A Survey of CO Emission in Water Maser Sources Associated with Low Color Index IRAS Sources

Jarken Esimbek[1,2], Yuefang Wu[1] & Hongbo Zhang[2]

(1 *Astronomy Dept, CAS-PKU Joint Beijing Astrophysics Center* 100871)
(2 *Urumqi Astronomical Observatory,NAO,CAS,Urumqi* 830011)

Abstract Using the 13.7 m radio telescope of the Qinghai station of Purple Mountain Observatory at Delingha, we searched for CO J=1-0 line in 98 water masers in December 2001. The results show that 66 sources are associated with molecular gas. 13 sources have been identified to be molecular outflow candidates. Their properties are discussed briefly in connection with low color index IRAS sources associated with water masers.

Key words pulsar-mode change-spectrum

1 Introduction

The masers spots and large-scale outflows tend to be associated with the deeply embedded and probably young stellar objects(YSOs). The relation between water masers and molecular gas is very important for understanding the evolution of YSOs and the interaction between sources and their parent clouds. Fig.1 shows distributions of IRAS sources associated with water masers in the IRAS color-color diagram(Jarken et al 2003). The upper-right region or high red color index region of the diagram satisfies Woot and Churchwell(WC) criterion which is related with high mass star formation (Wood and Cheuchwell 1989). The criterion of Emerson (Emerson 1987), is given to select low mass cloud cores. The lower-left region or high blue color index region satisfied the criterion of Wu (Wu Y et al. 1996), which is about the candidates of OH/IR sources. Lowwer red and blue color index objects which do not satisfy any criterio locate in the center region. This region contains 98 sources with -0.5<$\log(F_{25}/F_{12})$<0.5 and -0.5<$\log(F_{60}/F_{12})$<1. Are these masers still in gas and dust regions? Is there any high velocity gas near them? With these questions we observed the 98 objects in the CO (J=1-0) lines.

2 Observations

Our observations were carried out by the 2.6-mm system of the 13.7 m radio telescope at Qinghai station of Purple Mountain Observatory, in CO J=1-0 transition of 115271.201 MHz. We used a cooled frequency mixer receiver with a typical temperature 250 K (single band). The 1024-channel AOS spectrometer has a total bandwith of 170 MHz and equivalent velocity resolution of 0.43 km s^{-1}. The flux was corrected for atmospheric absorption. The antenna at the working wavelength had a half-power beamwidth of 54", the pointing and tracking accuracies were better than 10". The antenna efficiency is 0.50 during the observation period. All spectra are taken in the position switching mode.

3 Results and Discussions

Among 98 water maser sources 66 were detected with CO J=1-0 emission, that is, 37 of 45 interstellar sources and 29 of 53 stellar sources are associated with molecular clouds. The results suggest that the detection rate (82%)of CO emission in interstellar water maser sources is higher than that(55%) in stellar maser sources for these low IRAS color index objects. The reasons for the difference may be concerned with density, distribution of the associated gas and the size of the gas region.

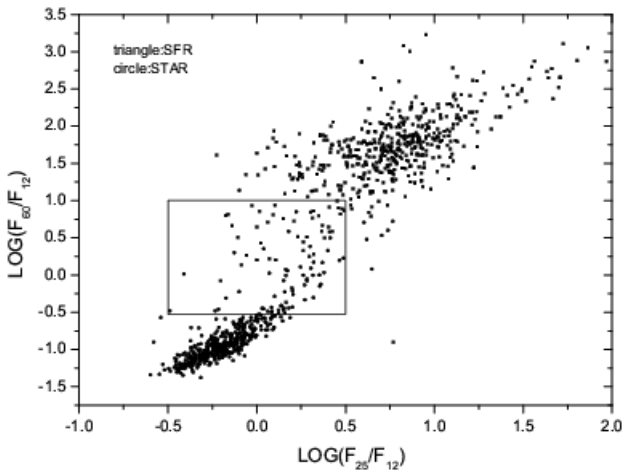

Fig.1.The IRAS colour-colour diagram of water masers

Table 1 Outflow Candidates Detected

Source Name	R.A.(1950) h m s	Dec.(1950) ° ′ ″	Class	V_{LSR} km/s	$\triangle V_{FWHM}$ km/s	$\triangle V_{FW}$ km/s	Pro.	V_{HD} km/s	MSX
12782-0002	01 30 27.60	62 11 31.08	STAR	4.3	3.2	5.3	WS	(-106.4 -22.2)	Y
14539+0400	03 54 24.00	58 19 20.93	SFR	-2.3	2.9	6.8	WS	(-110.1,-25.9)	Y
S209	04 06 24.70	50 52 08.04	SFR	-49.3	3.4	7.0	BW	(-96.1,-11.9)	Y
WB690	05 38 00.90	+36 08 27.00	SFR	-23.6	4.7	12.3	BW	(-189.0,149.0)	Y
NGC 2023	05 39 04.10	-07 17 56.00	SFR	4.2	2.8	5.0	RW	(-117.0,142.0)	N
G6.08-0.12	17 56 50.30	-23 45 24.00	SFR	9.5	15.9	16.5	Double	(1.0, 3.4)	Y
01008-0009	18 05 18.00	-20 16 40.06	STAR	79.7	6.5	13.0	WS	(-53.1,115.5)	Y
02872-0058	18 43 09.80	-04 04 02.07	STAR	82.6	10.8	21.0	Multi	(30.2, 59.1)	Y
18572+0618	18 57 13.70	+06 18 48.00	STAR	28.3	3.8	5.5	BW	(-100.0,100.0)	Y
19175+1042	19 17 34.90	+10 42 26.00	STAR	5.9	2.9	6.4	BW	(-55.0,160.0)	Y
19184+1055	19 18 24.20	+10 55 14.00	STAR	6.3	3.1	8.5	WS	(0.0,100.0)	Y
19319+2214	19 31 54.80	+22 14 38.00	STAR	8.5	4.3	6.6	Double	(-45.0, 60.0)	Y
V1685 Cyg	20 18 42.70	+41 12 18.00	STAR	7.1	2.4	11.5	Two comp	(-81.5,-65.7)	Y

Thirty-four of the 66 maser sources have multiple components, which may be involving clustering structure. Of the remaining detected sources, 13 have high-velocity gas, including 4 interstellar sources and 9 stellar sources. The high-velocity gas may be caused by the mass ejection of the center sources. Mapping observations are necessary to identify outflows in theses sources.

The 13 new outflow candidates are associated with MSX sources. This means that these low color index IRAS sources still have mid infrared radiation.

ACKNOWLEDGEMENTS We are grateful for the staff at Qinghai Station for their assistance for the observations. This project is supported by the NSFC Grant 10203003, 10128306 and 10133020 and the G1999075405 NKBRSF.

References

Jarken E., Wu Y., Wang J., 2003, in preparation
Wood D.O.S., Churchwell E., ApJ, 1989, 340, 265
Emerson J.P., Star Forming Regions, Peimbert M., Jugaku J., eds., Proc. Of the Symp, Tokyo, Japan, Nov. 11-15, 1985. Reidel publishing Co., 1987, 115, P.19
Wu Y., Mao R., Sun j., et al., in 3^{rd} EAMA Ground-Based Astronomy in ASIA. N. Kaifu(ed.), NAO press, 1996, 167-169