OBSERVACIONES EN OH DE FUENTES SELECCIONADAS DEL I.R.A.S. DESDE EL HEMISFERIO SUR

OH OBSERVATIONS OF SELECTED I.R.A.S. SOURCES FROM SOUTHERN HEMISPHERE

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RESUMEN: En este trabajo reportamos los resultados de observaciones de 53 objetos tomados del catálogo de puntos fuente del satélite IRAS, con declinaciones menores a -30°. Esos objetos fueron estudiados en la transición de 1612 MHz, así como en las líneas principales del radical OH en 1665 y 1667 MHz. Las observaciones fueron hechas en el Instituto Argentino de Radioastronomía con una antena de 30m. El criterio de selección aplicado corresponde a estrellas evolucionadas con envolturas circumestelares frías. Encontramos 12 objetos con radiación maser en emisión y/o absorción. Seis de ellos son nuevas detecciones no reportadas previamente. Diez objetos presentan perfiles con dobles picos en la línea satélite, típicos de estrellas OH/IR con envolturas en expansión. Un análisis global de las propiedades de color de los 53 objetos seleccionados no muestra ninguna diferencia significativa entre fuentes detectadas en OH y aquellas sin detección. Un análisis posterior de los datos permite concluír que el mecanismo de excitación del maser es producido por el polvo circumestelar que provee el bombeo infrarrojo de las moléculas, lo que es usual en este tipo de fuentes.

ABSTRACT: In this paper, we report the results of observations of 53 objects taken from the IRAS point source catalog, with $\delta < -30^{o}$. These objects were studied in the 1612 MHz transition, as well as in the 1665 and 1667 MHz main lines of the OH radical. The observations were made at the Instituto Argentino de Radioastronomía with a 30m antenna. The selection criteria applied to the objects place them among the stars of evolved type with cool circumstellar envelopes. We found 12 objects with maser radiation in emission and/or absorption. Six of them seem to be new detections previously unreported. Ten objects show double peak profiles in the satellite line, as is typical for OH/IR stars with expansion envelopes. An analysis of the global IRAS colour properties of the 53 selected objects does not show any significant difference between the sources detected at OH and those not detected. Further analysis of the data allow us to conclude that the excitation of the maser mechanism is produced by infrared pumping due to circumstellar dust, as is usual in these types of sources.

I. INTRODUCTION

The Infrared Astronomical Satellite IRAS was very efficient in the detection of point sources having colour temperatures between 200 and 1000K. This is a good match to the range of the colour temperatures, which are characteristic for the dust shells of AGB stars. Olnon et al. (1984) were the first to show that the OH/IR stars are located in a specific area of the colour-colour diagram. These objects are cool (Tenv =

2000K), oxygen rich ([O]/[C]>1), as well as high IR luminosity ($L = 10^4$ L⊙), (Goldreich & Scoville, 1976). OH/IR stars have proven to be very useful in such research areas as stellar evolution and galactic dynamics. The presence of the strong OH maser radiation, specially at the 1612 MHz transition, can be used in combination with infrared measurements as an indicator of the evolutionary status of the star (Zijlstra et al. 1989). The OH line provides a medium to know the expansion velocities of the envelopes and hints about the conditions of excitation of their neutral gas and the mass-loss process of the star. In the next sections we present preliminary results about both, the criteria for selecting the sources and the OH-observations of them.

II. THE SELECTION CRITERIA

The criteria used for selecting the IRAS sources are as follows (Likkel, 1989):

1) T25/60 < 250K, where T25/60 is the colour temperature as determined from the tabulated 25 and 60 um IRAS flux densities. This corresponds to a ratio of fluxes F25/F60 < 2.5.

2) Total IR luminosity L > 90 L⊙ (assuming a distance of 1 kpc). The approximate total IR flux was calculated using the four IRAS bands.

3) A ratio of T25/25 to T60/100 below 1.3. This is an empirical method of selection in order to avoid warm spots in interstellar clouds.

4) At most only one IRAS band could have an upper limit (in order to compare two temperatures). The flux F100 was not used when contamination or confusion from interstellar dust emission was likely. The 12, 25 and 60 um fluxes were generally required not to be upper

limits.

5) F100 might not exceed F60, or alternatively, F100 might not have an upper limit greater than twice F60. This is to avoid objects dominated by dust emission from interstellar clouds.

6) Cataloged objects that were optically identified as being non evolved stars were excluded. Thus, sources at positions which were associated **only** with HII regions, nebulae, early type emission line stars, or extragalactic objects were not considered.

III. OBSERVATIONS

The observations were made with the 30m-antenna, at the Instituto Argentino de Radioastronomía (IAR), during the period August 1989 to April 1990. We observed the satellite line of OH at 1612.231 MHz as well as both the principal lines, at 1667.359 and 1665.401 MHz. The circular beam had an HPBW of 29' and the aperture efficiency was $\eta a = 0.45$. This gives a factor of 8.7 Jy/K for converting antenna temperature into flux density. A single linear polarization was available. The receiver system temperature was 85K on cold sky. The sources of calibration were: G 267.9-1.1 (RCW38) for 1667, NGC 6334B for 1667 and 1665 and 331.5-0.1 for 1612 MHz. For the latter source we adopted a peak flux density of 139 Jy. At the backend we used a bank of 112 filters of 10 kHz wide (1.76 km/s in 1667) covering a velocity range of 200 km/s. In addition, a bank of 74 cristal filters of 2.2 kHz wide (0.4 km/s) was used for some of the selected objects.

The minimum integration time used was 40 minutes and the maximum one was 5 hours. We employed the frequency switching mode with the comparison frequencies at ± 1.5 MHz. The ranges of radial velocities adequate for the observation of the selected sources were chosen from the models of the galactic differential rotation (cf. Burton, 1988).

IV. RESULTS

In figures 1a-1h, we show eigth representative profiles as found in the sample of detected sources. The double peak of 17579-3121 (IRAS name) at 1612 MHz is a new detection. It is typical for OH/IR stars with expansion envelopes. The object 10197-5750 was first detected by Allen et al. (1980) and named "Roberts 22". It is interesting because of a possible transition towards a bipolar nebulae. The absorptions which occur in the three lines of OH in 16279-4757 are original detections. Their association with a nearby molecular cloud is studied. (Volk & Cohen, 1989).

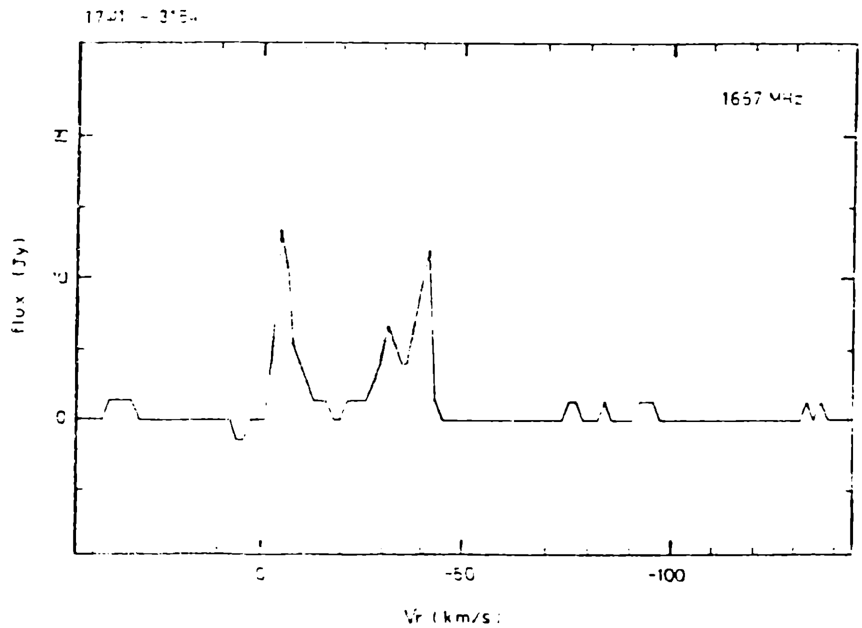
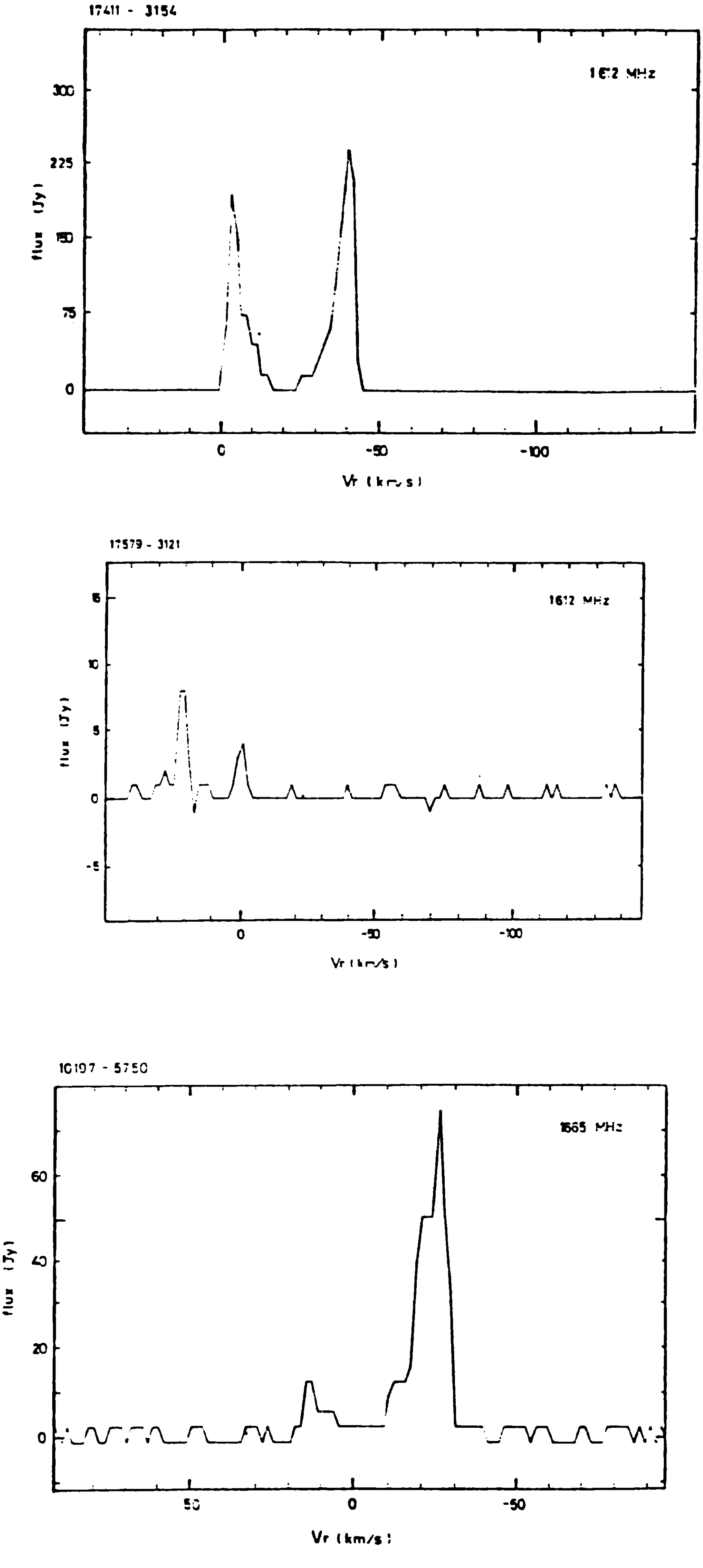
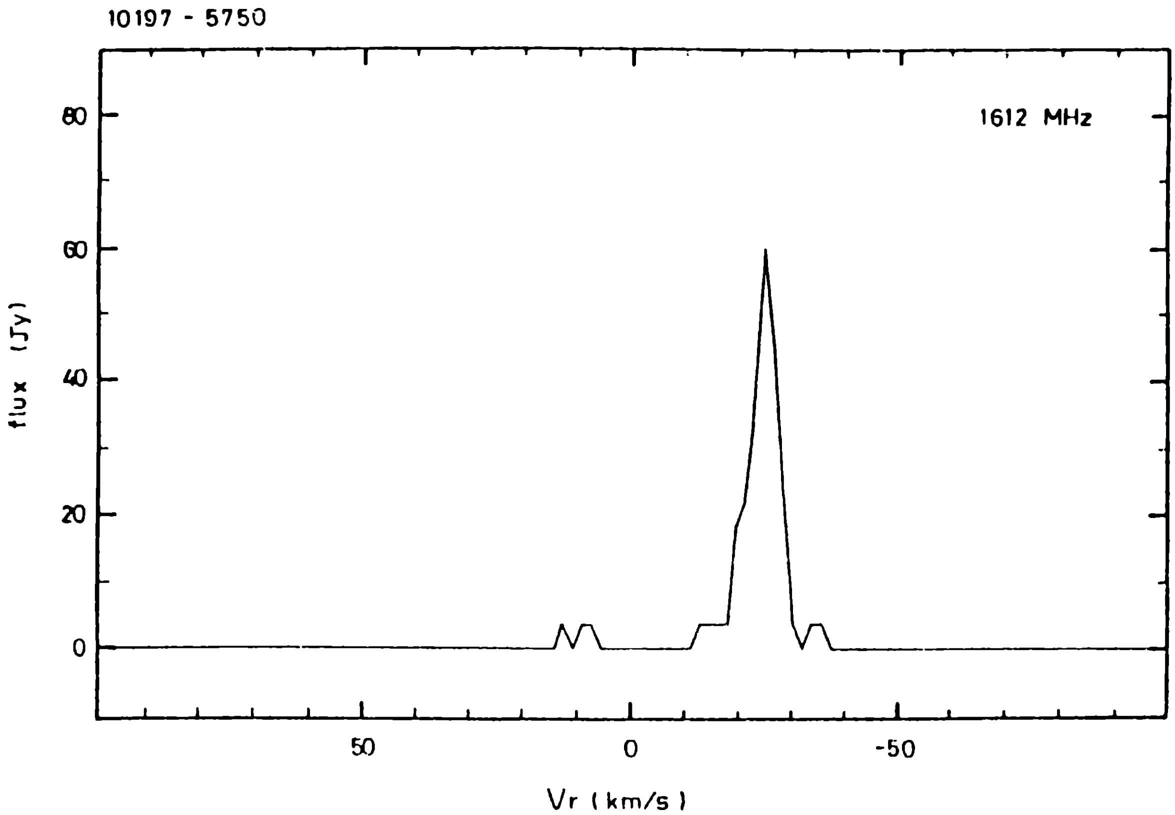
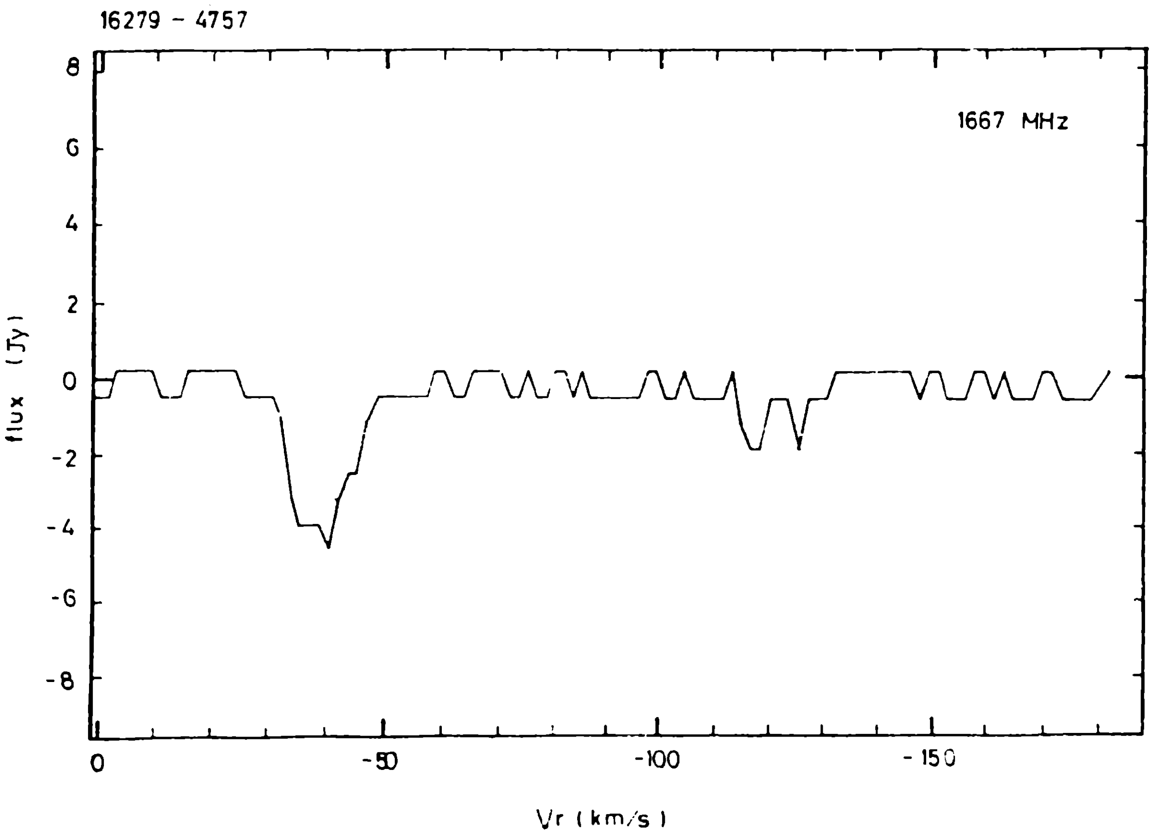


Figure 1a-h: Some representative profiles of objects detected in our sample of IRAS sources. The IRAS name and the frequency of observation are indicated.

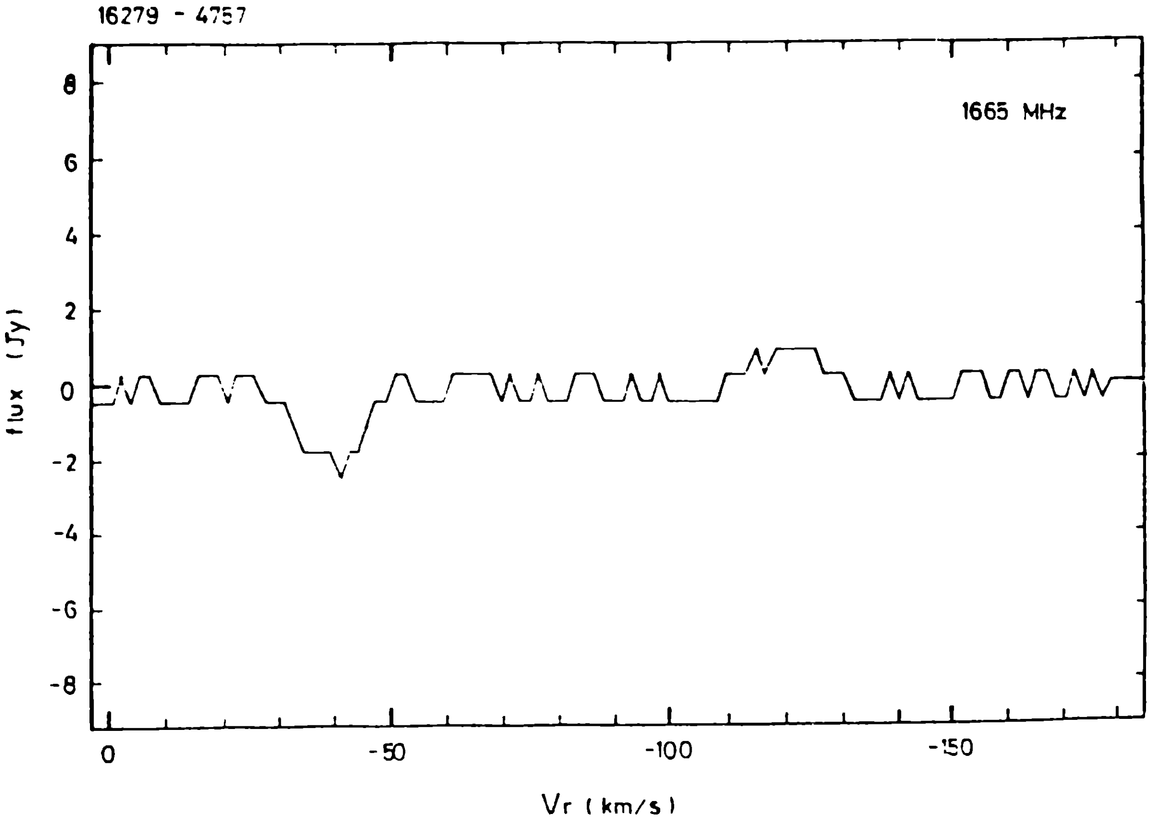


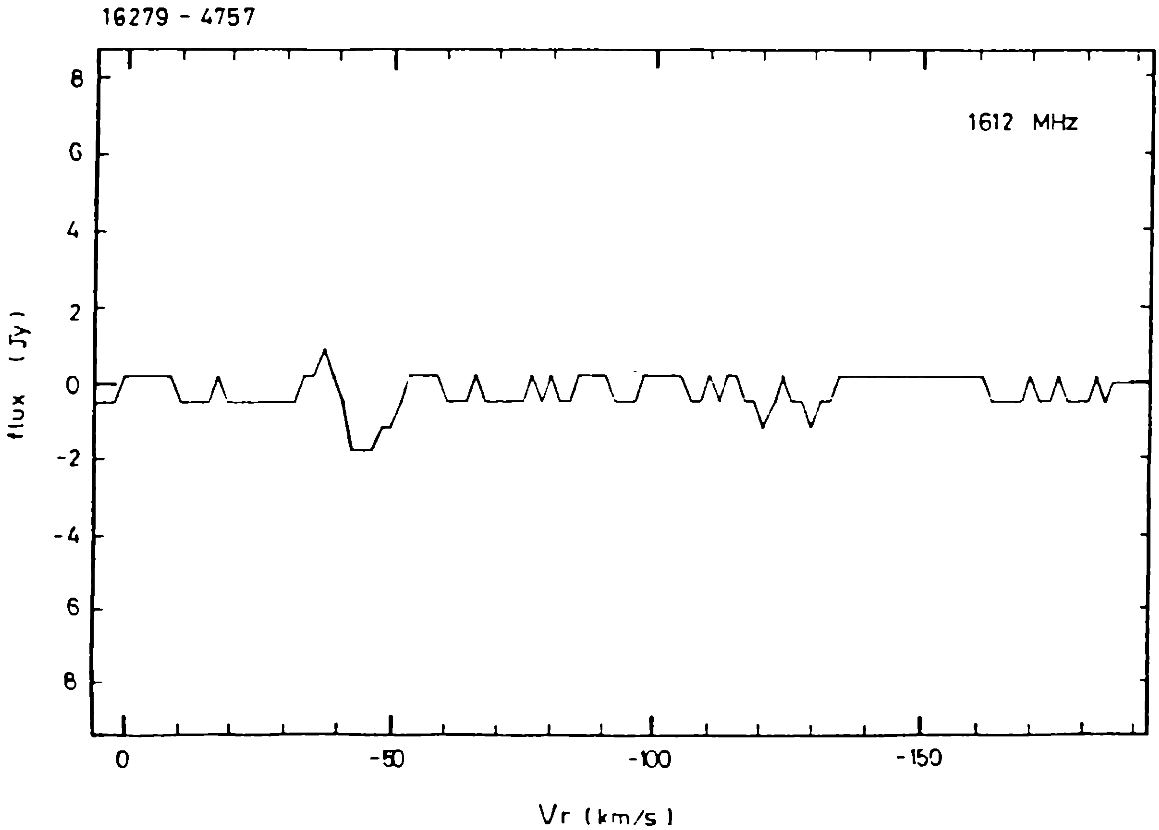
Figures 1a-h (b-c-d)





Figures 1a-h: (e-f)





Figures 1a-h: (g-h)

IRAS 17411-3154 is one of the most intense OH-masers as far known. It was detected at 1612 MHz by te Lintel Hekkert (1990). The detection in the 1667 MHz line is original.

In the colour-colour diagram (Fig. 2) the objects considered in this paper were classified into three groups (see figure caption) according to their OH-profile: 1) standard double peak profiles; 2) non standard peak profiles; 3) non-detections.

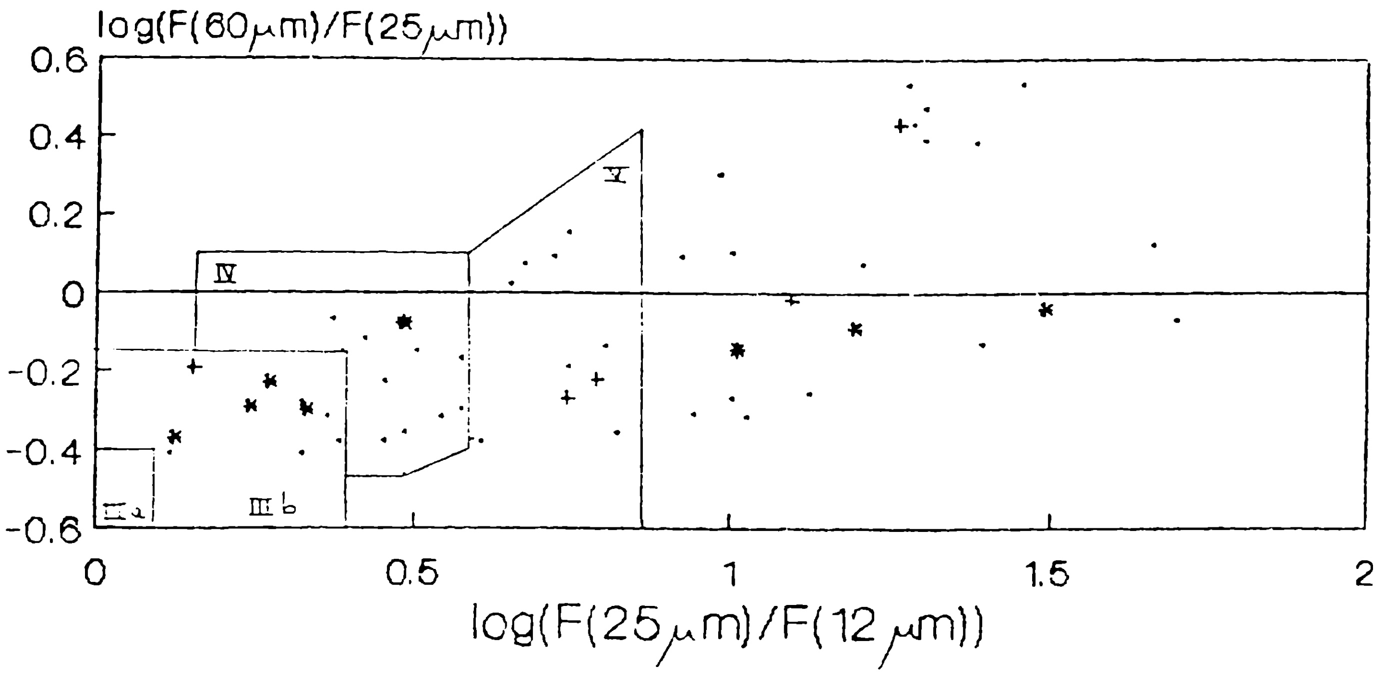


Figure 2: The colour-colour diagram. The following symbols are used: (*): IRAS point sources with detected 1612 MHz maser emission with standard double peak spectra. (+): IRAS point sources with detected maser radiation with non-standard double peak profiles. Here the profiles can have either a single emission peak, or a broad emission, or absorption feature . (.): IRAS point sources without detectable 1612 or 1667 MHz em.ssion. The subdivision into regions was taken from van den Veen (1989).

A subdivision into zones adapted from van den Veen (1989) is also included. The following zones are distinguished:

IIIa: Small mass progenitor types. Tenv ≅ 300K.

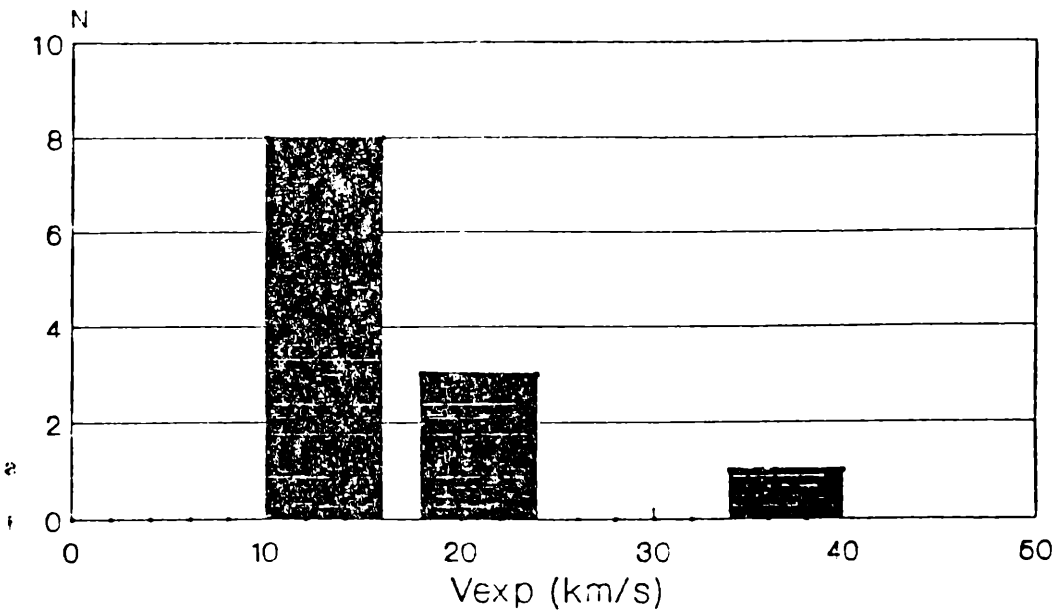
IIIb: Pulsating AGB stars with high mass-loss rates: OH/IR stars. Tenv ≅250K.

IV: Evolutive transition from IIIb to V. Tenv ≅ 200K.

V: Planetary nebulae: the pulsation is stopped. Tenv ≅ 160K.

As can be seen five positive detections are located out of these regions, towards the right of the diagram. We conclude that IRAS point sources located in this area are also candidates for having OH-maser radiation. The non-detections are distributed all over the diagram. Nevertheless, in the IIIb region, the ratio of detections to non-detections reaches its maximum value. Here the largest number of OH/IR stars was found.

The expansion velocities of the envelopes can be easly inferred from the double peak profiles, due to their correspondence to the red and blue shifted sides of the envelopes. The profile widths were calculated at 2 rms limits. Histograms for both these parameters are presented in figures 3 and 4.



gure 3: Distribution of the expansion velocities of the envelopes for the detect sources having standard double peak spectra.

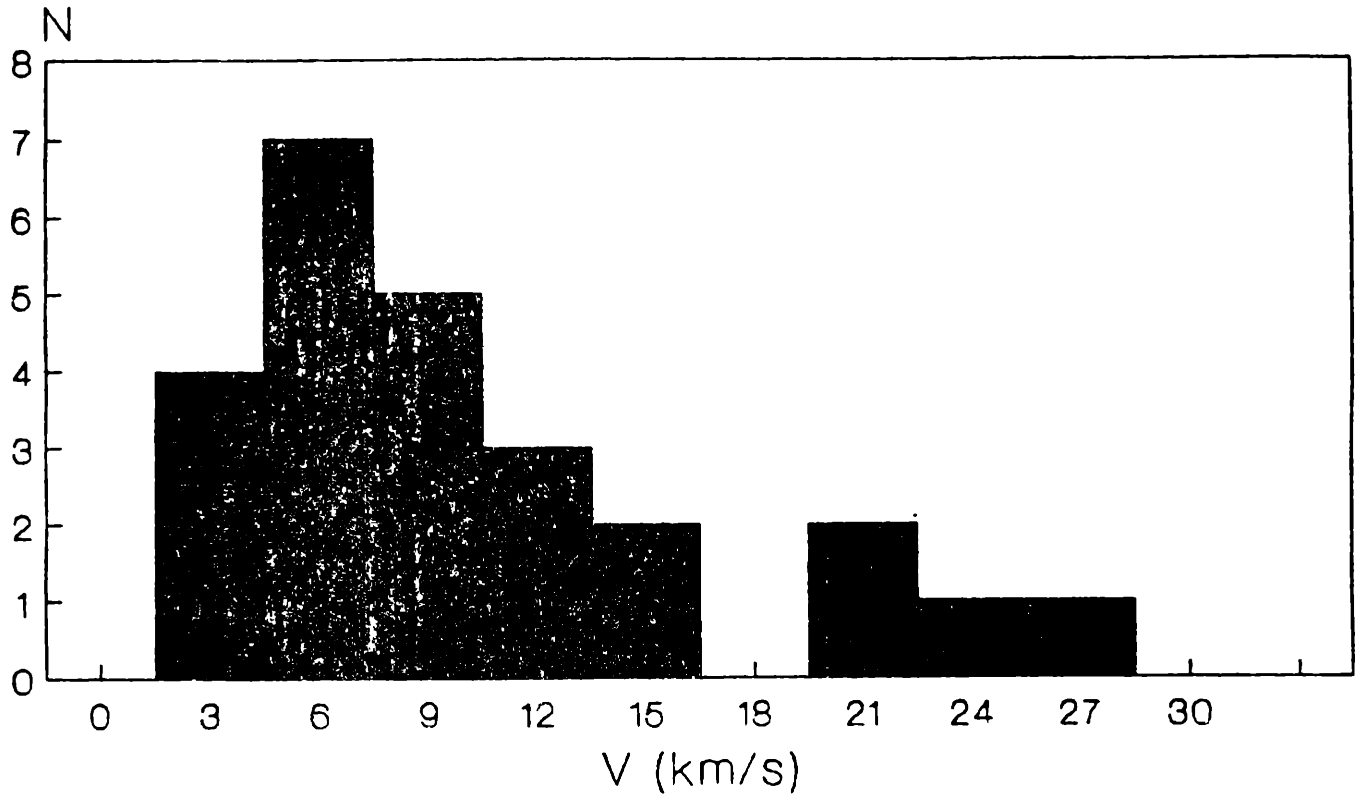


Figure 4: Distribution of the line widths.

To check the radiative pumping model of the 1612 OH maser by far infrared photons in the 35um pump-line (Evans & Beckwith 1977) we calculated the correlation between the 1612 OH flux and the 35um flux. The latter was inferred by interpolation between the 25 and 60um IRAS fluxes. We computed the mean pump efficiency:

$$\langle e \rangle = S_{OH} / S_{35um} = 0.12$$

with a correlation coefficient r = 0.9.

This value is somewhat below the preceding estimations (Elitzur 1982), but nevertheless it supports the model of infrared pumping by 35um photons.

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