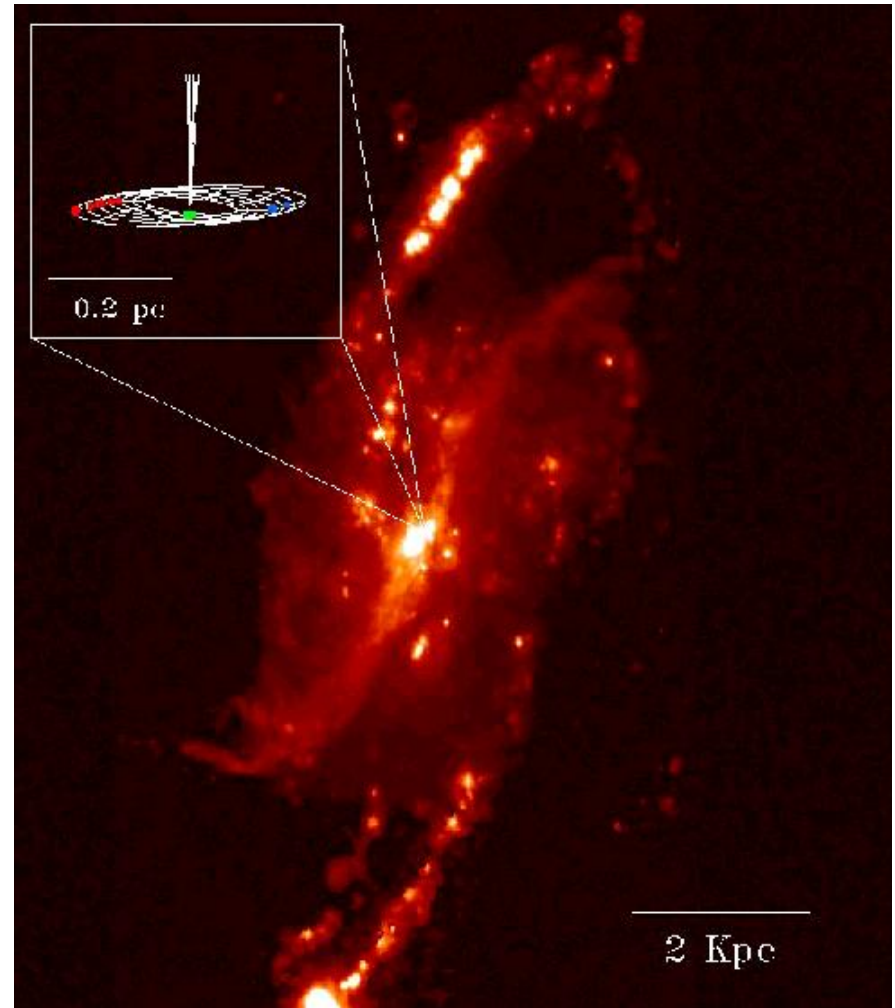


# The **W**ide-Field **I**nfrared **S**urvey **E**xplorer Properties of Maser and Non-Maser Galaxies in the Mid-Infrared

Catherine Witherspoon  
Anca Constantin

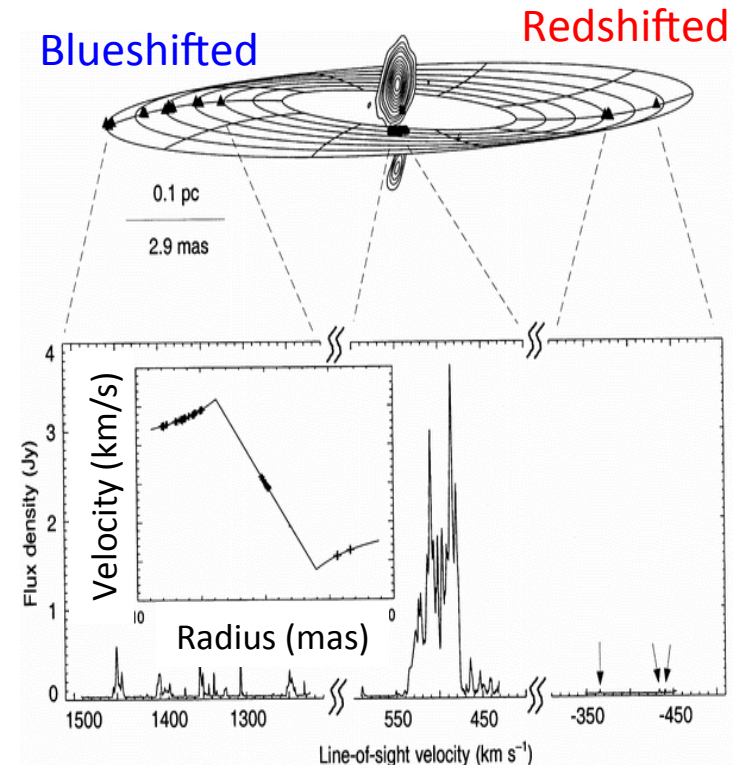
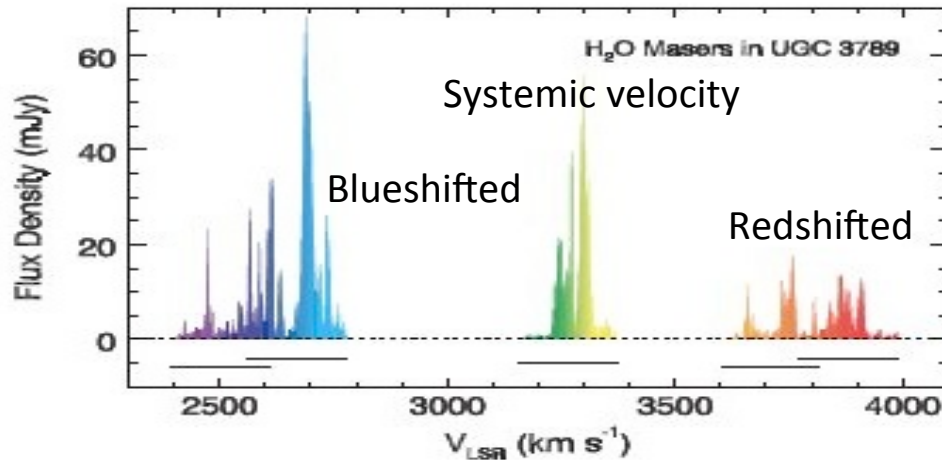
- The need for H<sub>2</sub>O maser disks
- Dust heating around AGN
- The need for infrared observations
- Spectral energy distributions (SEDs)



# Masers in Galaxy Centers

Maser = Microwave Amplification by Stimulated Emission of Radiation

- Water masers detected at  $\nu = 22$  GHz
- Usually associated with star formation (in spiral arms)
- 20% in galaxy centers and  $10^6$  more powerful  $\rightarrow$  Megamasers
  - Perfect disk-like configuration
    1. Direct measurement of distances to galaxies
    2. Most accurate measurement of SMBH masses



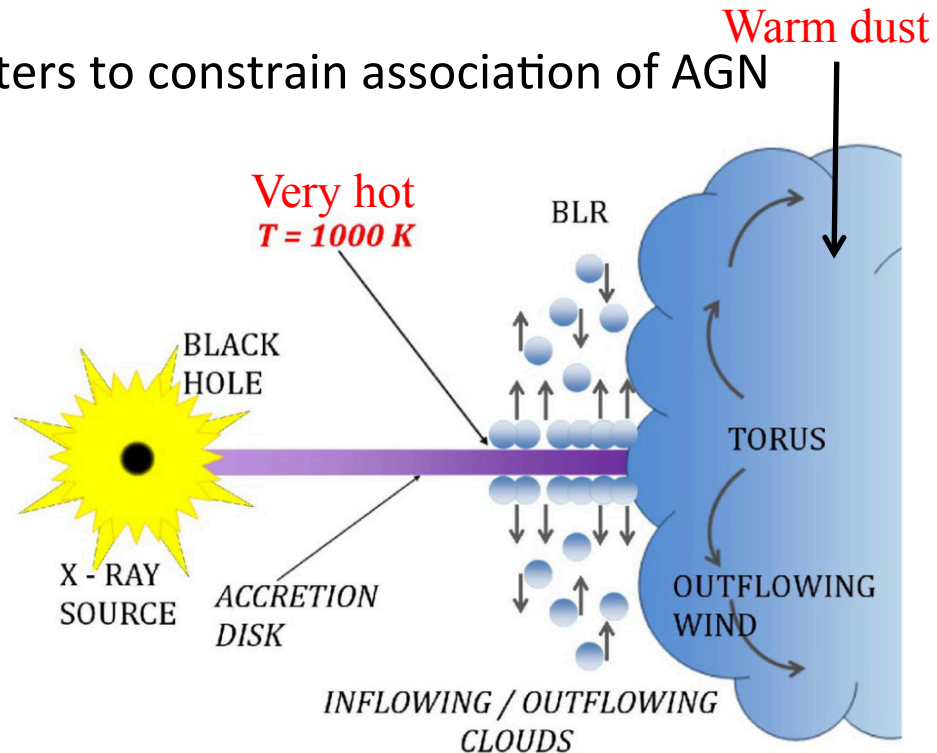
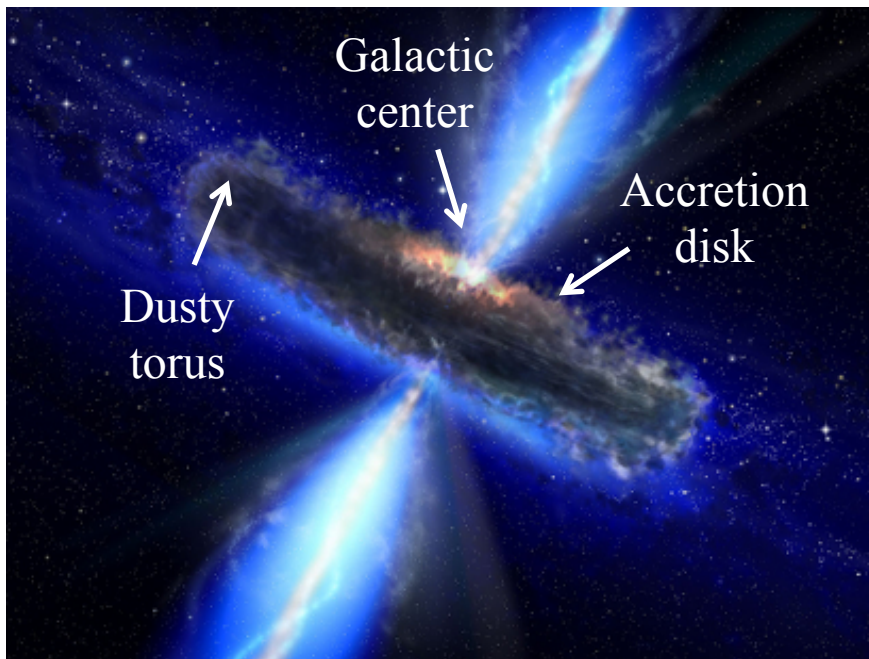
Only a handful known; really hard to find (<4% detection rate)  $\rightarrow$  Need more

# Dust Heating Around AGN

AGN = Active Galactic Nucleus

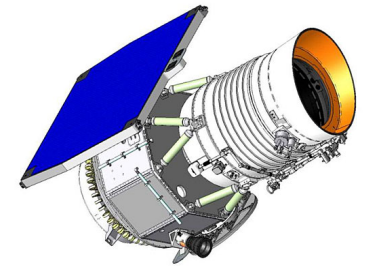
- Hints that maser emission is associated with hot dust around AGN
- Accretion disk provides seed photons for maser emission
- Dust in torus provides masing conditions
- Dust is reprocessing radiation from accretion disk and emits in mid-IR

-> Probe mid-IR properties of galaxy centers to constrain association of AGN with maser and non-maser galaxies





# The Data



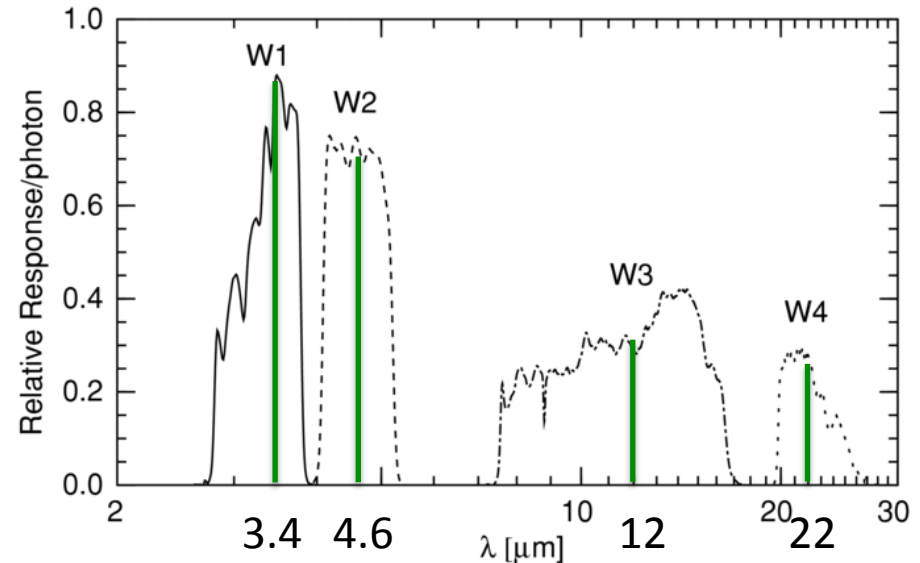
## Maser & Non-Maser Samples:

- Megamaser Cosmology Project (MCP)
  - International collaboration surveying for maser emission in galaxy centers using GBT, VLA, VLBA, and Effelsberg telescopes (radio)

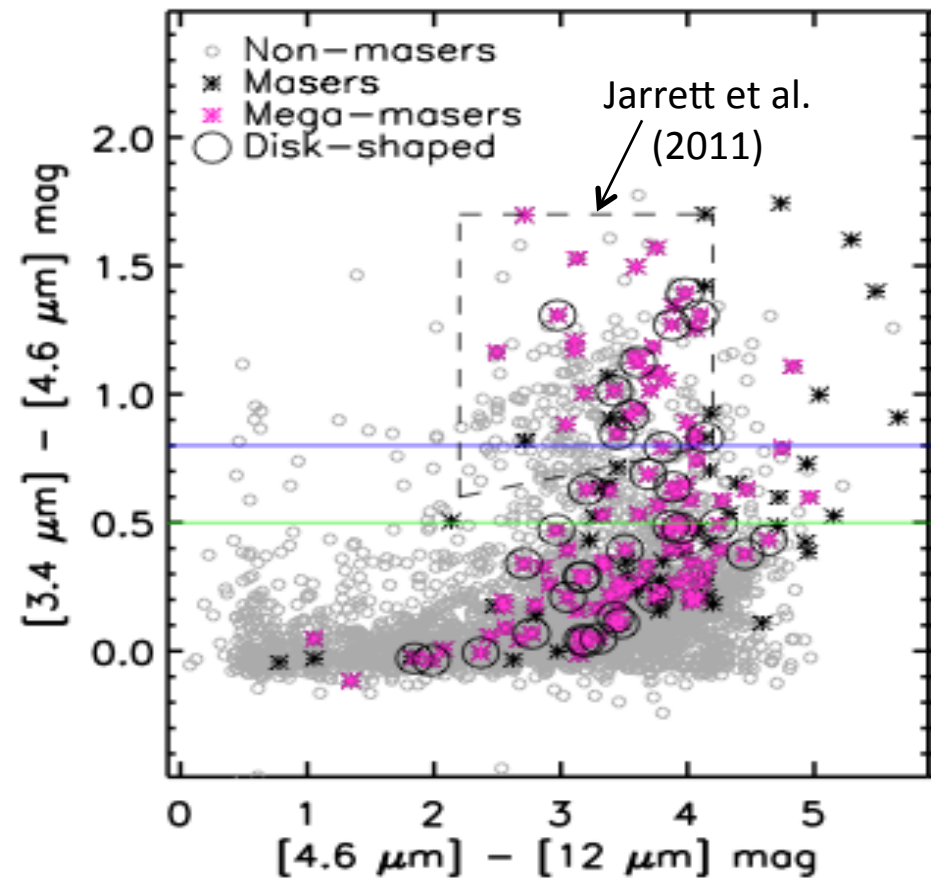
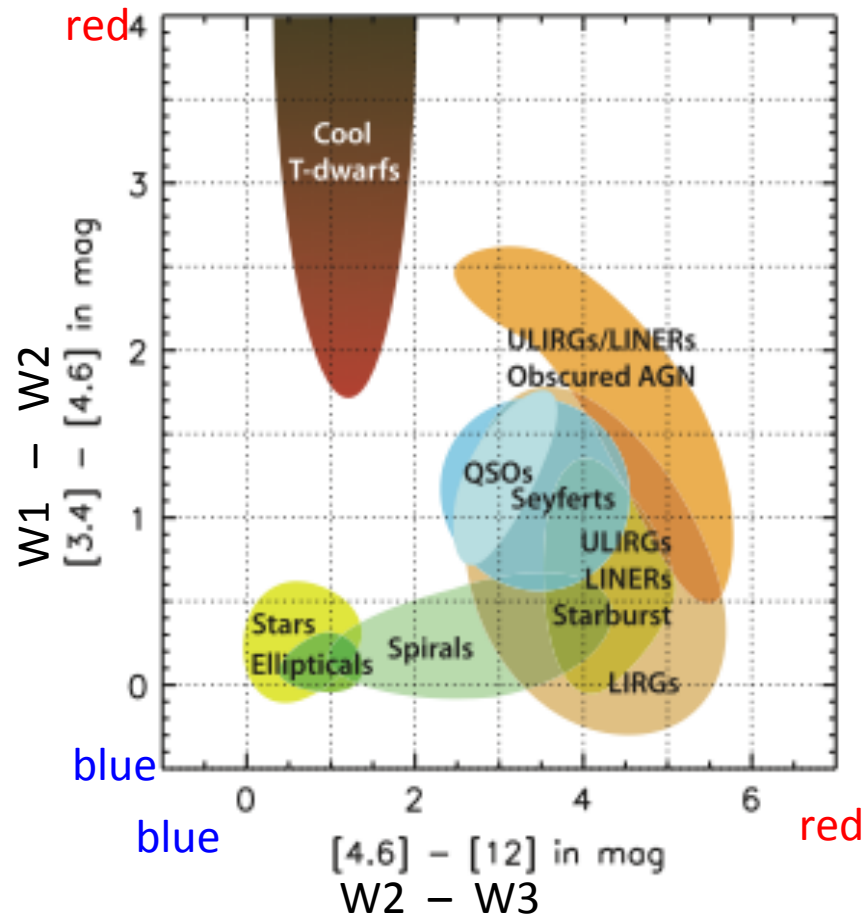


## Mid-IR WISE Surveys:

- All-sky survey with the best sensitivities (0.08, 0.11, 1, and 6 mJy at 4 wavelengths) in the mid-IR
- Measures magnitude of object at 4 wavelengths (W1, W2, W3, W4)



# WISE Mid-IR Color and Maser Activity



Proposed WISE AGN selection techniques:

1.  $W1 - W2 > 0.8$  (blue) (Stern et al. (2012))
2.  $W1 - W2 > 0.5$  (green) – more relaxed AGN criterion (Ashby et al. (2009))
3. Jarrett et al. (2011) (dashed gray) – least contamination

# WISE AGN – Maser Connection

## Use WISE-AGN Criteria

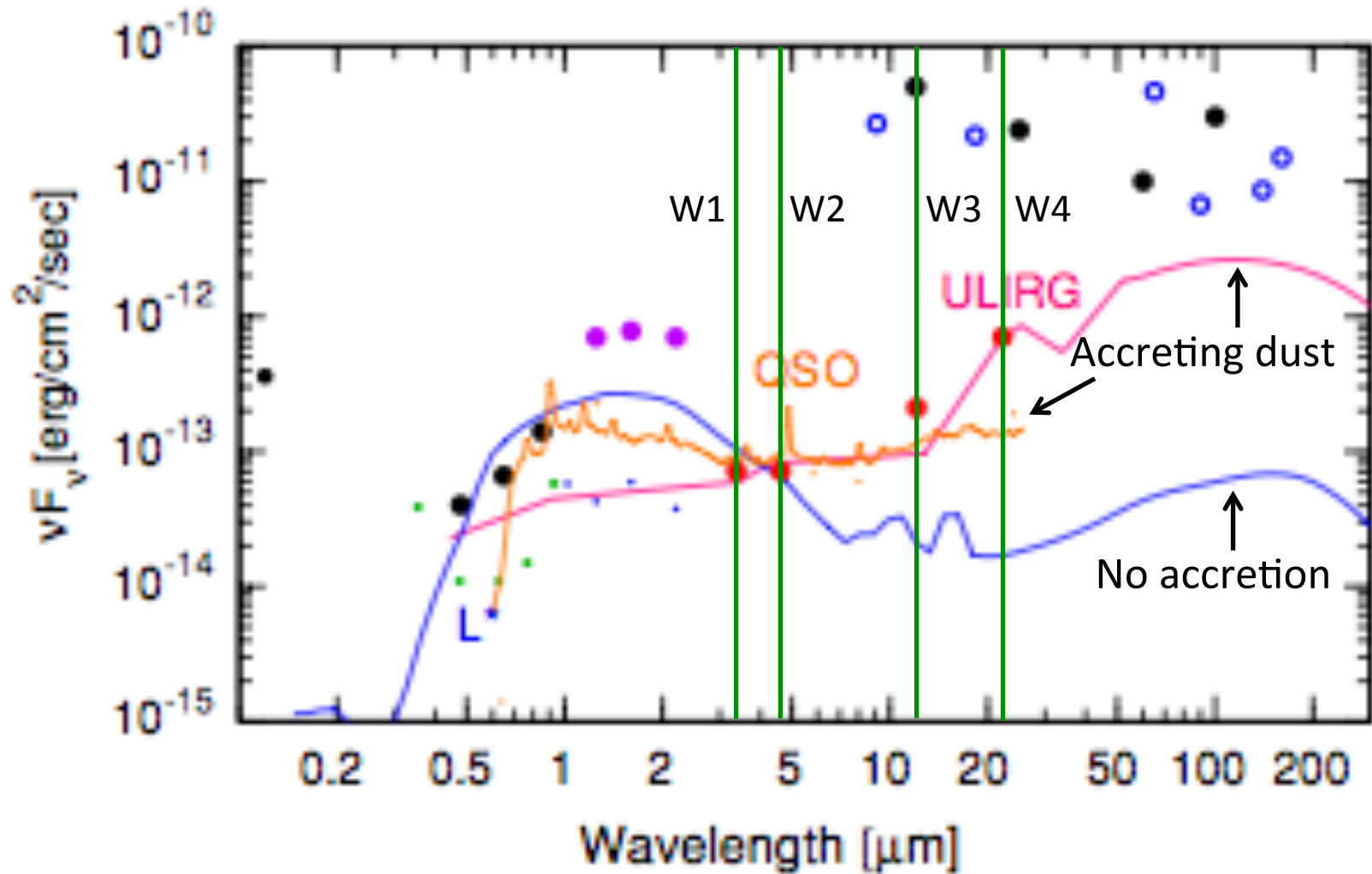
- Maser detection rate = 16-21%
- Recover less than 30% of known disks are red AGN
  - Missing most of maser disks

-> Megamaser disks located in galaxies that don't necessarily associate with AGN based on mid-IR colors

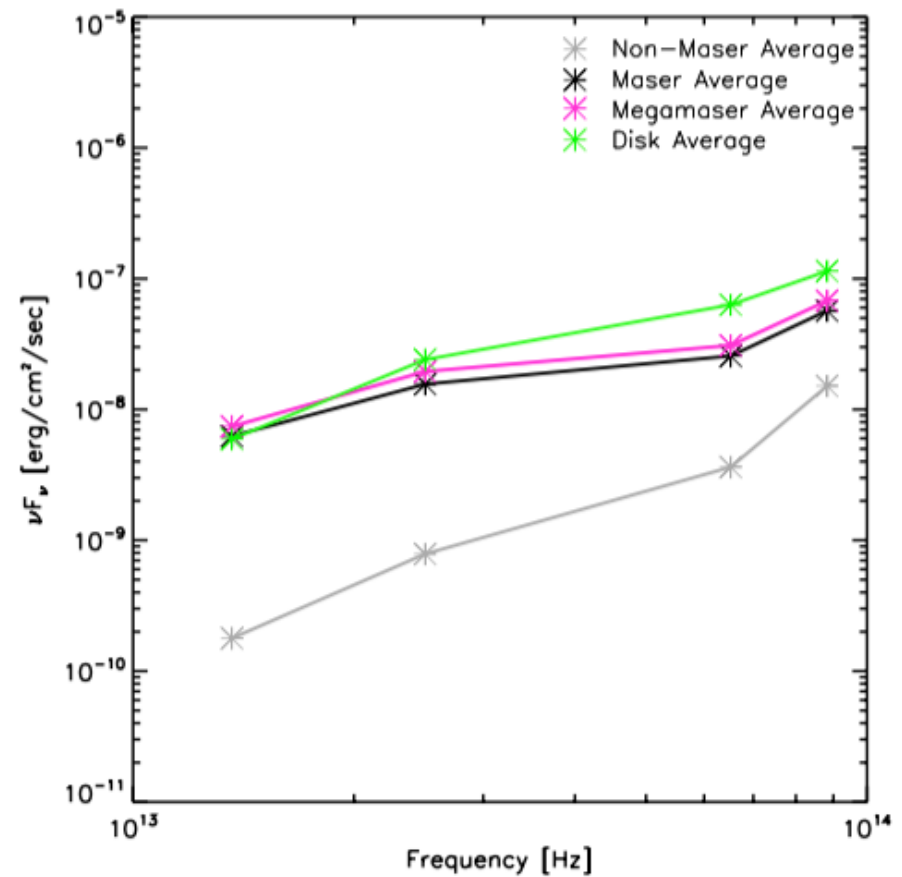
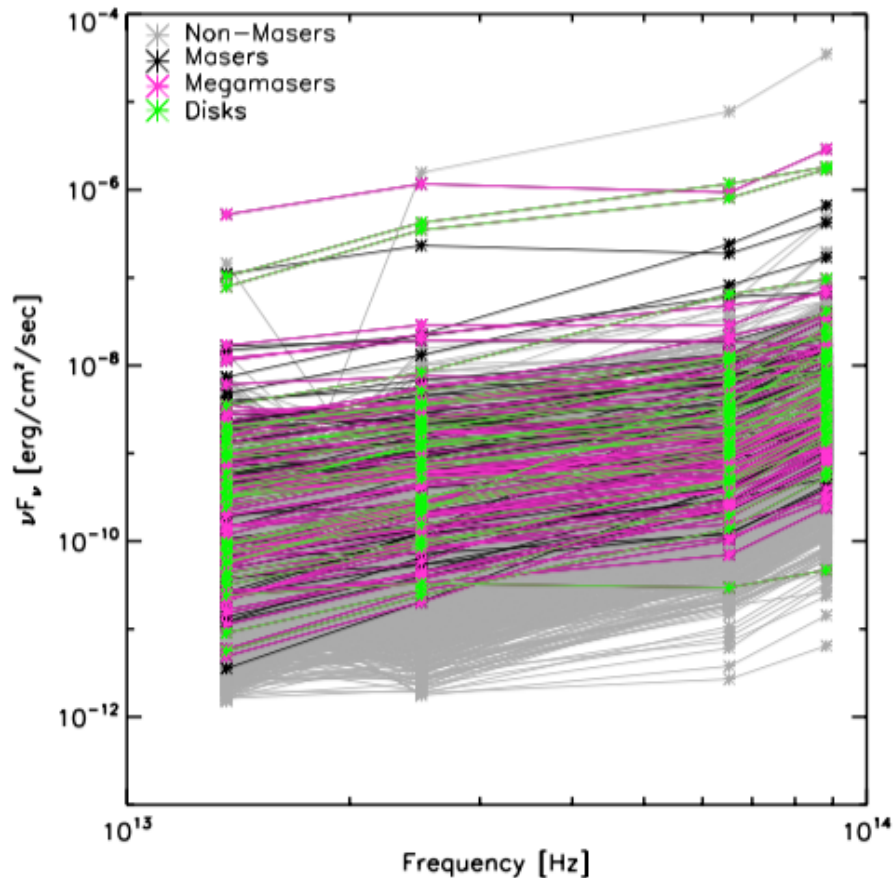
1. If AGN activity relates to megamaser disk emission:
  - Possible hidden AGN outside WISE-AGN criteria
  - New way to detect accreting SMBHs!
2. If AGN are not outside the AGN criteria:
  - 70% megamaser disks are not associated with AGN
  - What is the nature of these disks?

WISE AGN Criterion Detection Rates	W1-W2 > 0.8	Jarrett et al. (2011)	W1-W2 > 0.5
<b>Masers</b>	21% of galaxies surveyed	16% of galaxies surveyed	18% of galaxies surveyed
<b>Megamasers</b>	19% of all masers	19% of all masers	30% of all masers
<b>Disks</b>	26% of all disks	29% of all disks	38% of all disks

# Spectral Energy Distribution (SED) Comparison



# Our Analysis of SEDs



## Plans for the Future:

- Calculate error bars for the averages
- Investigate the SED trends for maser and non-maser galaxies
- Compare the SEDs of various objects with theoretical models of hot/warm dust emission