

# Analysis of APEX CO(2-1) emission line observation of a nearby galaxy

Rebecca Nguyen  
(Dated: October 23, 2022)

This abstract is abstract.

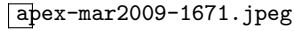
## I. INTRODUCTION

## II. THEORY

### A. Single-dish

The primary mirror is the first optical element of a telescope, encountered by light. The telescope's primary mirror is called a dish in radio/(sub-) mm bands (bands meaning frequency observation windows). Radio/(sub-)mm telescopes are either made with 1) A single dish meaning one single antenna connected to one or several receivers 2)  $N \geq 2$  antennas working as an interferometer. The second option provides a larger collecting area and better spatial resolution. However, single dishes are very optimal for studying very extended, low surface brightness structures and/or for surveys of large areas of the sky [1].

Examples of radio and sub-millimeter single-dish facilities are APEX and LMT. Atacama Pathfinder Experiment, APEX, operates at millimeter and submillimetre wavelengths - between infrared light and radio waves. It is placed at an elevation of 5100 meters in Chile's Atacama region [2]. The Large Millimeter Telescope is situated in Volcán Sierra Negra at an altitude of 4600 meters and is specifically designed to observe in the wavelength range of 0.85 - 4 mm [3].

 apex-mar2009-1671.jpeg

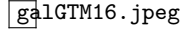
 galGTM16.jpeg

Figure 1. APEX depicted in the image on top [4] and LMT depicted on the bottom [5].

The antenna temperature is equal to the brightness temperature of the source convolved with the normalized beam pattern of the antenna [1].

$$F_\nu \equiv \Gamma F_\nu \rightarrow F_\nu = \Gamma^{-1} F_A^* \quad (1)$$

$$L'_{CO}[K \text{ km}/\text{spc}^2] = (3.25 \cdot 10^7) \frac{D_L^2}{V_{obs}^2 (1+z)^3} \int_{\Delta\nu} S_\nu d\nu \quad (2)$$

$$M_{H_2+He}[M_\odot] = \alpha_{CO} L'_{CO} \quad (3)$$

## III. METHOD

The data obtained from APEX consist of observations from different sources, among other things, the

observation of the molecular line transition CO(2-1) of the galaxy IRAS 13120-5453, a nearby ultraluminous infrared galaxy. The redshift of this galaxy is  $z = 0.0308$ , which corresponds to a luminosity distance of  $D_L = 139.4 \text{ Mpc}$  (using  $H_0 = 67.8 \text{ km/s}$ ,  $\Omega_M = 0.307$ ,  $\Omega_\Lambda = 0.693$  and  $k = 0$ , i.e. flat geometry) [6].

### A. Curve fit by Gaussian profile

Our goal is to analyze the CO(2-1) emission line. As emission lines closely resemble a Gaussian curve, it is, therefore, an interest to curve fit a Gaussian profile to the emission line.

$$g(x, \mathbf{P}) = ae^{-\frac{(x-b)^2}{2c^2}} + d; \quad \mathbf{P} = (a, b, c, d) \quad (4)$$

The purpose of the fitting is to optimize the parameters in  $\mathbf{P}$  based on the data. The parameters are as follows  
a: the amplitude of the Gaussian. The difference in the minimum value of your spectral line and the minimum.

b: the mean of the gaussian. The position of the peak on the x-axis.

c: width of the Gaussian.

d. y-value of the baseline. The maximum value of the spectrum

## IV. RESULTS



Figure 2: Caption

## V. DISCUSSION

## VI. CONCLUSION

## ACKNOWLEDGMENTS

I would like to thank myself for writing this beautiful document.

**Appendix A: Name of appendix**

This will be the body of the appendix.

**Appendix B: This is another appendix**

Tada.

## Appendix C: References

---

- [1] Cicone, C. (2022, October 21). AST2210 Lecture 6: Sub-millimeter/radio observations (single-dish). [\[PDF\]](#).
- [2] (-). APEX Reaching new heights in submillimetre astronomy. ESO.[\[Website\]](#). [\[website\]](#)
- [3] (-). Large Millimeter Telescope. Large Millimeter Telescope. [\[Website\]](#)
- [4] (2009). APEX antenna [\[Photograph\]](#). [\[Photograph\]](#)
- [5] (-). Large Millimeter Telescope or LMT. [\[Photograph\]](#)
- [6] Arroyave, I. M. (2022, October 21). Analysis of APEX CO(2-1) emission line observation of a nearby galaxy. [\[PDF\]](#).