Herschel observations of H_2O and OH in Zw049.057

CHALMERS

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Introduction

Many luminous infrared galaxies (LIRGs) host Compact Obscured Nuclei (CONs) where $L_{bol} > 10^9$ $L_\odot$ emerge from inside $d < 100$ pc, dusty (A_v $100 - 1000$ mag) cores. The nature of the nuclear power source is thus hidden from examination using conventional methods like optical and IR lines, the Compton thick shroud may render even X-rays unusable. It is important to determine if it is an accreting black hole or a compact starburst that powers the nuclear activity since this greatly affects our understanding of galaxy evolution. It has been suggested that a large portion of highly obscured Compton thick AGN are missed by X-ray surveys, a problem that may be even worse for low luminosity AGN (e.g. Lusso et al. (2013)).

Furthermore, more than 50% of the star formation at high redshifts may be obscured. Obscured star formation can be linked to the assembly of stellar mass, with deeper potential wells in massive galaxies providing dense, heavily obscured environments resulting in rapid star formation. (e.g. Ibar et al. (2013))

The dust of obscured galaxies may be opaque at all wavelengths. To study their nuclear structure, dynamics and physical conditions we thus need a tracer that can probe deep into the dust shroud. Molecules like H_2O and OH couple very well to the IR-field and can reach high abundances in warm embedded regions, making them ideal probes of physical conditions in dust enshrouded AGN and starburst galaxies.

In the near Universe a small sample of CONs have been identified with deep mid-IR silicate absorption and hot optically thick dust cores (e.g. Aalto et al. (2012); Costagliola & Aalto (2010); Costagliola et al. (2013); González-Alfonso et al. (2010); Sakamoto et al. (2010)). We have used the PACS and SPIRE instruments aboard Herschel to observe H_2O and OH in the CON Zw049.057 which is an OH megamaser with a very rich molecular spectrum and a compact molecular distribution. Its NICMOS image (Fig. 1) reveals a spectacular, narrow dust feature emerging along the minor axis from the obscured nucleus.

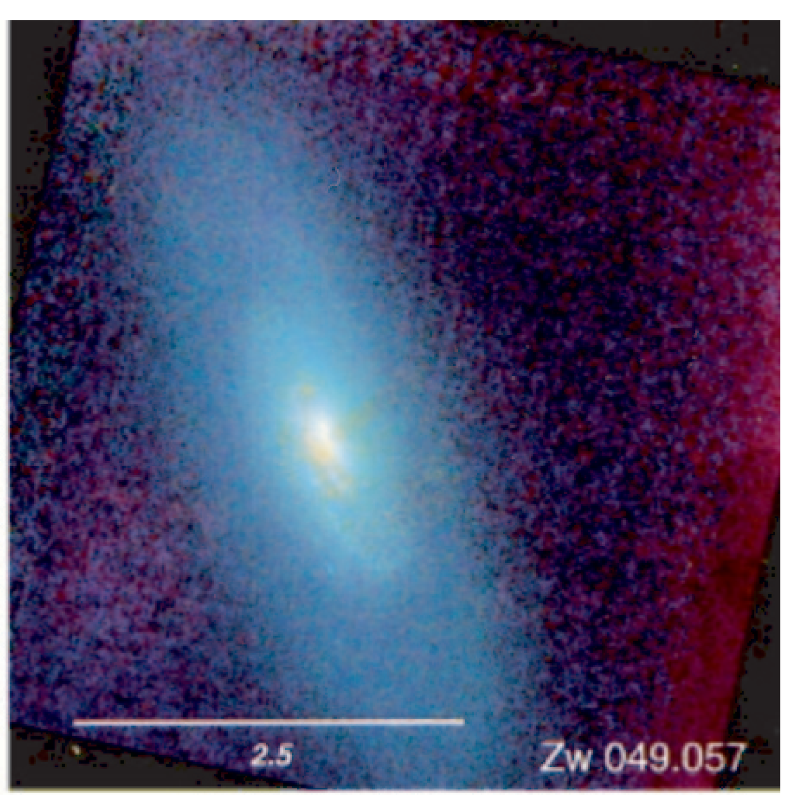

Figure 1: NICMOS image of Zw049.057 from Scoville et al. (2000)

Model and observations

We have used the spherically symmetric radiative transfer code described in González-Alfonso & Cernicharo (1999) to simultaneously model the observed dust continuum and H_2O lines of Zw049.057. The current model contains three components. A compact hot component accounts for most of the high lying lines, this component also exhibits an outlow of 60 km/s to better fit the profiles of these lines. A slightly larger but cooler component is needed to fit the lines with lower energy. Finally, an extended cold component is required to fit the continuum at longer wavelengths. A schematic representation of the model is shown in Fig. 2. A comparison with the observations can be seen in Figs. 3-5. To fit the continuum at shorter wavelengths ($< 20\mu$m), another hot (> 200 K) compact ($\sim$few pc) component would be required.

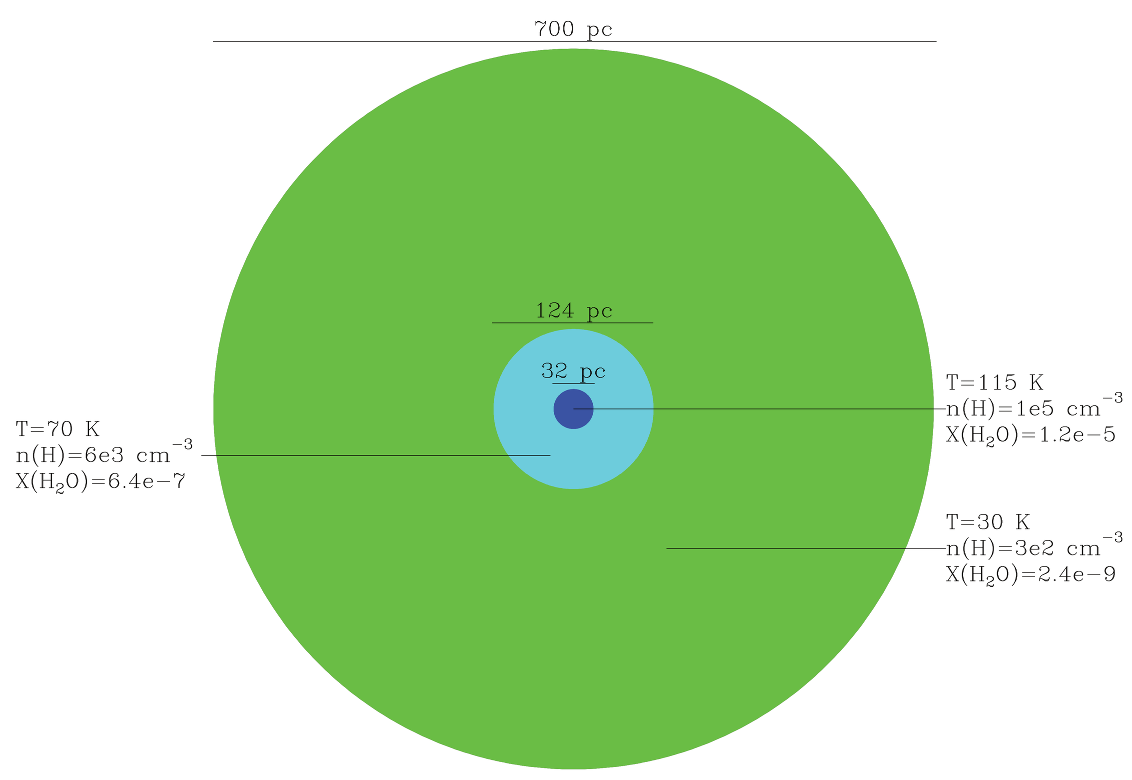

Figure 2: A schematic representation of the current model. The colors of the components are used in the comparison in Figs. 3-5.

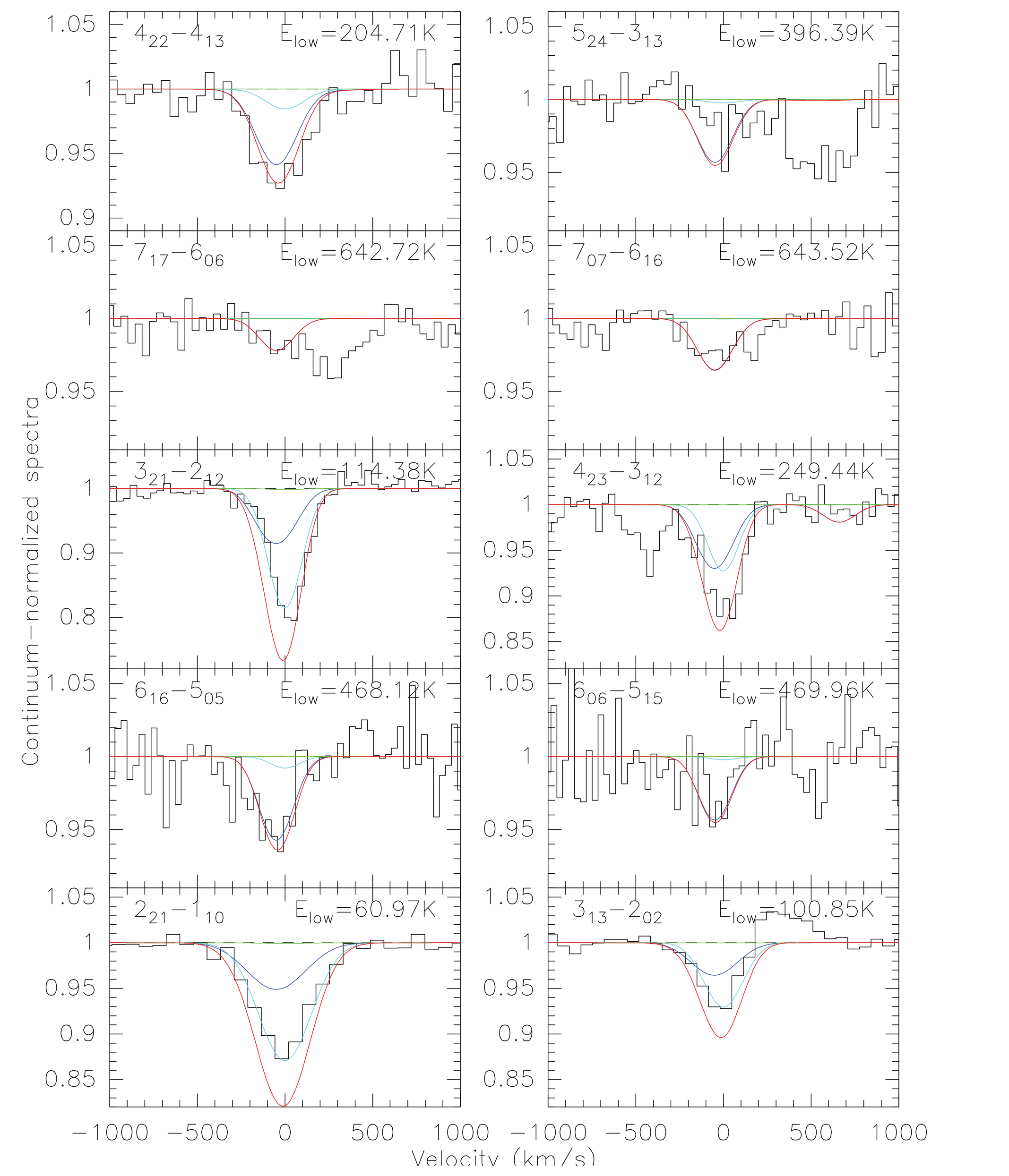

Figure 4: The model in Fig. 2 compared to the line profiles of the absorption lines observed with PACS. So far only the H_2O lines have been modeled.

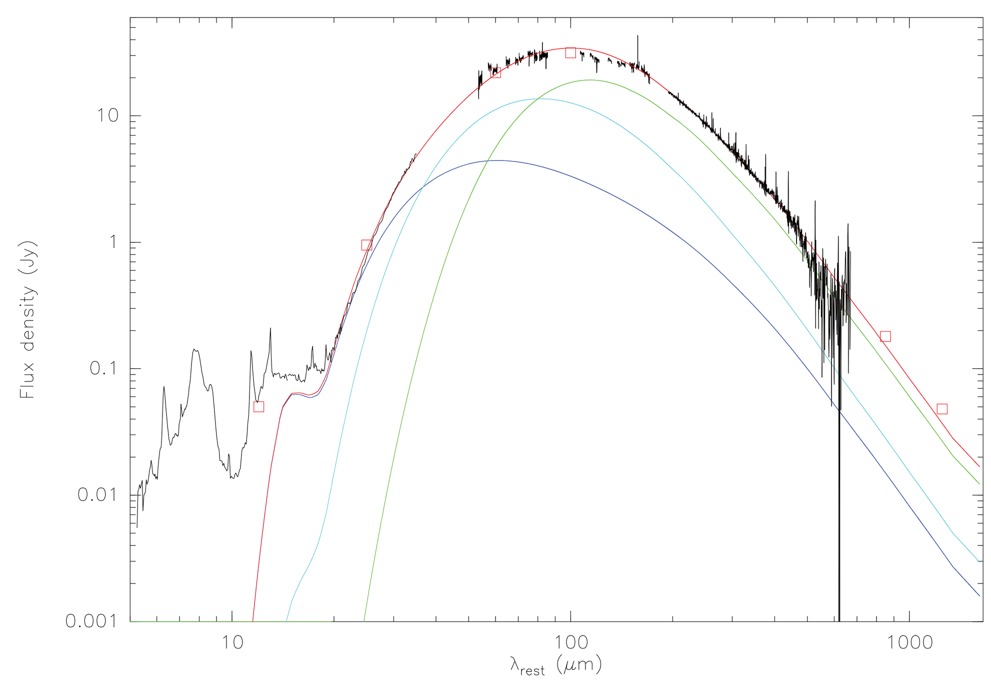

Figure 3: The model in Fig. 2 compared to the SED constructed from both PACS and SPIRE observations.

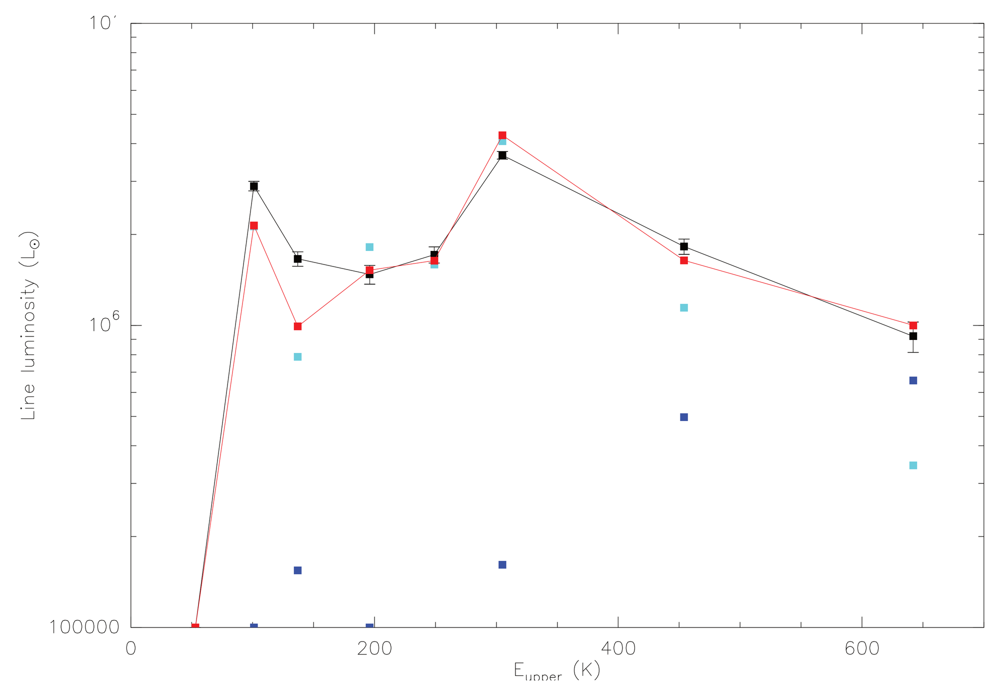

Figure 5: The model in Fig. 2 compared to the line luminosities of the H_2O lines observed with SPIRE.

Conclusions

The H_2O and dust modeling of Zw049.057 suggest (so far):

- Very high abundance of H_2O ($\sim 10^{-5}$, similar to that of the CON galaxy NGC4418 (González-Alfonso et al., 2012)) along with dust temperatures $\sim$ 115 K in the nuclear region, indicative of a hot core chemistry where grain mantles are evaporated
- A dense nuclear outflow that is seen in the high lying lines of H_2O

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