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Hunting for Isolated Warm Gas Clouds in the Virgo Cluster of Galaxies

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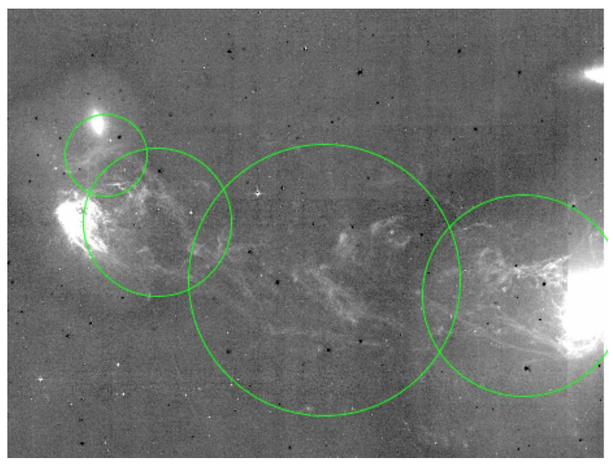
Overview

This project seeks to identify intergalactic ionized gas clouds as a component of galaxy evolution. Warm gas can be pulled away from a galaxy as it travels through the intergalactic medium, classified as ram pressure stripping, which can slow or even halt new star formation. While ram pressure stripping on galaxies has been well studied, little research has been done on individual clouds that exist in between galaxies. Thus, this project will search for isolated clouds of gas far from galaxies, then construct a sample from which to build further research.

NGC 4438 and M86; credit: Mark Hanson, Stan. Wilson Observatory



NGC 4438 and M86 Hα gas

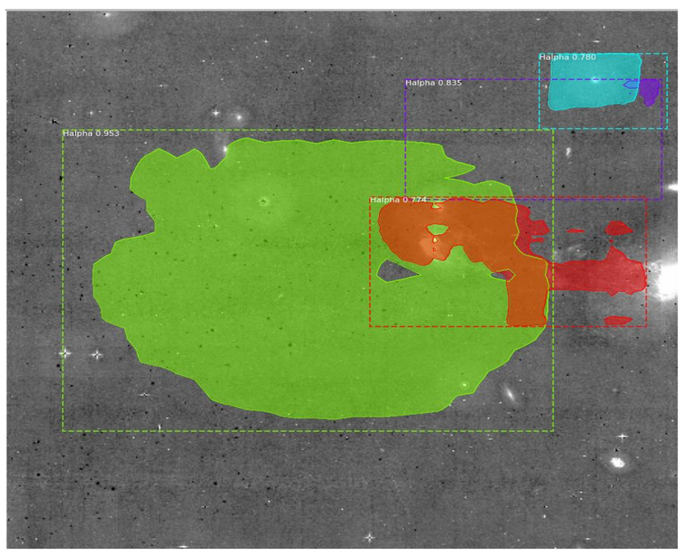
Key Findings

From the VESTIGE data images, an initial sample size of 16 gas clouds were selected based on visual gas stream patterns attributes. This sample set was modified to develop a larger training dataset for the object detection CNN. The CNN used 45 training images and 15 validation images, which were trained for 20 epochs at a learning rate of 0.002 and then for 10 epochs at a learning rate of 0.0002.
From the initial sample, 4 gas clouds can be classified as isolated clouds. These isolated clouds are located on the fringe of the Virgo cluster, far from the main cluster of galaxies in Markarian's Chain.

Methodology

The Virgo cluster was selected as the region of space for study: as it hosts more than a thousand galaxies, we expect a higher concentration of ionized gas sampling. These ionized gas clouds cannot be seen in the visible spectrum, so we analyze images using the narrow-band emission of H-alpha. We obtained 60 data images from VESTIGE (A Virgo Environmental Survey Tracing Ionised Gas Emission), conducted by the Canada-France-Hawaii Telescope (CFHT). Isolated clouds can be harder to analyze by sight, so the project integrated machine learning to advance the identification process. An object detection Python script was developed utilizing a CNN (Convolutional Neural Network), which has the highest accuracy amongst algorithms to predict images.

Conclusions



NGC 4438 and M86 CNN gas detections

The CNN sufficiently predicted H-alpha instances, but was limited to previously identified galactic sources. It is recommended to increase the dataset size to improve the object detection script. A standard object detection CNN uses up to thousands of images as a training dataset, thus the small dataset used may be insufficient.

Acknowledgements

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