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Investigating the nature of low-luminosity extragalactic H_2O masers

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Abstract. We have searched for 22 GHz water maser emission in a sample of FIR bright galaxies and detected two new kilomaser sources. The newly detected masers have been promptly followed-up using interferometric observations to derive positions and constraints on the size and brightness temperature of the emitting spots. Here we report results related to the newly detected kilomasers, also including the well-known kilomaser source in in NGC 253. These are discussed within the framework of the kilomaser/megamaser dichotomy.

Keywords. masers, galaxies: active, galaxies: starburst

1. Introduction

At present, it is still a tantalizing puzzle whether the extragalactic kilomasers ($L_{H_2O} < 10\,L_\odot$) belong to the same family as the Galactic masers associated with star formation or if some of them belong instead to a hypothetical weak tail of the megamasers ($L_{H_2O} > 10\,L_\odot$) associated with Active Galactic Nuclei. The small number of kilomasers found so far does not allow us to draw statistically definite conclusions on their nature. In order to extend the number of such sources, we have searched for 22 GHz water maser emission in a sample of galaxies with declination $\delta > -30°$ and IRAS point source flux densities of $S_{100\mu m} > 30$ Jy, with the Effelsberg 100-m telescope. The survey yields two new kilomaser sources with $L_{H_2O} \sim 1\,L_\odot$ in the nearby starburst galaxy NGC 3556 (Henkel *et al.* 2005) and in the merging system NGC 520 (Castangia 2006). Here we report the results of the interferometric follow-ups of the newly detected kilomasers, also including the prominent kilomaser source in NGC 253, which is also part of the sample. All the interferometric observations have been performed with the Very Large Array (VLA).

2. Results and discussion

All three extragalactic maser spots discussed below are found to be associated with star-forming activity. The H_2O emission in **NGC 520** coincides, within the relative positional uncertainty of $\sim 0.''1$ (~ 15 pc), with a continuum source associated with a compact non-thermal radio object that is probably a supernova remnant or a radio supernova (source D in Fig.1, lower panel). The small linewidth ($\sim 0.6\,km\,s^{-1}$) and the time variability (70% decrease of the flux density within 24 days, see Fig. 1, upper panel) of the maser resembles that of the two kilomasers in IC 10 (Henkel *et al.* 1986) and IC 342 (Tarchi *et al.* 2002), which are also associated with star formation activity, reinforcing our interpretation. The kilomaser in **NGC 3556** is somewhat resolved both in space and velocity, indicating that we are likely observing a collection of weak masers, the brightest of which has an isotropic luminosity of $\sim 0.3\,L_\odot$. This maser is coincident (within the

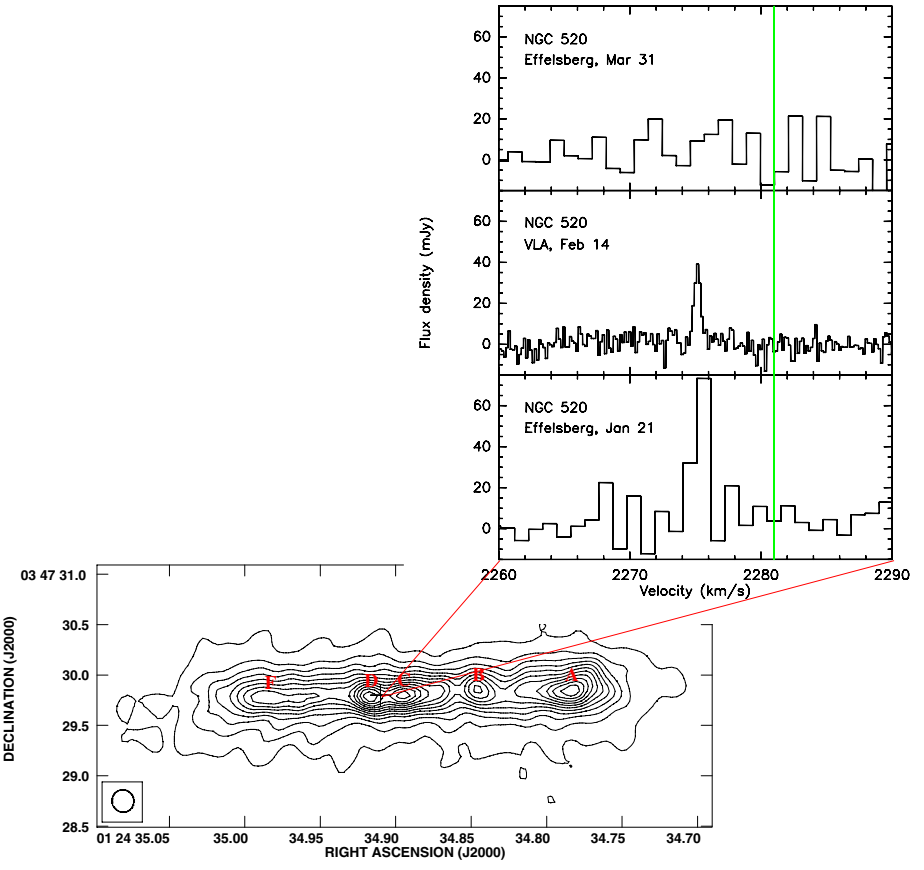

Figure 1. *Upper panel*: H_2O kilomaser spectra toward NGC 520, observed between January and March 2005. Channel spacings are 1.1 km s^{-1} (lower and upper panels) and 0.3 km s^{-1}. Pointing position is $\alpha_{2000} = 01^{h}\ 24^{m}\ 35.1^{s}$ and $\delta_{2000} = +03°\ 47'\ 33''$. The vertical line indicates the systemic velocity V_{sys}=2281 km s^{-1} (NED). *Lower panel*: VLA A-array radio continuum map of the nuclear region of NGC 520 at 8 GHz, with labels indicating the compact sources. Contour levels are: –1, 1, 2 ,3...16×0.1 mJy beam^{-1}. The cross marks the position of the maser spot.

relative position errors of $\sim 0.''1$, $\equiv 6$ pc) with a compact continuum source for which a multi-frequency study rules out an AGN nature. In **NGC 253**, the main H_2O maser component is associated with the source TH4 (for the nomenclature, see e. g. Ulvestad & Antonucci 1997), which is confidently a SNR, confirming the interpretation of Hofner *et al.* (2006). Our results, therefore, favour the conclusion that kilomasers and megamasers form two distinct well separated family of extragalactic H_2O masers.

References

Castangia, P. 2006, PhD Thesis, *"Water masers in active galaxies"*, Univ. of Cagliari
Henkel, C., Peck, A. B., Tarchi, A. Nagar, N.M, Braatz, J. A., Castangia, P., & Moscadelli, L. 2005, *A&A* 436, 75
Henkel, C., Wouterloot, J. G. A., & Bally, J. 1986 *A&A* 155, 193
Hofner, P., Baan, W. A., & Takano, S. 2006 *AJ* 119, 1592
Tarchi, A., Henkel, C., Peck, A. B., & Menten, K. M. 2002 *A&A* 385, 1049
Ulvestad, J. S., & Antonucci, R. R. J. 1997 *ApJ* 488, 621

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