# Moment Maps of Galaxy Datacubes from SÍGAME

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## Abstract

- **Simulator of Galaxy Millimeter/submillimeter Emission (SÍGAME) is a python based module that derives far-infrared (FIR) emissions for simulated galaxies.**
- **Using the outputs from SÍGAME, we present a method to create moment0 maps of these simulated galaxies.**
- **These maps can be then used to create line ratio maps that provides useful information on the physics of the galaxies.**
- **The same algorithm can be extended to create spectral cubes which are useful to create higher order moment maps and line profiles of the galaxies.**

## Introduction

- **The output from SÍGAME is a 3D datacube that is made up of smaller cells of various sizes that contains information on line luminosities in that region.**
- **To create moment0 maps, the line luminosities from each of these cells needs to be projected on a 2D map.**

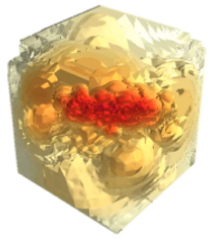


**Figure 1. Depiction of output galaxy datacube from SÍGAME. Credits: Dr. Karen Olsen.**

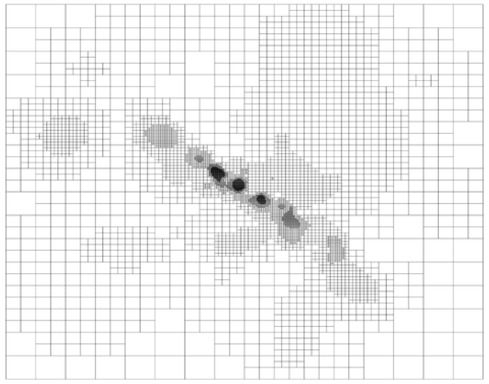


**Figure 2. A 2D depiction of cells in the galaxy datacube. Credits: Dr. Karen Olsen.**

## Algorithm

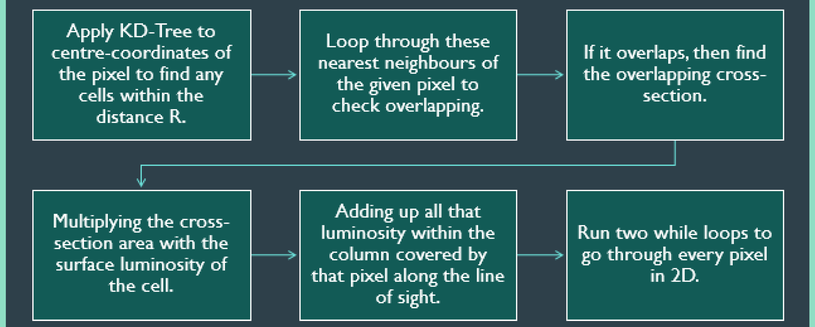
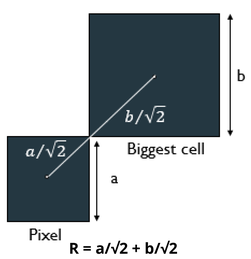



**Figure 3. Algorithm used to create moment0 maps from the galaxy datacubes.**

- **Take a pixel of the final 2D moment0 map separately.**
- **Find all the cells within a distance R of the center of the pixel using KD-Tree (finds everything within R).**
- **Set the distance to be the maximum distance between center of any touching cell and center of the pixel.**
- **Loop through all these nearest neighbor cells to check for overlapping.**
- **If it overlaps, then find the cross-section area of overlapping region.**
- **Multiply this this cross-section area with surface luminosity of the cell.**
- **Add up all these luminosity within that pixel.**
- **Repeat this process for all the pixels using loops.**




**R = a/√2 + b/√2**

**Figure 4. Depiction used to find the distance R.**

Cell and pixel overlaps if and only if:

$$start2 - end1 < 0$$

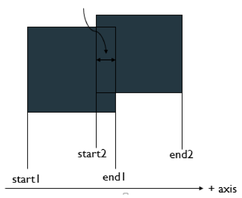



**Figure 5. Depiction used to find overlap between cell and pixel.**

$$a = end1 - start2$$

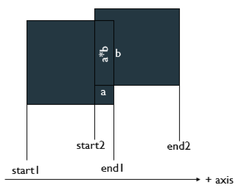



**Figure 6. Depiction used to find the cross-section area of overlap between cell and pixel.**

## Results

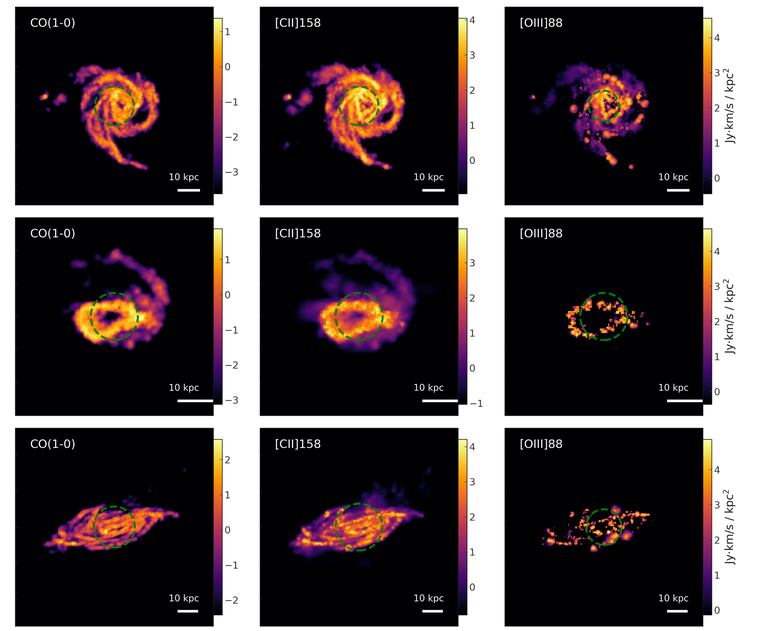



**Figure 7. Moment0 maps of three galaxies for three different emmission lines investigated.**

## Further Developments

- **Line ratio maps by taking the ratios of the pixel luminosities of moment0 maps of different line emissions.**
- **Spectral cubes by extending the algorithm to collect information in 3D velocity bins instead of 2D pixels.**

## Conclusion & Reference

- **Line ratio maps are direct indicator of various physics of the interstellar medium of the galaxy.**
- **By matching these results with observations, we can achieve an understanding of galaxy creation and galaxy evolution.**

**Olsen, K. P., et al. with Motka, J. 2021, ApJ, 922, 88, doi: 10.3847/1538-4357/ac20d4.**