The Study of the Relationship Between the Active Galactic Nuclei and Star Formation in Face-On Galaxies Within the MaNGA Survey

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Abstract: This study investigated the regions surrounding the Active Galactic Nuclei (AGN). Analysis and classification utilising Integral Field Unit (IFU) Spectroscopy data [6] from Data Release 17 (DR17) of the Mapping Nearby Galaxies at Apache Point Observatory (MaNGA) survey [1]. The regions of the AGN were classified as either AGN-like, HII-region-like/Star Formation-like (SF-like), or Composite. These results indicated the areas where both components influenced star formation. It examined the influence of AGN outflows to the star formation activities.

Introduction: The MaNGA survey provides a comprehensive framework for studying the detailed properties of nearby galaxies through IFU spectroscopy. By employing Gaussian modeling to analyze spectral emission lines, the survey enables precise classification of galactic regions based on their star-forming activities and AGN contributions. Furthermore, this research contributes to a deeper understanding of AGN-driven outflows and their impact on galactic environments [3].

Data Collection: The selection criteria were galaxies with AGN at their centers and non-AGN galaxies below redshift of 0.035, with the log of stellar mass ranging 9 to 11, and inclination angles less than 30 degrees to minimize obscuration effects. Flux density and wavelength relationship of spectral lines in the Hα and Hβ regions were visualized with Gaussian distribution function. Flux for the narrow and broad Hα and Hβ, [NII], and [OIII] were then performed by the determination of area under the Gaussian distribution curves [4]. Baldwin, Phillips & Terlevich (BPT) Diagrams [2] were generated as the following step incorporated with BPT maps shown in Figure 1. Star formation rate (SFR) map (Figure 1) of the galaxy has been generated to compare the star formation between galaxies with AGN and galaxies with normal star formation. The equation for SFR was as follows: $SFR\left(M_{\odot}\cdot yr^{-1}\right)=7.9\times10^{-42}L\,(H\alpha)(erg\cdot s^{-1})$ where SFR represented the star formation rate in solar mass per year, and $L\,(H\alpha)$ represented the luminosity of the hydrogen alpha spectral line [5]. Central wavelength values and standard deviations of the emission lines of various gases obtained from the Gaussian distribution function were used as input parameters for gas dispersion velocity in the region around the galaxy's nucleus (Figure 2). Gas dispersion velocity was determined with the following equation: $v_{dispersion}=\frac{2\sqrt{\ln(2)}\,\sigma}{\lambda_{cen}}\cdot c$ where $v_{dispersion}$ represented the gas dispersion velocity, σ represented the standard deviation obtained from the Gaussian distribution function, λ_{cen} represented the wavelength at centroid of the emission line, and c represented speed of light in vacuum.

Results and Discussions: The study revealed that galaxies hosting AGN exhibit reduced star formation rates compared to non-AGN galaxies, attributed to AGN-driven outflows disrupting the cold gas reservoir essential for star formation [3]. Gas velocity dispersion maps demonstrated elevated central velocity dispersion in AGN galaxies in contrast to non-AGN systems. BPT analysis also indicated enhancement of ionized hydrogen-dominated areas in AGN-dominated regions.

Conclusion: This emphasized the role of AGN in suppressing star formation in galaxies. AGN outflows destroyed cold gas needed for star formation, leading to the disrupt overall activity. This resulted in star formation becoming concentrated in specific regions rather than being uniformly distributed across the galaxy. This event highlighted the complex interactions between AGN and their host galaxies, and how the star formation was regulated.

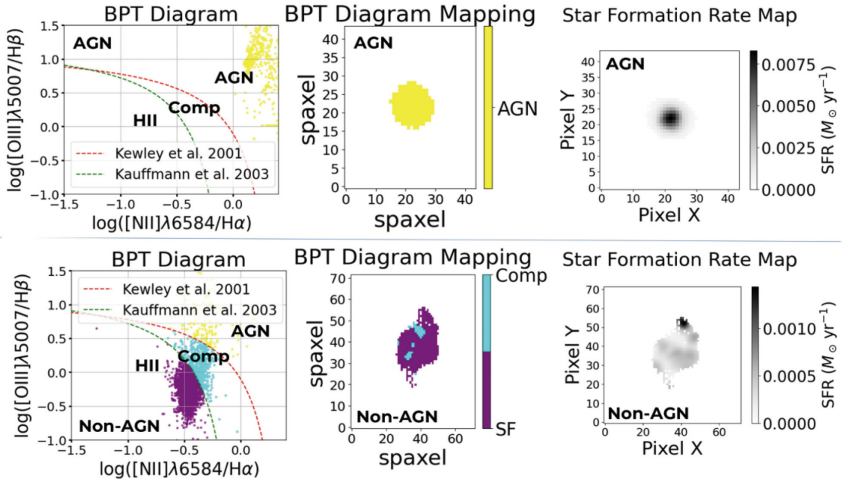

Figure 1: BPT Diagram (left), BPT map (center), and star formation rate (SFR) map (right) for AGN hosting galaxy (top) and non-AGN-hosting galaxy (bottom), respectively.

References:

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