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Water maser in Southern FIR-bright galaxies: detection and interferometric follow-ups

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A correlation between the presence of 22 GHz water masers and 100 μm flux density was proposed by [1] as a result of a survey on a sample of all northern galaxies (Dec $> -30^{\circ}$) associated with IRAS FIR point sources with 100 μm flux densities larger than 50 Jy. The survey provided the relevant maser detection rate of 22%, which is extremely high with respect to other surveys. Therefore, we decided to complete the sample by observing all southern galaxies (with the same FIR flux constraint and Dec $< -30^{\circ}$) with the 70-m Tidbinbilla telescope in a search for water maser emission. We have detected two new water masers in the merging system NGC3256 and in the spiral galaxy NGC3620, respectively, yielding a detection rate consistent with the northern sample. The detections have been followed-up through spectral line interferometric observations with the ATCA.

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1. Introduction

The far-infrared (FIR) emission commonly arises from dust grains heated by newly formed stars. Therefore, a sample of FIR bright galaxies is a suitable tool to find new extragalactic H_2O masers, in particular those associated with star forming regions. A correlation between the presence of H_2O masers and $100\,\mu$m flux density was indeed reported by [1] as a result of an Effelsberg 100-m survey of all galaxies with declination Dec $> -30^\circ$, associated with IRAS point sources showing $S_{100\,\mu m} > 50$ Jy [2]. This correlation has recently been confirmed by [3] with a sample of 41 galaxies with $30\,\text{Jy} < S_{100\,\mu m} < 50\,\text{Jy}$ and Dec $> -30^\circ$. Good results obtained by [1] and [3] in the northern hemisphere have motivated us to complete the FIR sample by including all southern galaxies (with declination Dec $< -30^\circ$) associated with IRAS point sources characterized by $S_{100\,\mu m} > 50$ Jy.

2. Results and Preliminary Discussion

The list of sources was compiled using the IRAS Point Sources Catalog [2]. Eight of these sources were observed in previous works. The sources of our sub-sample were observed in the $6_{16} - 5_{23}$ transition of H_2O (rest frequency: 22.23508 GHz) with the 70m Nasa Deep Space Network antenna located at Tidbinbilla (hereafter Tidbinbilla), Australia. Two new H_2O masers were detected, in the galaxies NGC 3256 and NGC 3620, which were followed-up by interferometric spectral line observations at 22 GHz with the Australia Telescope Compact Array (ATCA). Line profiles are shown in Fig. 1.

NGC 3256 is a well studied merging galaxy located at a distance of ~ 37 Mpc ($1'' \sim 180$ pc; $H_0 = 75\,\text{km s}^{-1}\,\text{Mpc}^{-1}$). Water maser emission has been found by us in August 2007. Its isotropic maser luminosity of $\sim 10\,L_\odot$ places the maser near the limit between water kilomasers and megamasers. In the ATCA observation, the emission is seen to originate from two separate maser spots: a northern one (labelled N) and a southern one (labelled S). Both features are redshifted with respect to the systemic velocity and their luminosities are 1.0 $L_\odot$ (N) and 2.4 $L_\odot$(S). A few days after the ATCA observations, we observed the maser source again with Tidbinbilla providing a single-dish luminosity of $\sim 13\,L_\odot$, higher than that measured in 2007. The H_2O kilomasers in NGC 3256 are associated with starburst processes present in the main gas disk of the galaxy.

NGC 3620 is a peculiar southern SB galaxy [4]. Located at a distance of ~ 20 Mpc ($1'' \sim 100$ pc; $H_0 = 75\,\text{km s}^{-1}\,\text{Mpc}^{-1}$). In February 2005, we detected a H_2O maser in NGC 3620 that has been monitored until April 2008. The maser emission is composed of two main spectral features, denoted "a" and "b". They are red-shifted with respect to the systemic velocity of the galaxy ($1680\,\text{km s}^{-1}$). The flux density of the *a* feature is smaller than the *b* component. The total isotropic maser luminosity is $\sim 4.7\,L_\odot$. In the more sensitive ATCA observation, the two features are confirmed and a third feature (*c*) is detected between the two main ones. All three maser components arise from a spatially unresolved spot associated with the center of the galaxy. The total isotropic maser luminosity is $\sim 2.1\,L_\odot$. The apparent swap of *a* and *b* between 2005 and 2006 and the subsequent swap-back in the following epochs may let us speculative about an anticorrelation between the maser features, possibly associated with an accretion disk like the one in the galactic star form-

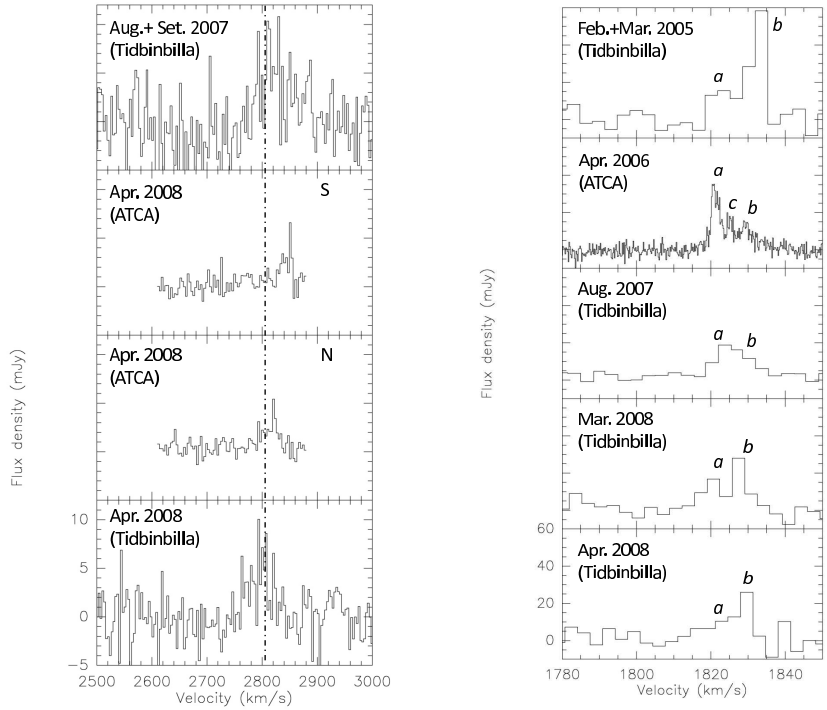

Figure 1: *Left*: The H_2O maser in NGC 3256. The channel spacing are $0.5\,\mathrm{km\,s^{-1}}$ (Tidbinbilla) and $3.7\,\mathrm{km\,s^{-1}}$ (ATCA), where two emission peaks have been found at different positions (N=north, S=south).The recessional velocity of the galaxy (the dot-dashed line) is $2804\,\mathrm{km\,s^{-1}}$ according to the NASA/IPAC database (NED). *Right*: H_2O spectra observed toward NGC 3620 between February 2005 and April 2008. Channel spacings are $0.5\,\mathrm{km\,s^{-1}}$ (Tidbinbilla) and $0.2\,\mathrm{km\,s^{-1}}$ (ATCA). The velocity scale for both is with respect to the local standard of rest (LSR).

ing region S255 [5]. The association of the kilomaser is still under investigation.

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