Water maser emission in hard X-ray selected AGN

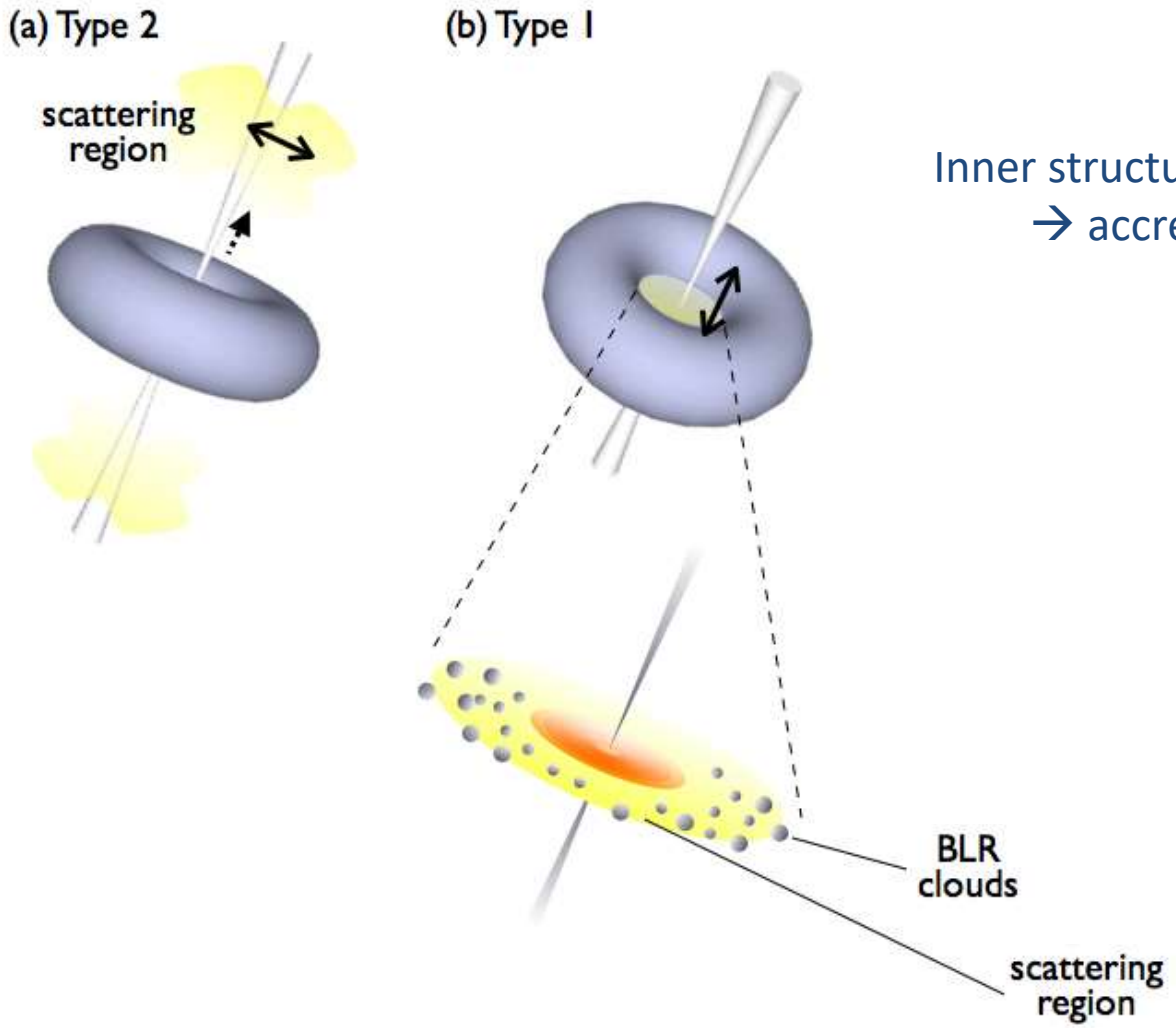
Francesca Panessa

iaps Institute for Space Astrophysics and Planetology
Istituto di Astrofisica e Planetologia Spaziali

INAF

Paola Castangia (OAC/INAF), **Andrea Tarchi** (OAC/INAF), **Loredana Bassani** (IASF-BO/INAF), **Angela Malizia** (IASF-BO/INAF), **Angela Bazzano** (IAPS/INAF), **Pietro Ubertini** (IAPS/INAF)

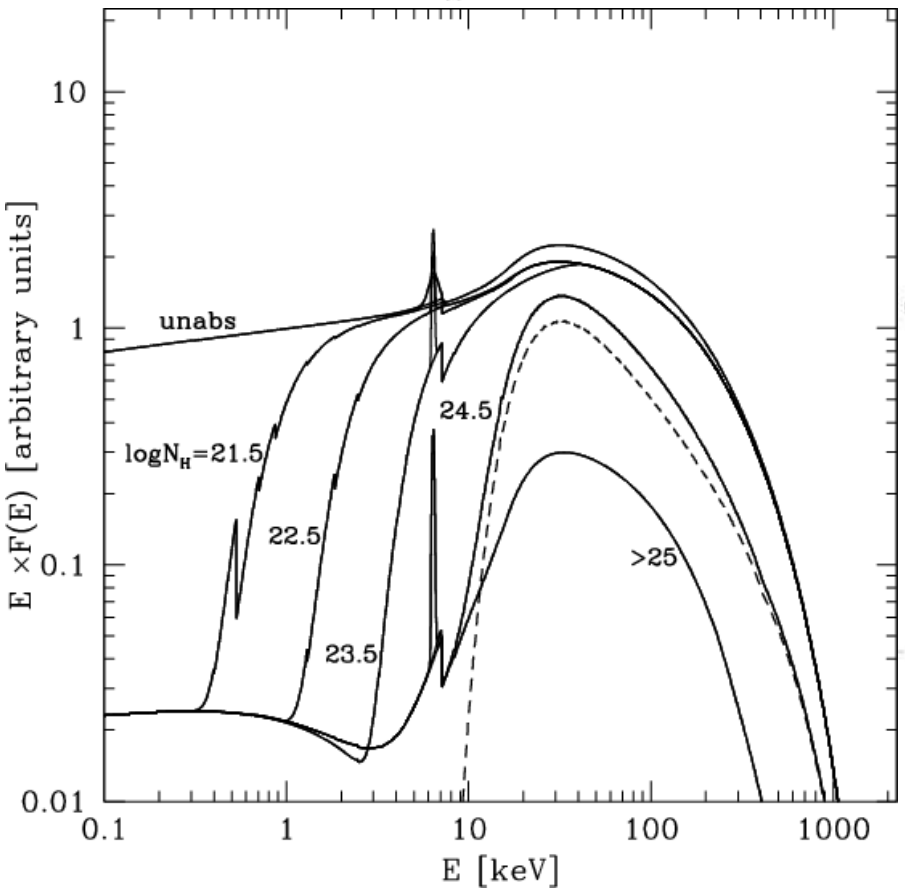
Obscuration in AGN

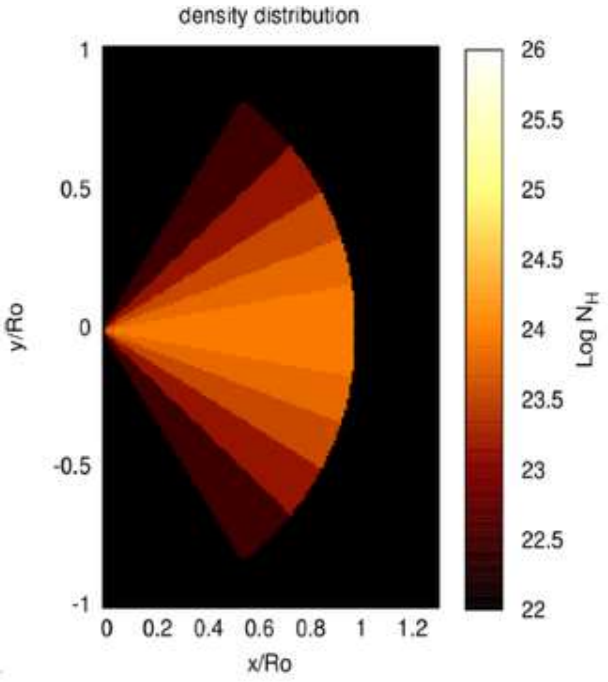


Inner structure of AGN still unknown
→ accretion disk, BLR, torus

Adapted from Kishimoto et al. (2008)

Obscuration from X-ray spectra





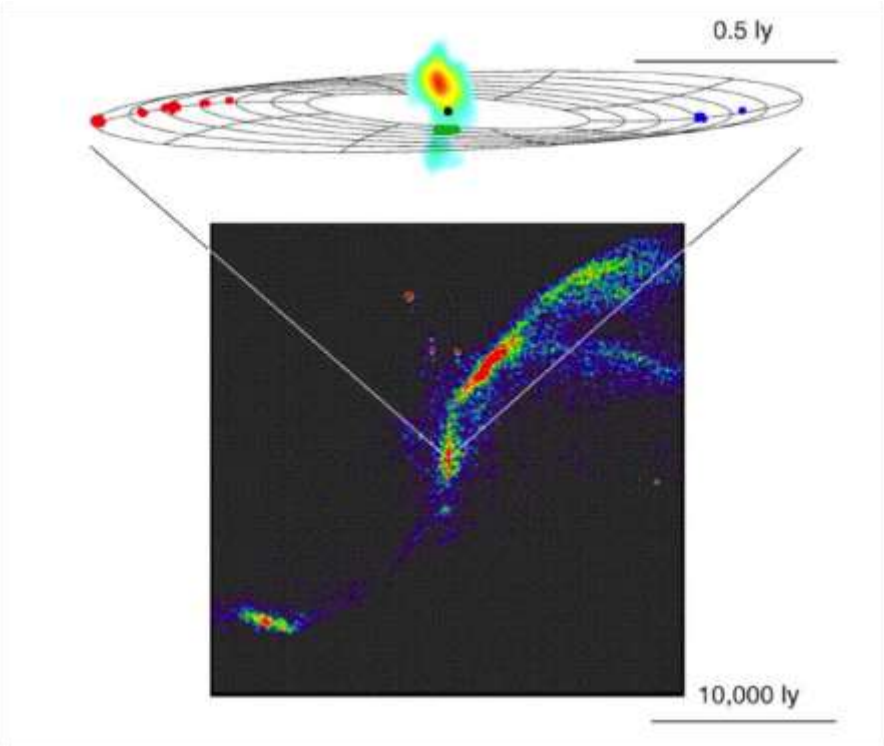
Compton thick AGN → $N_H > 1.5 \times 10^{24}$ cm^{-2}

Our knowledge on the column density ditribution of AGN has a fundamental role on

1. the comprehension of the AGN physical structure
2. the accretion history of the Universe

X-ray broad-band is needed!

Water mega maser emission in AGN



- ✓ Disk masers
  - → maps of accretion disks
- ✓ Jet masers
- ✓ Outflow masers

→ Fraction of water masers ~7% in galaxy surveys (Braatz et al. 1997)

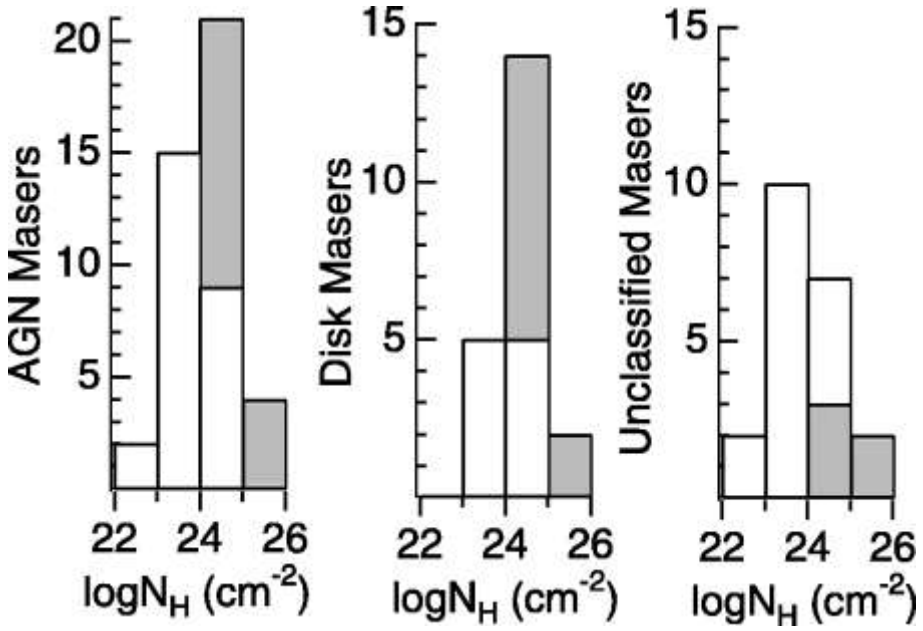
→ However, it raises up to ~26% in a complete distance limited sample (Panessa & Giroletti 2009)

H_2O masers and X-rays

→ **H_2O maser sources** associated with

→ **high column density** ($N_H > 10^{23}$ cm^{-2}) or **Compton-thick** ($N_H > 10^{24}$ cm^{-2})

(Zhang et al. 2006, Greenhill et al. 2008, Castangia et al. 2013, Masini et al. 2016)



In a sample of 42 masers in AGN:

- 95% have ($N_H > 10^{23}$ cm^{-2})
- 60% are Compton-thick

→ 76% in disk-masers

Greenhill et al. 2008

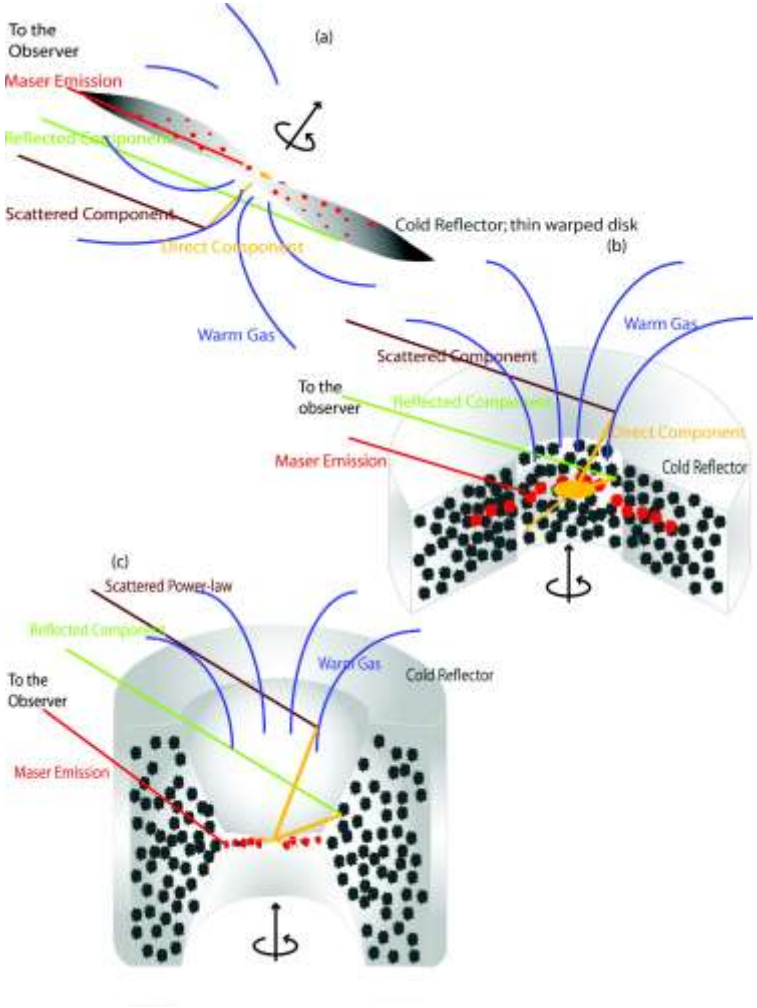
H_2O and X-rays

- ✓ A rough correlation have also been found between maser isotropic luminosity and unabsorbed X-ray luminosity

  (Kondratko et al. 2006)

- ✓ L_X may shape the accretion disk structure

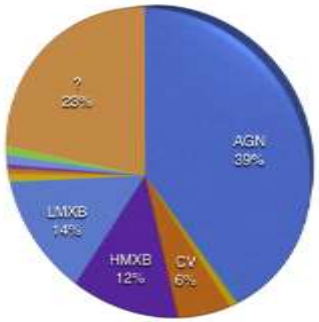
  (Tilak et al. 2008)



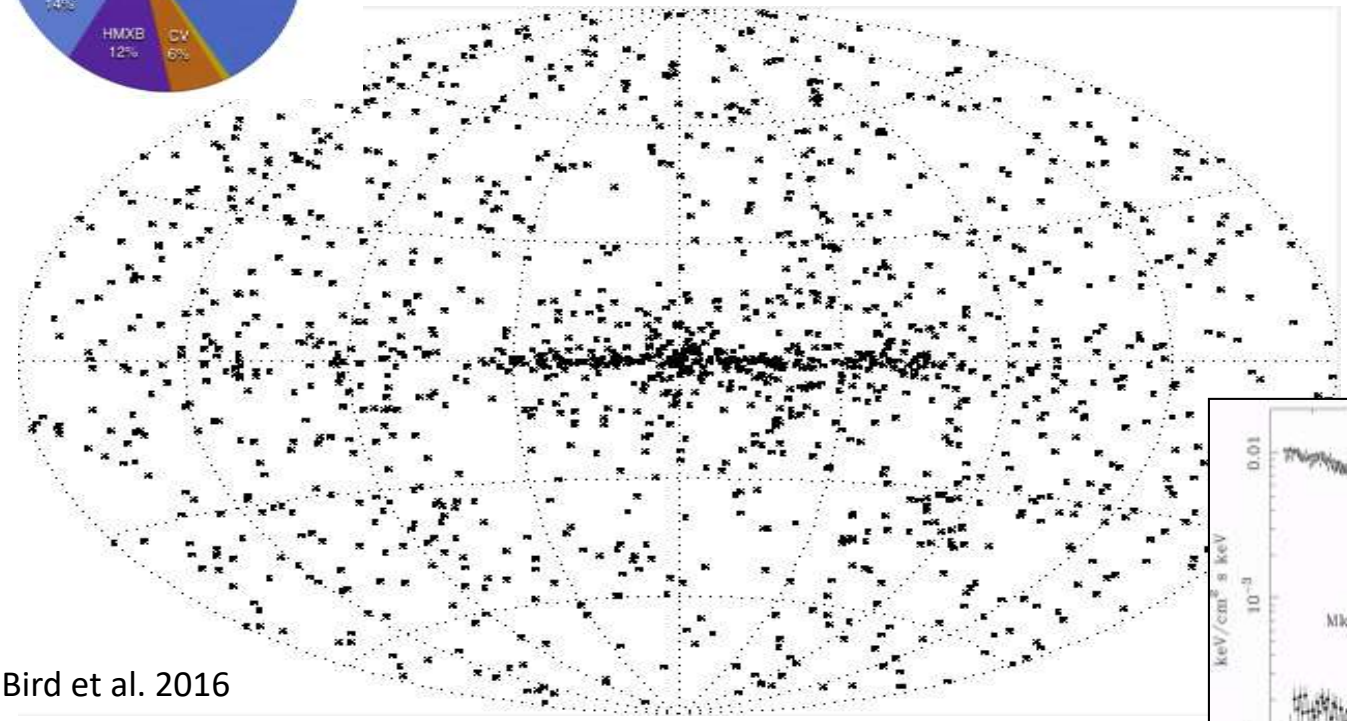
Statistics is poor!

Lack of X-ray data for most of the known maser sources!

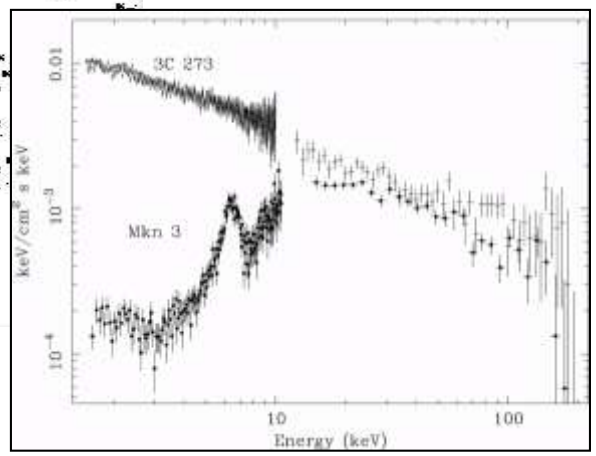
INTEGRAL hard X-ray sky







Bird et al. 2016



→ unbiased view of AGN obscuration

INTEGRAL AGN hard X-ray sky: characterizing water maser



INTEGRAL AGN sample
20-40 keV

→ Complete sample 87 AGN

→ Water maser survey of a complete sample

Castangia et al. in preparation

→ Total sample 380 AGN

→ Water maser survey of a complete sample+literature

Panessa et al. in preparation

INTEGRAL hard X-ray sky: statistics

→ Total sample 380 AGN

- ✓ 193 observed
- ✓ 29 water maser detection
- ✓ 187 not observed

→ 15 (+42) (-7) % detetion rate

→ Complete sample 87 AGN

- ✓ 65 observed
- ✓ 12 water maser detection
- ✓ 22 not observed

→ 18.5 (+20.5) (-4.7) % detetion rate

INTEGRAL hard X-ray sky: statistics among type 2

→ Total sample 163 type 2

- ✓ 103 observed
- ✓ 23 water maser detection
- ✓ 60 not observed

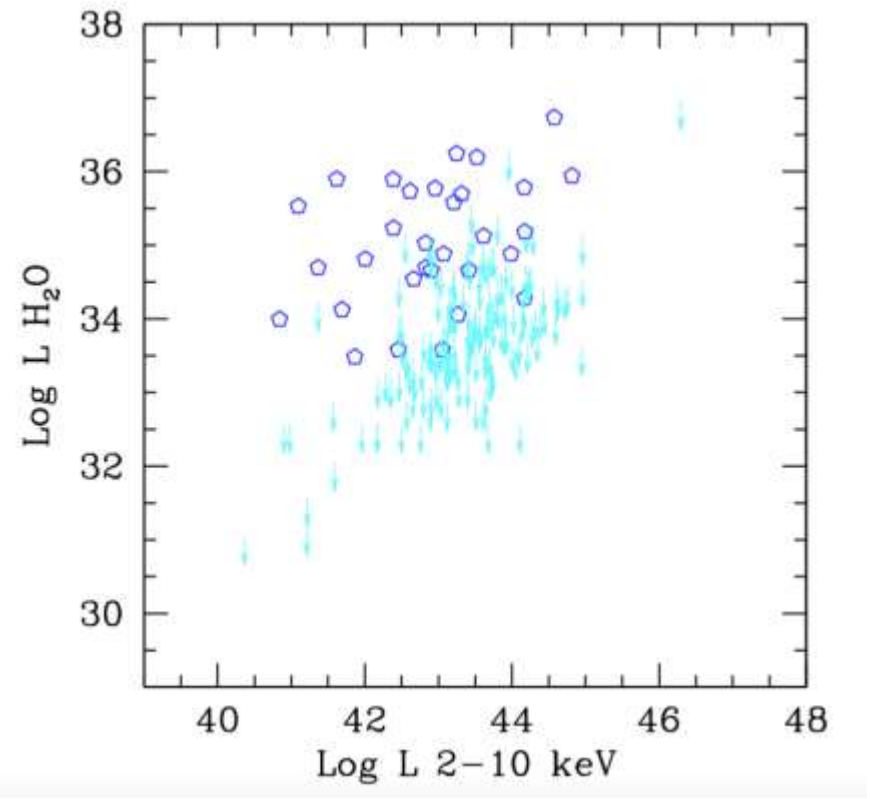
→ 22 (+36) (-7) % detetion rate

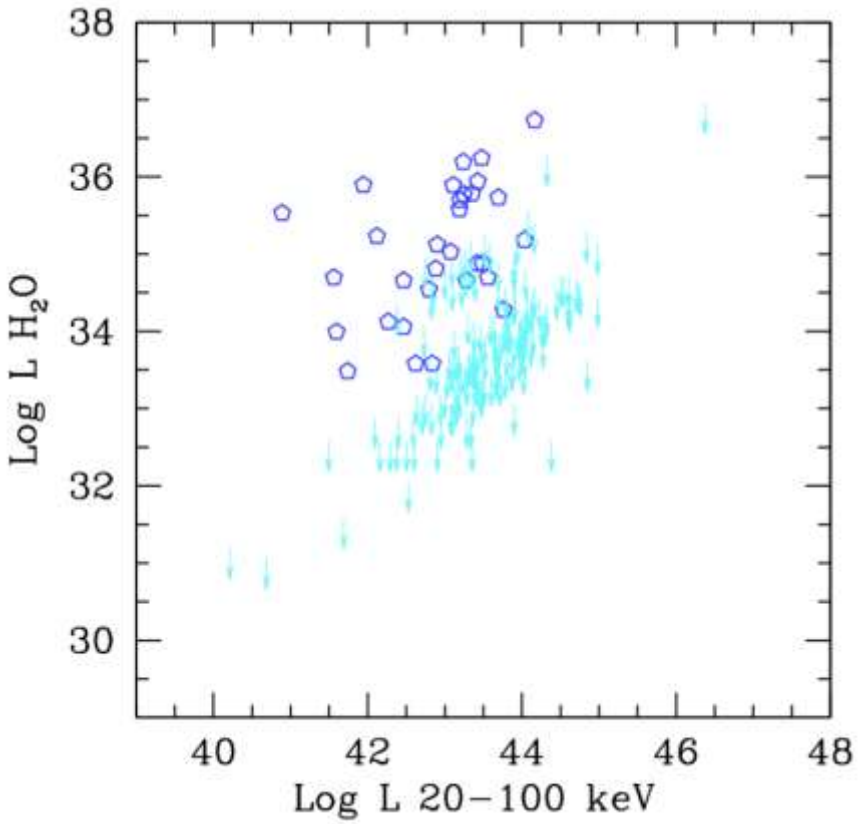
→ Complete sample 34 type 2

- ✓ 29 observed
- ✓ 9 water maser detection
- ✓ 5 not observed

→ 34 (+10) (-7.5) % detetion rate

H_2O and unabsorbed X-rays





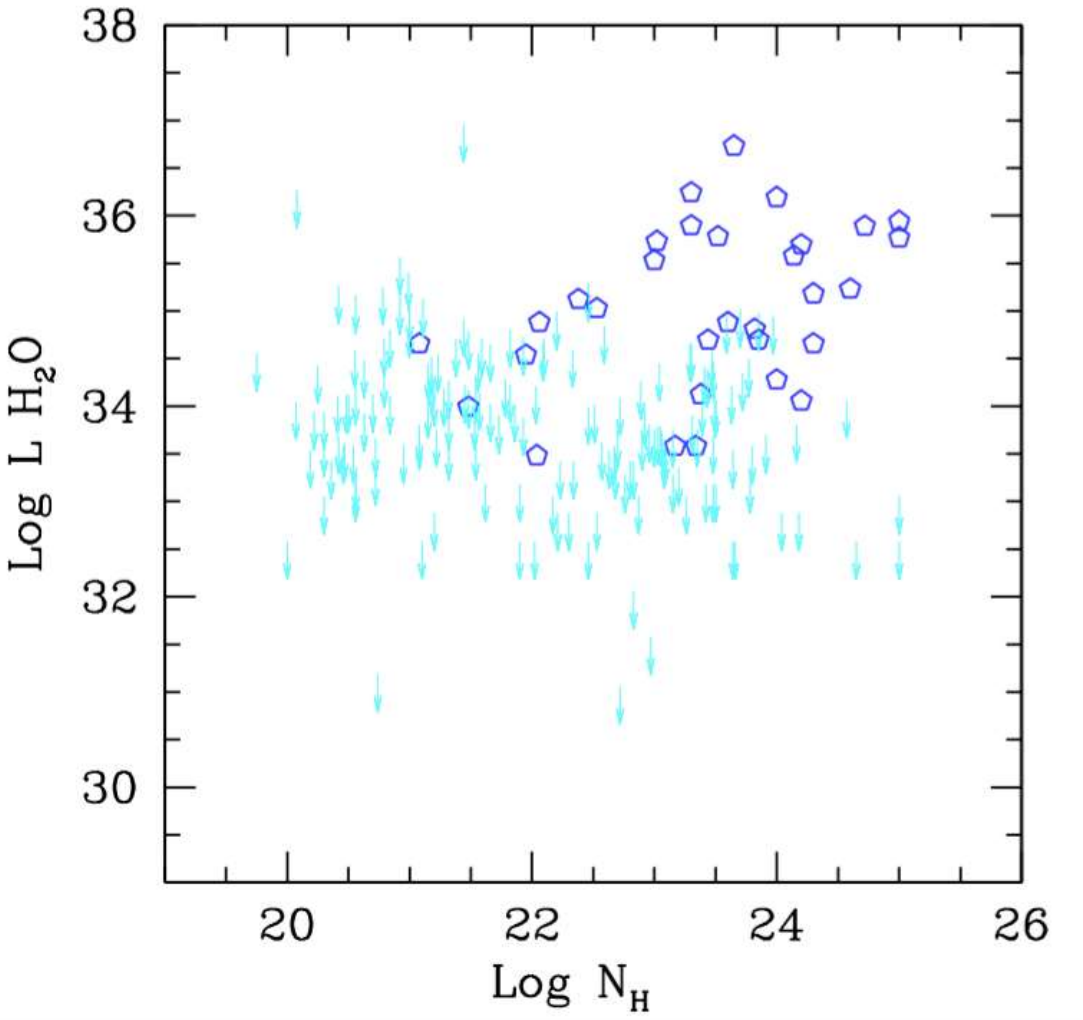
R = 0.34
two-tailed value P = 0.06222

Not statistically significant

R = 0.43
two-tailed value P = 0.01533

Marginally significant

H_2O and N_H



R is 0.3766

two-tailed value of P = 0.03675

not statistically significant

Conclusions from an hard X-ray sample

→ Water maser detection rate from 15% up to 34% (sey 2)

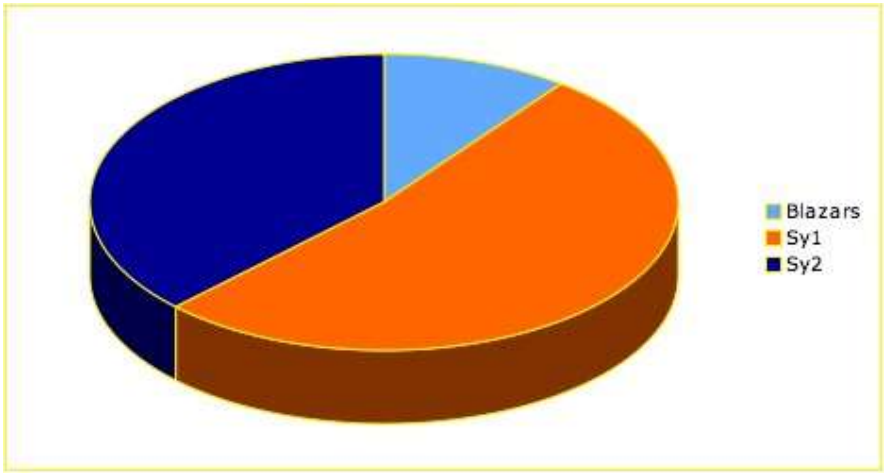
→ No clear correlation between X-ray and H_2O luminosities

→ No correlation between N_H and H_2O luminosities

….more work in progress

Thank you!

Hard X-ray selected AGN Complete sample



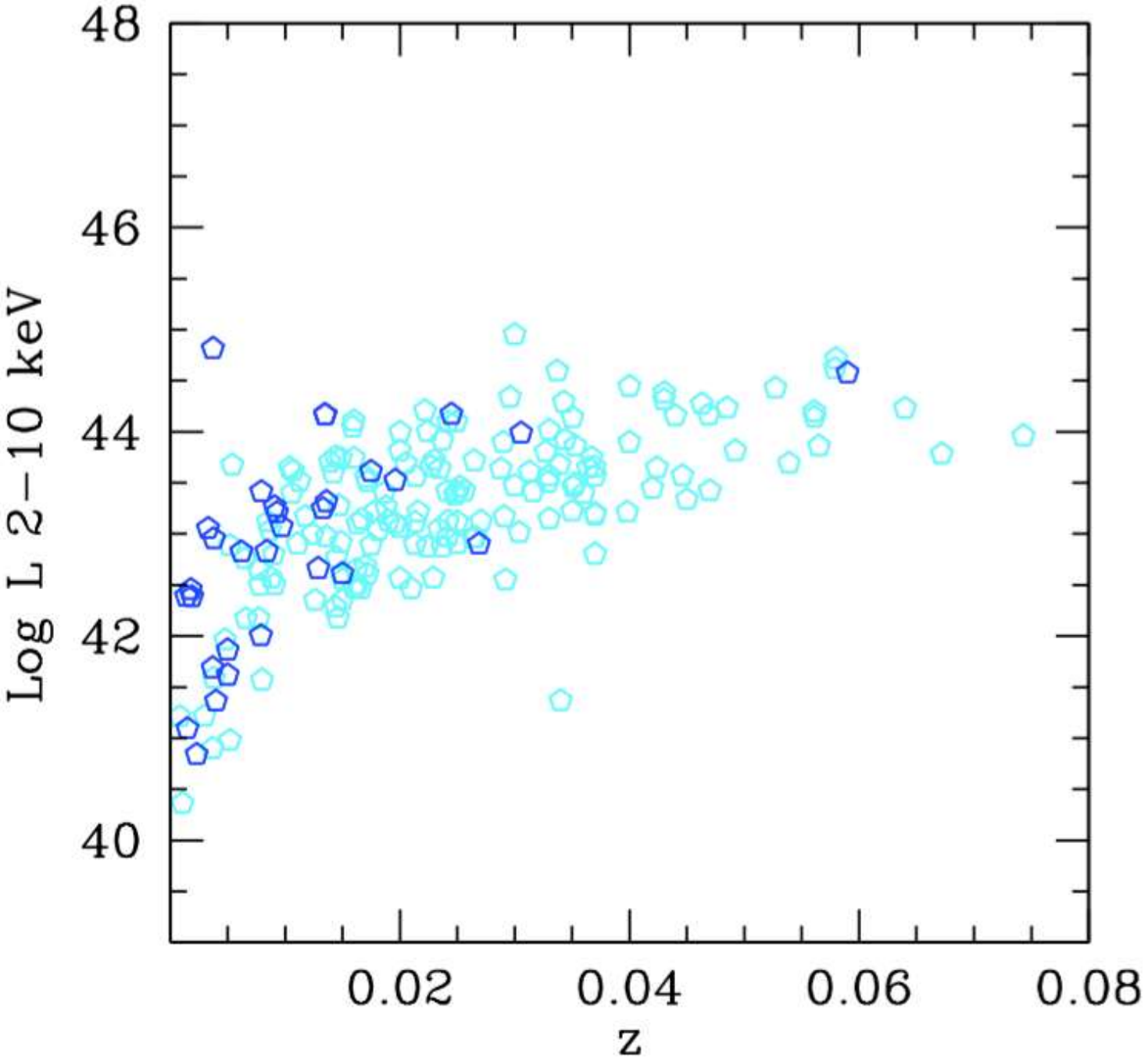
Complete sample

between 20-40 keV
(Malizia et al. 2009 MNRAS):

87 Seyfert galaxies:
- 41 type 1
- 33 type 2
- 6 NLSy1
- 8 Blazars

- Hard X-ray selected sample of luminous AGN:
  - -> INTEGRAL 20-100 keV (Malizia et al 2009)
  - -> 2-10 keV X-ray data (Malizia et al. + literature)
  - -> NVSS radio data (Panessa et al. 2015)

→ Water maser survey of the complete sample


48
46
44
42
40
Log L 2−10 keV
0.02
0.04
0.06
0.08
z