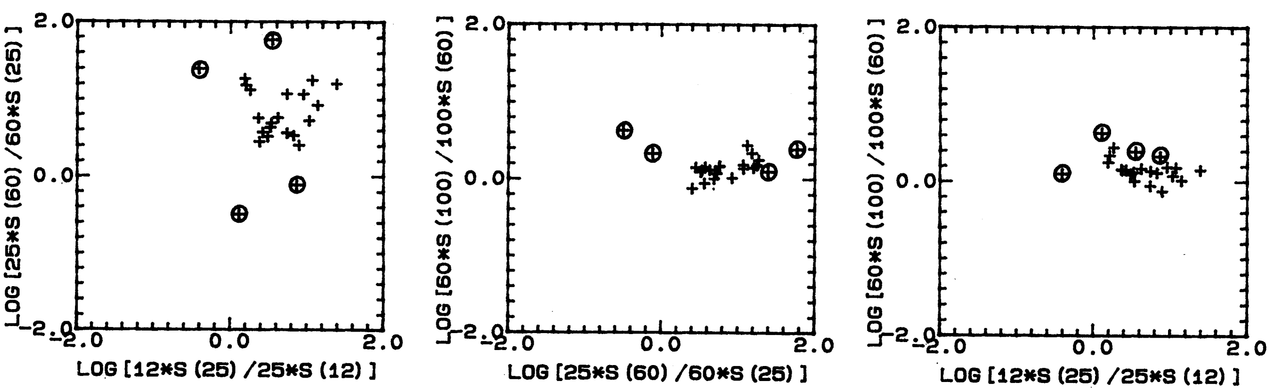

Figure 1: Colour-colour diagrams for the twenty three selected sources. a) [25-12] vs [60-25], b) [60-25] vs [100-60] and c) [25-12] vs [100-60]. Circles represent the masers presented in Figure 2.

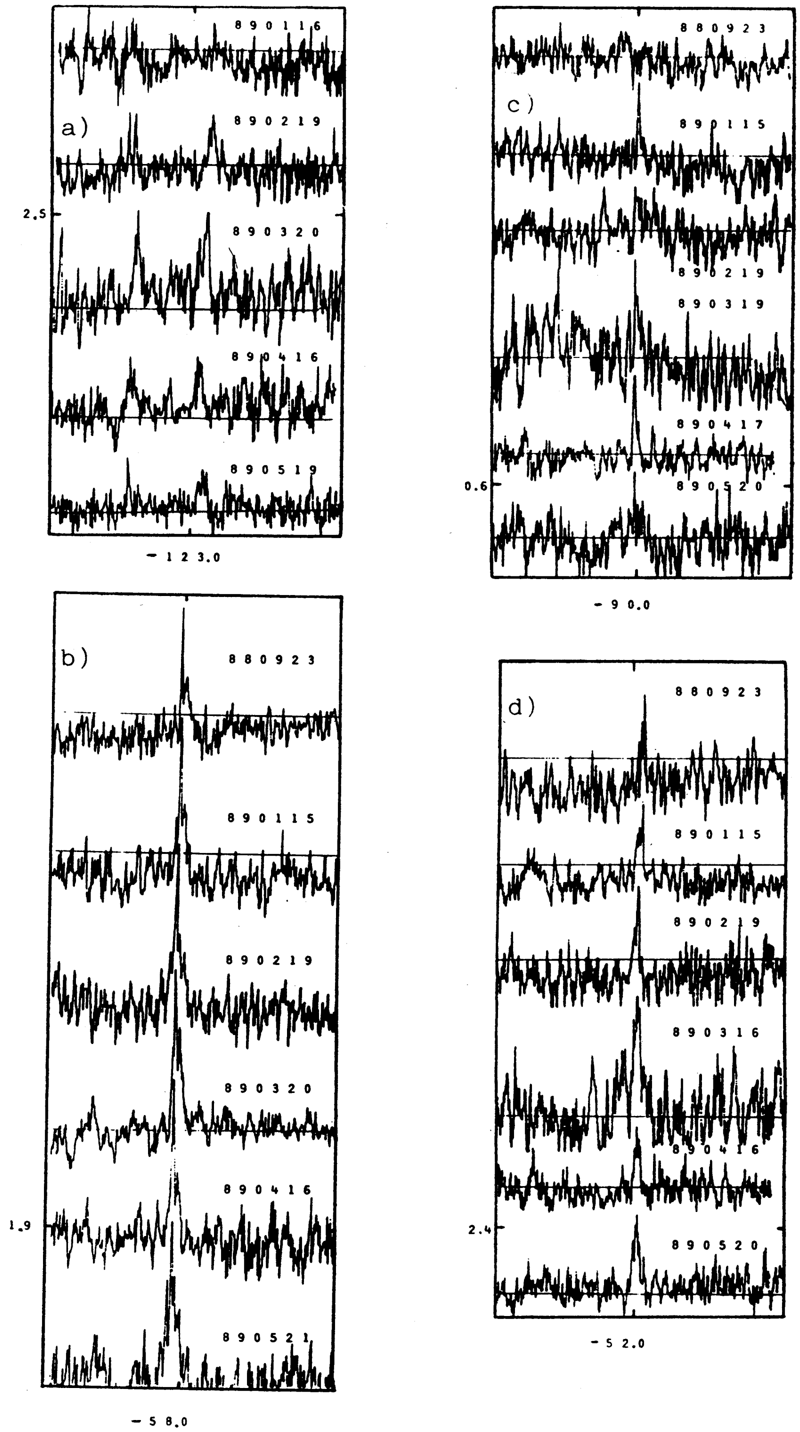

Figure 2: Temporal variability of the water maser spectrum in the period Set 1988 to May 1989. The axis of the ordinates is the corrected antenna temperature (K) whereas the axis of the abscissae is the velocity with respect to the Local Standard of Rest (km s^{-1}): a) 11097-6102; b) 15492-5426; c) 16162-4956; d) 16183-4958.

hows the spectra for the four out of the twenty three monitored masers in the eriod Set 1988 to May 1989. Since Jul 1989 this programme of monitoring have een carried out with a resolution of 40 kHz. Almost all sources presented rastic changes in the overall spectral line distribution in their spectra.

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