A Bipolar Molecular Outflow Near IRAS02461+6147

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Abstract A molecular outflow is discovered from the CO J=3-2 in the region around $02^{\rm h}\ 46^{\rm m}\ 11.7^{\rm s}$+61° 47′ 34.02″ (1950), with three masers and an ultra-compact (UC) H II region. The parameters of the outflow are obtained. There is approximately $85M_{\odot}$ of molecular materials in the high velocity flow, and the mass loss rate is $0.26\times10^{-5}M_{\odot}/\,\mathrm{yr}$, while the energy transferred reaches 3×10^{46} ergs. All above indicate that it is a massive outflow and this region is a solitary massive star formation (MSF) region. The mass of the central star and the driving source of the outflow are discussed.

Key words star: formation —ISM: clouds, outflow —ISM: kinematics and dynamics

1 Introduction

Molecular outflows indicate a remarkable early phase of star formation[1]. For a long time, works on the outflow mechanism and accompanying accretion onto the star are based on observations of low-mass object[2,3], while recently the focus turns to the massive stars. As well known, the massive star is deeply embedded in compact clouds and far from us. Thus the characteristics of MSFs are difficult to be determined[4]. So the search for molecular outflows in MSF regions and study of them are significant to understand the process of the MSF.

The phenomenon that massive stars are always close to each other making it hard for us to obtain the direct information from the star formations. As a result, the solitary MSF region provides a dramatic opportunity to throw some light on the myth of the MSF.

Whether the exciting source of UC HII is the driving source of outflow or not is significant to the upper mass of the star. So the region with only one IRAS source and HII is critical to this study. Because in such region we can easily determine which is exciting source of UC HII and which is the driving source of outflow.

In this paper, we report a new discovered outflow in a lonely massive star formation with an UC HII. We present the CO map of this region around $02^{\rm h}\ 46^{\rm m}\ 11.7^{\rm s}$+61° 47′ 34.02″ (1950). In II we summarize the observation, and in III the result of the observation is shown, and in IV we present our discussions, and in the last part we draw a conclusion.

2 Observation

Observations of the J=3-2 transition of CO were made with KOSMA 3-m telescope of Gornergrat Observatory in the Swiss Alps in October 2002. The half-power beam width of the telescope was 80″ at 345 GHz, the frequency of CO J=3-2. The pointing accuracy was better than 10″.The system temperature was about 260 K. The SIS receivers were operated in double sideband mode. The Variable Resolution Acousto Optic Spectrometer was used with a bandwith of 400 MHz. The velocity resolution is 0.294 km/s. The main beam efficiency of the telescope is 66% at 345 GHz and the forward efficiency is 93%. The mapped

area was $13' \times 13'$ with $0.5'$ grid spacing,and the integration time was 54 sec for each position. The mapping procedure was done in the On-The-Fly modus.

3 Results

Table 1 The parameters of the outflow

D	M	P	E	$\bar{\nu}$	t	F	L_{co}	$\dot{M}$	M_{cloud}
pc	$M_\odot$	$M_\odot \cdot km \cdot s^{-1}$	ergs	$km \cdot s^{-1}$	yr	$M_\odot \cdot km \cdot s^{-1} \cdot yr^{-1}$	$L_\odot$	$M_\odot \cdot a^{-1}$	$M_\odot$
4213	85	271	3×10^{46}	3.2	0.35×10^6	0.80×10^{-3}	0.71	0.26×10^{-5}	3000

4 Discussion

a)The mass of the central star

The Simbad data show there is an UC HII region in this cloud, which demonstrates this is a MSF region. The two colour index are $\log(\frac{F25}{F12})$=0.914>0.57 and $\log(\frac{F60}{F12})$=1.45>1.3 , where F_x is the *IRAS* flux. The luminosity is about $1.6 \times 10^6 L_\odot$.

The total luminosity of the star in process of accretion is composed of two parts, the accretion luminosity converted by the gravitational energy of the accreted matter and the luminosity by nuclear reaction in the star. Because of the existence of HII, the accretion rate can not be large, so we assume that the total luminosity is from nuclear reaction. Using the mass-luminosity relation of main sequence star, $\frac{L_{star}}{L_\odot} = (\frac{M_{star}}{M_\odot})^4$, we can get the mass of star about $12\,M_\odot$, assuming the IRAS source consisted of only one star.

b)The driving source of the outflow

The simbad data show there is only an IRAS source in this region. So the driving source of this flow is IRAS02461+6147. In addition, the position of IRAS02461+6147 overlaps with the geometric position of the driving source of the outflow, which illustrates it is the driving source.

The IRAS02461+6147 is also the exciting source of the UC HII region. The mass of the central star indicates that this source is likely a single source. If this is true, it indicates the massive star in the phase of the UC HII can also continue to accrete and increase its mass.

5 Conclusion

We mapped lines of CO J=3-2 and a bipolar outflow is found. The physical parameters are obtained, and the results are listed at table 1. We estimate the mass of the IRAS source, which shows it is a massive star. The driving source of outflow is IRAS 02461+6147, which illustrates that the exciting source of UC HII can also be the driving source of outflow, thus accretes and increases its mass.

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