Constraining the Cosmic Obscuration of Water Megamaser Disks

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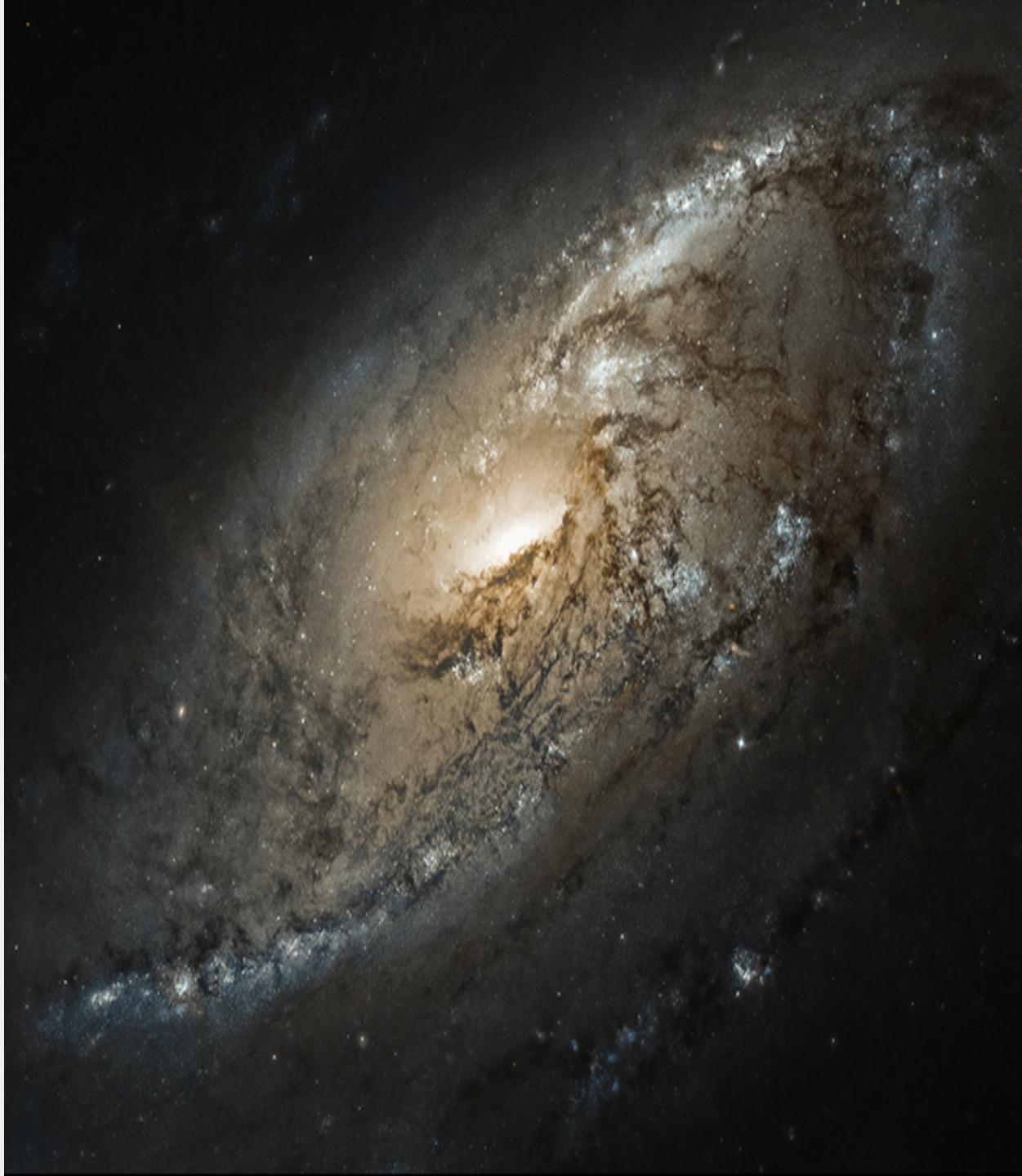
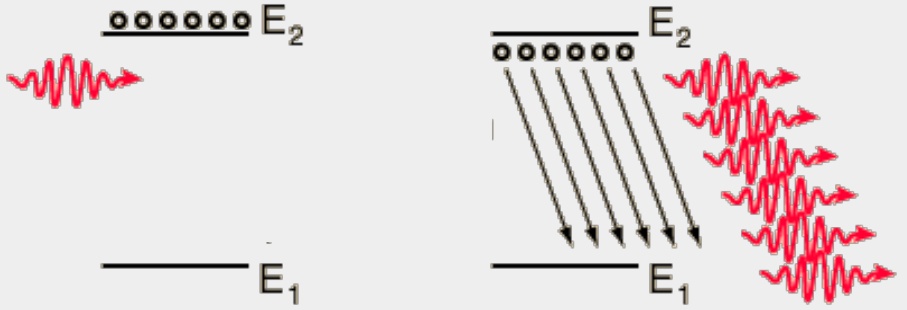


The Physics of Megamasers

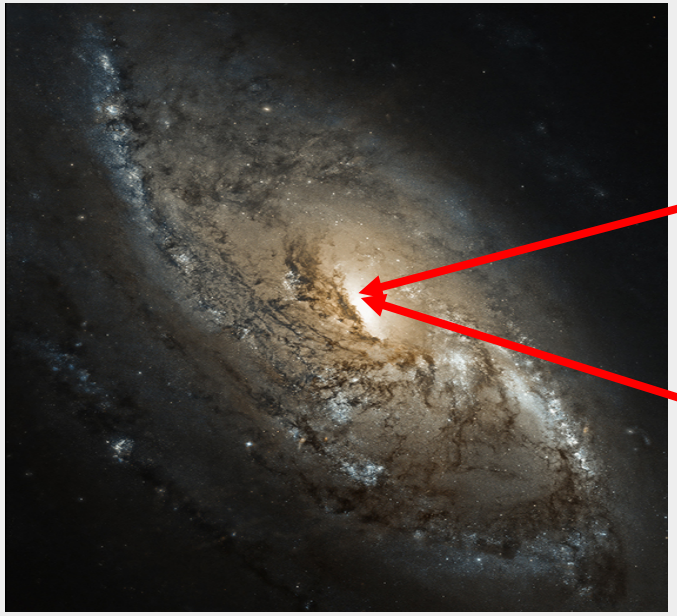
MASER- **M**icrowaves **A**mplified by **S**timulated **E**mission of **R**adiation



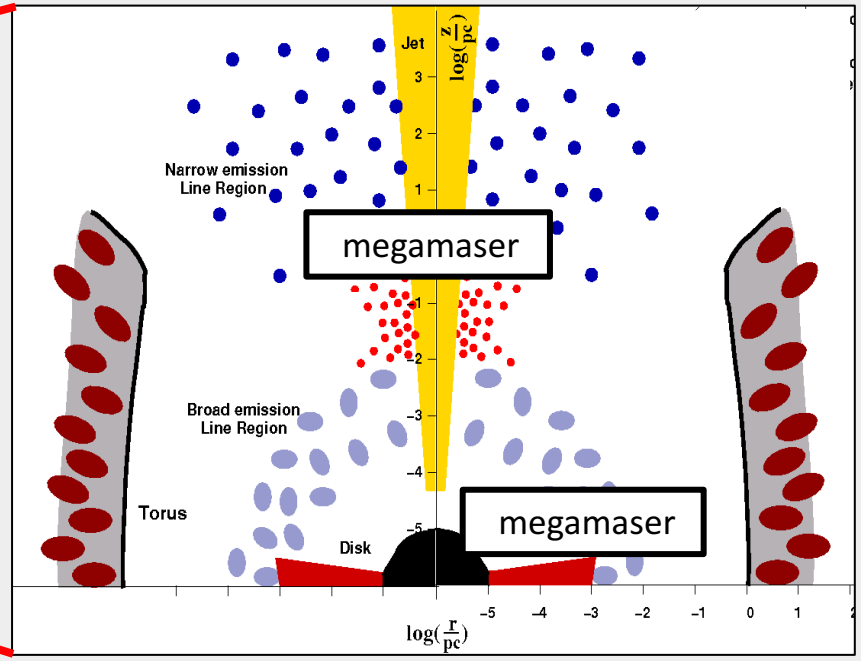
λ=1.4 cm
ν=22 GHz

Population inversion of a water molecule

Megamasers – 10^6 times more luminous than typical galactic masers



Optical image of NGC4258

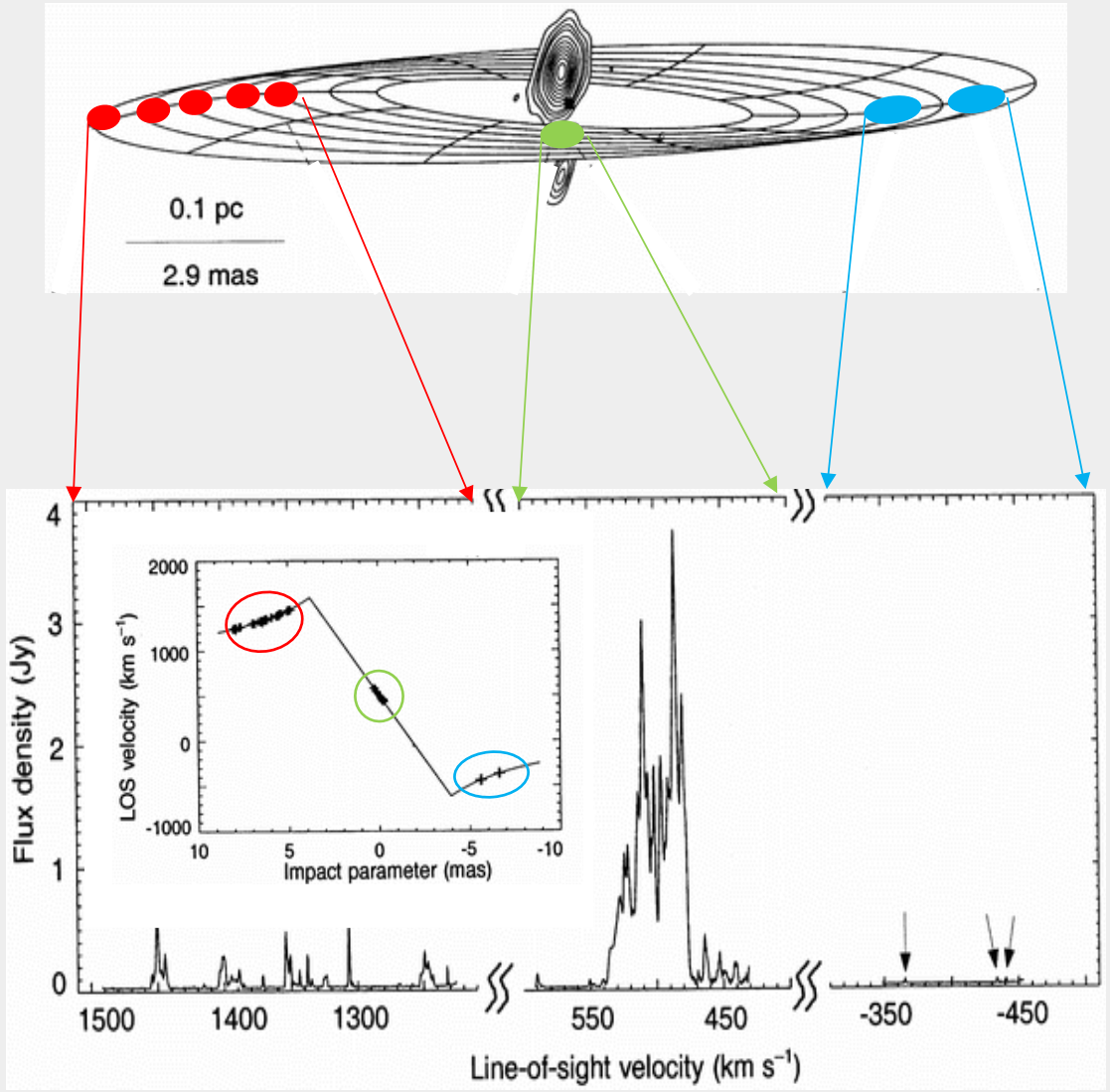


Megamaser Disks

Megamasers in a disk-like configuration:

- Measure **direct distances** to their host galaxies
  - Constrain geometry of universe
  - Independent constraint to the age of the universe
  - Better understand nature of dark energy

- Measure the **mass of the central supermassive black hole**

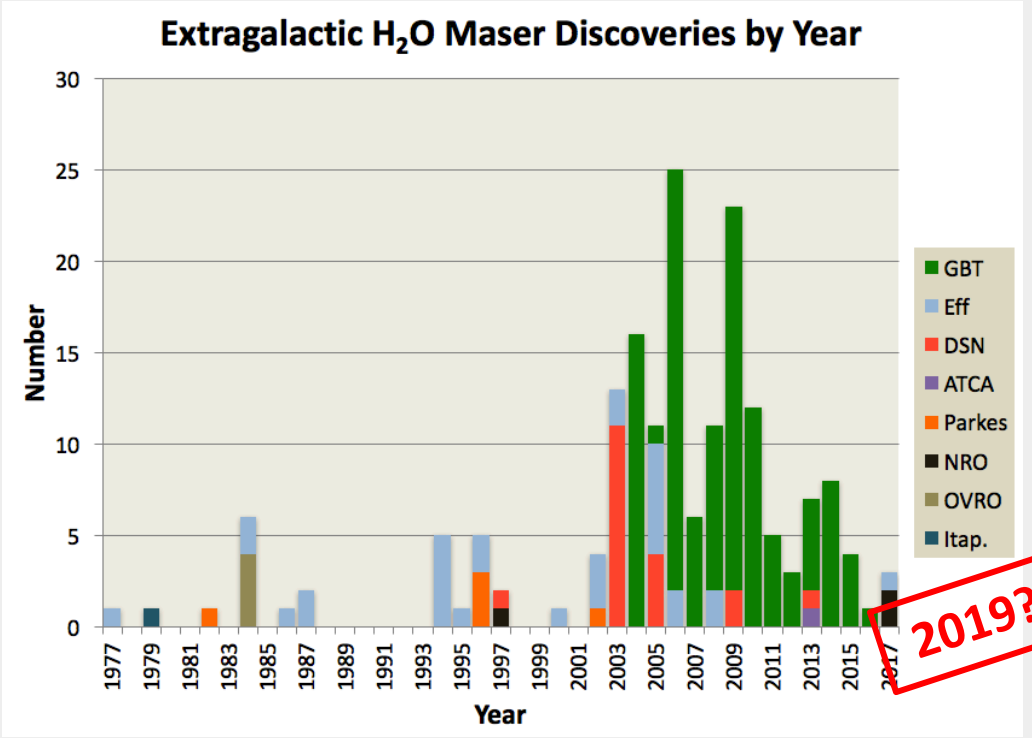


GBT spectrum of NGC4258 at 22 GHz (Hernstein et al. 1999).

The Need for More

- ~3% of all galaxies surveyed host maser emission
- ~30% of megamasers are found in disk-like configuration
- Previous searches: limited systematic analysis of properties of galaxies with maser emission and those without

To **find** more water megamasers disks, we must know **how to search for them!**



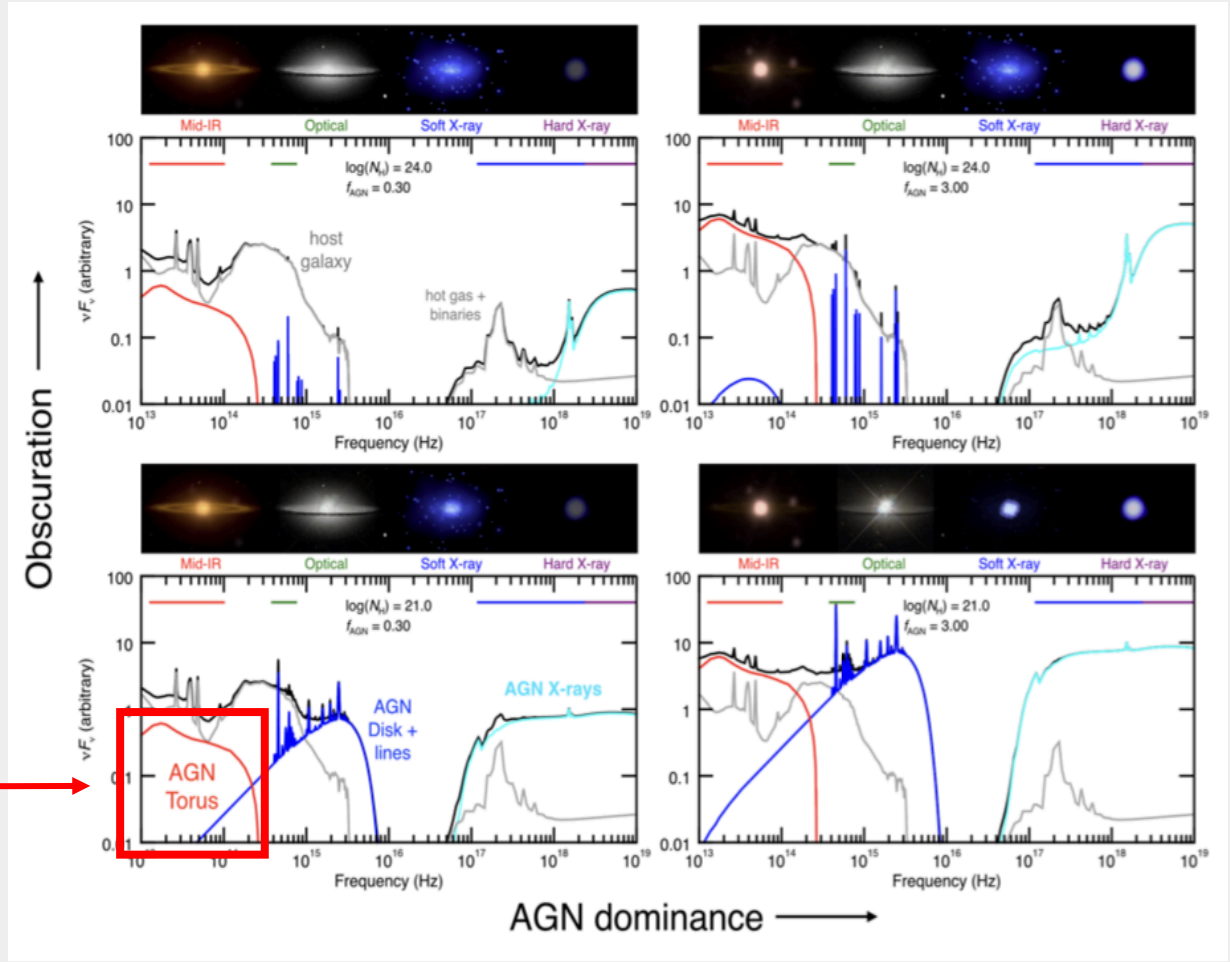
Our Study

- Systematic search to identify galaxy traits connected to the megamaser disk phenomenon to improve the maser detection rate

- Build **S**pectral **E**nergy **D**istributions (SEDs): total flux emitted across the electromagnetic spectrum

- Collect fluxes from each of the four band passes (3.4µm, 4.6µm, 12µm, 22µm) observed by the Wide-Field Infrared Survey Explorer (WISE)

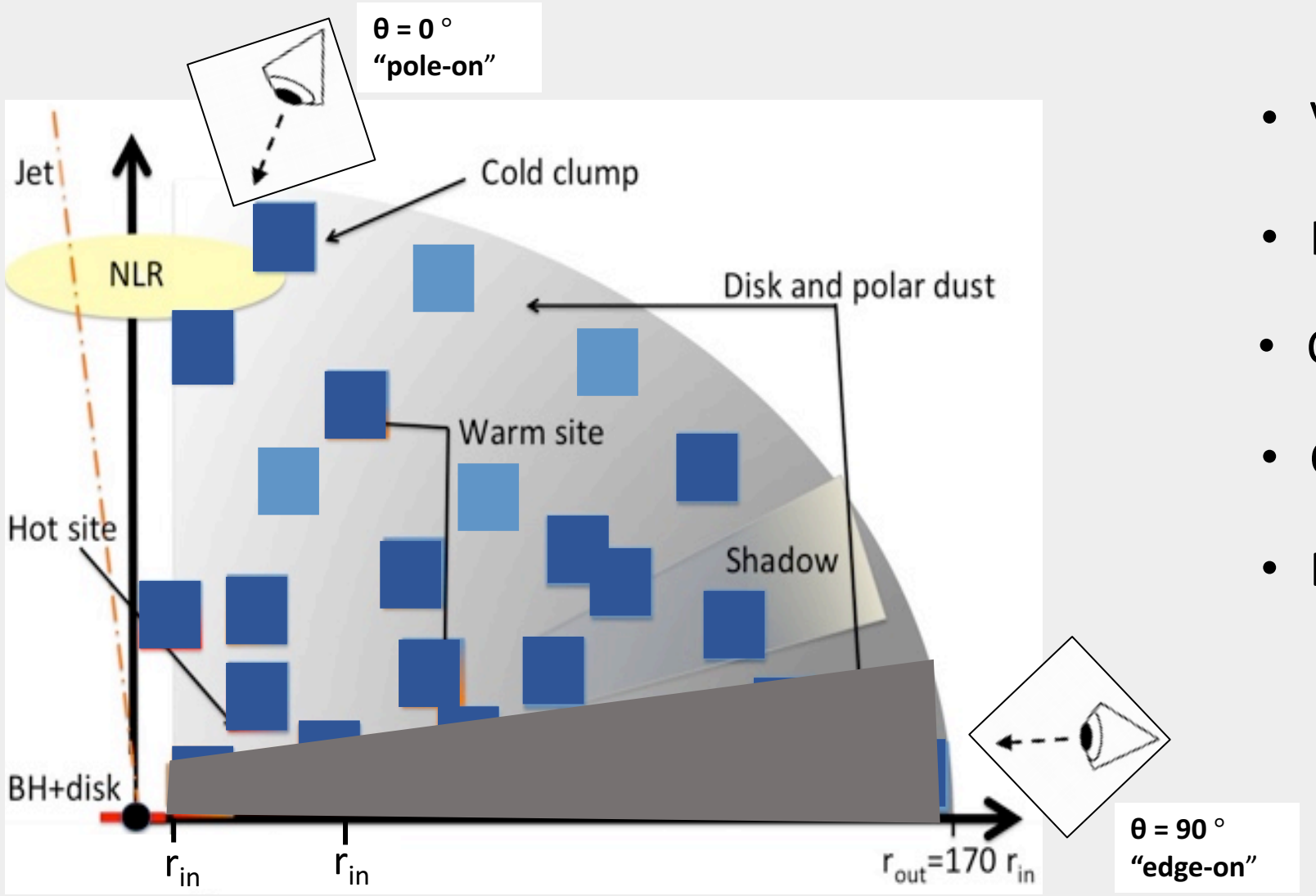
- Match WISE data with models to identify properties of dusty, obscuring torus



(Hickox & Alexander 2018)

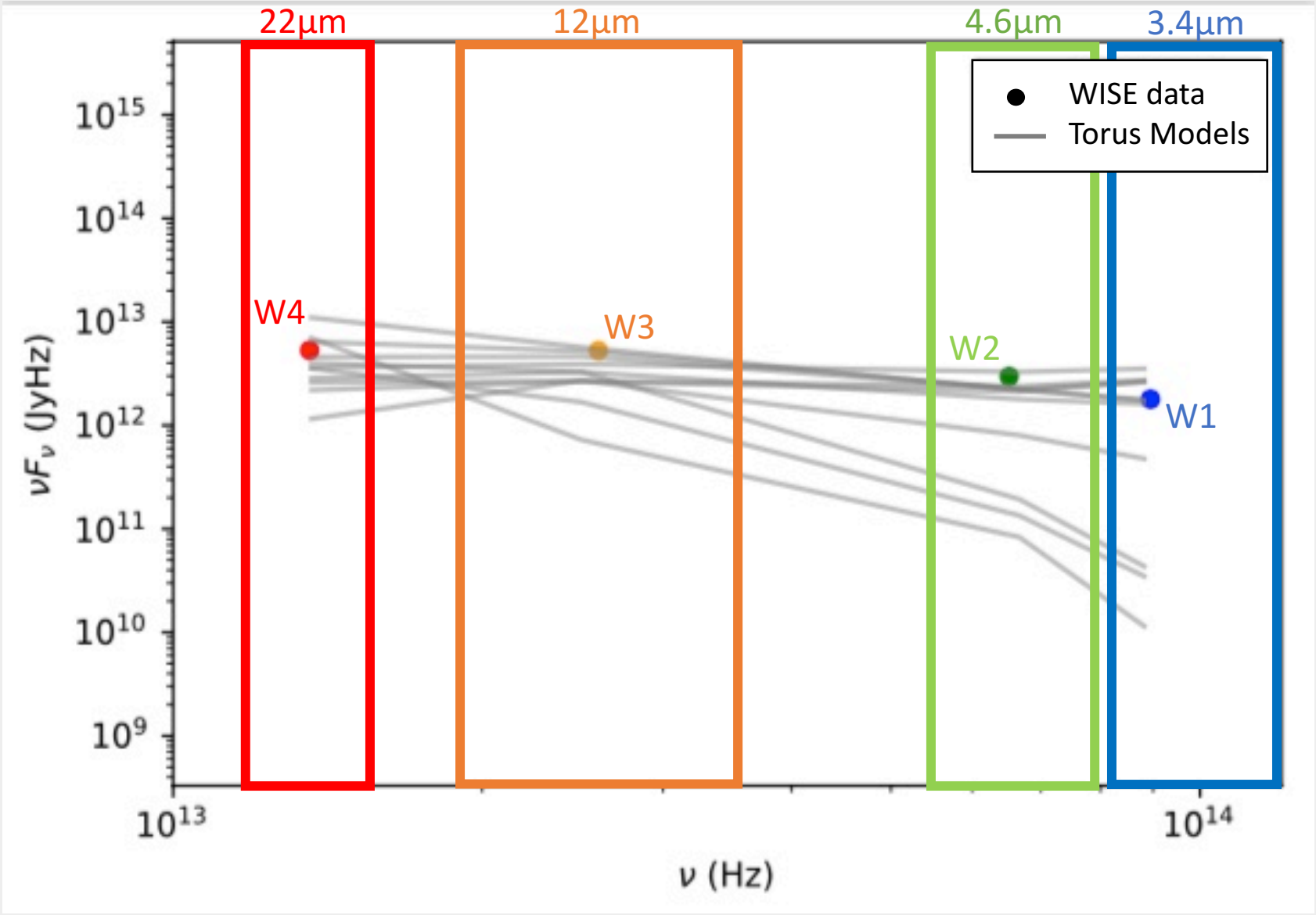
Models of Obscuring Torus

- Assumes fluffy dust grains and a 2-phase medium: clumpy medium and homogeneous disk

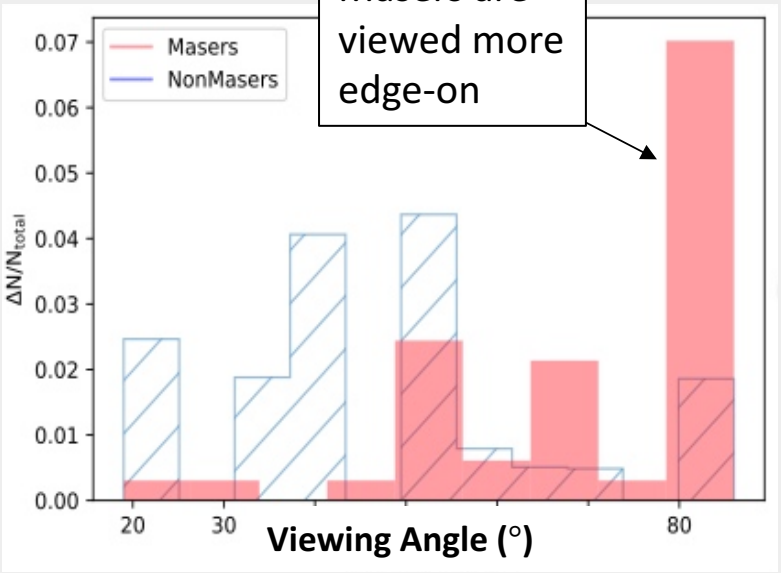


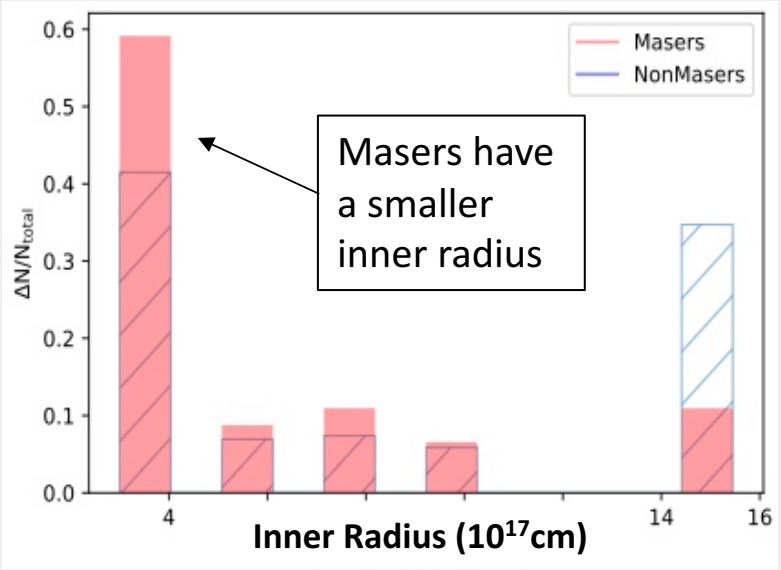
- Viewing Angle (θ)
- Inner Radius, r_{in} (10^{17}cm)
- Cloud Volume Filling Factor (%)
- Cloud Optical Depth ($\tau_{v,cl}$)
- Disk Optical Depth ($\tau_{v,\,mid}$)

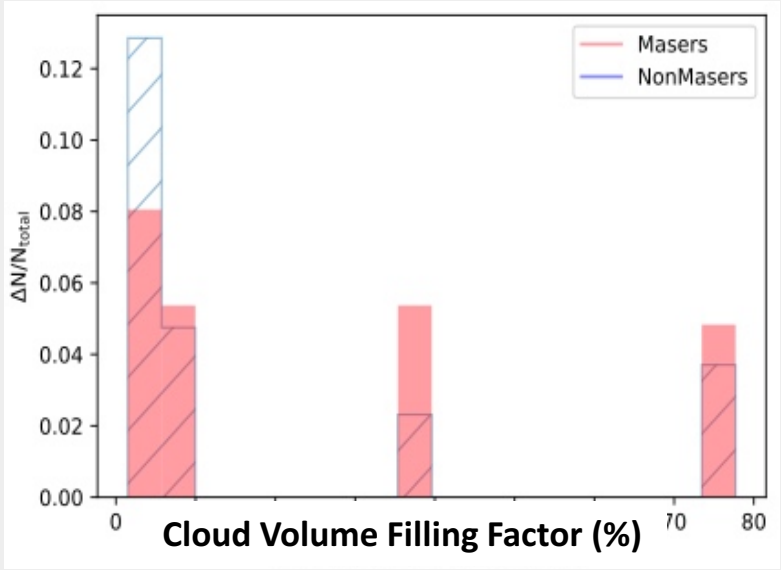
WISE Observations and Torus Models

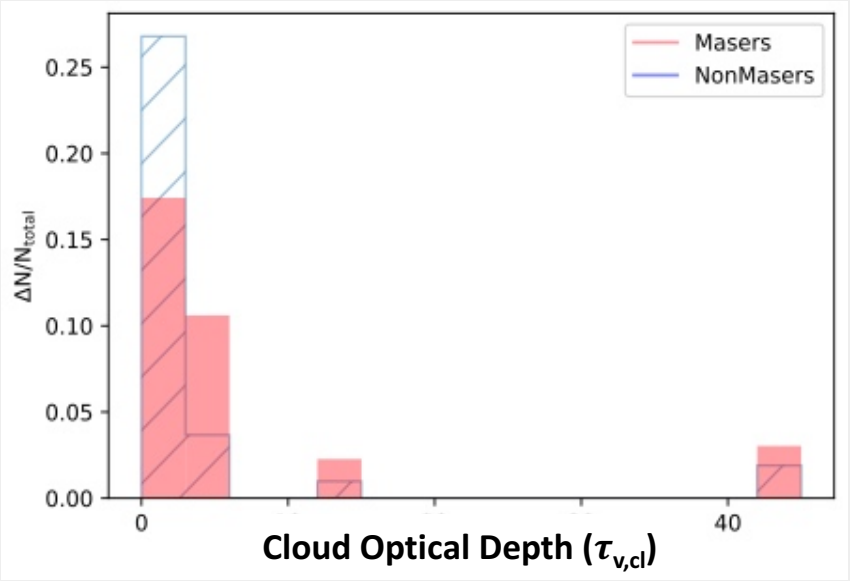


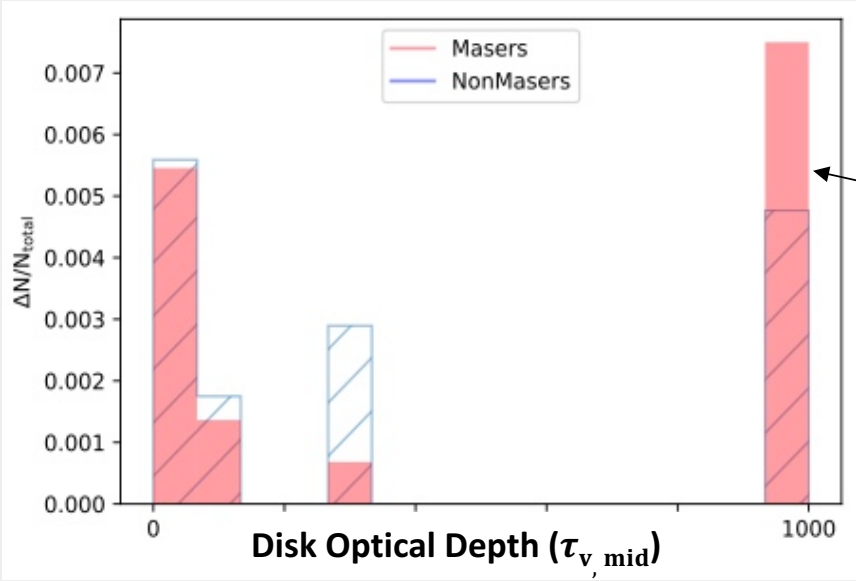
Masers vs. Non-Masers







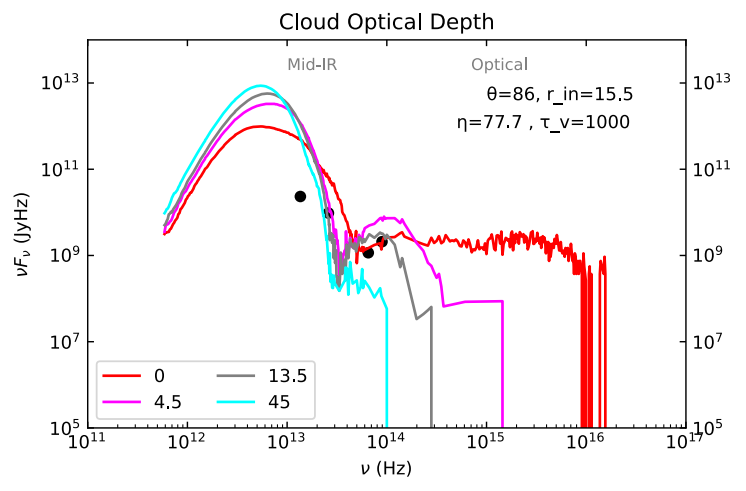




Future Work

- Statistically analyze (e.g. Kolmogorov-Smirnov test) distributions of obscuring material properties

- Extend analysis to observations in optical wavelengths



- Analyze other energetic phenomena (e.g., black hole accretion and star formation) of the host galaxies

Thank you

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(Astro Lab)

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