Statistical properties of extragalactic H_2O maser sources

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Abstract. Recently, with the development of sensitive maser receiver and wide-band spectrometer, maser emission were detected toward more and more galaxies. 69 galaxies beyond the Magellanic Clouds has been reported with H_2O maser emission (to 2006.12). The statistical properties of the sample of extragalactic H_2O masers are not well explored. Here we collect observation data of all these detected extragalactic H_2O maser sources and give a statistical analysis to investigate the statistical properties of the sample.

Keywords. H_2O masers, statistical properties

1. The sample

We collect all published data on extragalactic H_2O maser sources (69, to the end of 2006) and their observational parameters at other wavelengths. Some of these parameters reflect the properties of the host galaxies, include the distance, infrared luminosity, the dust temperature, the apparent B magnitude, and the absolute B magnitude. Others parameters reflect the nuclear properties, include the AGN type, the isotropic H_2O maser luminosity, the emission line flux and luminosity, the central black hole mass, the nuclear X-ray emission luminosity, the X-ray absorbing column density, and the radio flux and luminosity.

2. Statistical analysis

2.1. *Distributions of some parameters*

Based on the literature and archival data, X-ray absorbing column densities are compiled for the 69 galaxies with reported maser sources. We obtained X-ray column densities for 38 maser sources, 36 from the literature and 2 from processing archival data. Fig. 2 shows the distribution of their column density. More than 80% (22/26) of the megamaser sources are heavily obscured ($N_H > 10^{23} cm^{-2}$) and half are Compton-thick ($N_H \geqslant 10^{24} cm^{-2}$). Among the 13 known kilomaser sources ($L_{H_2O} < 10 L_\odot$), however, only NGC 2273 and NGC 5194 are Compton-thick. At a confidence level of at least 99.4%, the column density distributions of kilomaser and megamaser sources are different (see details in Zhang *et al.*. 2006).

2.2. *Possible correlations*

A correlation would be most convincing if there were a strong dominant X-ray source known to coincide with both the nuclear engine of the parent galaxy and the observed H_2O maser. In Fig. 1, the H_2O maser isotropic luminosities are plotted against their X-ray

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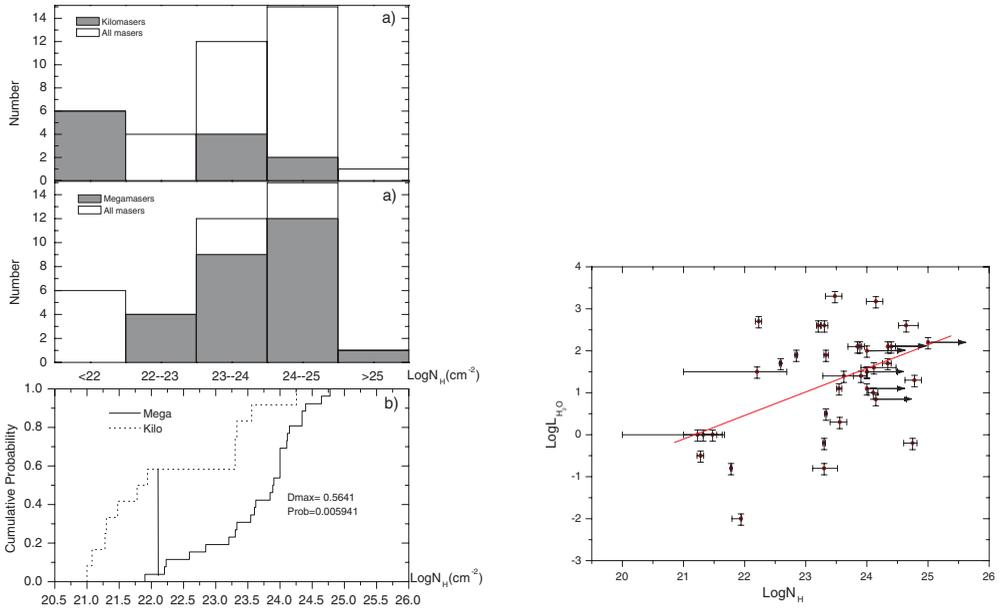
Figure 1. Isotropic maser luminosities (in $L_\odot$) versus X-ray absorbing column densities N_H (in cm^{-2}), including a linear fit. Taken from Zhang *et al.* (2006).

Figure 2. a. Histograms showing the number of H_2O masers (kilomasers: $L_{H_2O} < 10\,L_\odot$; megamasers: $L_{H_2O} > 10\,L_\odot$) as a function of column density determined from X-ray spectroscopy (upper panels). **b**. Kolmogorov-Smirnov test for the kilomaser and megamaser samples (lower panel). Taken from Zhang *et al.* (2006).

absorbing column densities. A trend of rising column density with rising maser luminosity may be apparent, but the scatter is large and the correlation is weak. The megamaser subsample (not displayed) shows no trend at all. Presumably a clumpy cloud structure in the cirumnuclear environment, diverging positions between maser and nuclear sources, and occasional amplification of a background radio continuum source are sufficiently decoupling the X-ray column densities and the H_2O maser properties not to show a clear correlation.

In addition, the nuclear $2-10\,$keV X-ray luminosity and the H_2O isotropic luminosity was discussed in Kondratko *et al.* (2006, see their Figure 3). The correlation between FIR luminosity and H_2O isotropic luminosity are confirmed (see Henkel *et al.*. 2005). Other possible correlations are also investigated (Zhang *et al.* in preparation).

References

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The Todd River

The Todd river in Alice Springs is usually dry but on the last day of the meeting it rained and the river flooded.