A Census of Star Formation and Active Galactic Nuclei Populations in Abell 1689

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Summary

We present the reduction and analysis of near-infrared (NIR) spectroscopic data of 24 galaxies in cluster Abell 1689. We find that objects identified as active galactic nuclei (AGN) by the shape of their mid-infrared spectral energy distribution are generally also identified as AGN by the emission line flux ratio [FeII]/Paβ.

Motivation

A recent multi-wavelength study of galaxy properties, AGN demographics, and cluster environment (hereafter A11) identified two largely disjoint populations of AGNs in low-*z* clusters: X-ray AGNs, selected by their X-ray luminosity, and IR AGNs, selected by the properties of their mid-infrared spectral energy distribution [1].

The main goals of this project are: 1) to confirm that their IR AGNs are generally powered by AGN activity and not dust heating, and 2) to provide a check on the SFR measurements reported in A11 by using cluster Abell 1689 as a case study. Combined with data in the literature on radial distributions within the cluster, AGN accretion rates, and other properties, our results will contribute to our understanding of the impact of environment on galaxy evolution and may inform future AGN surveys.

Sample

Multi-object spectroscopic (MOS) data of 26 galaxies in A1689 were obtained by David Atlee between May 2010 and June 2011 using the LUCI instrument on the Large Binocular Telescope, using the 200 *H*+*K* grating. Spectra for sources and for standard stars, used to flux calibrate the data, were obtained using four LUCI-MOS masks. Two sources were too faint to be detected in their slits after initial reduction, leaving 24 galaxies with *H* and *K* band spectroscopic data.

Reductions and Methods

Dark frames and flat-field frames could not be retrieved from the LUCI archive for all masks; these corrections were applied when possible. Individual target spectra showed significant residual OH lines after sky-subtraction and underwent bad pixel masking to mitigate their effects.

Telluric absorption correction was performed with the TelFit software [2]. After correcting stellar spectra for absorption and the wavelength response of the detector, the transmission profiles put out by TelFit were used to flux calibrate source spectra. This was done in a piecewise manner to account for some sources whose spectra fell outside of the wavelength range covered by their proper profile.

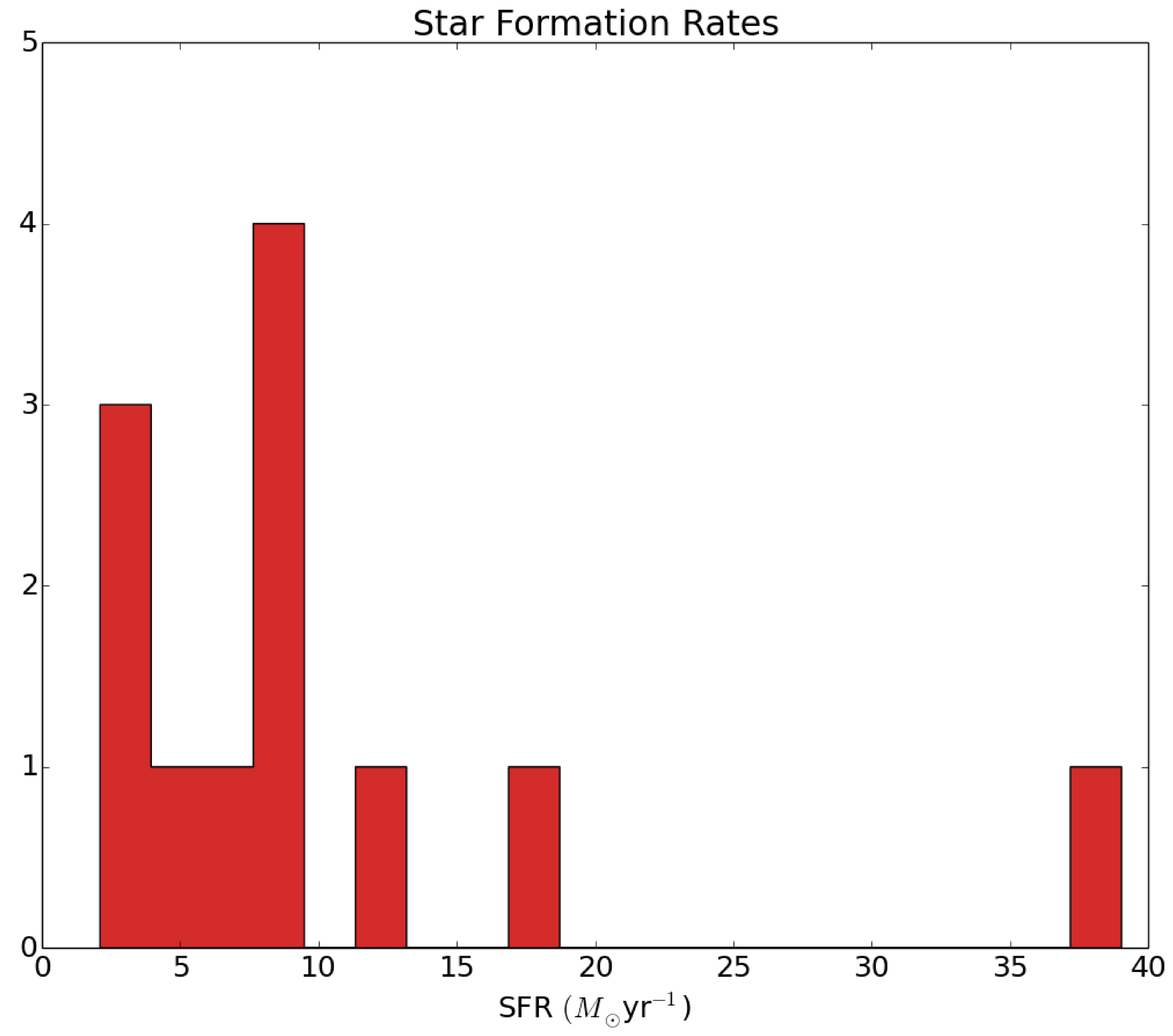
Using the luminosity of the Paschen alpha emission line *L*(Paα) as a proxy for the luminosity of Hα, SFRs were calculated using the relation given in Kennicutt, 1998 shown below [3,4]. AGN were identified by the value of the emission line ratio [FeII]/Paβ, where values less than 0.6 are characteristic of starburst galaxies, values greater than 2 are characteristic of LINERS, and intermediate values indicate Seyferts and other AGN [5].

$$\mathrm{SFR}\ (\mathrm{M_{sol}} \cdot \mathrm{yr}^{-1}) = 7.9 \times 10^{-42}\, L(\mathrm{H}\alpha)\ (\mathrm{erg} \cdot \mathrm{s}^{-1})$$

From Kennicutt, 1998.

Results

R.A.	Decl.	z	[FeII]/Paβ	SFR ($M_\odot$ yr^{-1})	Match in A11?	A11 SFR ($M_\odot$ yr^{-1})
13:11:35.61	-01:20:13.5	0.2003	0.897	9.03	Yes	< 1.00
13:11:34.13	-01:22:35.0	0.2100	1.360	-	Yes	< 24,400
13:11:29.98	-01:17:42.7	0.1830	0.764	2.98	Yes	2.40
13:11:39.78	-01:17:49.6	0.1977	1.989	4.57	No	-
13:11:28.24	-01:19:59.7	0.1760	< 1.846	6.00	No	-
13:11:45.25	-01:23:38.0	0.1868	0.848	-	Yes	< 1.13
13:11:49.21	-01:22:31.9	0.2140	1.597	11.81	Yes	< 1.10



Left: List of all sources identified as AGNs. *Right*: SFR distribution for galaxies with detectable Pa-α emission. Spectra for the remaining 12 galaxies were too noisy to discern Paα emission or were cut off shortward of 18750 Å due to malalignment of the slits.

Discussion

With the exception of two likely misclassifications, every galaxy identified as hosting an AGN in this project also has a counterpart in A11. However, A11 reports some objects in our sample as AGNs that we do not. This may be due to noise in our spectra, leading to misclassification, or be an instance of contamination in the A11 sample.

Future work includes comparing SFRs in non-AGN-hosting galaxies, more rigorous error analysis, and searching for evidence of AGN accretion or correlation with radial distance from the cluster center.

References

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