X-RAY LUMINOSITIES IN WATER MASER AND NON-MASER GALAXIES

K. LEITER[1,2], M. KADLER[1], J. WILMS[2], J. BRAATZ[3], C. GROSSBERGER[1,2,4], F. KRAUSS[1,2],
A. KREIKENBOHM[1,2], M. LANGEJAHN[1,2], E. LITZINGER[1,2], A. MARKOWITZ[2,5], C. MÜLLER[1,2]

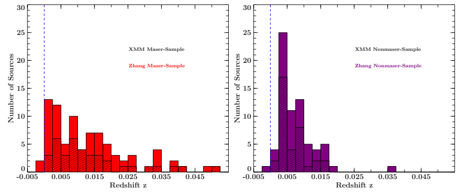
[1] Lehrstuhl für Astronomie, Universität Würzburg, Würzburg, Germany, [2] Dr. Karl Remeis Sternwarte & ECAP, Universität Erlangen-Nürnberg, Bamberg, Germany,
[3] NRAO, Charlottesville, USA, [4] MPE, Garching, Germany, [5] University of California, San Diego, USA

Abstract

Water maser galaxies are a rare subclass of Active Galactic Nuclei (AGN). They play a key role in modern cosmology, providing a significant improvement for measuring geometrical distances with high precision. Megamaser studies presently measure H_0 to about 5 %. The goal of modern programs is to reach 3 %, which would provide a powerful constraint on the equation of state of dark energy. Furthermore, an increasing number of independent measurements of suitable water masers is providing the statistics necessary to decrease the uncertainties. Studying these objects at X-ray energies yields important constraints on target-selection criteria for future maser surveys, leading to a higher detection rate.
We have studied the X-ray properties of a unique and homogeneous sample of Type 2 AGN with water-maser activity observed by *XMM-Newton* to investigate the properties of megamaser-hosting galaxies compared to a control sample of non-maser galaxies, both analyzed in a uniform way. A comparison of the observed luminosity distribution confirms previous studies, which have shown that water-maser galaxies appear more luminous than non-maser sources. However, comparing the intrinsic luminosity distributions of both samples shows no significant difference. Our results indicate that the discrepancy can be solely explained by higher absorption and, hence, higher column densities in water-maser sources.

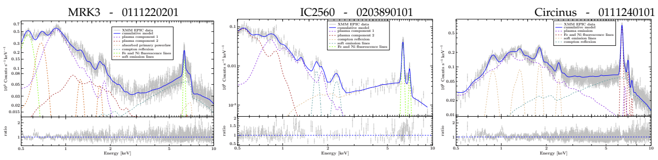
Sample Selection

Based on the sample of Zhang et al. (2012, A&A, 538, A152) we compiled a sample of maser (37 Type 2 AGN) and non-maser (36 Type 2 AGN) galaxies which have been observed with *XMM-Newton*. The sources were uniformly extracted and analyzed. The plots on the right hand side show a comparison of the redshifts of our *XMM*-selected sub-samples and the whole sample of Zhang et al. (2012).
Below, we present three X-ray spectra from each of the maser and non-maser samples, representing the typical distribution of the used spectral components (absorbed primary powerlaw, ionized plasma emission, soft powerlaw, Fe and Ni fluorescence lines, soft emission lines, Compton reflection) in each sample.

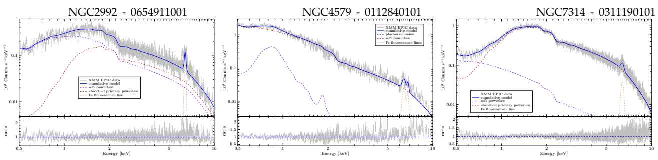


Comparison of Maser and Non-Maser Spectra (3 representatives out of each sample)

- **Maser sources**



- **Non-Maser sources**

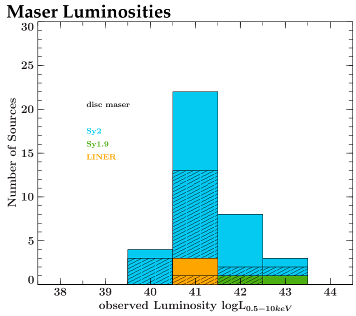


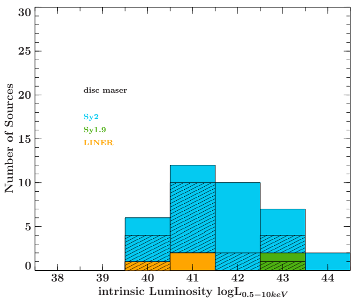
- Typical models of maser X-ray spectra include a highly absorbed power law, multiple ionized plasma emission components, strong iron lines and X-ray reflection.
- Non-maser spectra can typically be described by a dominating weakly or partially absorbed powerlaw, ionized plasma emission and emission from neutral iron.
- Soft X-ray emission of maser galaxies is generally more complex than in non-maser sources.
- Maser galaxies exhibit a higher fraction of X-ray reflection than non-maser galaxies. Purely reflection-dominated spectra are only observed among masers.

→ **In general, the physical processes in maser sources are more complex than in non-maser sources!**

Comparison of Maser and Non-Maser source properties (luminosities and column densities)

- **Maser Luminosities**

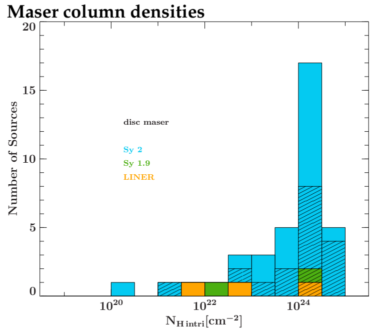




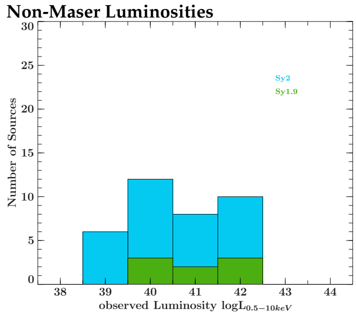
Left: Distributions of observed and intrinsic luminosities in the *XMM*-selected maser sample. Different colors indicate various types of Type 2 AGN. Additional shaded sources symbolize a subclass of maser sources, which are favoured candidates to measure H_0, so-called disc masers.

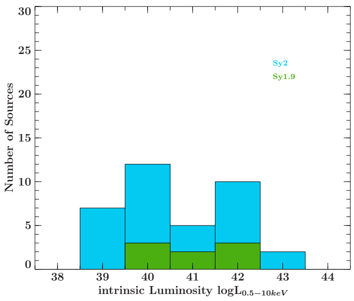
Right: Column density distribution of the *XMM*-selected maser sample. Color coding and shading as above

- **Maser column densities**



- **Non-Maser Luminosities**

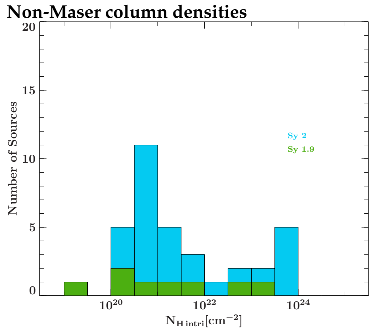




Left: Distributions of observed and intrinsic luminosities in the *XMM*-selected non-maser sample. Different colors indicate various type of Type 2 AGN.

Right: Column density distribution of the *XMM*-selected non-maser sample. Different colors indicate various type of Type 2 AGN.

- **Non-Maser column densities**



Results

- The observed luminosities of water-maser galaxies are higher than of non-maser sources
- The intrinsic luminosity distribution of both samples show no significant difference

→ **Discrepancy for the intrinsic luminosities results just from higher absorption**
→ **Previous findings of higher absorbing column densities in maser galaxies (e.g. Castangia et al. 2013, Greenhill et al. 2008) generally confirmed.**

Acknowledgments

This research makes use of data obtained by *XMM-Newton*, an ESA science mission funded by ESA Member States and the USA (NASA).
Futhermore this work was partially funded by the Graduiertenkolleg GRK 1147 from the DFG.

Contact

kleiter@astro.uni-wuerzburg.de