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.**
- **We present a method to create moment0 maps of these simulated galaxies outputted by SÍGAME.**
- **These maps can then be used to create line ratio maps that provide useful information on the physics of the simulated 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 contain information on line luminosities in the region.**
- **To create moment0 maps, the line luminosities from each of these cells needs to be projected on a 2D map.**

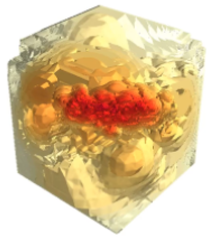

Figure 1. Depiction of an outputted galaxy datacube from SÍGAME. Credits: Dr. Karen Olsen.

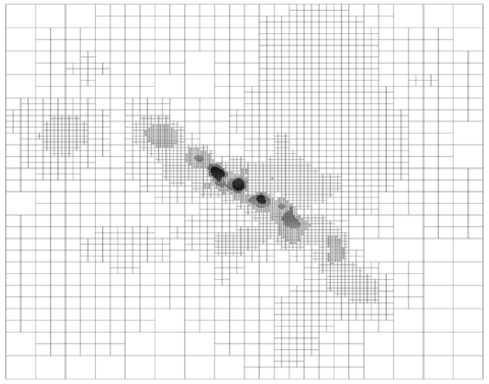

Figure 2. 2D depiction of the cells in the galaxy datacube. Credits: Dr. Karen Olsen.

Algorithm

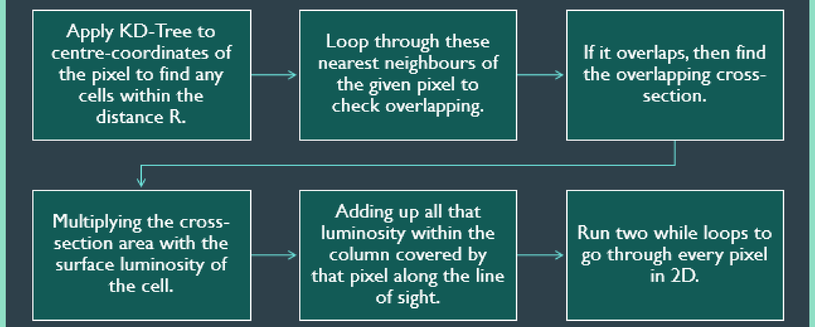

Figure 3. Algorithm used to create moment0 maps from the galaxy datacubes.

- **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 cross-section area with surface luminosity of the cell.**
- **Add up all these luminosities within that pixel.**
- **Repeat this process for all the pixels using loops.**

Figure 4. Depiction used to find the distance R.

Cell and pixel overlaps if and only if:

$$start2 - end1 < 0$$

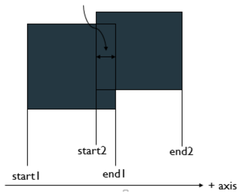

Figure 5. Depiction used to find the overlap between a cell and a pixel.

$$a = end1 - start2$$

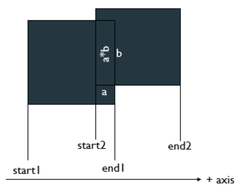

Figure 6. Depiction used to find the cross-section area of the overlap between the cell and the pixel.

Results

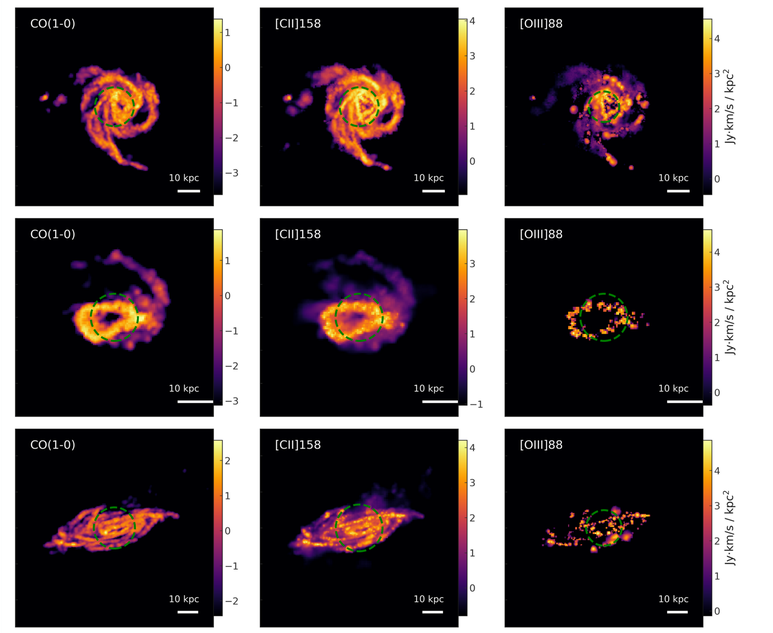

Figure 7. Moment0 maps of three galaxies for three different emmission lines investigated.

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., Burkhart, B., Mac Low, M.-M., et al. 2021, ApJ, 922, 88

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