Cosmic Masers - from OH to H_0
Proceedings IAU Symposium No. 287, 2012
R.S. Booth, E.M.L. Humphreys & W.H.T. Vlemmings, eds.

doi:10.1017/S1743921312006904

High-mass Star Formation in the Regions IRAS 19217+1651 and 23151+5912

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Abstract. We present and discuss VLA-EVLA high-sensitivity and spatial resolution observations of Water Vapor MASERs and continuum emission towards two sources that have been proposed in the literature to be high-mass star forming regions: IRAS 19217+1651 and 23151+5912. Our results indicate the presence of disks which can confirm that these regions are high-mass star forming regions.

Keywords. stars: formation, stars: high mass, ISM: HII regions, masers

1. Introduction

The study of high-mass star formation is complicated because the sources are embedded in regions of dense gas and dust limiting their study to radio and infrared frequencies. In addition, the evolution is much faster than for low-mass proto-stars and are distributed much farther away. Hence, they can only be studied indirectly from the molecular, IR, mm and maser emission associated to the ionized regions in which they form.

These regions were chosen from a large sample of candidates of high-mass protostellar objects (Sridharan *et al.* 2002) embedded in sites with dense gas traced by the CS molecule (J = 2-1) (Bronfman *et al.* 1996). The region IRAS 19217+1651 is located near the galactic plane, at a distance of 10.5 kpc and appears to be contained within a bubble-like structure labeled N109 by Churchwell *et al.* (2006). It has been classified as a region of massive star formation in an early state of evolution (Beuther *et al.* 2004) and it is characterized by its high infrared luminosity $10^{4.9}$ $L_{\odot}$. In addition, it contains several molecular species, such as SiO, CH_3OH and CH_3CN, which could trace outflows and hot cores. CS spectral lines have been also reported.

The region IRAS 23151-5912 is located in the molecular cloud of Cepheus. At a distance of 5.7 kpc and characterized by its high infrared luminosity 10^5 $L_{\odot}$ (Sridharan *et al.* 2002). The H_2O maser emission is highly variable (Felli *et al.*2007). No CH_3OH, OH or SiO maser emission has been detected (Shridharan *et al.*2002; Edris *et al.* 2007; Zapata *et al.* 2009). Strong bipolar outflows have been detected with the CO (2-1) and SiO (2-1) lines. The region is associated with a center of dense dust observed at 1.2mm, 850 and 450 μm (Beuther *et al.* 2002; Williams *et al.* 2004).

2. Observations

The observations were carried out in 2007 June 27 with the VLA-EVLA in transition mode with the configuration A. Continuum at 1.3 cm and H_2O maser emission were

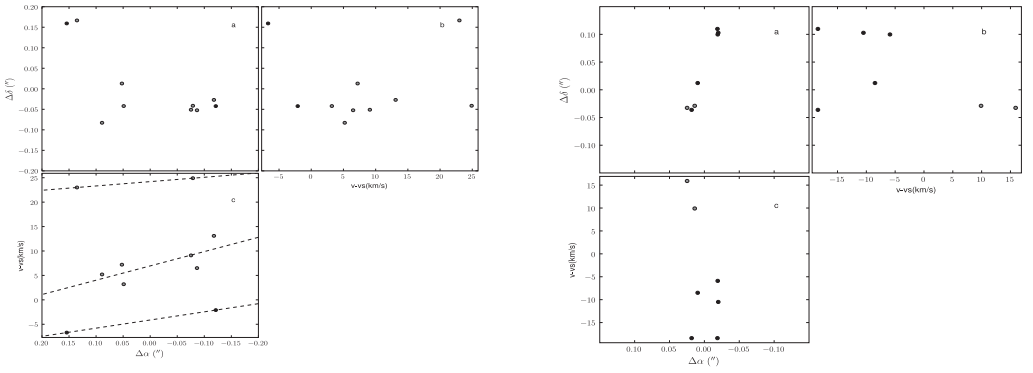

Figure 1. The spatial distribution of water vapor maser emission toward group M1 in IRAS 19217+1651 (left) and IRAS 23151+5912 (right). The axes indicate the positions relative to the average position of the masers for Right Ascension and Declination in 19217+1651 and with respect to the continuum source in 23151+5912. On the bottom-left, the horizontal axis represents the velocity of the masers minus the systematic velocity of the molecular cloud vs relative positions in RA. The dashed-line shows a linear fit to the distribution in each subgroup, which shows a velocity gradient. On the bottom-right, the distribution seems to indicate an elongated-elliptical distribution in RA.

observed simultaneously using two different IFs. The first with a bandwidth of 25 MHz and seven channels for the continuum and the second with a bandwidth of 3.125 MHz and 63 channels for the line emission, both centered at the rest frequency of 22235.080 MHz with V_{LSR}=10.5 & -54.4 km s^{-1}, respectively. RCP and LCP were sampled for both IFs. Data were reduced in AIPS.

3. Results

The source IRAS 19217+1651 A is the most intense and its morphology is consistent with a cometary UC HII region. Associated to it are 3 regions of maser emission which have a velocity gradient in the east-west direction along the elongation of the cometary H II region (see Fig. 1). Source B is extended and appears to be composed of more than one source or stellar component. The second maser cluster is not spatially coincident with any continuum source, but seems to be associated with the molecular outflow in the northeast-southwest direction observed in the region. The 1.3 cm continuum emission of the source IRAS 23151+5912 is consistent with a UC HII region and probably contains an embedded massive protostar of 15 $M_{\odot}$ of type B1 ZAMS. The data suggest the presence of two circumstellar disks: an expanding one with a radius of ∼415 AU and a smaller one with a radius of ∼84 AU and a central protostar of ∼10 $M_{\odot}$.

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https://doi.org/10.1017/S1743921312006904 Published online by Cambridge University Press