ALMA observations of molecular gas emission in the close vicinity of AGNs

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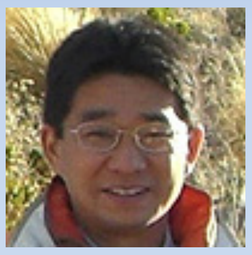
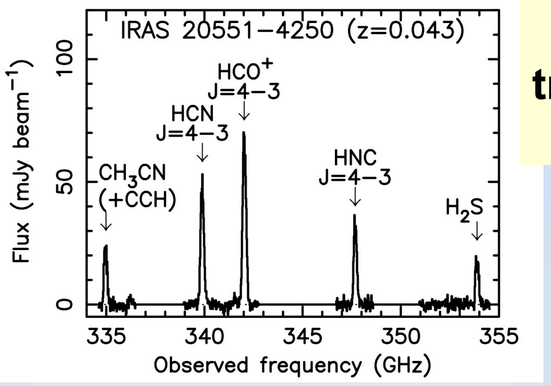
Abstract

We present the result of our ALMA observations of molecular gas in the close vicinity of AGNs. In this poster, I focus on observational results of the ultraluminous infrared galaxy, IRAS 20551-4250, which contains a luminous buried AGN. We clearly detected vibrationally excited HCN/HNC emission lines, suggesting that infrared radiative pumping mechanism plays an important role in this AGN-hosting ULIRG, in addition to collisional excitation.

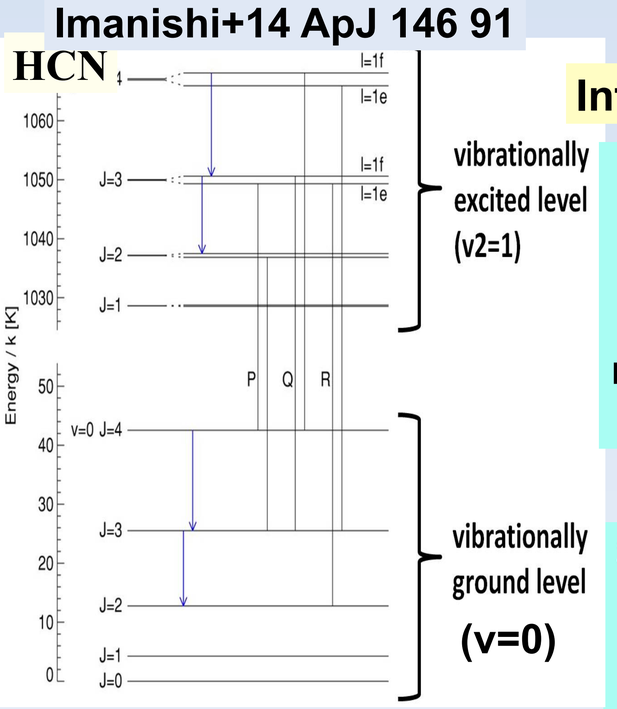


1. Introduction



Imanishi+14 ApJ 146 91

(Sub)millimeter molecular rotational transition lines in galaxies are usually assumed to be collisionally excited.



Sakamoto+10 ApJ 725 L228

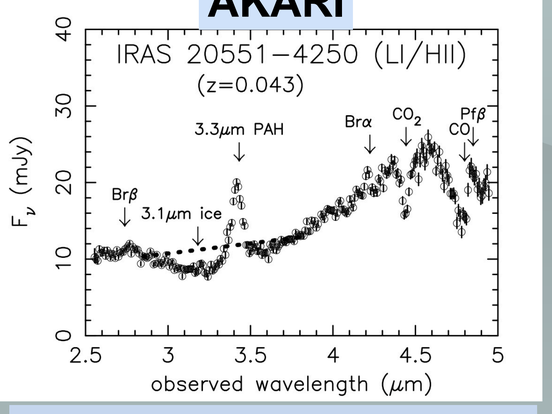
Infrared radiative pumping

Molecules can be vibrationally-excited to v=1 by absorbing mid-infrared photons (HCN 14um, HCO+ 12um, HNC 21.5 um). Through decay back to v=0, molecular rotational transition flux at v=0 can increase, compared to collisional excitation alone.

Since an AGN is a stronger mid-infrared emitter, due to AGN heated hot dust, than a starburst, this infrared radiative pumping mechanism is expected to work more effectively in an AGN.

2. Target: IRAS 20551-4250 (ULIRG at z=0.043)

AKARI



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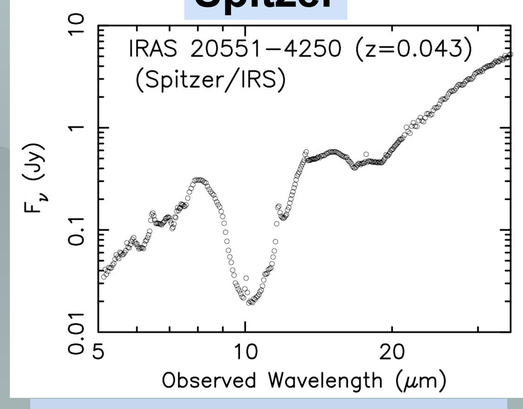
Spitzer

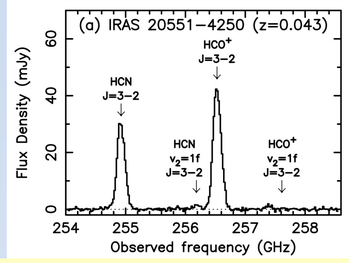


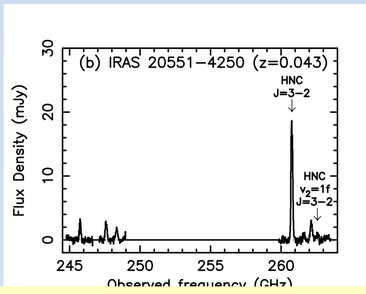
Imanishi+11 AJ 141 156

Infrared 2.5-30 micron spectroscopy suggests that a luminous buried AGN is present because the starburst indicator, PAH (polycyclic aromatic hydrocarbon) emission, is weak.

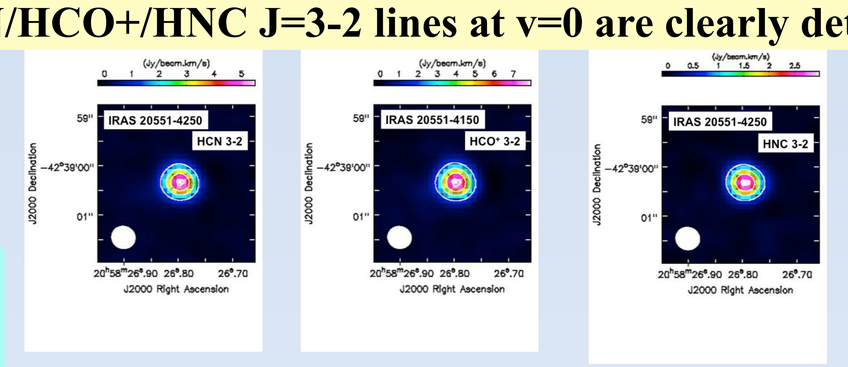
3. Result: emission lines (HCN, HCO+, HNC)

ALMA band 6 spectrum

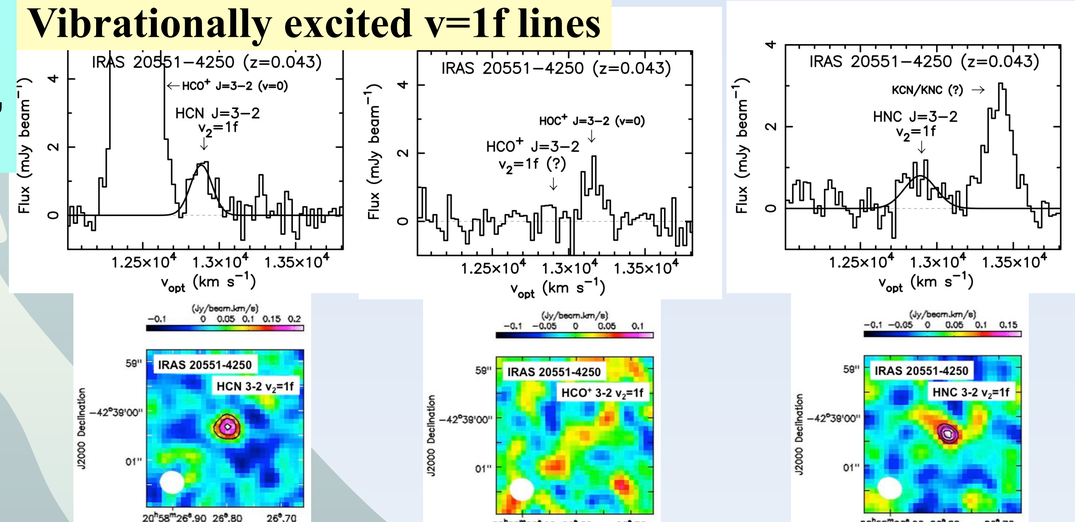




HCN/HCO+/HNC J=3-2 lines at v=0 are clearly detected



Vibrationally excited v=1f lines



HCN, HNC J=3-2 detected **HCO+ J=3-2: non-detected**

Infrared radiative pumping is required (Energy is too high for collisional excitation)

4. Discussion

We compared our observational results with our infrared radiative pumping calculation.

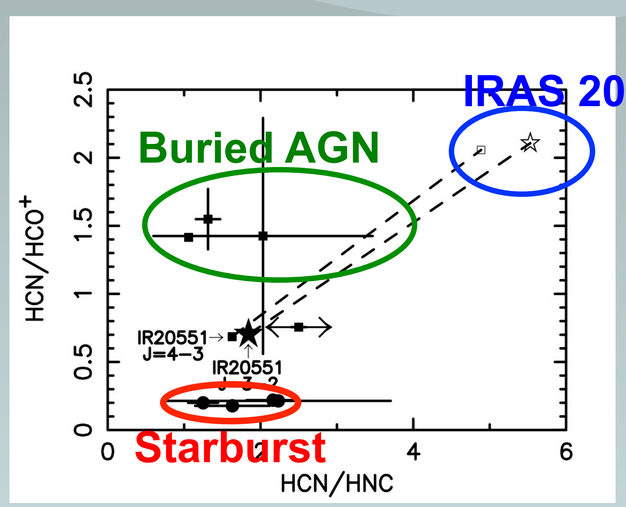
HCN/HCO+ abundance > 2.5 **HCN/HNC abundance ~10**

Flux attenuation at v=0 : HCN = 3-6, HCO+ ~ 1, HNC ~ 1

HCN abundance is enhanced in the close vicinity of the AGN in IRAS 20551-4250.

Infrared radiative pumping affects rotational excitation at v=0 (comparison of the rate of rotational and vibrational transition)

We need to understand infrared radiative pumping, in addition to collisional excitation, in IRAS 20551-4250 (and probably in other AGNs as well) .



If HCN abundance enhancement is common in AGNs, HCN/HCO+ and HCN/HNC flux ratios after opacity correction will increase in AGNs, even deviating from the ratios of starbursts. Molecular line flux ratio is useful to separate buried AGNs from starbursts in dusty galaxies, because of negligible dust extinction at (sub)millimeter.

Please refer to Imanishi+15 ApJ submitted (accepted soon, hopefully)