What is beyond the Sky?

Filament Identification using Image Processing in 3D data cubes

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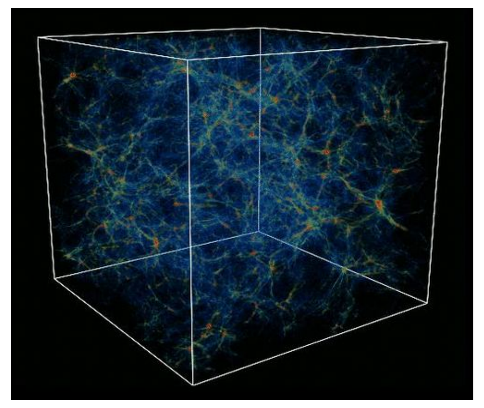
ABSTRACT

We developed a new algorithm for detecting filamentary structure using Image processing in Three Dimensions. The algorithm uses the technique of mathematical morphology for filament identification, presenting a complementary approach to current algorithms which use matched filtering or critical manifolds.

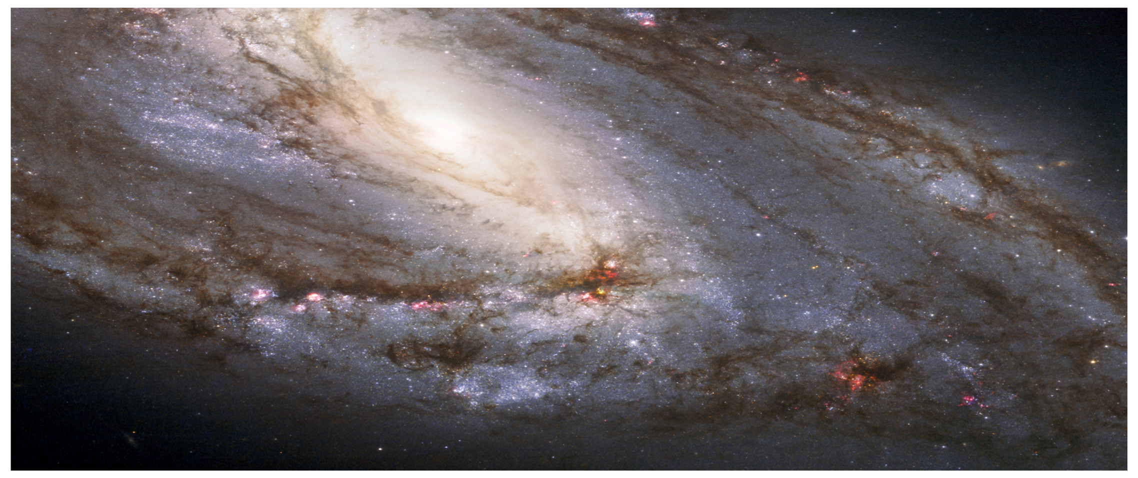


We have a basis in 2D images (Eric W. Koch and Erik W. Rosolowsky. **Filament identification through mathematical morphology)** that we want to extend in 3D

INTRODUCTION

Why to astronomer care?

These "filaments" are the structures in gas that form stars, so we are developing tools to identify and characterize them. We have new 3D data sets of star forming gas and we need a new filament algorithm that works in 3D



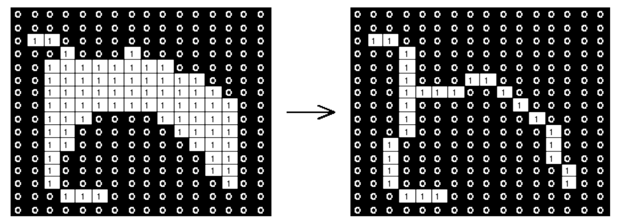
The key point is that the third dimension of our data is velocity derived from the Doppler effect.

Mathematic Morphology

Mathematical morphology (MM) is a theory and technique for the analysis and processing of geometrical structures, based on set theory, lattice theory, topology, and random functions.

Thinning

Thinning is a process of extracting a skeleton from an object in a digital image



Skeleton

In digital image processing, morphological skeleton is a skeleton (or medial axis) representation of a shape or binary image, computed by means of morphological operators.

Algorithms are implemented as Python code.

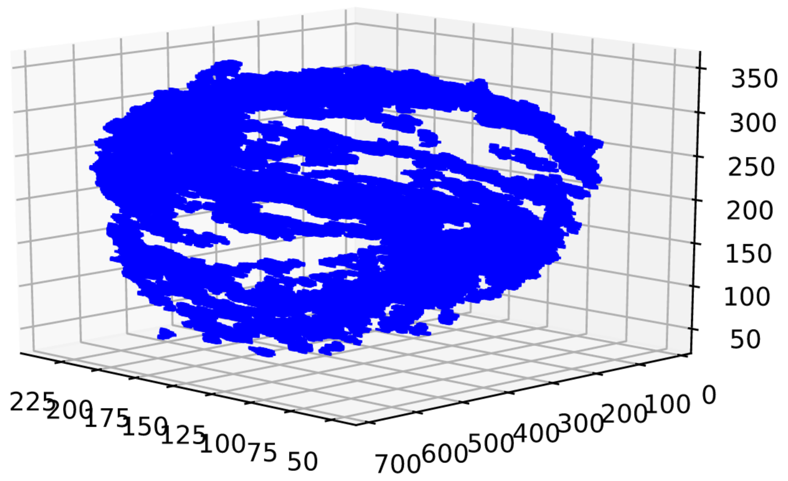
SKELETONIZATION

The Algorithm uses the following steps:

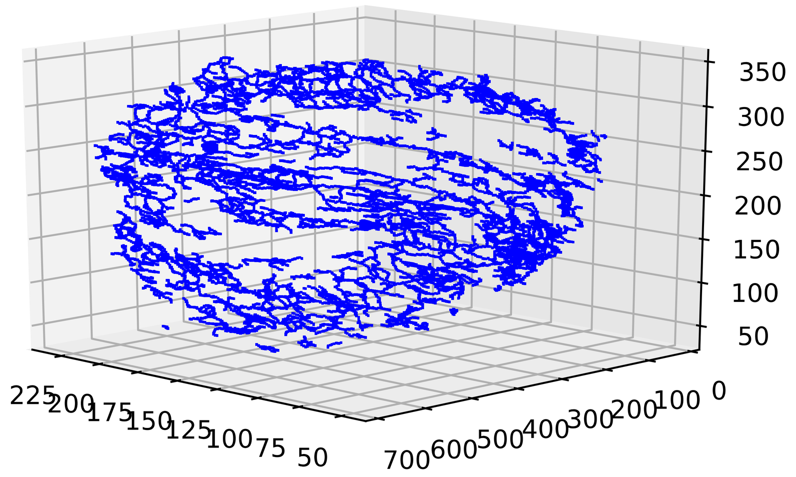
1. Skeletonization:

Skeletonization is performed on the original image for reducing foreground regions in a binary image to a skeletal remnant that largely preserves the extent and connectivity of the original region while throwing away most of the original foreground pixels.

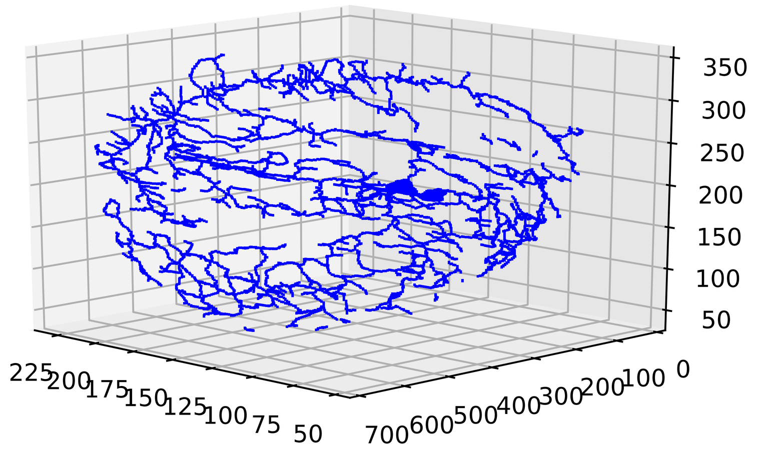
To obtain a better-skeletonized image the original image is first treated with the morphological operations that are "Closing" followed by "Dilation" operation.



Original Image



Skeletonization without preprocessing



Skeletonization with preprocessing

GRAPH REPRESENTATION

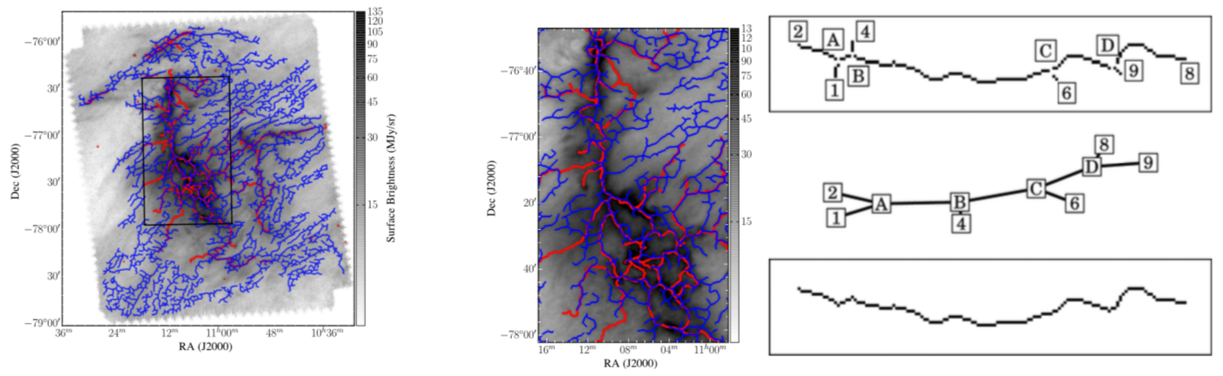
2. Skeleton analysis with Skan:

The obtained Skeleton is converted into graph structure using Skan Library for python which gives the following details-

Pixel graph that is a SciPy CSR matrix in which entry (i,j) is 0 if pixels i and j are not connected, and otherwise is equal to the distance between pixels i and j in the skeleton

Coordinates (in pixel units) of the points in the pixel graph.

Degrees is an image of the skeleton, with each skeleton pixel containing the number of neighboring pixels.



Why Graphs?

Graph structure allows us to prune off short branches and characterize the length of the filament effectively. They act as efficient data structure to obtain our results.

Mapping Graph to Skeleton

The obtained graph is mapped over the skeletonized image of the filaments, which makes it easy to complete the further tasks as described in next section.

FURTHER ACCOMPLISHMENT

- Labeled image of all pixels associated with each filament.
- Identified location of the ridge line.
- Length of each filament over Velocity and Spatial Direction.
- Pruning of branches of Filament based on Parameter.

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