# $H_2O$ maser observation using the 26-meter Nanshan Radio Telescope of the XAO

Yu-Xin He<sup>1,2</sup>, Jarken Esimbek<sup>2,1</sup>, Jian-Jun Zhou<sup>2,1</sup>, Gang Wu<sup>2,1</sup>, Xin-Di Tang<sup>3,2,1</sup>, Wei-Guang Ji<sup>2,1</sup>, Ye Yuan<sup>2,1</sup> and Da-Lei Li<sup>2,1</sup>

<sup>1</sup>Xinjiang Astronomical Observatory, Chinese Academy of Sciences, Urumqi 830011, P. R. China email: heyuxin@xao.ac.cn

<sup>2</sup>Key Laboratory of Radio Astronomy, Chinese Academy of Sciences, Urumqi 830011, P. R. China emails: jarken@xao.ac.cn, zhoujj@xao.ac.cn

<sup>3</sup>Max-Planck-Institut für Radioastronomie, Auf dem Hügel 69, 53121 Bonn, Germany

Abstract. In the past few years, we have performed a 22 GHz  $H_2O$  maser survey towards hundreds of BGPS sources using the 25-meter Nanshan Radio Telescope (NSRT) of the Xinjiang Astronomical Observatory, and detected more than one hundred masers. Our aim is to study star formation activities associated with these sources, as well as search for any correlations that may exist between 22 GHz  $H_2O$  masers and the evolutionary stage of high-mass star formation regions. The NSRT has been upgraded and have now an effective diameter of 26 meter. Besides, cryogenically cooled dual-beam receiver systems covering seven millimeter-wave observing bands have been installed on the NSRT. For the next step of maser observation, we will continue to do  $H_2O$  and SiO masers survey of massive dust clumps and monitor some maser sources.

Keywords. masers, stars: formation, radio lines: ISM

### 1. Introduction

Many unbiased pilot surveys for Galactic water masers suggest that interstellar  $H_2O$  masers are very abundant, are the most popular maser species, and one of the most sensitive and reliable tracers of newly forming massive young stellar objects in the Milky Way (MW) (e.g., Caswell & Breen 2010, Walsh *et al.* 2011). At the early stage of star formation,  $H_2O$  maser act as a good probe for discovering invisible stars which are shielded by the dust in the surrounding molecular cloud, and also for measuring the physical parameters of the environment. Very long baseline interferometry (VLBI) observations of  $H_2O$  masers are used to measure accurate distances via their trigonometric parallax (Hachisuka *et al.* 2006). Moreover, they have also been successfully used to infer properties of the magnetic field in the massive star-forming region W75N (Surcis *et al.* 2011). Therefore, finding more interstellar  $H_2O$  masers is important to understand high-mass star formation and construct the MW's structure.

In this paper, we focus on 22 GHz  $H_2O$  masers that were observed using the previous 25-meter Nanshan Radio Telescope (NSRT) of the Xinjiang Astronomical Observatory. In the past few years, we have performed a maser survey towards hundreds of Bolocam Galactic Plane Survey (BGPS) sources (Xi *et al.* 2015, Xi *et al.* 2016). After the completion of the upgrade, the NSRT has become a 26 meter effective diameter radio telescope with high-precision tracking and pointing. We have also installed a cryogenically cooled dual-beam receiver systems covering seven millimeter-wave observing bands on it. In the next months, we are planning to do an  $H_2O$  maser survey in single-pointing mode towards 481 molecular clouds identified by Du *et al.* (2016), of which 457 probably belong

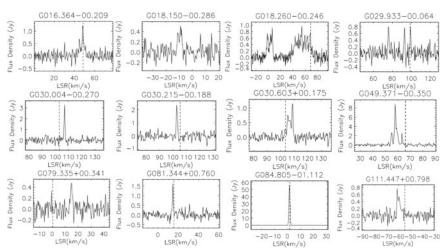


Figure 1. Examples of newly detected H<sub>2</sub>O masers.

to the Outer arm. The molecular clouds with  $H_2O$  masers will then be used to delineate the Outer arm through VLBI observation using the trigonometric parallax method.

## 2. Results

We have performed an  $H_2O$  maser survey towards BGPS sources twice, once for 221 BGPS sources in the v1.0 catalogue that have 1.1mm fluxes exceeding 5 Jy and once for 274 BGPS sources located at  $85^{\circ} < l < 193^{\circ}$ . Finally, we detected 132 H<sub>2</sub>O masers in total, of which 17 are new (Fig. 1). The detection rates of H<sub>2</sub>O masers are 48.4 per cent and 9 per cent, respectively for the two samples (see Xi *et al.* 2015 and Xi *et al.* 2016 for details). In addition, we obtained the position of the new H<sub>2</sub>O masers using OTF observations. Moreover, we found that the detection rate of H<sub>2</sub>O masers is correlated with the continuum emission fluxes of BGPS sources at FIR, sub-millimetre and millimetre wavelengths.

## Acknowledgements

This work was funded by the Program of the Light in China's Western Region under grant 2016-QNXZ-B-22, the National Natural Science foundation of China under grant 11703073, 11433008 and 11373062. This work is based on observations made with the NSRT, which is operated by the Key Laboratory of Radio Astronomy, Chinese Academy of Sciences.

## References

Caswell & Breen 2010, MNRAS, 407, 4

- Du, Xinyu, Xu, Ye, Yang, Ji, Sun, Yan, Li, Facheng, Zhang, Shaobo, & Zhou, Xin 2016, ApJS, 224, 1
- Hachisuka, K., Brunthaler, A., Menten, K. M., et al. 2006, ApJ, 645, 1
- Surcis, G., Vlemmings, W. H. T., Curiel, S., Hutawarakorn Kramer, B., Torrelles, J. M., & Sarma, A. P. 2011, A&A, 527, A48
- Walsh, A. J., Breen, S. L., Britton, T., et al. 2011, MNRAS, 416, 3
- Xi, Hongwei, Zhou, Jianjun, Esimbek, Jarken, Wu, Gang, He, Yuxin, Ji, Weiguang, & Tang, Xiaoke 2015, MNRAS, 453, 4
- Xi, Hong-Wei, Zhou, Jian-Jun, Esimbek, Jarken, Wu, Gang, He, Yu-Xin, Ji, Wei-Guang, Tang, Xiao-Ke, & Yuan, Ye 2016, RAA, 16, 6