Astrophysical Masers:
Unlocking the Mysteries of the Universe
Proceedings IAU Symposium No. 336, 2017
A. Tarchi, M.J. Reid & P. Castangia, eds.

doi:10.1017/S174392131700895X

SMA, VLA and VLBA observations in a 10^5 $L_\odot$ high mass star formation region IRAS 18360-0537

Gang Wu[1,2,3,4], Keping Qiu[2], Jarken Esimbek[1,4] and Xingwu Zheng[2]

[1]Xinjiang Astronomical Observatory, Chinese Acadmy of Sciences, Science 1-street 150, Beijing Road, Urumuqi, P. R. China, email: wug@xao.ac.cn
[2]School of Astronomy and Space Science, Nanjing University, Nanjing 210093, P. R. China
[3]Key Laboratory of Radio Astronomy, Chinese Academy of Sciences, Urumqi 830011, P. R. China
[4]University of the Chinese Academy of Sciences, Beijing 100080, P. R. China

Abstract. We have observed a young stellar object, IRAS 18360-0537, with a far-infrared luminosity of 1.2×10^5 $L_\odot$. It is perhaps the most promising candidate of a high-mass protostar associated with a Keplerian disk and a jet/outflow system in the regime of $L > 10^5 L_\odot$. We are conducting the SMA, VLA, and VLBA studies to provide a comprehensive understanding of this interesting high mass star formation scenario.

1, Introduction

In star formation studies, whether high-mass stars form mediated by disk/outflow systems as their low-mass counterparts is a key question under debate. Outflows have been proved to be omnipresent in high-mass star forming regions. Until now, there are only ∼40 candidates observed to harbor rotating disks or toroids in high-mass star forming regions (Beltrán & de Wit 2016). Furthermore, most of these candidates are limited to objects with masses up to 25-30 $M_\odot$ or $L < 10^5 L_\odot$. The low number of disk detections, especially in $L > 10^5 L_\odot$ star formation regions, might be an observational bias or might be a real effect to be explained by detailed models of high mass star formation, involving turbulent core or competitive accretion models (e.g. McKee & Tan 2003, Bonnell & Bate 2002). We have observed a young stellar object, IRAS 18360-0537, with a far-infrared luminosity of 1.2×10^5 $L_\odot$ (Qiu *et al.* 2012). It is perhaps the most promising candidate of a high-mass protostar associated with a Keplerian disk and a jet/outflow system in the regime of $L > 10^5 L_\odot$. We are conducting the SMA, VLA, and VLBA studies to provide a comprehensive understanding of this interesting high mass star formation scenario.

2, Results

SMA: In IRAS 18360-0537, the SMA 1.3 mm continuum map shows two condensations, MM1 and MM2. Meanwhile the SMA CO and SiO indicate a northeast-southwest bipolar outflow centered at MM1 while CH_3OH and CH_3CN trace a northwest-southeast rotation gradient perpendicular to the outflow axis. Furthermore, CN spectra also from the SMA, present typical inverse P-Cygni profiles which demonstrate infall motions (see the panels in the first row of Fig. 1, and also Qiu *et al.* 2012).

VLA: To constrain the ionized gas, we carried out VLA 3.6 cm, 1.3 cm, and 7 mm radio continuum observations. The lower flux at 3.6 cm indicates that IRAS 18360-0537 is presently in a very early evolutionary stage, e.g in a stage prior to the formation of an HII region. The existing VLA observations are not well confining the parameters of free-free emission. We are proposing 2 cm and 6 cm observations with the JVLA to further

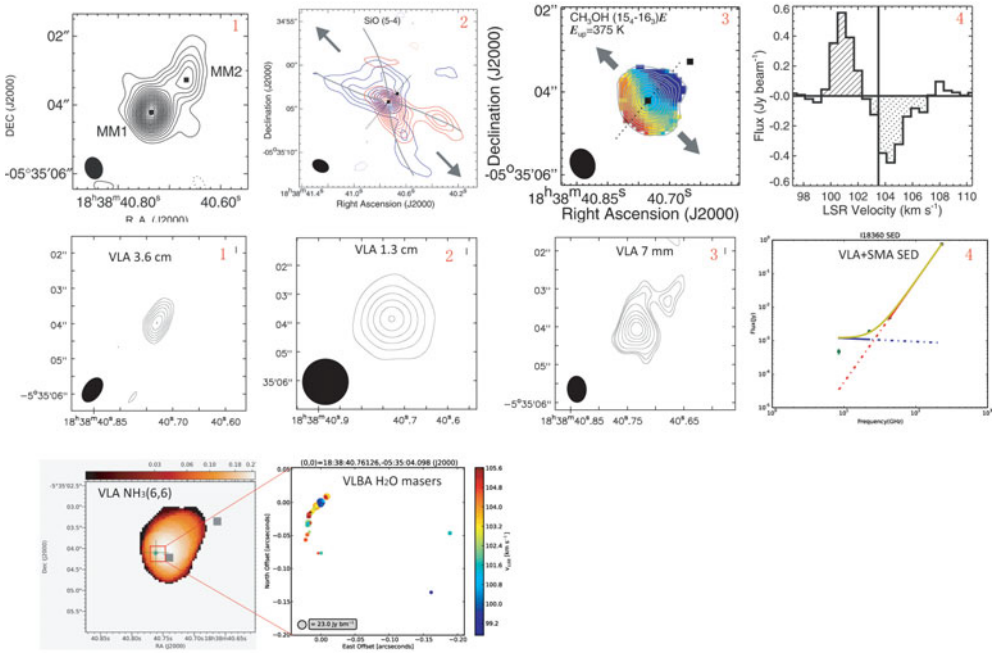

Figure 1. *First row:* SMA 1.3 mm continuum (1), SiO (2), CH_3OH (the first moment)(3) and the inverse P-Cygni profiles of CN (4) (adapted from Qiu *et al.* 2012). *Second row:* VLA 3.6 cm (1), 1.3 cm (2), 7 mm (3) continuum and SED of VLA and SMA continuum data (4). *Third row:* VLA NH_3 (6,6)(color) emission (Left) and BeSSeL H_2O masers (Right).

constrain the properties of the ionized gas in IRAS 18360-0537. We are also proposing an A configuration observation at 7 mm to reveal the spatial morphology with a resolution of ~ 0.065" (see the panels in the second row of Fig. 1).

VLBA: For a better understanding of IRAS18360-0537, we are conducting the OH, H_2O, and CH_3OH maser studies in IRAS 18360-0537 with VLBA to investigate the immediate vicinity of the central (proto) star. The panels in the third row of Fig. 1 present the H_2O masers in the region obtained from the BeSSeL Survey. According to our previous identified morphologies of outflow and 'disk', H_2O masers are likely associated with the outflow. CH_3OH and OH masers were observed with the VLBA in August 2017. We will use these maser spots to constrain the kinematics with a millisecond (10 AU) resolution and explore the B field along line of sight with the Zeeman splitting of OH masers.

Acknowledgements

This work was funded by the Program of the Light in China's Western Region under grant 2015-XBQN-B-03, the National Natural Science foundation of China under grant 11603063, 11433008.

References

Beltrán, M. T. & de Wit, W. J. 2016, *A&AR*, 24, 6
Bonnell, I. A. & Bate, M. R. 2002, *MNRAS*, 336, 659
McKee, C. F. & Tan, J. C. 2003, *ApJ*, 585, 850
Qiu, K., Zhang, Q., Beuther, H., & Fallscheer, C. 2012, *ApJ*, 756, 170

https://doi.org/10.1017/S174392131700895X Published online by Cambridge University Press